# FINAL RESTORATION PLAN

## HEATH DAIRY ROAD RESTORATION SITE
### RANDOLPH COUNTY, NORTH CAROLINA



Prepared for:

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## EXECUTIVE SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) plans to restore a degraded reach of Back Creek, several unnamed tributaries, and enhance and preserve associated floodplain wetlands located in Randolph County, North Carolina. The Heath Dairy Road Restoration Site (the Site) encompasses approximately 7,384 linear feet of degraded channels.

### *General Site Conditions*

The Heath Dairy Road Restoration Site is located approximately five miles northwest of Asheboro, NC in Randolph County. The Site is located within the Yadkin River Basin in Hydrologic Unit Code (HUC) 03040103050050. This HUC is identified as a Targeted Local Watershed (TLW) in EEP's 2003 and 2009 Yadkin River Basin Restoration Priority (RBRP) Plan (http://www.nceep.net/services/lwps/pull_down/by_basin/Yadkin_RB.html).

Historic land use of the site has consisted primarily of agriculture and livestock grazing. The streams within the project area are 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.

### *Restoration Concept*

The majority of the stream reaches on the Site are designed as a Type B4c streams. These channel configurations provide the most stable and natural form for these slightly entrenched channels flowing through moderately sloped colluvial valleys. Along the lower portion of Back Creek where the topography opens into a broad flat alluvial floodplain the channel is designed as a Type E4 stream. The proposed channel dimensions, patterns, and profiles are based on hydraulic relationships and morphologic dimensionless ratios of the reference reaches.

The installation of brush, rock, and wood structures will be utilized throughout the restored reaches of the Site. Brush toe structures will be installed along the channel toes to provide roughness and bank stability on outer meander bends. Rock cross vanes will be used for grade control to prevent headcut formation. Log vanes with rootwads will be installed in meander bends to direct the flow away from the outside of the bend and provide toe and bank protection. On-site material including brush, boulders, logs, and bed material will be used to the maximum extent possible and in-stream structures will be designed to improve aquatic habitat.

Wetland restoration and enhancement activities are proposed for the existing disturbed wetland areas and will include soil restoration, limited grading, and planting of wetland vegetation. There are two minor unavoidable impacts to existing wetland areas resulting from restoration activities that total approximately 0.011 acres.

### *Goals and Objectives*

Restoration goals identified in the 2009 Yadkin Pee Dee RBRP Plan include protection of wildlife resources, improved management of stormwater runoff, and mitigation of impacts resulting from urbanization in the area. Within the Back Creek watershed, 26% of streams are

lacking riparian buffer. The following goals are established to guide the restoration process for the project:

- Improve local water quality within the restored channel reaches as well as the downstream watercourses through:
    a. the reduction of current channel and off-site sediment loads by restoring appropriately sized channels with stable beds and banks,
    b. the reduction of nutrient loads from adjacent agricultural fields by restoring the riparian buffer, and
    c. the reduction of water temperatures provided through shading of the channel by canopy species along with the resultant increase in oxygen content.
- Improve local aquatic and terrestrial habitat and diversity within the restored channels and their vicinity through:
    a. the restoration of appropriate bed form to provide habitat for fish, amphibian, and benthic species,
    b. the enhancement of riparian wetlands along the stream corridor to provide additional landscape and habitat diversity,
    c. the restoration of a suitable riparian buffer corridor in order to provide both vertical and horizontal structure and connectivity with adjacent upland areas, and
    d. the restoration of understory and canopy species in order to provide forage, cover, and nesting for a variety of mammals, reptiles, and avian species.
- Preclude the construction of additional infrastructure and the combination of agricultural practices including cattle grazing and the application of pesticides and fertilizer within the riparian buffer area by providing a permanent conservation easement.

See Figure 4b for the proposed site configuration. The projects measurable objectives are:

- Restore natural stable channel morphology and proper sediment transport capacity;
- Create and/or improve bed form diversity and improve aquatic and benthic macroinvertabrate habitat;
- Construct a floodplain (or local bankfull bench) that is accessible at the proposed bankfull channel elevation;
- Improve channel and stream bank stabilization by integrating in-stream structures and native bank vegetation;
- Restore 7,781 linear feet of stream through Priority I and II restoration from the existing 6,748 linear feet of stream;
- Enhance 960 linear feet of stream from the existing 960 linear feet of stream;
- Preserve 636 linear feet of stream;
- Enhance 0.6 acres of wetlands from the existing 0.6 acres of wetlands (all are riparian non-riverine wetlands);
- Preserve 1.18 acres of wetlands (all are riparian non-riverine wetlands, except Wetland J which is a riparian riverine wetland consisting of 0.090 acres of preservation); and,
- Restore approximately 30 acres of riparian buffer by establishing a native forested and herbaceous riparian buffer plant community.

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# 1.0 PROJECT SITE IDENTIFICATION AND LOCATION

The Heath Dairy Road Restoration Site is located in Randolph County, North Carolina, northwest of Asheboro and southwest of Randleman (Figure 1).

## 1.1 Directions to Project Site

To reach the site from Asheboro, take US-220 north for approximately five miles. Exit onto Pineview Road and proceed west for approximately one mile; turn right onto Heath Dairy Road and proceed approximately a quarter of a mile to the bridge crossing over Back Creek.

## 1.2 USGS Hydrologic Unit Code and NCDWQ River Basin Designation

The site is located in the Back Creek watershed of the Yadkin-Pee Dee River Basin, United States Geological Survey (USGS) Hydrologic Unit Code 03040103050050, within the North Carolina Division of Water Quality (NCDWQ) sub-basin 03-07-09. Back Creek drains into the Back Creek (Lucas) Lake and then into the Uwharrie River approximately eleven miles downstream of the site. The Uwharrie River in turn drains into the Yadkin-Pee Dee River.

# 2.0 WATERSHED CHARACTERIZATION

The site is located in a rural watershed within the Piedmont hydrophysiographic region of North Carolina (Figure 2). The site watershed is characteristic of the Piedmont region with moderate rainfall and moderately steep valley walls. Annual precipitation within Randolph County averages 45.6 inches (SERCC, 2006) and elevations within the project site range from 586 feet to 678 feet (NGVD 29). The site encompasses 8,344 linear feet of stream including a 5,018 linear feet reach of Back Creek, and four tributaries named for the purposes of this project as West Branch, UT to West Branch, North Branch, and East Branch. There are also nine existing floodplain wetlands within the project limits (Figure 4a). See Table I for total linear footage of streams by reach and total acres of wetlands. While the restored length of certain reaches is less than the existing length, the overall length will increase after proposed restoration is completed. Photographs of the site are included in Appendix A.

EEP develops River Basin Restoration Priorities (RBRPs) to guide its restoration activities within each of the state's 54 cataloging units (CUs). RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream, and riparian buffer restoration. These watersheds are called Targeted Local Watersheds (TLWs) and receive priority for EEP planning and restoration project funds. The 2003 and 2009 Yadkin River Basin RBRP identified HUC 03040103050050, which includes the Heath Dairy Road Restoration Site, as a TLW. The watershed is characterized by 16% agricultural area with 26% of its streams lacking riparian buffer. Restoration goals for the watershed include protection of wildlife resources, improved management of stormwater runoff, and mitigation of impacts resulting from urbanization in the area. The Heath Dairy Road Restoration Site will improve local water quality, increase bank stability, reduce erosion, and reduce nutrient loading by establishing a riparian buffer, eliminating cattle access to the stream, constructing floodplain benches, and integrating in-stream structures.

## 2.1 Drainage Area

The drainage area of Back Creek is 0.94 square miles ($mi^2$) at the upstream end of the site and 2.69 $mi^2$ at the downstream end. At their respective confluences with Back Creek, the drainage areas of the tributaries are: West Branch, 0.14 $mi^2$; North Branch, 1.14 $mi^2$; and East Branch, 0.25 $mi^2$. The drainage area of UT to West Branch at its confluence with West Branch is 0.05 $mi^2$. See Table IV for a complete listing of the drainage areas by stream reach.

## 2.2 Surface Water Classification / Water Quality

Back Creek is classified as Water Supply II (WS-II) waters (DWQ, 2006), which are waters used as sources of potable water where a WS-I classification is not feasible. WS-II waters are generally in *predominantly undeveloped* watersheds and only general permits for discharges are allowed. All WS-II waters have a supplemental classification of High Quality Waters (HQW) by definition, and are also protected for Class C uses including secondary recreation, fishing, wildlife, fish and aquatic life propagation and survival, and agriculture. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner.

On-site stream reaches ultimately discharge into Back Creek Lake (also called Lucas Lake), the primary water supply for the City of Asheboro, approximately 3 miles downstream of the site. Back Creek Lake has been designated as eutrophic since first monitored in 1989 (DWQ, 2002) which is exacerbated by activities in the watershed such as the use of fertilizers on agricultural fields and the effluent of animal and human wastes. Additionally, two algal blooms were documented in Back Creek Lake in 1999, and public complaints regarding bad taste of drinking water were reported by the Director of Water Resources for the City of Asheboro in 1999.

## 2.3 Physiography, Geology, and Soils

The site is located in the Carolina Slate Belt Piedmont ecoregion of North Carolina. This ecoregion consists of dissected, irregular plains, some hills, linear ridges, and isolated monadnocks. The region contains low to moderate gradient streams with mostly boulder and cobble substrates. Felsic metavolcanic rocks, including metamorphosed dacitic to rhyolitic flows and tuffs interbedded with mafic and intermediate volcanic rock, meta-argillite, and metamudstone, underlie this area of the state.

The valleys throughout the site are moderately sloped colluvial valleys with cross-slopes ranging from 6% to 20% and longitudinal slopes typically ranging from 0.3% to 1.0%. Throughout the site well developed colluvial wash-slopes or valley toe-slopes are evident with slopes ranging from 1% to 5%. West Branch displays a somewhat narrower and steeper valley than other portions of the site. The lower reach of Back Creek opens into a broad alluvial floodplain that is distinctive within the site and probably a consequence of the downstream dam. See Table IV for a listing of the valley slopes within the project site.

The Randolph County Soil Survey (NRCS, 2002) indicates the site is underlain by four soil series: Dogue sandy loam and three series of Badin-Tarrus Complex (Figure 3). The majority of the soils on the Heath Dairy Site are BtC2 – Badin-Tarrus complex, 8-15 % slopes. These soils are described as silty clay loam. BtC2 soils are listed as “moderately eroded”. Depth to bedrock is listed as 40 to 60 inches. “Erodibility” is listed as a management concern. Other soils on the site in the southeast corner consists of DoB - Dogue Sandy loam 2 – 6 % slopes, occasionally flooded and BaD – Badin Tarrus complex silty loam 15 to 25 % slopes. Erodibility is not listed as a management concern for DoB soils and bedrock depth is greater than 60 inches. Erodibiltity is listed as a management concern for BaD soils and depth to bedrock for BaD soils is 38 to 60 inches.

Due to the relatively shallow bedrock (40-60 inches) and moderately erodible soils, streams may downcut until bedrock is encountered. This may result in additional streambank erosion due to bedrock resistance to further downcutting.

Soils in the Piedmont region of North Carolina tend to be erodible. Land use in the Heath Dairy area is mainly agricultural resulting in significant clearing of vegetation. Dairy and cattle operations can have significant impacts on soil erosion and streambank degradation due to livestock activity.

The soils on site are not described as having high percentages of fine sands, and are therefore not as erodible as soils such as Chewacla loam and Wickham sandy loam soils (found farther north

and west in the upper Yadkin River watershed). Nonetheless, the potential for erosion of soils on the Heath Dairy Site can be described as moderate to high.

Table IV lists the dominant soil series and characteristics. None of the soil series found on site are classified as hydric. However, field investigations revealed that nine wetland areas occur within the site totaling approximately 1.78 acres (Figure 4a). Soils within these areas display hydric properties such as low-chroma colors and mottling.

## 2.4 Historic Land Use and Development Trends

The watershed upstream of the site is rural characterized mainly by pasture and agricultural land (Figure 2). There is no apparent trend toward urbanization in the watershed. Tables IV summarizes land use within the watershed. The Randolph County Planning Department has no plans for development near the project site at this time.

Current on-site land uses include pastureland, agriculture, and several small hardwood forest stands that occur in upland areas. Pastureland is grazed by livestock (cattle) which have access to most on-site stream reaches and the adjacent floodplains. The lack of exclusionary barriers appears to have contributed to the degradation of stream banks, water quality and floodplain soils. Agricultural buildings and a lagoon are located in the western portion of the Site between West Branch and UT to West Branch (Figure 4a). A heavily grazed feedlot is located south of the agricultural buildings and discharges concentrated flow into the West Branch buffer near Wetland J. Additionally, a trash dump is located directly adjacent to the site to the south.

## 2.5 Plant Communities

There were three terrestrial communities observed within the project site. Plant community boundaries within the site are generally well defined without a significant transition zone between them. The observed communities include Mesic Mixed Hardwood Forest (Piedmont Subtype) (Schafale and Weakley, 1990), agricultural pasture, and riparian buffer.

Agricultural pasture is the dominant plant community within the project boundary. This community is well maintained by a large herd of dairy cattle thus dominated by herbaceous/early successional species including buttercup (*Ranunculus* spp.), clover (*Trifolium* spp.), fescue (*Festuca* spp.), foxtail bristle (*Setaria italica*), jimson weed (*Datura stramonium*), and multiflora rose (*Rosa multiflora*).

A Mesic Mixed Hardwood Forest (Piedmont Subtype) occurs throughout the site but never forms a large contiguous stand due to the abundance of open pastures. Observed species include black cherry (*Prunus serotina*), Chinese privet (*Ligustrum sinense*), Christmas fern (*Polystichum acrostichoides*), common greenbrier (*Smilax rotundifolia*), May apple (*Podophyllum peltatum*), poison ivy (*Toxicodendron radicans*), red maple (*Acer rubrum*), red oak (*Quercus rubra*), sassafras (*Sassafras albidum*), trout lily (*Erythronium rostratum*), tulip poplar (*Liriodendron tulipifera*), and white oak (*Quercus alba*).

The riparian plant community is very sparse due to heavy grazing but is represented by characteristic piedmont riparian species. These species include American sycamore (*Platanus occidentalis*), iron wood (*Carpinus caroliniana*), and tulip polplar (*Liriodendron tulipifera*).

## 2.6 Federally Protected Species

There are two federally protected species listed for Randolph County, North Carolina: the Cape Fear shiner and the Schweinitz's sunflower (NCNHP, 2006). Appendix K contains a complete description of these species, habitat requirements, known populations, and threats to populations.

As of May 31, 2006, a review of the NCNHP database for rare species and unique habitats revealed no populations of the Cape Fear shiner within one mile of the Heath Dairy Road Restoration Site. Because all known populations of the Cape Fear shiner occur within the Cape Fear river basin and this project is located within the adjacent Yadkin River Basin, it is unlikely that proposed stream restoration activities will adversely affect populations of the Cape Fear shiner. David Rabon, specialist with the Raleigh Field Office of the United States Fish and Wildlife Service (USFWS) was contacted on August 1, 2006 regarding the need for conducting surveys for the Cape Fear Shiner. He agreed that there was not a need to conduct any surveys and that the stream restoration activities do not present any threat to the Cape Fear shiner. Therefore, the biological conclusion for the Cape Fear shiner is *"No Effect"*.

Habitat for Schweinitz's sunflower within the project site include woodland openings/edges and other sunny or semi-sunny situations. As of May 31, 2006, a review of the NCNHP database for rare species and unique habitats revealed no populations of Schweinitz's sunflower within 1.0 mi the Heath Dairy Road Restoration Site. Field surveys for presence of the Schweinitz's sunflower were completed on August 23, 2006 during the blooming period. Prior to field survey, a visit to a known population of Schweinitz's sunflower within Randolph County was conducted to observe the species in native surroundings. No populations of Schweinitz's sunflower were found at the Heath Dairy Road Restoration Site, therefore, the biological conclusion is *"Not Likely to Adversely Affect"*.

## 2.7 Cultural Resources

An archaeological investigation of the site was conducted by Coastal Carolina Research, Inc. in June, 2006. The complete archaeology report can be found in Appendix J. Two stacked-stone dams are present on-site (Figure 4a); one located at the Heath Dairy Road crossing (Site 31RD1330) and a second located in the middle reach of Back Creek (Site 31RD1440).

Site 31RD1330 is a recorded resource and is recommended as eligible for the National Register of Historic Places (NRHP) as an architectural resource, and as such, impacts to the structure would require mitigation. Because this dam is at the terminus of the project, the construction of the stream restoration project at the Heath Dairy Road site will not impact the structure. A letter requesting concurrence was submitted to the State Historic Preservation Office (SHPO) and the Office of State Archeology (OSA) on December 13, 2006. A concurrence letter was received from the SHPO on February 1, 2007. A copy of both letters is included in Appendix J.

Due to the condition of the stone dam in the center of the site, Site 31RD1440 is recommended as not eligible for the NRHP. Thus, a concurrence letter from SHPO and OSA will not be necessary.

## 2.8 NCFMP Status

As a Federal Emergency Management Agency (FEMA) Cooperating Technical Partner (CTP), North Carolina has assumed the ownership and responsibility for the Federal Insurance Rate Maps (FIRMS) for all communities in the state that are part of the National Flood Insurance Program (NFIP). This endeavor is designated the North Carolina Floodplain Mapping Program. A part of this initiative is to produce updated digital FIRMS (DFIRMS) for each county and its incorporated municipalities throughout the state. The updated DFIRMS for Randolph County became effective January 2, 2008. The FEMA Floodplain Requirements Checklist can be found in Appendix O.

Limited detail studies were completed on a reach of North Branch and Back Creek as part of the NFIP. The HSMM project team prepared an existing conditions, detailed model for these reaches and the proposed design will create a change in the base flood elevation (BFE) and hydraulic characteristics of the streams. Therefore, a Conditional Letter of Map Revision (CLOMR) will be required for compliance with FEMA regulations, and will be completed before construction commences. When construction is complete a Letter of Map Revision (LOMR) will be required to complete compliance with FEMA regulations. The FEMA Floodplain Requirements Checklist can be found in Appendix O.

## 2.9 Potential Constraints

The upper 40.4 acres of the easement on the Site is owned by Mr. Phillip Ridge and the lower 16.4 acres of the easement is owned by Dr. Edward Shackleford. Currently, there is livestock on both properties within the easement. Livestock control during construction and provision for an alternative watering source during and after construction for the livestock will be the responsibility of the landowners. Exclusionary fencing will be provided on Mr. Ridge's property only. The contact information for the landowners can be found in Table III.

There is an AT&T utility easement on the Ridge property (see plans in Appendix Q). This utility does cross the ingress/egress easement, but is below ground and will not be affected. The AT&T easement also crosses the upper end of the conservation easement above the preservation reach of West Branch. The Contractor will be made aware of this infrastructure and will be responsible for locating it and avoiding damage to it during the construction period.

Constraints considered in the proposed design included: the potential for hydrologic trespass at the upstream end of Back Creek and North Branch, protection of the historic dam at the terminus of the project site, the effect on sediment transport due to backwater caused by the structure at Heath Dairy Road, and the presence of bedrock outcrops. Accommodations for each of these constraints were made in the proposed design and are specifically addressed in Section 6.0 of this report. Therefore, none of these constraints should be considered as "fatal flaws".

# 3.0 PROJECT STREAMS

On-site streams have been characterized based on fluvial geomorphic principles (Rosgen, 1996). Three reaches were identified as representative of the site and detailed geomorphic surveys were conducted to provide assessment of existing conditions. Topographic surveys of the entire site provide additional information on stream geomorphic conditions throughout the site.

Additionally, all stream reaches were identified as perennial according to methods presented in *Identification Methods for the Origins of Intermittent and Perennial Streams, Version 3.1* (DWQ, 2005) except for the upper portions of West Branch which were identified as intermittent and ephemeral. Stream identification forms can be found in Appendix D.

The dominant stressors to the stream systems include dredging, livestock access, and general agricultural practices. Past dredging of the channels has produced low sinuosity and incised streams which contribute to erosional processes by elevating shear stress on the channel bed and banks. Livestock access contributes to the structural degradation of the channel banks and degrades water quality through direct waste inputs. Livestock access also ensures that vegetation growth along the riparian zone remains limited, further contributing to the poor structural integrity of the channel banks. Additionally, agricultural practices such as application of fertilizers and maintenance of brush contribute to channel instability and poor water quality.

## 3.1 Channel Morphology and Classification

Detailed geomorphic surveys were conducted on existing stream conditions and the data can be found in Appendix B. Morphological characteristics of existing stream reaches are summarized in Tables Va through Vf.

The Back Creek–Lower Reach is representative of dredged portions of Back Creek, having little to no sinuosity and moderately incised. The channel classifies as a Type E stream under the Rosgen classification system, however, due to its incised vertical position, low sinuosity, and high bank height ratio, its morphologic form is more indicative of a Type G channel. Although the bed profile is vertically stable due to downstream limits on degradation, there is little variation in the profile features. Pools and riffles are almost indistinguishable from runs and glides and therefore provide little to no habitat value. Bed material exhibits a strong bimodal distribution with 32% of the surface bed material being composed of silt and sand. The reach has maintained a gravel bed designation and can be expected to become increasingly coarse in response to restoration efforts.

The Back Creek–Upper Reach is representative of portions of Back Creek in a somewhat narrower valley that have degraded to the point that it is classified as a Type G stream. Although portions of the reach still access the historic floodplain during high flooding events, the reach generally exhibits the character and dimensions of a fully entrenched channel. The vertical profile displays distinctive pool and riffle forms, but they are primarily associated with scarp and head-cut features. These features indicate the profile is not vertically stable and will continue to degrade over time.

The West Branch–Upper Reach is representative of the smaller West Branch tributary. The valley is considerably narrower, representing a colluvial form, and the valley slope is significantly steeper than the lower portions of the site. The channel is classified as a Type G stream and it is completely entrenched. The entrenchment and bank height ratios indicate that the channel flows rarely access the historic floodplain. A significant head-cut was identified at the downstream end of this reach indicating that additional degradation can be expected.

The North Branch Reach is a dredged portion of the site, having little to no sinuosity and is moderately incised. The channel classifies as a Type E stream under the Rosgen classification system, however, due to its incised vertical position, low sinuosity, and high bank height ratio, its morphologic form is more indicative of a Type G channel. Although the bed profile is vertically stable due to downstream limits on degradation, there is little variation in the profile features. Pools and riffles are almost indistinguishable from runs and glides and therefore provide little to no habitat value. Bed material exhibits a strong bimodal distribution with 32% of the surface bed material being composed of silt and sand. The reach has maintained a gravel bed designation and can be expected to become increasingly coarse in response to restoration efforts.

The East Branch Reach is a smaller tributary with a valley that is considerably narrower, which represents a colluvial form, and the valley slope is steeper than the other portions of the site. The channel is classified as a Type G stream and it is completely entrenched. The entrenchment and bank height ratios indicate that the channel flows rarely access the historic floodplain.

## 3.2 Discharge and Bankfull Verification

Bankfull identification on degraded reaches is subject to a significant amount of discretion 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 (Harman, et al., 1999) as shown in Appendix G. Also included in this plot are the bankfull cross sectional areas for the reference reaches. 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 and bankfull discharges from the reference reaches (See Appendix G). The graphing of this 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 bank erosion hazard indices. Data for each stream reach can be found in Table Va through Vf and in Appendix L.

Width-depth ratios within the project site range from 3.7 to 8.3 with typical ratio values of 5.0. 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 result in a higher mean depth during bankfull events and subsequent increased shear stress on the bed and banks.

Bank height ratios within the project site range from 1.3 to 2.9 with typical ratio at a value of 2.0. 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.

Bank erosion hazard indices and near-bank stress were evaluated for all streams in the project area using the methodology presented by Rosgen in "A Practical Method of Computing Streambank Erosion Rate." Total bank erosion on the site is estimated at 1,590 tons per year. Bank erosion estimates for individual reaches can be found in Table VI.

## 3.4 Vegetation

Dominant riparian vegetation within the project site consists of: Chinese privet (*Ligustrum sinense*), red maple (*Acer rubrum*), American sycamore (*Platanus occidentalis*), iron wood (*Carpinus caroliniana*), black cherry (*Prunus serotina*), and tulip poplar (*Liriodendron tulipifera*). Non-native invasive species are present within the project site. Specifically, Chinese privet (*Ligustrum sinense*), multiflora rose (*Rosa multiflora*), and Japanese stiltgrass (*Microstegium vimineum*) are abundantly present throughout the project site in upland, wetland and riparian habitats.

# 4.0 REFERENCE STREAMS

Two reference reaches were identified and surveyed to assist in the design of the project streams. The first reference is located on a UT to Polecat Creek in Randolph County, northeast of Randleman (Figure 5a) in HUC 03030003010080. The second reference is located on Fork Creek in Randolph County, south of Asheboro (Figure 5b) in HUC 03030003020060. Photographs of the two reference reaches can be found in Appendix E. Stream identification forms and data on reference stream conditions can be found in Appendices D and F.

## 4.1 Watershed Characterization

Both reference reaches are located in the Piedmont hydrophysiographic region of North Carolina and within the same county of the project site. The watersheds are similar to the character of the project watershed in average annual rainfall, elevation ranges, and valley types. Both watersheds are predominately rural with land use consisting of agriculture, pasture, and forested stands (Figures 6a and 6b). The drainage area for 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 proposed configurations for the proposed stream restoration. Detailed geomorphic surveys and Level II Rosgen classification were conducted on each of the reference reaches. A summary of morphological characteristics of reference stream reaches upon which design is based can be found in Tables Va through Vd.

The UT to Polecat Creek represents a meandering E channel in a moderately confined valley with a well developed floodplain and Fork Creek represents 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 project site and provide reasonable models for the potential channel forms that can be expected on the project 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 (Harman, et al., 1999) as shown in Appendix G. 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 this 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, however site features indicate that Bank Erosion Hazard Index (BEHI) values are low and the Near Bank Stress (NBS) are low to moderate, suggesting that the annual rate of bank erosion would be less than 0.1 feet. 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 surveyed 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 where observed, their presence was not sufficiently dominant to separate out a riparian community type from the Mesic Mixed Hardwood Forest (Piedmont Subtype).

# 5.0 PROJECT SITE WETLANDS

Nine wetlands were delineated within the site on April 20-22, 2009 (Figure 4a). The survey data can be found in Appendix M. USACE Routine Wetland Determination Forms can be found in Appendix C for each wetland, and total acreage for each existing wetland can be found in Table I. The wetland delineation will be field-verified by the USACE and a Jurisdictional Determination will be issued.

Wetlands A and B are located along the historic floodplain and historic channel of Back Creek in a relatively flat area bound in the south by steep topography. Wetlands A and B are connected beyond the property boundary forming an approximately 2-acre wetland system. Wetlands C, E, F, I, K, and L are seep wetlands, all of which occur adjacent to one of the project streams. These wetlands are relatively small ranging in size between 0.003 and 0.08 acres. Wetland J is a floodplain wetland formed by an alluvial fan in the upstream reach of West Branch.

## 5.1 Hydrological Characterization

Wetland A and B have a permanently saturated hydrology driven primarily by surface drainage and toe-of-slope groundwater seepage from the bounding hillside. Additionally, an ephemeral stream flows into the wetland from the adjoining property.

Wetlands C, E, F, I, K, and L are all driven by toe-of-slope groundwater seepage. Because the associated stream channels are incised and entrenched and flood flows rarely access the floodplain, these wetlands are *not* primarily supplied by overbank flow. Wetland K specifically is very small because it has been ditched to drain the adjacent Back Creek floodplain.

Wetland J is formed by a small tributary flowing from a cattle feeding area which is depositing sediment at the confluence with West Branch forming an alluvial fan. This in turn is decreasing flow and maintaining a saturated state within the alluvial fan. Wetland J is the only wetland on Site classified as riparian riverine rather than palustrine because it is the only wetland fed by a stream, whereas the other wetlands are fed by groundwater seepage.

Groundwater monitoring gauges were installed in six locations throughout the site on June 23, 2006 (Figure 4a). Three of these gauges were installed in existing wetland areas (Wetland A, Wetland B, and Wetland J) to represent the largest wetlands present at the site, and the remaining three gauges were installed in upland areas in an attempt to evaluate groundwater hydrology in other “dry” areas within the floodplain.

In early 2007, the gauge placed within Wetland B (serial #EBDC711) was removed due to the suspicion that it was producing erroneous data. During a site visit in May 2008 it was found that three other gauges - 1 upland of Wetland B (serial #EBCFAE1) and 2 by Upper Back Creek (serial #B651714 and EDB875E) - had disappeared during a period in which the project work was temporarily suspended. Four new gauges were installed in these locations on August 26, 2008 and protective fencing was installed by EEP.

Data from the gages shows the presence of groundwater within twelve inches of the ground surface in wetlands A, B and J during the growing season and is included in Appendix H. The rainfall data plotted in the groundwater level graphs was taken from the Cronos database maintained by the State Climate Office.

Anomalies are present in the early data from two gauges. The gage installed in wetland J (serial # A27B4E1) indicated the presence of water above the land surface on every recording, however, as this gauge was observed over time for indications of malfunction, more recent gauge results seem to have normalized. The gage installed in Wetland B indicated the presence of water at a constant 22.5 inches below the land surface at a time when it is known to have been inundated, therefore this gauge was removed and replaced as mentioned above due to malfunction of the unit. Results from the replacement unit indicated results within the expected range for an existing wetland.

## 5.2 Soil Characterization

According to the Randolph County Soil Survey (NRCS, 2002), none of the soils shown on the soil maps of the Heath Dairy site are hydric. However, soils within the delineated existing wetlands display hydric properties such as low-chroma colors and mottling. Specific information on soil profiles for each wetland area can be found on the Wetland Determination Forms found in Appendix C. Additionally, cattle have access to nearly all of the existing wetlands, therefore, soils are impacted in all wetlands.

## 5.3 Plant Community Characterization

Because cattle have access to the majority of the wetlands onsite, wetland vegetation is kept in an early successional state. Wetlands A and B can be characterized as a Forested Wetland (*Broad-leaved Deciduous*) (Cowardin 1979) with a mature canopy, but highly disturbed shrub and herbaceous layer. Wetlands C, E, and K were being actively grazed by cattle at the time of delineation. Wetlands F, I, J, and L all exhibit evidence of regular grazing by cattle, and a lack of a shrub and canopy stratum. Additionally, all wetlands delineated include invasive exotic species, most notably Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*). Specific information on vegetation for each wetland area can be found on the Wetland Determination Forms found in Appendix C. Exclusionary fencing was placed by the landowner near the mouth of West Branch, which has limited subsequent impact to the vegetation in this area.

# 6.0 REFERENCE WETLANDS

The reference wetland is located onsite and partially on the adjacent property on the opposite side of the fence that defines the edges of Wetland A and B (Figure 7). It is the largest found within the site covering approximately 2 acres and includes portions of Wetland A and B when considered as a contiguous wetland. The wetland is located along the historic floodplain and historic channel of Back Creek. This wetland is located in a flat area bound in the south by steep topography. A USACE Routine Wetland Determination Form can be found in Appendix C.

## 6.1 Hydrological Characterization

The reference wetland has a permanently saturated hydrology driven primarily by surface drainage and toe-of-slope groundwater seepage from the bounding hillside. Additionally, an ephemeral stream flows into the wetland from the adjoining property.

## 6.2 Soil Characterization

The reference wetland is characterized by a permanently saturated silt-clay soil. The soil surface has a 0.5 inch organic layer. Below the organic layer from 0.5 – 4 inches the horizon has a matrix color of 10YR 3/2 with many mottles of 10YR 5/8 and 7.5YR 4/6. From 4 – 8 inches the matrix color is 2.5Y 4/2 with common mottles of 7.5YR 4/6. From 8 – 12 inches the matrix color is 10YR 4/1 with common mottles of 10YR 3/6.

## 6.3 Plant Community Characterization

The reference wetland is dominated by bottomland species commonly found in the Piedmont Physiographic Region. The plant community is well established containing a mature canopy and a distinct subcanopy stratum. Canopy species observed within the reference wetland include American elm (*Ulmus americana*), American sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), green ash (*Fraxinus pennsylvanica*), ironwood (*Carpinus caroliniana*), and red maple (*Acer rubrum*). Observed shrub and woody vine species include American elder (*Sambucus canadensis*), American elm, black willow, common buttonbush (*Cephalanthus occidentalis*), common persimmon (*Diospyros virginiana*), green ash, ironwood, red maple, silky dogwood (*Cornus amomum*), tag alder (*Alnus serrulata*), and Virginia trumpet creeper (*Campsis radicans*). Observed herbaceous species include Alleghany monkey flower (*Mimulus ringens*), bunched arrow-head (*Sagittaria fasciculata*), bushy seedbox (*Ludwigia alternifolia*), climbing hempweed (*Mikania scandens*), false nettle (*Boehmeria cylindrical*), netted chain fern (*Woodwardia areolata*), and spotted jewelweed (*Impatiens capensis*).

# 7.0 PROJECT SITE RESTORATION PLAN

## 7.1 Restoration Project Goals and Objectives

The RBRP identified the following major stressors in the Back Creek Watershed: nutrients, bank erosion, absence of riparian buffers, and urbanization. See Figure 4b for the proposed site configuration.

Restoration goals for this project include:

- Improve local water quality within the restored channel reaches as well as the downstream watercourses through:
    a. the reduction of current channel and off-site sediment loads by restoring appropriately sized channels with stable beds and banks,
    b. the reduction of nutrient loads from adjacent agricultural fields by restoring the riparian buffer, and
    c. the reduction of water temperatures provided through shading of the channel by canopy species along with the resultant increase in oxygen content.
- Improve local aquatic and terrestrial habitat and diversity within the restored channels and their vicinity through:
    a. the restoration of appropriate bed form to provide habitat for fish, amphibian, and benthic species,
    b. the enhancement of riparian wetlands along the stream corridor to provide additional landscape and habitat diversity,
    c. the restoration of a suitable riparian buffer corridor in order to provide both vertical and horizontal structure and connectivity with adjacent upland areas, and
    d. the restoration of understory and canopy species in order to provide forage, cover, and nesting for a variety of mammals, reptiles, and avian species.
- Preclude the construction of additional infrastructure and the combination of agricultural practices including cattle grazing and the application of pesticides and fertilizer within the riparian buffer area by providing a permanent conservation easement.

The projects measurable objectives include:

- Restore natural stable channel morphology and proper sediment transport capacity;
- Create and/or improve bed form diversity and improve aquatic and benthic macroinvertabrate habitat;
- Construct a floodplain (or local bankfull bench) that is accessible at the proposed bankfull channel elevation;
- Improve channel and stream bank stabilization by integrating in-stream structures and native bank vegetation;
- Restore 7,781 linear feet of stream through Priority I and II restoration from the existing 6,748 linear feet of stream;
- Enhance 960 linear feet of stream from the existing 960 linear feet of stream;
- Preserve 636 linear feet of stream;

- Enhance 0.6 acres of wetlands from the existing 0.6 acres of wetlands (all are riparian non-riverine wetlands);
- Preserve 1.18 acres of wetlands (all are riparian non-riverine wetlands, except Wetland J which is a riparian riverine wetland consisting of 0.09 acres of preservation); and,
- Restore approximately 30 acres of riparian buffer by establishing a native forested and herbaceous riparian buffer plant community

### 7.1.1 Proposed Channel Design and Classification

With the exception of the lower portion of Back Creek, the proposed channel is designed as a Type B4c stream. This channel configuration will provide the most stable form in moderately sloping colluvial valleys. Not only does it effectively convey bankfull discharge and sediment load but also conforms to the natural conveyance of flood flows. Along the lower reach of Back Creek where the topography opens into a broad flat alluvial floodplain the proposed channel is designed as a Type E4 stream. The proposed channel dimensions, patterns, and profiles are based on hydraulic relationships and morphological dimensionless ratios of the reference reaches as shown in Tables VIa through VIf. The proposed typical sections and channel alignment are shown in the attached preliminary plans (see Appendix Q).

Restoration will consist of Priority I and II activities which will involve reconstruction of the proposed channels along new and existing alignments. In-stream structures such as rock cross vanes, J-hook vanes, log vanes, and root wads will be incorporated into the proposed stream to provide energy dissipation, bank stabilization, grade control, and habitat diversity. Coir fiber matting will be used to provide bank stability until vegetation is established. Bed material from the existing channel will be mined and used in the riffles of the proposed channels.

The proposed channel alignments were established to provide maximum conformance to the existing valley form. Where stream channels had been previously moved away from the low point in the valley, the proposed alignments will reposition the channel to the proper location. Where the valley width narrows, proposed channel sinuosity was reduced. Where rock outcrops where present at the surface, proposed channel alignments were kept near their present locations. Conforming the proposed channel alignments to the valley form provides the benefits of duplicating natural flow conditions at greater than bankfull flow, minimizing earthwork, and reducing the likelihood of conflicts with bedrock. It is not anticipated that seismic refraction sampling will be necessary for mapping all possible conflicts with bedrock outcrops. Instead, it is anticipated that conflicts with bedrock that are encountered during construction can be readily resolved with minor field adjustments to the alignment.

At the request of the EEP the upper portion of Back Creek was redesigned as an enhancement reach to facilitate a paired watershed study to be conducted by North Carolina State University (NCSU). To the maximum extent possible, full reconstruction and restoration efforts were reduced to in-channel work and augmentation of the existing stream. Enhancement efforts will entail raising the profile in place to reconnect the stream to the relic floodplain, construction of in-stream structures, and stabilization of the banks.

### 7.1.2 Wetland Impacts

The implementation of the restoration plan will require two minor unavoidable impacts to existing wetlands. The total wetland impacts will be approximately 0.011 acres with approximately 0.008 acres of impact occurring in Wetland A-2 and approximately 0.003 acres of impact occurring in Wetland I.

Wetland A-2 is located at the downstream end of Back Creek and consists of a linear swale that is connected to Wetland A-1. The lower portion of this feature, which is incised into the terrace, was probably dredged to provide drainage of the adjacent pasture. The proposed restoration plan calls for filling in 60 feet of the downstream end of the ditch. There are two concerns with leaving the existing drainage feature intact. First, the incised nature of the lower portion likely results in a reduced hydroperiod for the middle and upper portions of the wetlands. Second, the linear position of the wetlands provides a possible route for flood waters of Back Creek which could encourage flow divergence around the constructed channel. Backfilling the lower portion of this drainage feature would improve the hydroperiod of the remaining wetlands and reduce the threat of flow divergence of Back Creek.

Wetland I, which is located at the upstream end of West Branch, extends across the valley and will be impacted by construction of the proposed channel. The channel restoration efforts along this reach require that the channel profile be raised and that the channel pattern and dimensions be reconstructed to provide a stable form. Impacts to Wetland I will be partially mitigated by the channel restoration efforts. The stream profile will be raised by 1.8 feet which will improve groundwater hydrology conditions within the adjacent wetlands. Additionally, the area of the existing channel which will require filling will be graded to match existing wetland elevations and be planted with wetland vegetation.

## 7.2 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 25 mm and a $D_{84}$ of 60 mm to 80 mm. The proposed channels were designed to mobilize particles in the 25 mm to 80 mm range and the target critical shear stress was 0.25 $lb/ft^2$ with a range of 0.2 to 0.3 $lb/ft^2$ (See Table VII).

## 7.3 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. Included in this analysis is modeling of the existing dam/culvert/bridge complex at Heath Dairy Road. An existing conditions analysis consisting of the HEC-RAS water surface profile model and a hydraulic routing model have been conducted. Complete results of the existing condition models are discussed in detail in Appendix I.

Upon completion of the design, the same analyses were conducted for the proposed condition. Comparison of the existing and proposed conditions HEC-RAS models demonstrates that the 100yr water surface elevations at the upstream most cross sections of each reach will be slightly lowered in the proposed model. In every instance, the difference in water surface elevation is less than one foot compared to the existing. Hydraulic routing of the proposed site conditions demonstrates restoration activities will have little to no effect on the hydraulic performance of the structures located at Heath Dairy road. Furthermore, both analyses demonstrate that the proposed construction activities will not result in hydraulic trespass onto any adjacent properties.

## 7.4 Stormwater Best Management Practices

Due to the eutrophication of Back Creek Lake, and the water quality classifications of Back Creek as WS II/HQW, there is an emphasis on improvement to water quality. Specific contributors to existing poor water quality include: runoff from agricultural operations, direct discharge of animal waste due to cattle access to streams and wetlands, and sediment loading due to bank collapse. Therefore, the use of structural stormwater best management practices (BMPs), such as wet detention ponds or stormwater wetlands, was carefully considered for the Heath Dairy Road project.

However, once design elements were placed and stormwater needs were assessed, structural BMPs were ruled out as an effective option to improve water quality for the following reasons:

- Agricultural operations are a non-point source of pollutants; therefore, it is difficult to concentrate flow to capture a significant portion of the offending area. Riparian buffers are a much more effective BMP against non-point source pollutants.
- All streams entering the project site where water quality is a concern (UT to West Branch and West Branch in particular) are intermittent or perennial; therefore, structural BMPs cannot be placed “inline” according to DWQ’s stormwater rules.
- Other areas that would be ideal to capture water to treat in a structural BMP (for example, the drainage ditch adjacent to Wetland J) have developed depositional areas with emergent wetland vegetation. These areas are currently providing sediment detention and water quality filtering functions comparable to what could be provided through installation of a structural BMP.

Therefore, structural stormwater BMPs are not part of the overall design of the Heath Dairy Road stream and wetland restoration project. However, it is important to note that the restoration of the riparian buffer is itself considered a stormwater BMP.

## 7.5 Soil Restoration

Due to severe degradation of soils and compaction due to cattle access, it is proposed that the majority of soils onsite, with the exception of Wetland A1, heavily wooded areas, and upland areas outside of the riparian zone, be ripped and disked to an appropriate depth. A small number of areas will require scarification by hand, or small mechanized equipment in order to avoid impacting mature vegetation to be retained onsite.

Also, soils may require some amendment to properly encourage the growth of proposed vegetation. However, due to a long period of "nutrient loading" by the cattle, soil samples of representative areas were collected on December 5, 2006 and submitted to The Agronomic Division of the N.C. Department of Agriculture and Consumer Services for free testing. The test results can be found in Appendix N. Soil amendment recommendations obtained as a result of the tests will be incorporated into the project construction specifications and Table VIII. Table VIII cannot be completed until the project specifications are prepared.

## 7.6 Wetland Preservation and Enhancement

Wetland restoration, enhancement and preservation activities for mitigation purposes were considered for this project. All parties agree that restoring wetland function is beneficial for water quality and provides excellent wildlife habitat. Although the decision was made not to pursue wetland mitigation credits for restoration or creation, the associated grading, soil restoration, and planting of wetland/depressional areas will be conducted within the floodplain and easement for enhancement and preservation credits. This decision is based on the designation of soils as non-hydric on the Randolph County Soil Survey (NRCS, 2002), the potential for sediment deposition in the wetlands associated with Lower Back Creek due to impoundment of surface waters due to the dam under Heath Dairy Road, and the small amount of total wetlands.

Specific activities proposed for the wetland areas include the following:

ENHANCEMENT

- Hand scarifying minor areas of soils within Wetlands B, C, and F in order to restore the severely impacted top six inches of soil without disturbing the mature canopy species;
- Ripping and discing unvegetated areas or areas denuded for construction within Wetlands B, C, F, and K and replanting native wetland species; and,
- Preserving soils in Wetland E and planting native species to encourage the development of canopy and shrub stratums.

PRESERVATION

- Installation of tree protection fencing, or other construction barrier, during the construction period around Wetland A in order to protect this reference quality wetland;
- Careful construction of the proposed West Branch channel from the left side of the stream bank in the vicinity of Wetlands I and L in order to avoid impacts to existing wetland soils and vegetation;
- Limitation on access of construction traffic to within restoration reaches of West Branch, thus protecting Wetland J from adverse impact during the construction period; and,
- All wetland preservation areas are within the designated conservation easement obtained by NCDOT, therefore, will be protected in perpetuity.

Hydrology will continue to be supplied by groundwater seeps and surface water flow, as well as occasional overbank flooding once the proposed streams are reconnected to the adjacent floodplains.

## 7.7 Natural Plant Community Restoration

Appropriate natural plant communities will be restored within the site. Planting riparian 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 to a minimum of 50 feet on both sides of the stream, except for approximately 750 linear feet of stream (7.9% of total stream length). The majority of this length that cannot achieve the 50 foot buffer on one side is on Upper Back Creek where the design was changed to enhancement from restoration per EEP's request and the stream alignment, therefore, cannot be moved. A portion of this stream length is in areas where alignment was set based on the pattern requirements and valley low point positioning.

Throughout the majority of the site, the target community for the riparian zone and the floodplain will be a Mesic Mixed Hardwood Forest (Piedmont Subtype) with the lower reaches of the Back Creek floodplain as a Piedmont/Mountain Bottomland Forest (see Figure 8). Wetland areas in the upper reaches of the project will also be a Piedmont/Mountain Bottomland Forest, and wetlands on the lower reaches will be a Piedmont/Low Mountain Alluvial Forest.

Bare root seedlings of the species mentioned in Table X will be used. Bare root tree seedlings 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. Planting should occur during the dormant season (from November to March).

Additionally, disturbed areas within the project will be seeded during the dormant season with a mix of native herbaceous species. Seed mixes used shall be certified by the North Carolina Department of Agriculture, and contain at least 15 of the species listed for that type of seed mix in Table IX. Disturbed areas that required stabilization outside of the dormant season will be stabilized with the appropriate temporary seed mix, to exclude aggressive grasses that may out-compete native species in the permanent seed mix. These areas will require the application of permanent seed mix as soon as the dormant season and weather allows.

Tables IX and X from EEP Restoration Plan (RP) template show seeding rates and planting rates/densities by species.

Prior to re-vegetation of the project, non-native invasive species will be removed from the site within the planting areas with special attention to the control of Chinese privet (*Ligustrum sinense*) and multiflora rose (*Rosa multiflora*).

Mechanical Controls that will provide effective invasive control of Chinese privet are mowing/cutting, hand pulling, or Cut Stump Method; recommended by the Southeast Exotic Pest Plant County Invasive Plant Manual. Mowing and cutting methods are more appropriate for small initial populations or in environmental sensitive areas where herbicides cannot be used. Stems should be cut at least once per growing season as close to ground level as possible.

Mature plants should be controlled with the Cut Stump Method. Plants shall be cut with hand tools and a 25% solution of glyphosphate and water shall be applied to the horizontally cut stump. The applicator should use caution when applying these solutions in sensitive areas. The same invasive species controls are applicable with multiflora rose.

For Japanese stiltgrass, mechanical control can be used. Mow plants as close to the ground as possible using a string trimmer or similar grass cutting tool. Treatments should be made when plants are in flower and before seeds are produced. Treatments made earlier may result in plants producing new seed heads in the axils of lower leaves.

Widespread application of herbicides in wetland and stream restoration areas is not recommended.

It is recommended that invasive species management continue through the 5-year monitoring period. Management procedures should conform to the recommendation in the Southeast Exotic Pest Plant Council Invasive Plant Manual.

Soil results obtained from North Carolina Division of Agriculture and Consumer Services (NCDA&CS) Agronomic Division dated 12-4-08 show that the pH of soils on the Heath Dairy site range from 5.5 to 6.1 standard pH units. A general rule of thumb is to apply 1 ton lime per acre for soils with pH of 5.2 to 6.0. The recommendations provided by NCDA&CS lime applications between 0 and 1.0 ton per acre. Recommendations for fertilizer range from 0 to total of 110 to 150 lbs/1,000 $ft^2$ $P_2O_5$ & $K_2O$) (no nitrogen addition was recommended). The Bid Document will direct the Contractor to collect additional area specific soil samples and amend soils accordingly.

Fertilizer should be applied in accordance with North Carolina Department of Transportation Standard Specifications for Roads and Structures, Section 10602, and with fifty percent of the elements derived from organic sources, or proportion necessary to eliminate any deficiencies of topsoil, to the following proportions: Nitrogen 10%; phosphoric acid 10%, soluble potash 10%. Apply evenly at a rate of 1,000 lbs/acre.

Areas to be planted with grass with slopes of less than 3:1 should be mowed and scarified to a depth of 2-4 inches. Wheat straw mulch should be placed in areas where temporary and permanent grass seeding will occur. Coir fiber matting or jute mesh should be placed along slopes of 2:1 or better and on restored stream banks. All materials shall be biodegradable.

# 8.0 PERFORMANCE CRITERIA

## 8.1 Streams

The stream restoration monitoring will be in accordance with the USACE *Stream Mitigation Guidelines,* April 2003. Monitoring will consist of collection and analysis of stream stability and vegetation survival data on an annual basis for at least five years or the occurrence of two bankfull events occurring in 2 separate monitoring years. Monitoring will include measurement of morphological parameters and channel stability, evaluation of photographs, vegetation sampling, and monitoring of bankfull occurrence.

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. Bed material should indicate a reduction in the percentage of fine sediments and a particle distribution in the target range of $D_{50}$ of 20 mm to 30 mm.

## 8.2 Vegetation

Quantitative sampling plots (10 meter (m) x 10 m) for vegetation will be established in the wetland restoration and riparian buffer restoration areas throughout the site. Vegetation plots will be inventoried at the conclusion of each growing season until vegetation success criteria is achieved. Floristic inventories will begin within the first growing season following completion of construction. Permanent photography stations will be established for each sampling plot at selected vantage points to provide a visual record of vegetation development over time. All vegetation monitoring plots will be correlated with hydrological monitoring sites where possible.

Typical success criteria are as follows:

- 320 stems per acre through year 3 of monitoring
- 288 stems per acre through year 4
- 260 stems per acre through year 5

These values include both planted and native volunteer species. Meeting these criteria for the relatively humid temperate climate at the Heath Dairy Site in North Carolina should be more than feasible.

## 8.3 Wetland Hydrology

Six groundwater gauges are installed on Site and data has been collected periodically and will continue through the monitoring phase (See Figure 4a). These gauges record data once daily.

Wetland hydrology success criterion will be satisfied in restored wetland areas when saturated soil conditions occur within 12 inches of the ground's surface for a minimum of 12.5% of the growing season during average climatic conditions, or if the hydroperiod in the restored area is within 20% of the reference wetland's hydroperiod during drought conditions. These conditions

do not have to be met since only enhancement and preservation credits are being sought, but collecting this data will provide additional supporting information.

## 8.4 Schedule / Reporting

As-built plans will be submitted within 90 days following the completion of mitigation construction. The as-built plans will show final site grading along with a description of post-construction site conditions. The report will also provide a map of groundwater monitoring gauge locations, proposed photographic monitoring stations, and proposed vegetation sampling areas.

The first year monitoring report will be submitted to EEP in hard copy and digital format. Subsequent monitoring reports will be submitted by EEP annually to the resource agencies following each growing season. Table II outlines the schedule of significant project milestones.

## 9.0 REFERENCES

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| Table I. Project Restoration Structure and Objectives | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Restoration Reach / Area | Station Range/ Location | Restoration Type | Priority Approach | Existing LF or AC | Designed LF or AC | Note |
| Back Creek - Upper | Back Creek 1a | 10+00 – 11+55 -BC- | Restoration | P2 | 149 LF | 155 LF | |
| | Back Creek 1b | 11+55 – 16+25 -BC- | Enhancement | E1 | 470 LF | 470 LF | |
| | Back Creek 1c | 16+25 – 17+00 -BC- | Restoration | P1 | 75 LF | 75 LF | |
| | Back Creek 1d | 17+00 – 18+50 -BC- | Enhancement | E1 | 150 LF | 150 LF | |
| | Back Creek 2a | 18+50 – 20+90 -BC- | Enhancement | E1 | 240 LF | 240 LF | |
| | Back Creek 2b | 20+90 – 24+60 -BC- | Restoration | P1 | 374 LF | 370 LF | |
| | Back Creek 2c | 24+60 – 25+60 -BC- | Enhancement | E1 | 100 LF | 100 LF | |
| | Back Creek 2d | 25+60 – 30+80 -BC- | Restoration | P2 | 568 LF | 520 LF | |
| | Back Creek 3 | 30+80 – 48+30 -BC- | Restoration | P1 | 1836 LF | 1750 LF | |
| Back Creek - Lower | Back Creek 4a | 48+30 – 57+20 -BC- | Restoration | P1 | 531 LF | 890 LF | |
| | Back Creek 4b | 57+20 – 60+45 -BC- | Restoration | P2 | 310 LF | 325 LF | |
| | Back Creek 5 | 60+45 – 63+45 -BC- | Restoration | P2 | 205 LF | 300 LF | |
| West Branch | West Preserve | 14+58 - 18+75 - EXWB- | Preservation | NA | 417 LF | 417 LF | |
| | West Branch 1 | 10+00 – 13+80 - WESTB- | Restoration | P1 | 439 LF | 380 LF | |
| | West Branch 2 | 13+80 – 19+55 - WESTB- | Restoration | P1 | 609 LF | 553 LF | 22’ crossing easement |
| | West Branch 3 | 19+55 – 26+12 - WESTB- | Restoration | P1 | 475 LF | 657 LF | |
| North Branch | North Branch 1 | 10+30 – 21+97 - NORTHB- | Restoration | P2 | 495 LF | 1167 LF | |
| East Branch | East Preserve | 5+01 - 7+20 - EXEB- | Preservation | NA | 219 LF | 219 LF | |
| | East Branch 1 | 9+96 – 15+93 - EASTB- | Restoration | P1 | 580 LF | 537 LF | 60’ crossing easement |
| UT to West Branch | UT to West Br. | 10+36 – 11+38 - UTWESTB- | Restoration | P1 | 102 LF | 102 LF | |
| | | | | | | | |
| Total Designed Stream Length | | | Restoration | | 7,781 LF | | |
| | | | Enhancement | | 960 LF | | |
| | | | Preservation | | 636 LF | | |

| | Table I. Project Restoration Structure and Objectives - continued | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Restoration Reach / Area** | **Station Range/ Location** | **Restoration Type** | **Priority Approach** | **Existing LF or AC** | **Designed LF or AC** | **Note** |
| Wetlands | Wetland A1 | *NA* | Preservation | *NA* | 1.075 AC | 1.075 AC | |
| | Wetland A2 | *NA* | Enhancement | *NA* | 0.136AC | 0.136 AC | 0.008ac impacted |
| | Wetland B | *NA* | Enhancement | *NA* | 0.307 AC | 0.307 AC | |
| | Wetland C | *NA* | Enhancement | *NA* | 0.104 AC | 0.104 AC | |
| | Wetland E | *NA* | Enhancement | *NA* | 0.010 AC | 0.010 AC | |
| | Wetland F | *NA* | Enhancement | *NA* | 0.036 AC | 0.036 AC | |
| | Wetland I | *NA* | Preservation | *NA* | 0.007 AC | 0.007 AC | 0.003ac impacted |
| | Wetland J | *NA* | Preservation | *NA* | 0.090 AC | 0.090 AC | |
| | Wetland K | *NA* | Enhancement | *NA* | 0.010 AC | 0.010 AC | |
| | Wetland L | *NA* | Preservation | *NA* | 0.007 AC | 0.007 AC | |
| | Riparian Buffer | *NA* | Preservation | *NA* | *NA* | 30 AC | |

| | | |
|---|---|---|
| Total Designed Wetland Area (minus impacted acreage) | Enhancement | 0.60 AC |
| | Preservation | 1.18 AC |
| Total Designed Riparian Buffer Area | Restoration | 30 AC |

| Table II. Project Activity and Reporting History | | |
|---|---|---|
| **Activity or Report** | **Data Collection Complete** | **Completion or Delivery** |
| Restoration Plan | April 22, 2009 | May 18, 2009 |
| CLOMR | | |
| Final Design – Construction Plans | | |
| Construction | NA | |
| Permanent seed applied to entire site | NA | |
| Plantings for entire site | NA | |
| Mitigation Plan (Year 0 Monitoring – baseline) | | |
| Year 1 Monitoring | | |
| Year 2 Monitoring | | |
| Year 3 Monitoring | | |
| Year 4 Monitoring | | |

| Table III. Project Contact Table | |
|---|---|
| **Owner**<br><br>NC Ecosystem Enhancement Program | Melonie Allen<br>2728 Capital Boulevard Suite 1H 103<br>Raleigh, NC 27604<br>919-368-9352 |
| **Designer**<br><br>HSMM of North Carolina, Inc. | Rick Prosser<br>3333 Regency Parkway Suite 120<br>Cary, NC 27518<br>919-460-6895 x 4202 |
| **Landowner**<br><br>Mr. Phillip Ridge<br><br><br><br>Dr. Edward Shackleford | <br><br>3562 Plainfield Road<br>Sophia, NC 27350<br>336-861-4555<br><br>203 Shannon Road<br>Asheboro, NC 27203<br>336-625-6222 |
| **Construction Contractor** | |
| **Planting Contractor** | |
| **Seeding Contractor** | |
| **Monitoring Performer**<br><br>HSMM of North Carolina, Inc. | Rick Prosser<br>3333 Regency Parkway Suite 120<br>Cary, NC 27518<br>919-460-6895 x 4202 |

| Table IV. Project Attribute Table | | | | |
|---|---|---|---|---|
| Project County | Randolph | | | |
| Physiographic Region | Blue Ridge/Piedmont | | | |
| Ecoregion | Carolina Slate Belt Piedmont | | | |
| Project River Basin | Yadkin | | | |
| USGS HUC for Project | 03040103050050 | | | |
| NCDWQ Sub-basin for Project | 03-07-09 | | | |
| Within extent of EEP Watershed Plan? | Yadkin River Basin Restoration Priority Plan 2009 | | | |
| WRC Class (Warm, Cool, Cold) | Cool | | | |
| % of project easement fenced or demarcated? | 100 | | | |
| Beaver activity observed during design phase? | No | | | |
| **Restoration Component Attribute Table** | | | | |
| | Back Creek Reach 1 | Back Creek Reach 2 | Back Creek Reach 3 | Back Creek Reach 4 |
| Drainage area ($mi^2$) | 1.04 | 1.08 | 1.22 | 1.30 |
| Stream order | 2nd | 2nd | 2nd | 2nd |
| Restored length (feet) | 230 | 890 | 1,750 | 890 |
| Enhanced length (feet) | 620 | 340 | 0 | 0 |
| Perennial or Intermittent | perennial | | | |
| Watershed type | rural | | | |
| Watershed LULC Distribution | | | | |
| Agricultural (%) | 55 | 55 | 55 | 55 |
| Forested (%) | 35 | 35 | 35 | 35 |
| Residential (%) | 7 | 7 | 7 | 7 |
| Roadway/Right of Way (%) | 3 | 3 | 3 | 3 |
| Watershed impervious cover (%) | 3 | 3 | 3 | 3 |
| NCDWQ AU/Index number | 13-2-3-3-(0.3) | | | |
| NCDWQ classification | WS-II; HQW | | | |
| 303d listed? | no | | | |
| Upstream of a 303d listed segment? | yes | | | |
| Reasons for 303d listing or stressor | low dissolved oxygen | | | |
| Total acreage of easement | 56.8 | | | |
| Total vegetated acreage within easement | 15.8 | | | |
| Total planted acreage as part of the restoration | 31.6 | | | |
| Rosgen classification of pre-existing | G4 | G4 | G4 | E4 |
| Rosgen classification of proposed | B4c | B4c | B4c | E4 |
| Valley type | II | II | II | VIII |
| Valley slope (%) | 0.6 – 1.2 | 0.6 – 0.8 | 0.4 – 0.8 | 0.2 – 0.3 |
| Valley side slope range (%) | 7 – 12 | 7 – 12 | 10 – 20 | 10 – 20 |
| Valley toe slope range (%) | 2 - 5 | 2 - 5 | 1.2 – 1.6 | 1.2 – 1.6 |
| Cowardin classification | R3UB1 | R3UB1 | R3UB1 | R3UB1 |
| Trout waters designation | no | | | |
| Species of concern, endangered, etc.? | yes | | | |
| Dominant soil series and characteristics | Moderately erodible clay loam | | | |
| Series | BtC2 – Badin-Tarrus Complex, 8-15% Slope | | | |
| Depth | 37 inches (60 inches to weathered moderately fractured argillite rock) | | | |
| Clay% | 30-40 | | | |
| K | 1.97e-4 ft/min to 1.97e-5 ft/min | | | |
| T | 5.91e-4 ft2/min to 5.91e-5 ft2.min | | | |

| Table IV. Project Attribute Table - continued | | | | |
|---|---|---|---|---|
| Project County | Randolph | | | |
| Physiographic Region | Blue Ridge/Piedmont | | | |
| Ecoregion | Carolina Slate Belt Piedmont | | | |
| Project River Basin | Yadkin | | | |
| USGS HUC for Project | 03040103050050 | | | |
| NCDWQ Sub-basin for Project | 03-07-09 | | | |
| Within extent of EEP Watershed Plan? | Yadkin River Basin Restoration Priority Plan 2009 | | | |
| WRC Class (Warm, Cool, Cold) | Cool | | | |
| % of project easement fenced or demarcated? | 100 | | | |
| Beaver activity observed during design phase? | No | | | |
| **Restoration Component Attribute Table** | | | | |
| | Back Creek Reach 4b | Back Creek Reach 5 | East Branch | North Branch |
| Drainage area ($mi^2$) | 1.34 | 2.69 | 0.25 | 1.14 |
| Stream order | 2nd | 3rd | 1st | 2nd |
| Restored length (feet) | 325 | 300 | 537 | 1,167 |
| Enhanced length (feet) | 0 | 0 | 0 | 0 |
| Perennial or Intermittent | perennial | | | |
| Watershed type | rural | | | |
| Watershed LULC Distribution | | | | |
| Agricultural (%) | 55 | 55 | 59 | 60 |
| Forested (%) | 35 | 35 | 39 | 28 |
| Residential (%) | 7 | 7 | 0 | 10 |
| Roadway/Right of Way (%) | 3 | 3 | 2 | 2 |
| Watershed impervious cover (%) | 3 | 3 | 2 | 4 |
| NCDWQ AU/Index number | 13-2-3-3-(0.3) | | | |
| NCDWQ classification | WS-II; HQW | | | |
| 303d listed? | no | | | |
| Upstream of a 303d listed segment? | yes | | | |
| Reasons for 303d listing or stressor | low dissolved oxygen | | | |
| Total acreage of easement | 56.8 | | | |
| Total vegetated acreage within easement | 15.8 | | | |
| Total planted acreage as part of the restoration | 31.6 | | | |
| Rosgen classification of pre-existing | E4 | E4 | G4 | E4 |
| Rosgen classification of proposed | B4c | B4c | B4c | B4c |
| Valley type | VIII | VIII | II | II |
| Valley slope (%) | 0.2 – 0.3 | 0.2 – 0.3 | 0.3 – 0.9 | 0.3 – 0.4 |
| Valley side slope range (%) | 10 – 20 | 10 – 20 | 8 – 12 | 6 – 8 |
| Valley toe slope range (%) | 1.2 – 1.6 | 1.2 – 1.6 | 4 - 5 | 1 – 2 |
| Cowardin classification | R3UB1 | R3UB1 | R3UB1 | R3UB1 |
| Trout waters designation | no | | | |
| Species of concern, endangered, etc.? | yes | | | |
| Dominant soil series and characteristics | Moderately erodible clay loam | | | |
| Series | BtC2 – Badin-Tarrus Complex, 8-15% Slope | | | |
| Depth | 37 inches (60 inches to weathered moderately fractured argillite rock) | | | |
| Clay% | 30-40 | | | |
| K | 1.97e-4 ft/min to 1.97e-5 ft/min | | | |
| T | 5.91e-4 ft2/min to 5.91e-5 ft2.min | | | |

| Table IV. Project Attribute Table - continued | | | | |
|---|---|---|---|---|
| Project County | Randolph | | | |
| Physiographic Region | Blue Ridge/Piedmont | | | |
| Ecoregion | Carolina Slate Belt Piedmont | | | |
| Project River Basin | Yadkin | | | |
| USGS HUC for Project | 03040103050050 | | | |
| NCDWQ Sub-basin for Project | 03-07-09 | | | |
| Within extent of EEP Watershed Plan? | Yadkin River Basin Restoration Priority Plan 2009 | | | |
| WRC Class (Warm, Cool, Cold) | Cool | | | |
| % of project easement fenced or demarcated? | 100 | | | |
| Beaver activity observed during design phase? | No | | | |
| **Restoration Component Attribute Table** | | | | |
| | West Br. Reach 1 | West Br. Reach 2 | West Br. Reach 3 | UT to West Branch |
| Drainage area ($mi^2$) | 0.05 | 0.06 | 0.14 | 0.05 |
| Stream order | 0 | 0 | 0 | 0 |
| Restored length (feet) | 380 | 553 | 657 | 102 |
| Enhanced length (feet) | 0 | 0 | 0 | 0 |
| Perennial or Intermittent | perennial | | | |
| Watershed type | rural | | | |
| Watershed LULC Distribution | | | | |
| Agricultural (%) | 58 | 58 | 58 | 60 |
| Forested (%) | 39 | 39 | 39 | 25 |
| Residential (%) | 0 | 0 | 0 | 12 |
| Roadway/Right of Way (%) | 3 | 3 | 3 | 3 |
| Watershed impervious cover (%) | 2 | 2 | 2 | 4 |
| NCDWQ AU/Index number | 13-2-3-3-(0.3) | | | |
| NCDWQ classification | WS-II; HQW | | | |
| 303d listed? | no | | | |
| Upstream of a 303d listed segment? | yes | | | |
| Reasons for 303d listing or stressor | low dissolved oxygen | | | |
| Total acreage of easement | 56.8 | | | |
| Total vegetated acreage within easement | 15.8 | | | |
| Total planted acreage as part of the restoration | 31.6 | | | |
| Rosgen classification of pre-existing | G4 | G4 | G4 | G4 |
| Rosgen classification of proposed | B4c | B4c | B4c | B4 |
| Valley type | II | II | II | II |
| Valley slope (%) | 1.4 – 2.0 | 2.0 – 3.6 | 1.2 – 1.7 | 2.0 – 3.5 |
| Valley side slope range (%) | 6 – 12 | 6 – 12 | 10 – 20 | 6 – 9 |
| Valley toe slope range (%) | 3 - 5 | 3 - 5 | 2 - 3 | 2 - 3 |
| Cowardin classification | R3UB1 | R3UB1 | R3UB1 | R3UB1 |
| Trout waters designation | no | | | |
| Species of concern, endangered, etc.? | yes | | | |
| Dominant soil series and characteristics | Moderately erodible clay loam | | | |
| Series | BtC2 – Badin-Tarrus Complex, 8-15% Slope | | | |
| Depth | 37 inches (60 inches to weathered moderately fractured argillite rock) | | | |
| Clay% | 30-40 | | | |
| K | 1.97e-4 ft/min to 1.97e-5 ft/min | | | |
| T | 5.91e-4 ft2/min to 5.91e-5 ft2.min | | | |

| Table Va. Morphological Table | | | | | |
|---|---|---|---|---|---|
| | **Existing Conditions** | **Reference Reach** | **Design** | | |
| **Stream Reach** | **Back Creek Upper** | **Fork Creek** | **Back Cr. Reach 1** | **Back Cr. Reach 2** | **Back Cr. Reach 3** |
| Stream Type | G4 | B4c | B4c | B4c | B4c |
| Drainage Area ($mi^2$) | 0.94 | 2.2 | 1.04 | 1.08 | 1.22 |
| Bankfull Width (ft) | 10.1 | 20.1 | 16.5 | 16.6 | 17.5 |
| Mean Depth (ft) | 1.68 | 1.73 | 1.2 | 1.2 | 1.3 |
| Bankfull $XS_{AREA}$ ($ft^2$) | 17.0 | 34.8 | 19 | 19 | 22 |
| Bankfull Discharge (cfs) | 75 | 163 | 86 | 88 | 101 |
| Bkf Mean Velocity (ft/s) | 4.4 | 4.7 | 4.5 | 4.5 | 4.5 |
| Width/Depth Ratio | 6.0 | 12 | 14 | 14 | 14 |
| Max. Riffle Depth (ft) | 2.4 | 2.0 | 1.6 | 1.6 | 1.7 |
| Riffle Depth Ratio | 1.4 | 1.2 | 1.3 | 1.3 | 1.3 |
| Max. Pool Depth (ft) | 2.8 | 2.6 | 2.4 | 2.5 | 2.6 |
| Pool Depth Ratio | 1.7 | 1.5 | 2.0 | 2.0 | 2.0 |
| Flood Prone Width (ft) | 29 | 63 | 30 – 45 | 28 – 77 | 34 – 120 |
| Entrenchment Ratio | 1.4 – 4.5 | 2.7 – 3.1 | 1.9 – 2.9 | 1.7 – 4.8 | 2.0 – 7.0 |
| Bank Height Ratio | 1.4 – 2.3 | 1.2 | 1.0 | 1.0 | 1.0 |
| Meander Length (ft) | 190 | 37 – 172 | 110 – 120 | 125 – 145 | 130 – 145 |
| Meander Length Ratio | 19 | 1.8 – 8.6 | 7.1 – 7.7 | 7.8 – 9.1 | 7.6 – 8.5 |
| Radius of Curvature (ft) | 18 | 47 – 318 | 31 – 46 | 32 – 48 | 34 – 51 |
| Rc Ratio | 1.8 | 2.3 – 16 | 2 – 3 | 2 – 3 | 2 – 3 |
| Belt Width (ft) | 25 | 33 – 40 | 30 – 35 | 40 – 50 | 45 – 60 |
| Meander Width Ratio | 2.5 | 1.6 – 2.0 | 1.9 – 2.2 | 2.5 – 3.1 | 2.6 – 3.5 |
| Sinuosity | 1.0 | 1.05 | 1.1 | 1.1 | 1.1 |
| Channel Slope (ft/ft) | 0.0087 | 0.0079 | 0.0060 | 0.0062 | 0.0062 |
| Valley Slope (ft/ft) | 0.0087 | 0.0083 | 0.0066 | 0.0068 | 0.0068 |
| Riffle Slope (ft/ft) | 0.023 | 0.013 | 0.0060 | 0.0062 | 0.0062 |
| Riffle Slope Ratio | 2.6 | 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) | 7.8 | 19.9 | 18.1 | 18.3 | 19.2 |
| Pool Width Ratio | 0.8 | 1.0 | 1.1 | 1.1 | 1.1 |
| Pool Spacing (ft) | 57.6 | 71 – 134 | 66 – 99 | 66 – 99 | 70 – 105 |
| Pool Spacing Ratio | 5.7 | 3.5 – 6.7 | 4 - 6 | 4 – 6 | 4 – 6 |
| $D_{50}$ (mm) | 25 | 28 | 25 | 25 | 25 |
| $D_{84}$ (mm) | 63 | 81 | 63 | 63 | 63 |

| Table Vb. Morphological Table | | | | | |
|---|---|---|---|---|---|
| | **Existing Conditions** | **Reference Reach** | **Design** | | |
| **Stream Reach** | **Back Creek Lower** | **UT to Polecat Cr.** | **Back Creek Reach 4** | | |
| Stream Type | E4 | E4 | E4 | | |
| Drainage Area ($mi^2$) | 2.5 | 0.4 | 1.3 | | |
| Bankfull Width (ft) | 13.8 | 9.4 | 16.5 | | |
| Mean Depth (ft) | 3.07 | 1.13 | 1.4 | | |
| Bankfull $XS_{AREA}$ ($ft^2$) | 42.3 | 10.6 | 23 | | |
| Bankfull Discharge (cfs) | 167 | 37.4 | 101 | | |
| Bkf Mean Velocity (ft/s) | 3.9 | 3.5 | 3.0 | | |
| Width/Depth Ratio | 4.5 | 8.3 | 12 | | |
| Max. Riffle Depth (ft) | 4.1 | 1.6 | 2.0 | | |
| Riffle Depth Ratio | 1.3 | 1.4 | 1.45 | | |
| Max. Pool Depth (ft) | 5.0 | 1.6 | 3.5 | | |
| Pool Depth Ratio | 1.6 | 1.8 | 2.2 | | |
| Flood Prone Width (ft) | 200 | 50 | 200 | | |
| Entrenchment Ratio | 14.5 | 5.3 | 12.5 | | |
| Bank Height Ratio | 1.5 | 1.2 | 1.0 | | |
| Meander Length (ft) | 160 | 56 – 85 | 135 – 155 | | |
| Meander Length Ratio | 12 | 6 – 9 | 8.4 – 9.7 | | |
| Radius of Curvature (ft) | 15 | 19 – 50 | 32 – 48 | | |
| Rc Ratio | 1.1 | 2.0 – 5.3 | 2 – 3 | | |
| Belt Width (ft) | 23 | 28 – 50 | 90 | | |
| Meander Width Ratio | 1.7 | 3.0 – 5.3 | 5.6 | | |
| Sinuosity | 1.0 | 1.4 | 1.3 | | |
| Channel Slope (ft/ft) | 0.0045 | 0.012 | 0.0023 | | |
| Valley Slope (ft/ft) | 0.0045 | 0.017 | 0.0030 | | |
| Riffle Slope (ft/ft) | 0.0037 | 0.027 | 0.0023 | | |
| Riffle Slope Ratio | 0.8 | 2.3 | 1.0 | | |
| Pool Slope (ft/ft) | 0.0 | 0.017 | 0.0 | | |
| Pool Slope Ratio | 0.0 | 1.4 | 0.0 | | |
| Pool Width (ft) | 13.4 | 7.1 | 18.1 | | |
| Pool Width Ratio | 1.0 | 0.8 | 1.1 | | |
| Pool Spacing (ft) | 43 | 34 – 52 | 66 – 99 | | |
| Pool Spacing Ratio | 3.1 | 3.6 – 5.5 | 4 – 6 | | |
| $D_{50}$ (mm) | 25 | 15 | 25 | | |
| $D_{84}$ (mm) | 81 | 91 | 81 | | |

| Table Vc. Morphological Table | | | | | |
|---|---|---|---|---|---|
| | **Existing Conditions** | **Reference Reach** | **Design** | | |
| **Stream Reach** | **Back Creek Lower** | **Fork Creek** | **Back Cr. Reach 4b** | **Back Cr. Reach 5** | |
| Stream Type | E4 | B4c | B4c | B4c | |
| Drainage Area ($mi^2$) | 2.5 | 2.2 | 1.34 | 2.69 | |
| Bankfull Width (ft) | 13.8 | 20.1 | 17.5 | 22.5 | |
| Mean Depth (ft) | 3.07 | 1.73 | 1.2 | 1.6 | |
| Bankfull $XS_{AREA}$ ($ft^2$) | 42.3 | 34.8 | 22 | 36 | |
| Bankfull Discharge (cfs) | 167 | 163 | 101 | 174 | |
| Bkf Mean Velocity (ft/s) | 3.9 | 4.7 | 3.0 | 4.5 | |
| Width/Depth Ratio | 4.5 | 12 | 14 | 14 | |
| Max. Riffle Depth (ft) | 4.1 | 2.0 | 1.7 | 2.2 | |
| Riffle Depth Ratio | 1.3 | 1.2 | 1.4 | 1.4 | |
| Max. Pool Depth (ft) | 5.0 | 2.6 | 2.6 | 3.3 | |
| Pool Depth Ratio | 1.6 | 1.5 | 2.1 | 2.1 | |
| Flood Prone Width (ft) | 200 | 63 | 35 | 45 | |
| Entrenchment Ratio | 14.5 | 2.7 – 3.1 | 2.0 | 2.0 | |
| Bank Height Ratio | 1.5 | 1.2 | 1.0 | 1.0 | |
| Meander Length (ft) | 55 | 37 – 172 | 115 | 145 | |
| Meander Length Ratio | 4.0 | 1.8 – 8.6 | 6.6 | 6.6 | |
| Radius of Curvature (ft) | 13 | 47 – 318 | 35 – 52 | 44 – 66 | |
| Rc Ratio | 1.0 | 2.3 – 16 | 2 – 3 | 2 – 3 | |
| Belt Width (ft) | 35 | 33 – 40 | 40 | 60 | |
| Meander Width Ratio | 2.5 | 1.6 – 2.0 | 2.3 | 2.7 | |
| Sinuosity | 1.0 | 1.05 | 1.1 | 1.1 | |
| Channel Slope (ft/ft) | 0.0045 | 0.0079 | 0.0095 | 0.0095 | |
| Valley Slope (ft/ft) | 0.0045 | 0.0083 | 0.0105 | 0.0105 | |
| Riffle Slope (ft/ft) | 0.0037 | 0.013 | 0.0095 | 0.0095 | |
| Riffle Slope Ratio | 0.8 | 0.1 | 1.0 | 1.0 | |
| Pool Slope (ft/ft) | 0.0 | 0.001 | 0.0 | 0.0 | |
| Pool Slope Ratio | 0.0 | 0.1 | 0.0 | 0.0 | |
| Pool Width (ft) | 13.4 | 19.9 | 19.2 | 24.7 | |
| Pool Width Ratio | 1.0 | 1.0 | 1.1 | 1.1 | |
| Pool Spacing (ft) | 43 | 71 – 134 | 70 – 105 | 90 – 135 | |
| Pool Spacing Ratio | 3.1 | 3.5 – 6.7 | 4 – 6 | 4 – 6 | |
| $D_{50}$ (mm) | 25 | 28 | 25 | 25 | |
| $D_{84}$ (mm) | 81 | 81 | 81 | 81 | |

| Table Vd. Morphological Table | | | | | |
|---|---|---|---|---|---|
| | **Existing Conditions** | **Reference Reach** | **Design** | | |
| **Stream Reach** | **North Branch** | **Fork Creek** | **North Branch** | | |
| Stream Type | E4 | B4c | B4c | | |
| Drainage Area ($mi^2$) | 2.5 | 2.2 | 1.14 | | |
| Bankfull Width (ft) | 13.8 | 20.1 | 16.5 | | |
| Mean Depth (ft) | 3.07 | 1.73 | 1.2 | | |
| Bankfull $XS_{AREA}$ ($ft^2$) | 42.3 | 34.8 | 20 | | |
| Bankfull Discharge (cfs) | 167 | 163 | 92 | | |
| Bkf Mean Velocity (ft/s) | 3.9 | 4.7 | 4.5 | | |
| Width/Depth Ratio | 4.5 | 12 | 13 | | |
| Max. Riffle Depth (ft) | 4.1 | 2.0 | 1.7 | | |
| Riffle Depth Ratio | 1.3 | 1.2 | 1.4 | | |
| Max. Pool Depth (ft) | 5.0 | 2.6 | 2.6 | | |
| Pool Depth Ratio | 1.6 | 1.5 | 2.1 | | |
| Flood Prone Width (ft) | 200 | 63 | 40 – 57 | | |
| Entrenchment Ratio | 14.5 | 2.7 – 3.1 | 2.4 – 3.4 | | |
| Bank Height Ratio | 1.5 | 1.2 | 1.0 | | |
| Meander Length (ft) | 55 | 37 – 172 | 150 – 160 | | |
| Meander Length Ratio | 4.0 | 1.8 – 8.6 | 9.1 – 9.7 | | |
| Radius of Curvature (ft) | 13 | 47 – 318 | 33 – 49 | | |
| Rc Ratio | 1.0 | 2.3 – 16 | 2 – 3 | | |
| Belt Width (ft) | 35 | 33 – 40 | 40 – 50 | | |
| Meander Width Ratio | 2.5 | 1.6 – 2.0 | 2.4 – 3.0 | | |
| Sinuosity | 1.0 | 1.05 | 1.1 | | |
| Channel Slope (ft/ft) | 0.0045 | 0.0079 | 0.0036 | | |
| Valley Slope (ft/ft) | 0.0045 | 0.0083 | 0.0040 | | |
| Riffle Slope (ft/ft) | 0.0037 | 0.013 | 0.0036 | | |
| Riffle Slope Ratio | 0.8 | 0.1 | 1.0 | | |
| Pool Slope (ft/ft) | 0.0 | 0.001 | 0.0 | | |
| Pool Slope Ratio | 0.0 | 0.1 | 0.0 | | |
| Pool Width (ft) | 13.4 | 19.9 | 16.5 | | |
| Pool Width Ratio | 1.0 | 1.0 | 1.0 | | |
| Pool Spacing (ft) | 43 | 71 – 134 | 66 – 99 | | |
| Pool Spacing Ratio | 3.1 | 3.5 – 6.7 | 4 – 6 | | |
| $D_{50}$ (mm) | 25 | 28 | 25 | | |
| $D_{84}$ (mm) | 81 | 81 | 81 | | |

| Table Ve. Morphological Table | | | | | |
|---|---|---|---|---|---|
| | **Existing Conditions** | **Reference Reach** | **Design** | | |
| **Stream Reach** | **East Branch** | **Fork Creek** | **East Branch** | | |
| Stream Type | G4 | B4c | B4c | | |
| Drainage Area ($mi^2$) | 0.05 | 2.2 | 0.25 | | |
| Bankfull Width (ft) | 5.0 | 20.1 | 10.0 | | |
| Mean Depth (ft) | 0.62 | 1.73 | 0.7 | | |
| Bankfull $XS_{AREA}$ ($ft^2$) | 3.1 | 34.8 | 7 | | |
| Bankfull Discharge (cfs) | 8.5 | 163 | 30 | | |
| Bkf Mean Velocity (ft/s) | 2.7 | 4.7 | 4.5 | | |
| Width/Depth Ratio | 8 | 12 | 14 | | |
| Max. Riffle Depth (ft) | 0.8 | 2.0 | 1.00 | | |
| Riffle Depth Ratio | 1.3 | 1.2 | 1.4 | | |
| Max. Pool Depth (ft) | 1.4 | 2.6 | 1.5 | | |
| Pool Depth Ratio | 2.3 | 1.5 | 2.1 | | |
| Flood Prone Width (ft) | 5.8 | 63 | 26 – 42 | | |
| Entrenchment Ratio | 1.2 | 2.7 – 3.1 | 2.7 – 4.4 | | |
| Bank Height Ratio | 2.6 | 1.2 | 1.0 | | |
| Meander Length (ft) | 80 | 37 – 172 | 90 | | |
| Meander Length Ratio | 16 | 1.8 – 8.6 | 9.5 | | |
| Radius of Curvature (ft) | 9 – 43 | 47 – 318 | 21 – 31 | | |
| Rc Ratio | 1.8 – 8.6 | 2.3 – 16 | 2 – 3 | | |
| Belt Width (ft) | 16 | 33 – 40 | 25 | | |
| Meander Width Ratio | 3.2 | 1.6 – 2.0 | 2.6 | | |
| Sinuosity | 1.05 | 1.05 | 1.1 | | |
| Channel Slope (ft/ft) | 0.011 | 0.0079 | 0.0080 | | |
| Valley Slope (ft/ft) | 0.012 | 0.0083 | 0.0088 | | |
| Riffle Slope (ft/ft) | 0.31 | 0.013 | 0.0080 | | |
| Riffle Slope Ratio | 28 | 0.1 | 1.0 | | |
| Pool Slope (ft/ft) | 0.0 | 0.001 | 0.0 | | |
| Pool Slope Ratio | 0 | 0.1 | 0.0 | | |
| Pool Width (ft) | 4.4 | 19.9 | 11.0 | | |
| Pool Width Ratio | 0.9 | 1.0 | 1.1 | | |
| Pool Spacing (ft) | 9 – 45 | 71 – 134 | 40 – 60 | | |
| Pool Spacing Ratio | 2 – 9 | 3.5 – 6.7 | 4 – 6 | | |
| $D_{50}$ (mm) | 9 | 28 | 25 | | |
| $D_{84}$ (mm) | 19 | 81 | 81 | | |

| Table Vf. Morphological Table | | | | | |
|---|---|---|---|---|---|
| | **Existing Conditions** | **Reference Reach** | **Design** | | |
| **Stream Reach** | **West Branch** | **Fork Creek** | **West Branch Reach 1** | **West Branch Reach 2** | **West Branch Reach 3** |
| Stream Type | G4 | B4c | B4c | B4c | B4c |
| Drainage Area ($mi^2$) | 0.05 | 2.2 | 0.05 | 0.06 | 0.14 |
| Bankfull Width (ft) | 5.0 | 20.1 | 5.8 | 6.2 | 8.2 |
| Mean Depth (ft) | 0.62 | 1.73 | 0.4 | 0.44 | 0.6 |
| Bankfull $XS_{AREA}$ ($ft^2$) | 3.1 | 34.8 | 2.4 | 2.7 | 4.7 |
| Bankfull Discharge (cfs) | 8.5 | 163 | 9 | 10 | 19 |
| Bkf Mean Velocity (ft/s) | 2.7 | 4.7 | 4.5 | 4.5 | 4.5 |
| Width/Depth Ratio | 8 | 12 | 14 | 14 | 14 |
| Max. Riffle Depth (ft) | 0.8 | 2.0 | 0.55 | 0.6 | 0.8 |
| Riffle Depth Ratio | 1.3 | 1.2 | 1.38 | 1.36 | 1.36 |
| Max. Pool Depth (ft) | 1.4 | 2.6 | 0.8 | 0.9 | 1.0 |
| Pool Depth Ratio | 2.3 | 1.5 | 2.0 | 2.0 | 2.0 |
| Flood Prone Width (ft) | 5.8 | 63 | 12 – 22 | 12 – 30 | 16 |
| Entrenchment Ratio | 1.2 | 2.7 – 3.1 | 2.0 – 3.8 | 2.0 – 4.8 | 2.0 |
| Bank Height Ratio | 2.6 | 1.2 | 1.0 | 1.0 | 1.0 |
| Meander Length (ft) | 60 – 120 | 37 – 172 | 50 – 55 | 50 – 60 | 60 – 70 |
| Meander Length Ratio | 12 – 24 | 1.8 – 8.6 | 8.6 – 9.5 | 8.1 – 9.7 | 7.3 – 8.5 |
| Radius of Curvature (ft) | 9 – 43 | 47 – 318 | 12 – 17 | 12 – 19 | 16 – 25 |
| Rc Ratio | 1.8 – 8.6 | 2.3 – 16 | 2 – 3 | 2 – 3 | 2 – 3 |
| Belt Width (ft) | 20 | 33 – 40 | 15 – 20 | 15 – 20 | 25 – 30 |
| Meander Width Ratio | 4.0 | 1.6 – 2.0 | 2.6 – 3.4 | 2.4 – 3.2 | 3.1 – 3.7 |
| Sinuosity | 1.07 | 1.05 | 1.1 | 1.2 | 1.1 |
| Channel Slope (ft/ft) | 0.011 | 0.0079 | 0.0128 | 0.0174 | 0.00108 |
| Valley Slope (ft/ft) | 0.019 | 0.0083 | 0.0141 | 0.0209 | 0.00119 |
| Riffle Slope (ft/ft) | 0.31 | 0.013 | 0.0128 | 0.0174 | 0.0108 |
| Riffle Slope Ratio | 28 | 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 | 0.1 | 0.0 | 0.0 | 0.0 |
| Pool Width (ft) | 4.4 | 19.9 | 6.4 | 6.8 | 9.0 |
| Pool Width Ratio | 0.9 | 1.0 | 1.1 | 1.1 | 1.1 |
| Pool Spacing (ft) | 9 – 45 | 71 – 134 | 23 – 35 | 25 – 37 | 32 – 49 |
| Pool Spacing Ratio | 2 – 9 | 3.5 – 6.7 | 4 – 6 | 4 – 6 | 4 – 6 |
| $D_{50}$ (mm) | 9 | 28 | 9 | 9 | 9 |
| $D_{84}$ (mm) | 19 | 81 | 19 | 19 | 19 |

| Table VI. Estimate of Annual Bank Erosion | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Bank** | **From Station** | **To Station** | **Length (feet)** | **Near Bank Stress Index** | **BEHI Curve** | **Bank Erosion Rate (feet/year)** | **Bank Height (feet)** | **Annual Erodibility (tons/year)** |
| Back Creek | Both | 5800 | 6018 | 218 | Very Low | High | 0.08 | 5.5 | 7.7 |
| | Both | 5204 | 5800 | 596 | Very Low | High | 0.08 | 5.4 | 20.6 |
| | Both | 5059 | 5204 | 145 | Very Low | High | 0.08 | 2.7 | 2.5 |
| | Both | 4695 | 5059 | 364 | Very Low | High | 0.08 | 3.0 | 7.0 |
| | LT | 4491 | 4695 | 204 | Very Low | Very High | 0.14 | 5.0 | 5.7 |
| | RT | 4491 | 4695 | 204 | Very Low | High | 0.08 | 3.5 | 2.3 |
| | Both | 3765 | 4491 | 726 | Very Low | High | 0.08 | 3.0 | 13.9 |
| | Both | 3166 | 3765 | 599 | Very Low | High | 0.08 | 3.0 | 11.5 |
| | Both | 3081 | 3166 | 85 | Very Low | Very High | 0.14 | 3.0 | 2.9 |
| | Both | 1933 | 3081 | 1148 | Low | Extreme | 1.8 | 4.5 | 743.9 |
| | Both | 1010 | 1933 | 923 | Low | Extreme | 1.8 | 3.0 | 403.1 |
| East Branch | Both | 1958 | 2007 | 49 | Low | High | 0.1 | 3.0 | 1.4 |
| | Both | 1519 | 1958 | 439 | Very Low | Low | 0.005 | 1.3 | 0.2 |
| | Both | 1396 | 1519 | 123 | Very Low | High | 0.08 | 1.4 | 2.1 |
| | LT | 0 | 0 | 0 | Very Low | High | 0.08 | 3.0 | 2.1 |
| | RT | 0 | 0 | 0 | Very Low | High | 0.08 | 1.3 | 0.9 |
| North Branch | Both | 1457 | 1560 | 103 | Very Low | Moderate | 0.005 | 4.5 | 0.2 |
| | RT | 1000 | 1457 | 457 | Low | High | 0.1 | 4.4 | 8.0 |
| | LT | 1065 | 1457 | 392 | Very Low | Extreme | 1.5 | 4.0 | 109.7 |

| Table VI. Estimate of Annual Bank Erosion - continued | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Stream** | **Bank** | **From Station** | **To Station** | **Length (feet)** | **Near Bank Stress Index** | **BEHI Curve** | **Bank Erosion Rate (feet/year)** | **Bank Height (feet)** | **Annual Erodibility (tons/year)** |
| West Branch | Both | 2702 | 3210 | 508 | Low | Very High | 0.6 | 4.3 | 104.9 |
| | Both | 2466 | 2702 | 236 | Very Low | Extreme | 1.5 | 2.5 | 70.8 |
| | Both | 2128 | 2466 | 338 | Very Low | High | 0.08 | 2.0 | 4.3 |
| | Both | 1687 | 2128 | 441 | Very Low | High | 0.08 | 4.0 | 28.9 |
| UT to West Branch | Both | 1030 | 1138 | 108 | High | Very High | 1.0 | 4.0 | 34.6 |

| Table VII. Sediment Transport Analysis | | | | | |
|---|---|---|---|---|---|
| **Location** | **Wetted Perimeter (ft)** | **Hydraulic Radius (ft)** | **Channel Slope (ft/ft)** | **Shear Stress ($lb/ft^2$)** | **Predicted Particle Range (mm)** |
| Back Creek – U/S End | 17.2 | 1.03 | 0.004 | 0.26 | 12 – 52 |
| Back Creek – Reach 1 | 17.8 | 1.09 | 0.005 | 0.38 | 17 – 82 |
| Back Creek – Reach 2 | 17.9 | 1.09 | 0.005 | 0.37 | 17 – 80 |
| Back Creek – Reach 3 | 19.0 | 1.15 | 0.006 | 0.46 | 21 – 74 |
| Back Creek – Reach 4 | 19.0 | 1.15 | 0.009 | 0.68 | 31 – 152 |
| Back Creek – Reach 5 | 24.4 | 1.49 | 0.009 | 0.88 | 41 – 222 |
| West Branch – Reach 1 | 6.3 | 0.38 | 0.013 | 0.30 | 14 – 62 |
| West Branch – Reach 2 | 6.7 | 0.41 | 0.017 | 0.44 | 20 – 97 |
| West Branch – Reach 3 | 8.8 | 0.54 | 0.011 | 0.36 | 17 – 77 |
| UT to West Branch | 6.5 | 0.40 | 0.032 | 0.79 | 36 – 189 |
| North Branch | 18.2 | 1.13 | 0.003 | 0.25 | 11 – 51 |
| East Branch | 10.7 | 0.66 | 0.008 | 0.33 | 15 – 70 |

| Table VIII. Soil Preparation and Amendment Summary per Community Type | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Community Type I*** | | | | | | **Acres** | **16.61** |
| **Mechanical Treatment** | **Approx. Date** | **Ground Cover Fabric** | **Mulch Type** | **Mulch Density / Thickness** | **Nutrient Amendments** | **Nutrient Total (lbs)** | |
| | | | | | | | |
| | | | | | | | |
| | | | | | **Subtotal** | | |
| | | | | | | | |
| ***Community Type II*** | | | | | | **Acres** | **14.42** |
| **Mechanical Treatment** | **Approx. Date** | **Ground Cover Fabric** | **Mulch Type** | **Mulch Density / Thickness** | **Nutrient Amendments** | **Nutrient Total (lbs)** | |
| | | | | | | | |
| | | | | | | | |
| | | | | | **Subtotal** | | |
| | | | | | | | |
| ***Community Type III*** | | | | | | **Acres** | **0.56** |
| **Mechanical Treatment** | **Approx. Date** | **Ground Cover Fabric** | **Mulch Type** | **Mulch Density / Thickness** | **Nutrient Amendments** | **Nutrient Total (lbs)** | |
| | | | | | | | |
| | | | | | | | |
| | | | | | **Subtotal** | | |
| | | | | | **Total** | | **31.59** |

| Table IX. Seeding Summary for Permanent Vegetation per Planting Type | | | | |
|---|---|---|---|---|
| ***Community Type I (recommend 15 lbs/acre total)*** | | | **Acres** | **16.6** |
| **Species Name** | **Stratum** | **Common Name** | **Lbs/acre** | |
| *Andropogon gerardii* | Herb | Big Bluestem, Niagara | 0.75 | |
| *Andropogon scoparius* | Herb | Little Bluestem | 1.2 | |
| *Asclepias syriaca* | Herb | Common Milkweed | 0.3 | |
| *Baptisia australis* | Herb | Blue False Indigo | 0.15 | |
| *Carex vulpinoidea* | Herb | Fox Sedge | 1.5 | |
| *Chamaecrista fasciculata* | Herb | Partridge Pea | 0.9 | |
| *Cornus amomum* | Canopy | Silky Dogwood | 0.6 | |
| *Desmodium canadense* | Herb | Showy Tick Trefoil | 0.3 | |
| *Elymus riparus* | Herb | Riverbank Wild Rye | 0.9 | |
| *Elymus virginicus* | Herb | Virginia Wild Rye | 0.9 | |
| *Eupatorium fistulosum* | Herb | Joe Pye Weed | 0.3 | |
| *Eupatorium perfoliatum* | Herb | Boneset | 0.3 | |
| *Euthamia graminifolia* | Herb | Grass Leaved Goldenrod | 0.15 | |
| *Heliopsis helianthoides* | Herb | Ox Eye Sunflower | 0.75 | |
| *Juncus effusus* | Herb | Soft Rush | 0.3 | |
| *Monarda fistulosa* | Herb | Wild Bergamot | 0.3 | |
| *Panicum virgatum* | Herb | Switch Grass, Shelter | 0.6 | |
| *Penstemon digitalis* | Herb | Tall White Beard Tongue | 0.3 | |
| *Rhus typhina* | Shrub | Staghorn Sumac | 0.3 | |
| *Rudbeckia hirta* | Herb | Black Eyed Susan | 0.3 | |
| *Panicum scoparium* | Herb | Tioga' Deer Tongue | 1.2 | |
| *Sorghastrum nutans* | Herb | Indian Grass | 0.6 | |
| *Verbena hastata* | Herb | Blue Vervain | 0.9 | |
| *Vernonia gigantea* | Herb | Giant Ironweed | 0.15 | |
| *Eupatorium maculatum* | Herb | Spotted Joe Pye Weed | 0.3 | |
| *Viburnum dentatum* | Herb | Arrow Wood | 0.75 | |
| | | **Subtotal** | **15 lbs** | |

| Table IX. Seeding Summary for Permanent Vegetation per Planting Type - continued | | | | |
|---|---|---|---|---|
| ***Community Type II (recommend 15 lbs/acre)*** | | | **Acres** | **14.4** |
| **Species Name** | **Stratum** | **Common Name** | **Lbs/acre** | |
| *Carex lupulina* | Herb | Hop Sedge | 1.5 | |
| *Carex lurida* | Herb | Lurid (Shallow) Sedge | 1.05 | |
| *Carex squarrosa* | Herb | Squarrose Sedge | 0.45 | |
| *Hibiscus noscheutos* | Shrub | Crimsoneyed Rosemallow | 0.15 | |
| *Juncus coriaceus* | Herb | Leathery Rush | 0.3 | |
| *Juncus effusus* | Herb | Soft Rush | 1.5 | |
| *Panicum rigidulum* | Herb | Redtop Panic Grass | 9.0 | |
| *Saururus cernuus* | Herb | Lizard's Tail | 0.3 | |
| *Scirpus cyperinus* | Herb | Wool Grass | 0.75 | |
| | | **Subtotal** | **15 lbs** | |
| | | | | |
| ***Community Type III (recommend 15 lbs/acre or 1/3 to 1/2 lbs/1,000 ft2)*** | | | **Acres** | **0.6** |
| **Species Name** | **Stratum** | **Common Name** | **Lbs/acre** | |
| *Asclepias incarnata* | Herb | Swamp Milkweed | 0.17 | |
| *Aster puniceus* | Herb | Purple Stemmed Aster | 0.17 | |
| *Carex comosa* | Herb | Cosmos (Bristly) Sedge | 0.25 | |
| *Carex crinita* | Herb | Fringed (Nodding) Sedge | 0.25 | |
| *Carex lupulina* | Herb | Hop Sedge | 0.25 | |
| *Carex lurida* | Herb | Lurid (Shallow) Sedge | 0.84 | |
| *Carex scoparia* | Herb | Blunt Broom Sedge | 0.84 | |
| *Carex stipata* | Herb | Awl Sedge | 0.08 | |
| *Carex vulpinoidea* | Herb | Fox Sedge | 1.68 | |
| *Eupatorium fistulosum* | Herb | Joe Pye Weed | 0.17 | |
| *Eupatorium perfoliatum* | Herb | Boneset | 0.25 | |
| *Iris versicolor* | Herb | Blue Flag | 0.08 | |
| *Juncus effusus* | Herb | Soft Rush | 0.34 | |
| *Mimulus ringens* | Herb | Square Stemmed Monkey Flower | 0.25 | |
| *Scirpus cyperinus* | Herb | Wool Grass | 0.17 | |
| *Bidens cernua* | Herb | Nodding Bur Marigold | 0.17 | |
| *Helenium autumnale* | Herb | Common Sneezeweed | 0.17 | |
| *Solidago patula* | Herb | Rough Leaved Goldenrod | 0.08 | |
| *Sparganium americanum* | Herb | Eastern Bur Reed | 0.59 | |
| *Sparganium eurycarpum* | Herb | Giant Bur Reed | 1.26 | |
| *Verbena hastata* | Herb | Blue Vervain | 0.34 | |
| | | **Subtotal** | **8.4 lbs** | |

| Table X. Planting Summary for Vegetative Communities and Zones | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Community Type I- Mesic Hardwood Forest*** | | | | | | | **Acres** | **16.6** |
| **Species** | **Common Name** | **Max Spacing (feet)** | **Unit Type*** | **Size**** | **Stratum** | **Indiv. Spacing (feet)** | **# of Stems** | |
| *Acer barbatum* | Southern Sugar Maple | 11 | R | 1" | Canopy | 30 | 63 | |
| *Fagus grandifolia* | American beech | 11 | R | 1" | Canopy | 30 | 63 | |
| *Quercus falcata var. falcata* | Southern Red Oak | 11 | R | 1" | Canopy | 30 | 62 | |
| *Quercus rubra* | Northern Red Oak | 11 | R | 1" | Canopy | 30 | 62 | |
| *Ilex opaca* | American holly | 11 | R | 1" | Subcanopy | 30 | 62 | |
| *Prunus serotina* | Black cherry | 11 | R | 1" | Subcanpoy | 30 | 62 | |
| *Cornus florida* | Flowering dogwood | 11 | R | 1" | Subcanopy | 30 | 62 | |
| | | | | | | **Subtotal** | **436** | |
| *Kalmia latifolia* | Mountain laurel | 9 | R | 1" | Shrub | 9 | 681 | |
| | | | | | | **Subtotal** | **681** | |
| | | | | | | | | |
| ***Community Type II - Pidemont/Mountain Bottomland Forest*** | | | | | | | **Acres** | **14.4** |
| **Species** | **Common Name** | **Max Spacing (feet)** | **Unit Type*** | **Size**** | **Stratum** | **Indiv. Spacing (feet)** | **# of Stems** | |
| *Acer barbatum* | Souther sugar maple | 11 | R | 1" | Canopy | 35 | 44 | |
| *Carya cordiformis* | Bitternut hickory | 11 | R | 1" | Canopy | 35 | 44 | |
| *Carya ovata* | Shagbark hickory | 11 | R | 1" | Canopy | 35 | 44 | |
| *Fraxinus pennsylvanica* | Green ash | 11 | R | 1" | Canopy | 35 | 44 | |
| *Quercus facate var. pagodiflora* | Cherrybark oak | 11 | R | 1" | Canopy | 35 | 44 | |
| *Quercus michauxii* | Swamp Chestnut oak | 11 | R | 1" | Canopy | 35 | 44 | |
| *Ulmus americana* | American elm | 11 | R | 1" | Canopy | 35 | 43 | |
| *Caprinus caroliana* | Ironwood | 11 | R | 1" | Subcanopy | 35 | 43 | |
| *Celtis laevigata* | Sugarberry | 11 | R | 1" | Canopy | 35 | 43 | |
| *Cornus florida* | Flowering dogwood | 11 | R | 1" | Subcanopy | 35 | 43 | |
| | | | | | | **Subtotal** | **436** | |

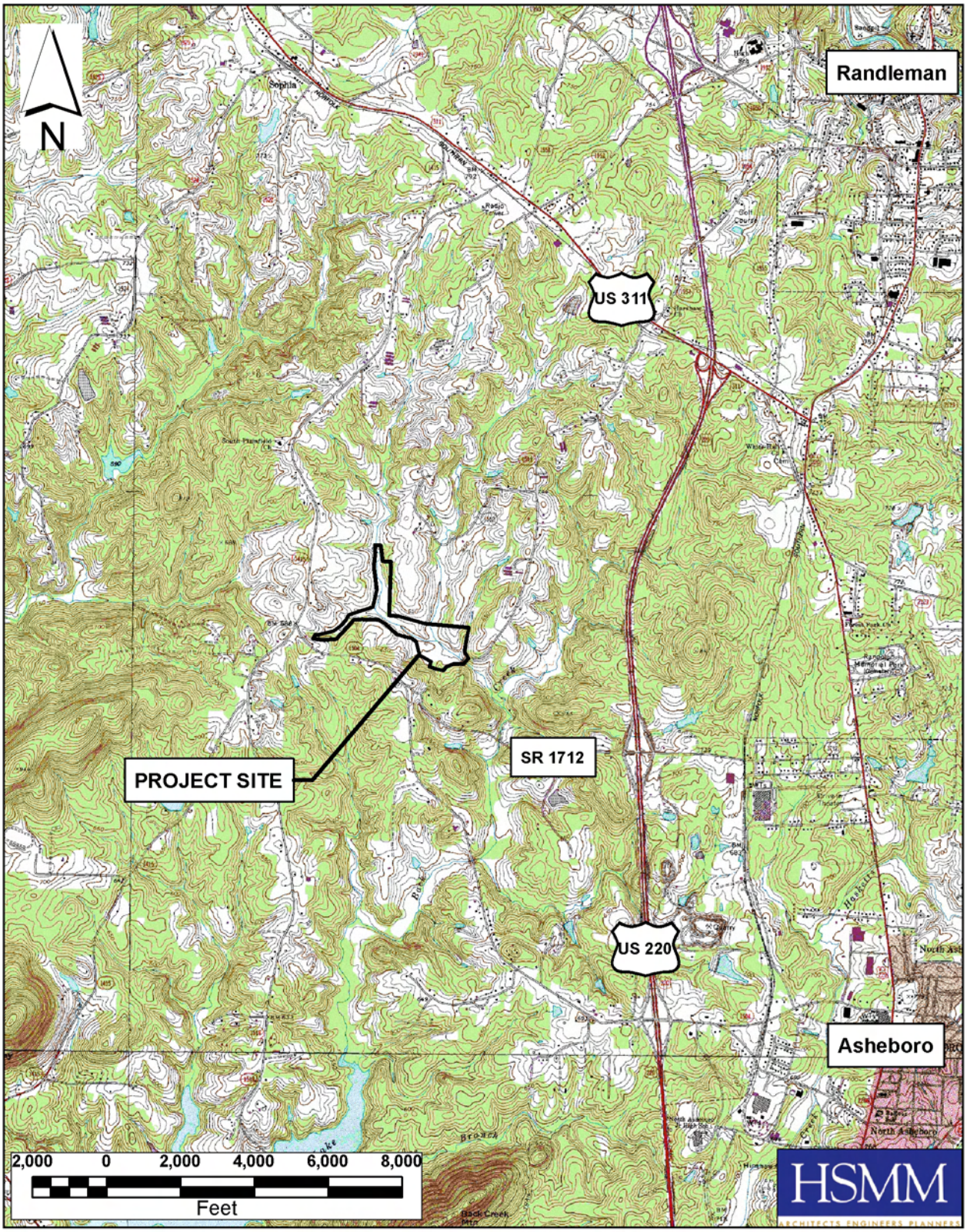
** Unit type choices include: Transplant (T), Live stakes (L), Ball and Burlap (B), Pot (P), Tubling (T), Bare Root (R), Mechanically plant (M), and Seed (S)*

***Size units may vary, but must be stated.*

| **Table X. Planting Summary for Vegetative Communities and Zones - continued** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Community Type III - Piedmont/low Mountain Alluvial Forest*** | | | | | | | **Acres** | **0.6** |
| **Species** | **Common Name** | **Max Spacing (feet)** | **Unit Type*** | **Size**** | **Stratum** | **Indiv. Spacing (feet)** | **# of Stems** | |
| *Platanus occidentalis* | American sycamore | 11 | R | 1" | Canopy | 30 | 62 | |
| *Betula nigra* | River birch | 11 | R | 1" | Canopy | 30 | 62 | |
| *Ulmus americana* | American elm | 11 | R | 1" | Canopy | 30 | 62 | |
| *Fraxinus pennsylvanica* | Green ash | 11 | R | 1" | Canopy | 30 | 62 | |
| *Acer negundo* | Box elder | 11 | R | 1" | Canopy | 30 | 63 | |
| *Celtis laevigata* | Sugarberry | 11 | R | 1" | Canopy | 30 | 63 | |
| *Caprinus caroliniana* | Ironwood | 11 | R | 1" | Subcanopy | 30 | 62 | |
| | | | | | | **Subtotal** | **436** | |
| *Alnus serrulata* | Tag alder | 9 | R | 1" | Shrub | 18 | 170 | |
| *Cephalanthus occidentalis* | Buttonbush | 9 | R | 1" | Shrub | 18 | 170 | |
| *Cornus amomum* | Silky dogwood | 9 | R | 1" | Shrub | 18 | 170 | |
| *Lindera benzoin* | Spicebush | 9 | R | 1" | Shrub | 18 | 171 | |
| | | | | | | **Subtotal** | **681** | |

** Unit type choices include: Transplant (T), Live stakes (L), Ball and Burlap (B), Pot (P), Tubling (T), Bare Root (R), Mechanically plant (M), and Seed (S)*

***Size units may vary, but must be stated.*



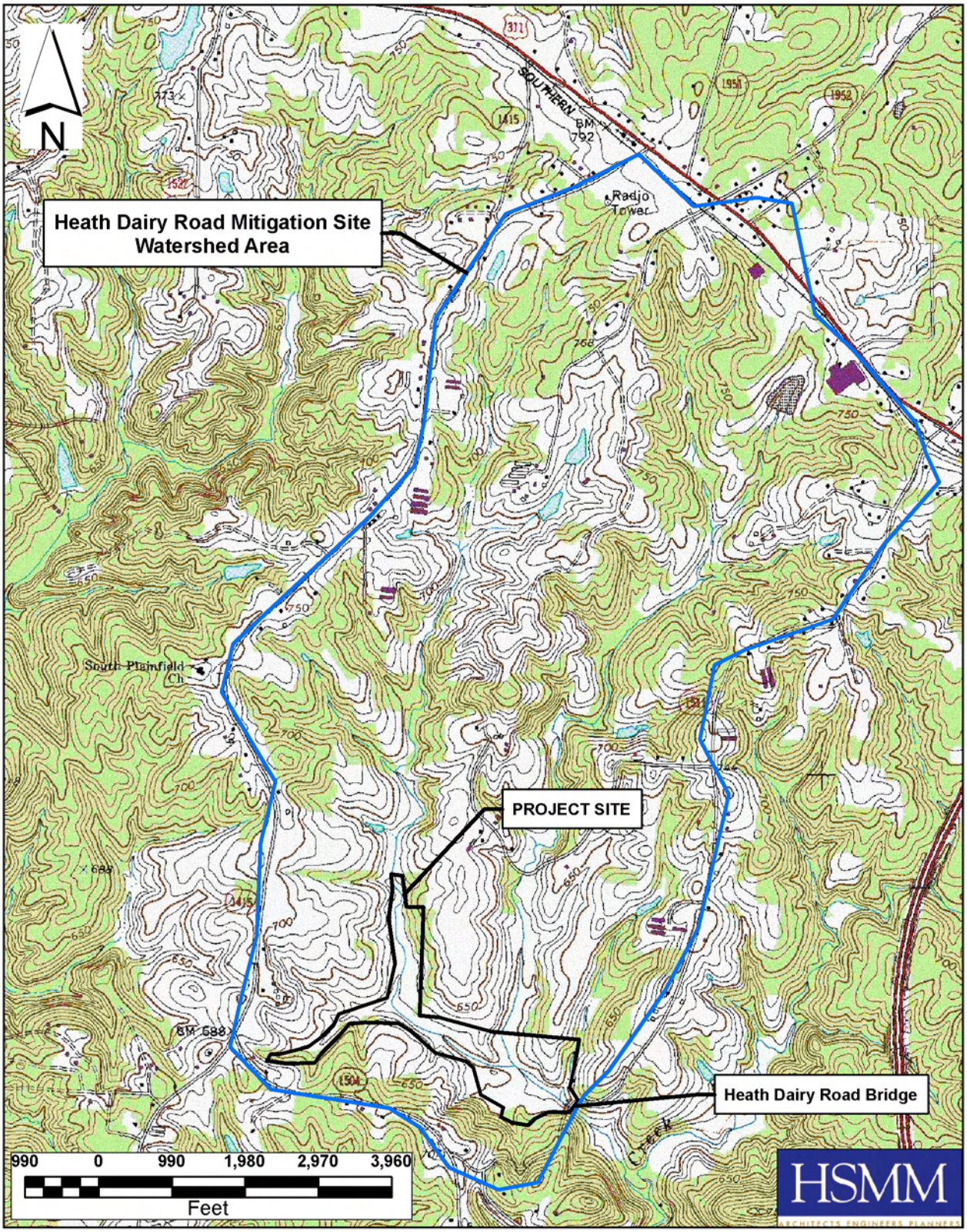

Ecosystem Enhancement PROGRAM

## Vicinity Map

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

## Figure 1

**Drawn By:** AMH
**Checked By:** AJW
**Date:** 07/27/2006



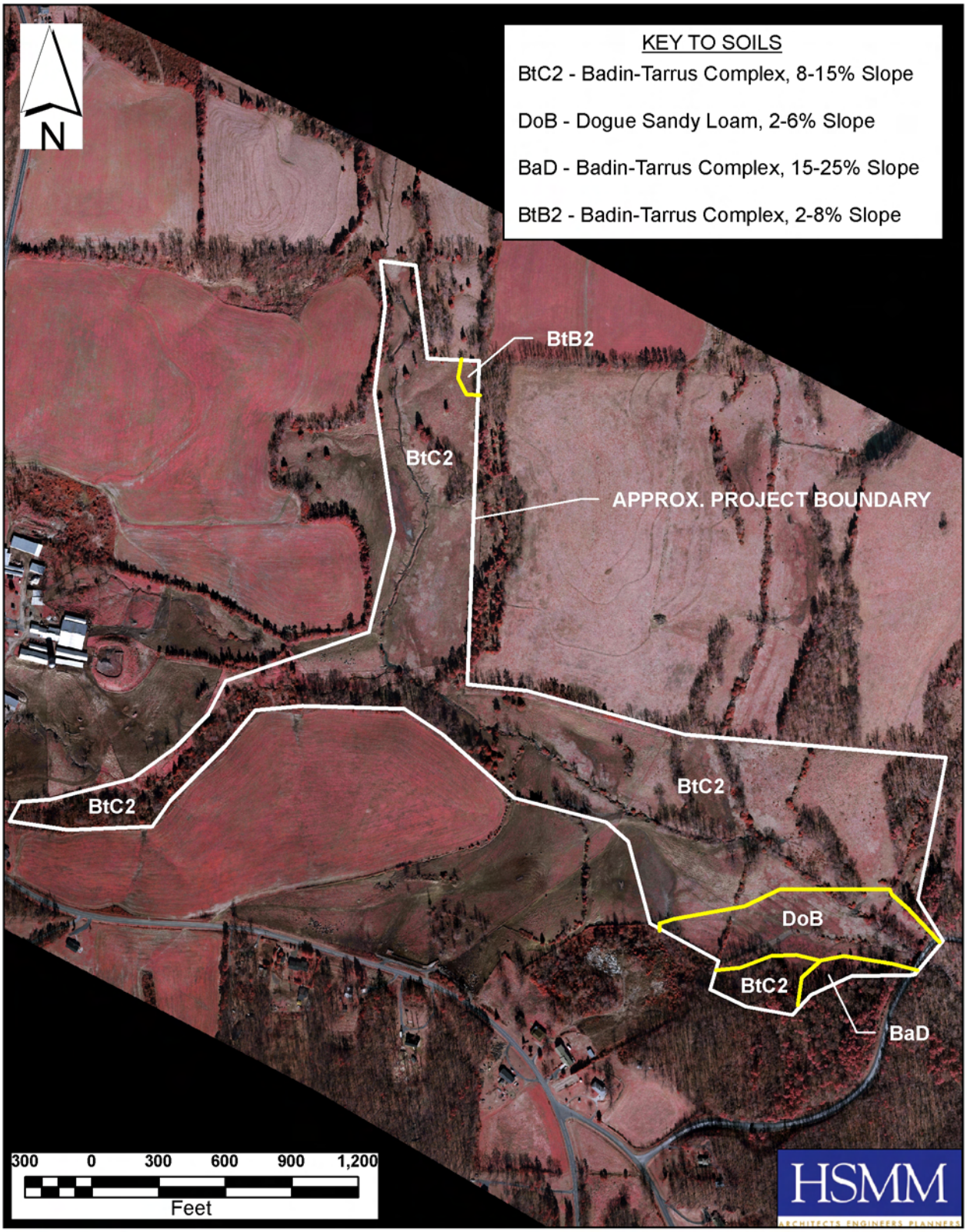

Ecosystem Enhancement PROGRAM

**Watershed Map**

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 2**

**Drawn By: AMH**
**Checked By: AJW**
**Date: 07/27/2006**



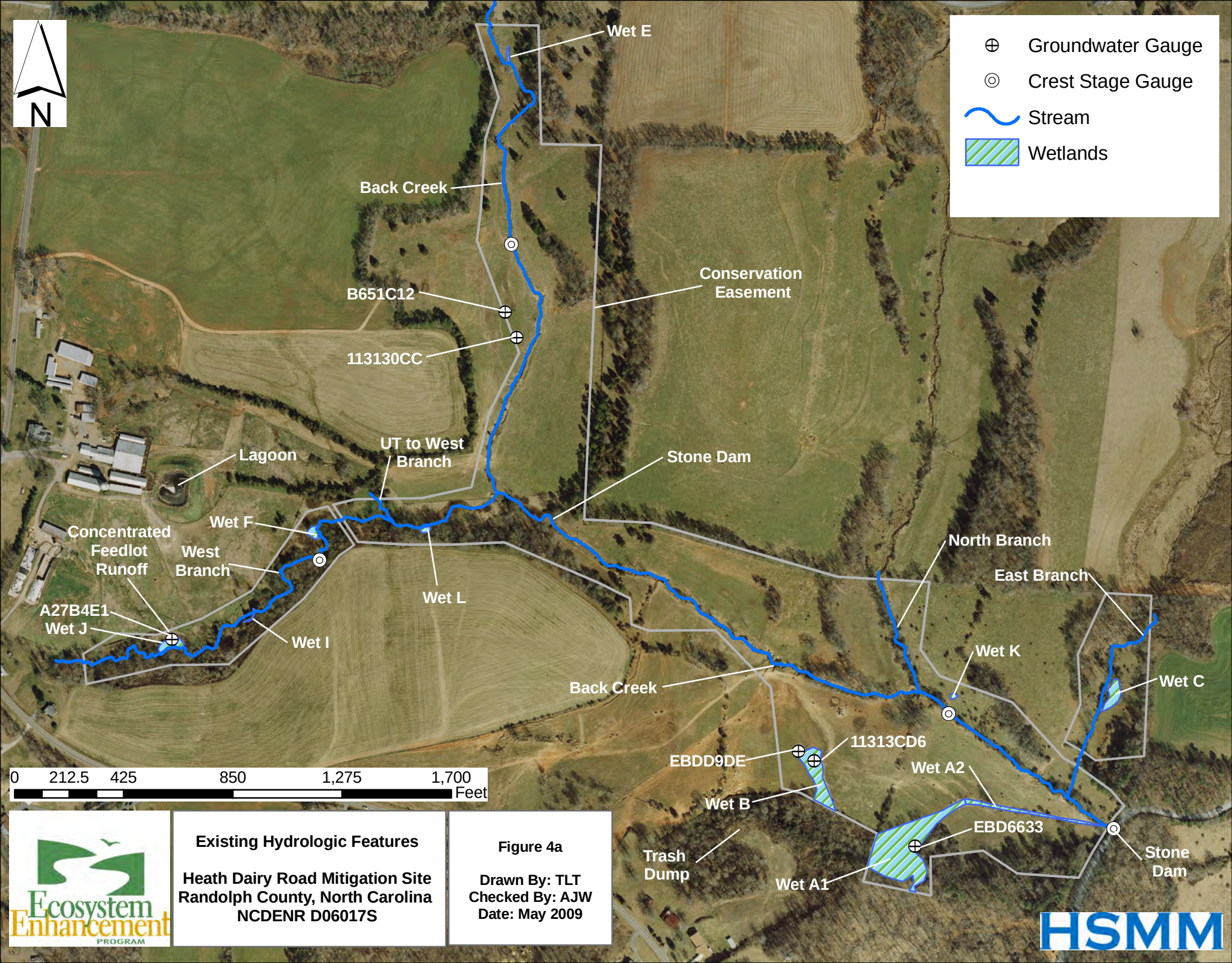

Ecosystem Enhancement PROGRAM

**Soils Map**

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 3**

**Drawn By: AMH**
**Checked By: AJW**
**Date: 07/27/2006**




Ecosystem Enhancement Program

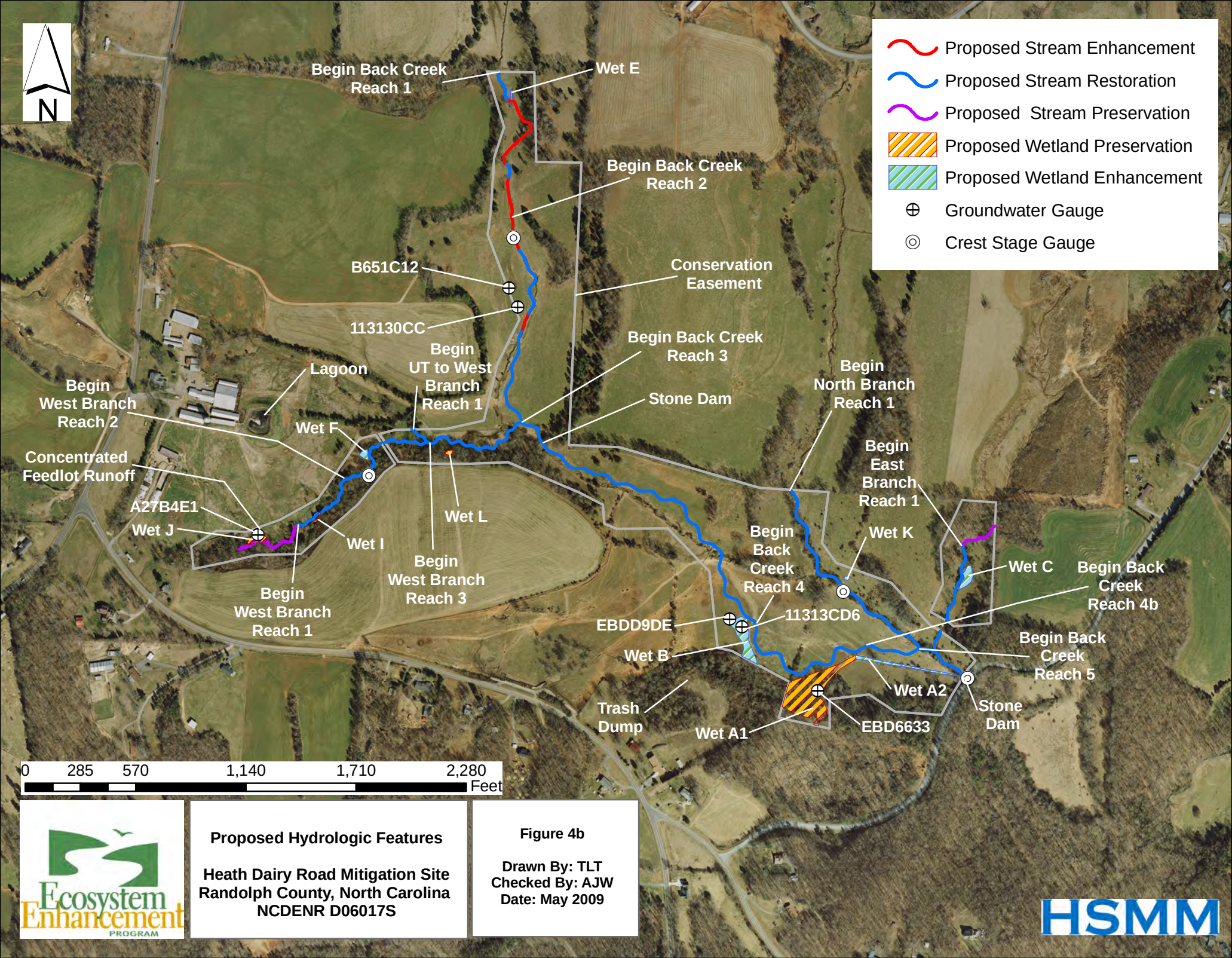
**Existing Hydrologic Features**

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 4a**

**Drawn By: TLT**
**Checked By: AJW**
**Date: May 2009**

HSMM




Ecosystem Enhancement Program

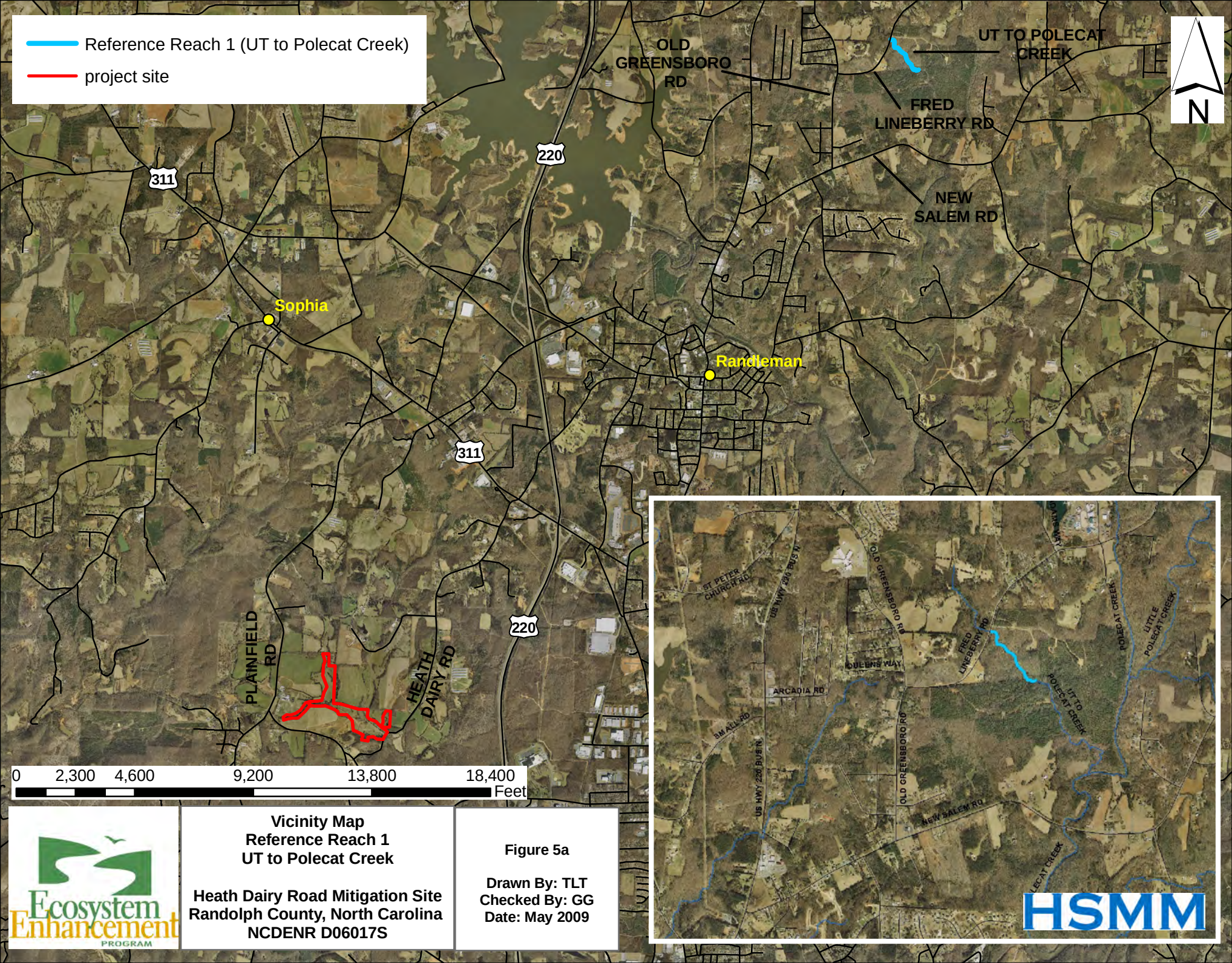
**Proposed Hydrologic Features**

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 4b**

**Drawn By: TLT**
**Checked By: AJW**
**Date: May 2009**

HSMM



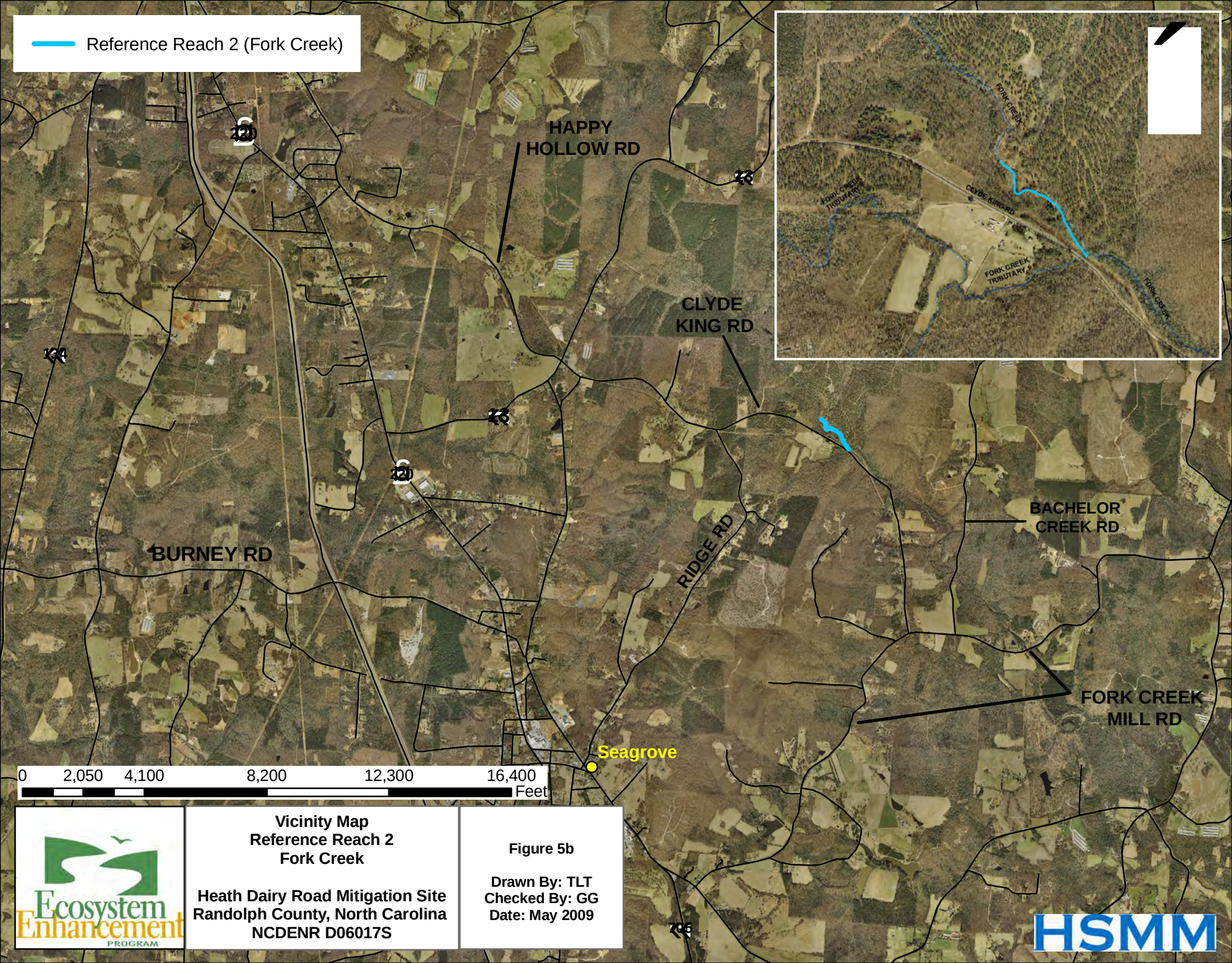

Ecosystem Enhancement PROGRAM

**Vicinity Map**
**Reference Reach 1**
**UT to Polecat Creek**

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 5a**

**Drawn By: TLT**
**Checked By: GG**
**Date: May 2009**




Ecosystem Enhancement Program

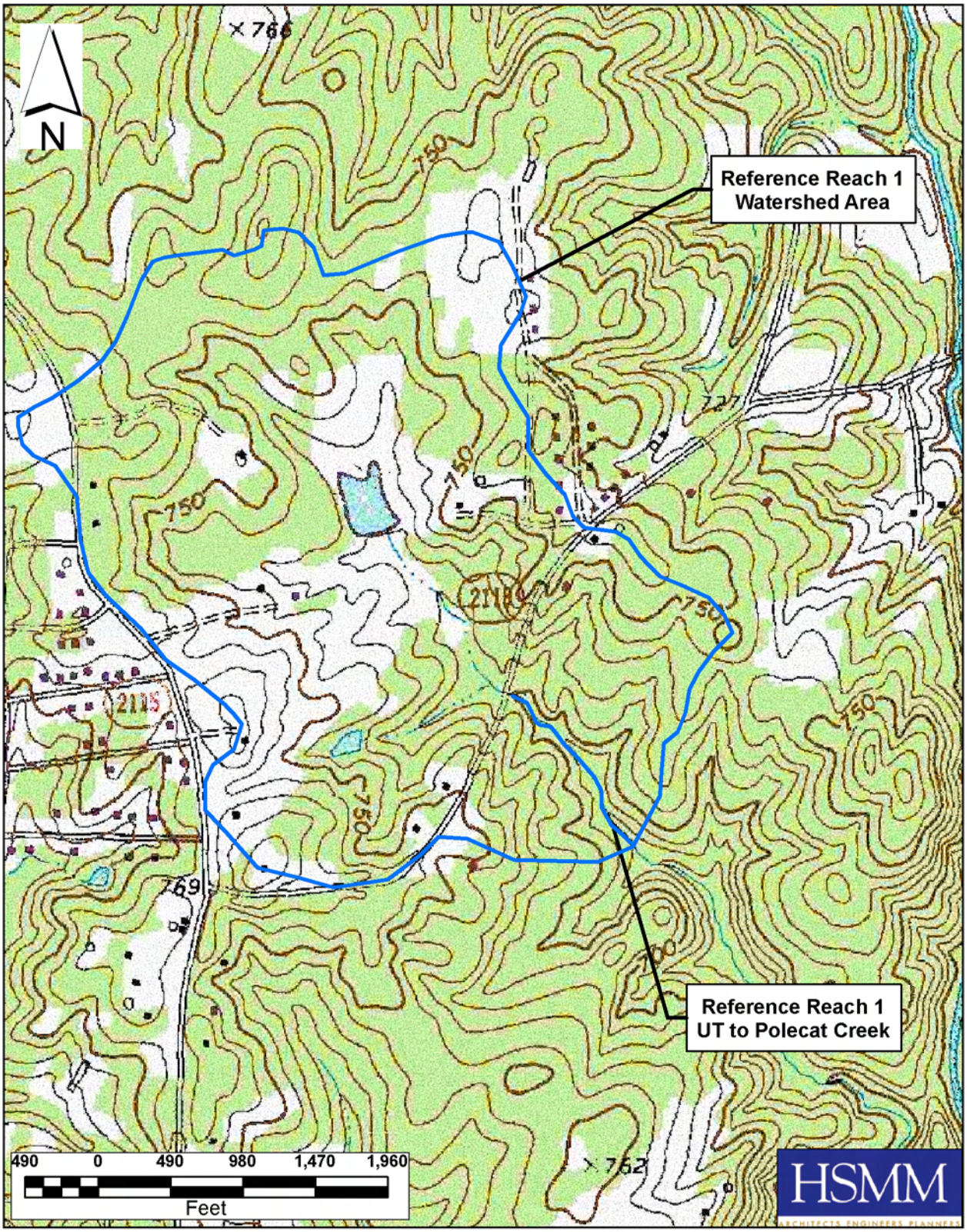
**Vicinity Map**
**Reference Reach 2**
**Fork Creek**

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 5b**

**Drawn By: TLT**
**Checked By: GG**
**Date: May 2009**

HSMM



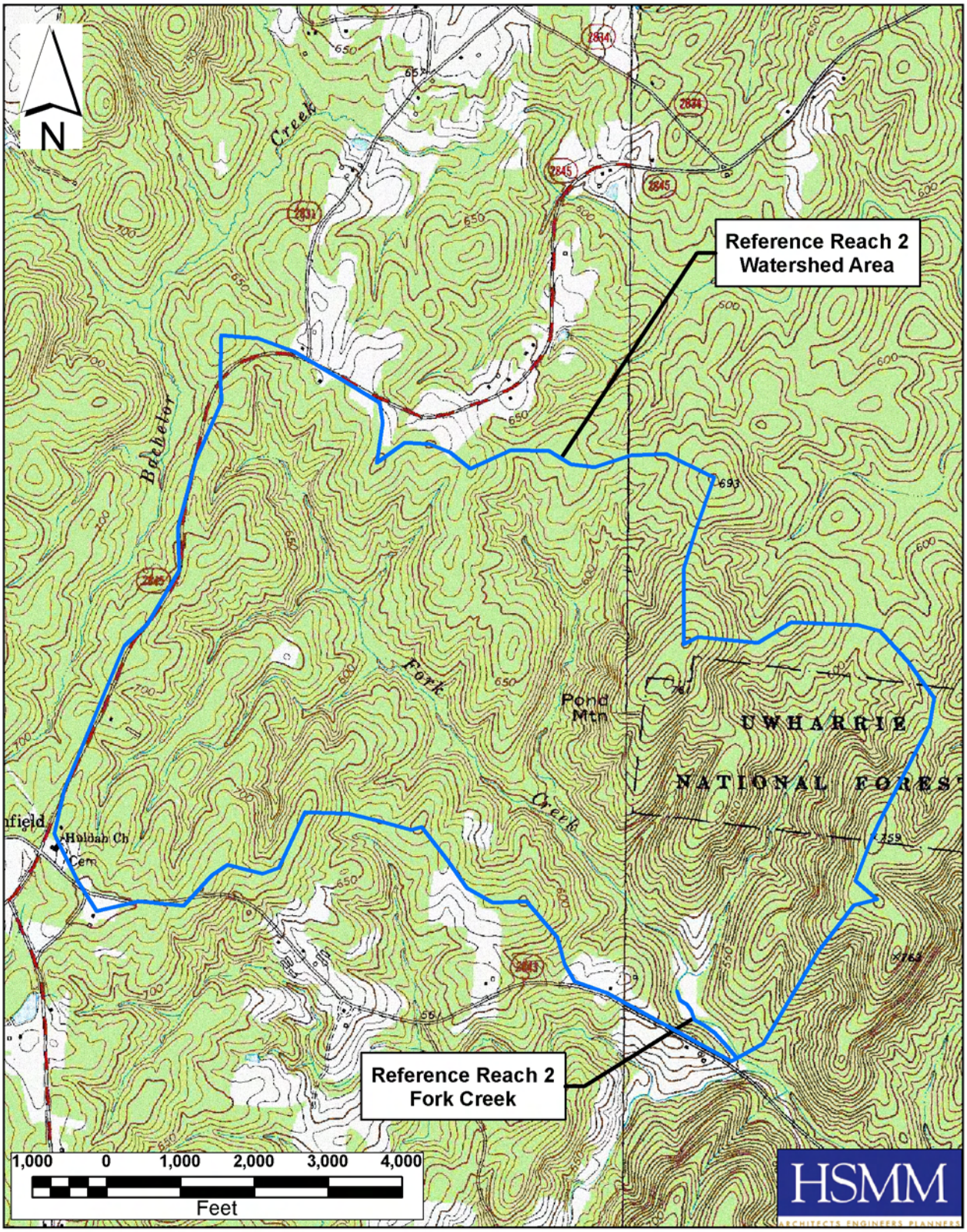

Ecosystem Enhancement PROGRAM

**Reference Reach 1 - UT to Polecat Creek Watershed Map**

Heath Dairy Road Mitigation Site
Randolph County, North Carolina
NCDENR D06017S

**Figure 6a**

Drawn By: AMH
Checked By: AJW
Date: 07/27/2006



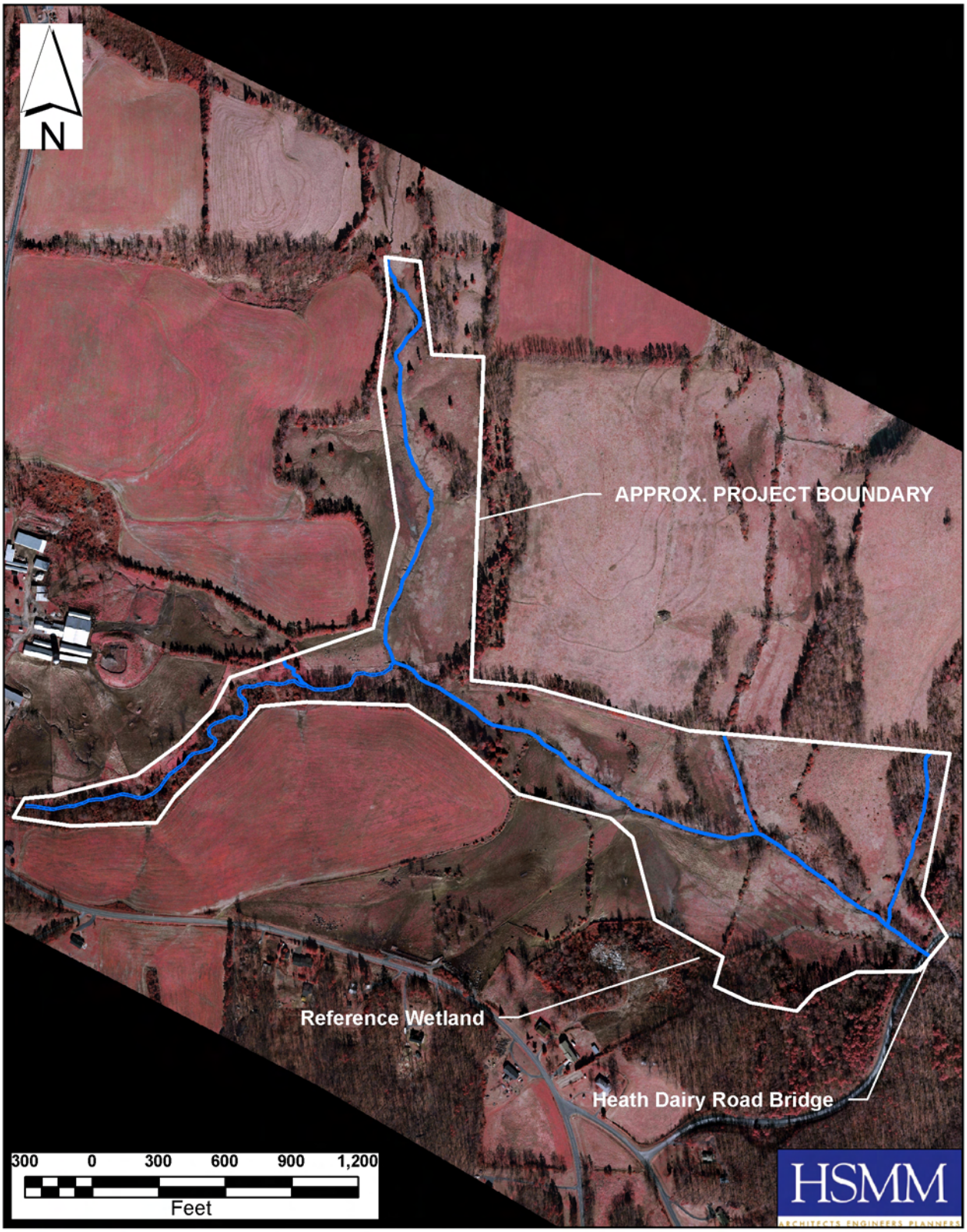

Ecosystem Enhancement PROGRAM

**Reference Reach 2 - Fork Creek Watershed Map**

Heath Dairy Road Mitigation Site
Randolph County, North Carolina
NCDENR D06017S

**Figure 6b**

Drawn By: AMH
Checked By: AJW
Date: 07/27/2006

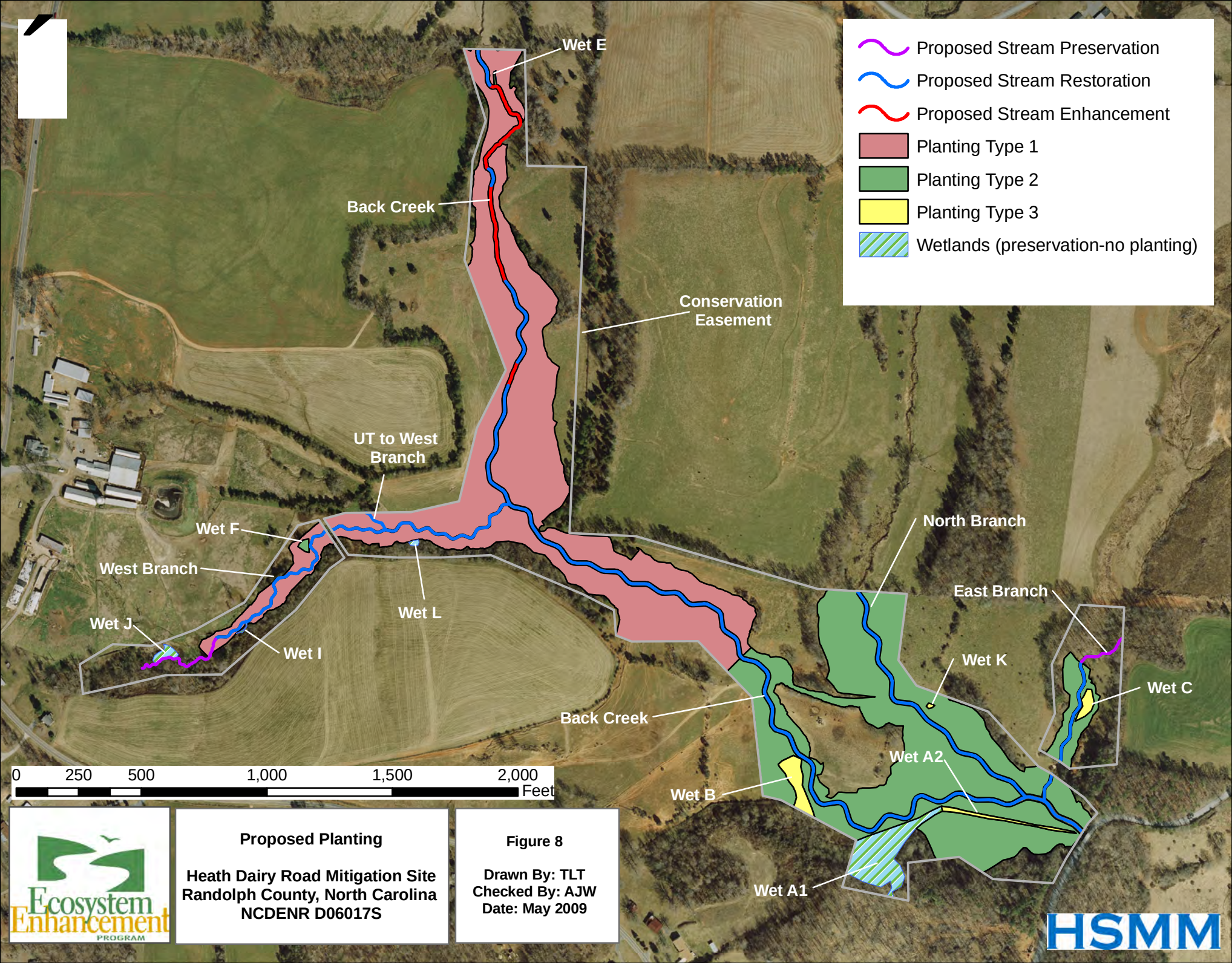



Ecosystem Enhancement PROGRAM

**Reference Wetland**
**Vicinity Map**
**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 7**

Drawn By: AMH
Checked By: AJW
Date: 07/27/2006




**Proposed Planting**

**Heath Dairy Road Mitigation Site**
**Randolph County, North Carolina**
**NCDENR D06017S**

**Figure 8**

**Drawn By: TLT**
**Checked By: AJW**
**Date: May 2009**

# APPENDIX A

## Site Photographs



**Back Creek - Upper: Crest Gage at Station 20 + 00**



**Back Creek - Upper: Station 22 + 00**



**Back Creek - Upper: Station 22 + 00**



**Back Creek - Upper: Station 23 + 50**



**Back Creek - Upper: Station 24 + 00**



**Back Creek - Upper: Station 24 + 50**



**Back Creek - Upper: Station 25 + 00**



**Back Creek - Upper: Station 26 + 50**



**Back Creek - Upper: Station 46 + 50**



**Back Creek - Upper: Station 46 + 75**



**Back Creek - Lower: Station 52 + 00**



**Back Creek - Lower: Station 56 + 00**



**Back Creek - Lower: Station 56 + 50**



**Back Creek - Lower: Station 57 + 00**



**Back Creek - Lower: Station 57 + 50**



**Back Creek - Lower: Station 59 + 75**



**West Branch: Station 21 + 50**



**West Branch: Station 22 + 80**



**West Branch: Station 23 + 50**



**Confluence of West Branch and UT to West Branch**



**West Branch: Station 29 + 00**



**West Branch: Station 29 + 00**



**Confluence of West Branch and Back Creek – Upper**



**East Branch: Station 18 + 50**



**UT to West Branch: Station 10 + 75**



**Monitoring Gage at Wetland A**



**Monitoring Gages at Wetland B and B-P**

# APPENDIX B

## Existing Site Stream Data

## Summary

| | |
|---|---|
| Stream: | Back Creek - Upper Reach |
| Watershed: | --- |
| Location: | Heath Dairy Road |
| Latitude: | --- |
| Longitude: | --- |
| State: | NC |
| County: | Randolph |
| Date: | February 16, 2006 |
| Observers: | SGG, AJW, EA, BAM, AMH |
| Channel type: | G4 |
| Drainage area (sq.mi.): | 0.94 |
| notes: | --- |

| Dimension | | bankfull channel typical | min | max |
|---|---|---|---|---|
| floodplain: | width flood prone area (ft) | 29.0 | 14.0 | 45.0 |
| | low bank height (ft) | 3.1 | 2.8 | 3.3 |
| riffle-run: | x-area bankfull (sq.ft.) | 17.0 | 15.1 | 17.0 |
| | width bankfull (ft) | 10.1 | 10.1 | 11.2 |
| | mean depth (ft) | 1.68 | 1.4 | 1.7 |
| | max depth (ft) | 2.4 | 1.8 | 2.4 |
| | hydraulic radius (ft) | 1.2 | | |
| pool: | x-area pool (sq.ft.) | 17.0 | 14.2 | 17.0 |
| | width pool (ft) | 7.8 | 7.8 | 9.3 |
| | max depth pool (ft) | 2.8 | 2.0 | 2.8 |
| | hydraulic radius (ft) | 1.4 | | |

| dimensionless ratios: | typical | min | max |
|---|---|---|---|
| width depth ratio | 6.0 | 6.1 | 8.3 |
| entrenchment ratio | 2.9 | 1.4 | 4.5 |
| riffle max depth ratio | 1.4 | 1.1 | 1.4 |
| bank height ratio | 1.3 | 1.2 | 1.4 |
| pool area ratio | 1.0 | 0.8 | 1.0 |
| pool width ratio | 0.8 | 0.8 | 0.9 |
| pool max depth ratio | 1.7 | 1.2 | 1.7 |

| hydraulics: | typical | min | max |
|---|---|---|---|
| discharge rate (cfs) | 75.0 | 59.3 | 75.1 |
| channel slope (%) | 0.87 | | |

| | riffle-run | min | max | pool |
|---|---|---|---|---|
| velocity (ft/s) | 4.4 | 3.9 | 4.4 | 4.4 |
| Froude number | 0.71 | 0.66 | 0.66 | 0.43 |
| shear stress (lbs/sq.ft.) | 0.651 | 0.601 | 0.752 | 0.760 |
| shear velocity (ft/s) | 0.580 | 0.557 | 0.623 | 0.626 |
| stream power (lb/s) | 40.7 | 32.2 | 40.8 | |
| unit stream power (lb/ft/s) | 4.031 | 2.874 | 4.017 | |
| relative roughness | 19.0 | --- | --- | |
| friction factor u/u* | 7.6 | 6.6 | 7.2 | |
| threshold grain size (t*=0.06) (mm) | 36.9 | 29.5 | 36.9 | |
| Shield's parameter | 0.071 | | | |

**Pattern**

| | typical | min | max |
|---|---|---|---|
| meander length (ft) | --- | --- | --- |
| belt width (ft) | --- | --- | --- |
| amplitude (ft) | --- | --- | --- |
| radius (ft) | --- | --- | --- |
| arc angle (degrees) | --- | --- | --- |
| stream length (ft) | --- | | |
| valley length (ft) | --- | | |
| Sinuosity | --- | | |
| Meander Length Ratio | --- | --- | --- |
| Meander Width Ratio | --- | --- | --- |
| Radius Ratio | --- | --- | --- |

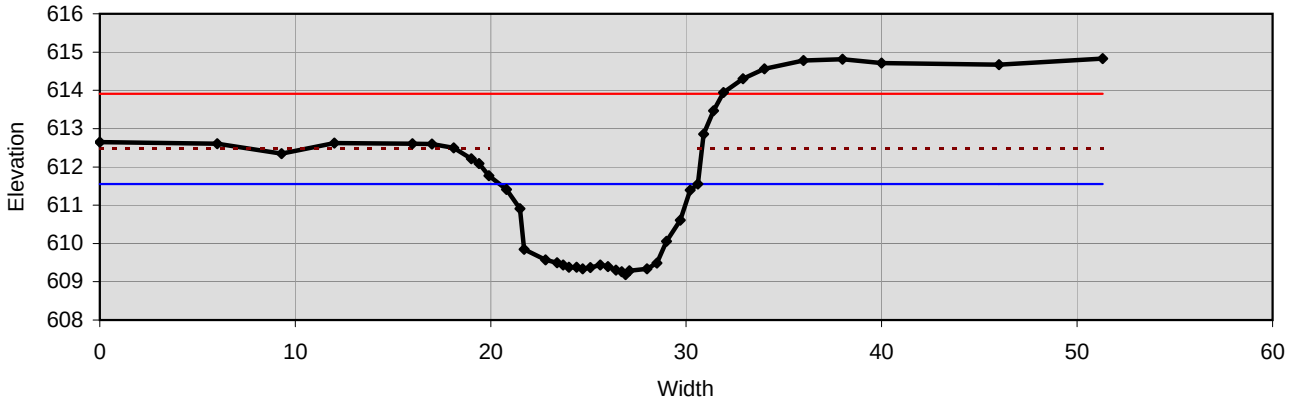
**Profile**

| | typical | min | max |
|---|---|---|---|
| pool-pool spacing (ft) | 57.6 | 25.3 | 95.4 |
| riffle length (ft) | 15.3 | 5.4 | 29.5 |
| pool length (ft) | 21.5 | 7.0 | 32.4 |
| run length (ft) | 8.1 | 5.2 | 9.9 |
| glide length (ft) | 11.5 | 3.0 | 25.5 |
| channel slope (%) | 0.87 | | |
| riffle slope (%) | 2.3 | 0.19 | 3.8 |
| pool slope (%) | | | 0.062 |
| run slope (%) | 2.6 | | 7.3 |
| glide slope (%) | 0.61 | | 1.3 |
| measured valley slope (%) | --- | | |
| valley slope from sinuosity (%) | --- | | |
| Riffle Length Ratio | 1.5 | 0.5 | 2.9 |
| Pool Length Ratio | 2.1 | 0.7 | 3.2 |
| Run Length Ratio | 0.8 | 0.5 | 1 |
| Glide Length Ratio | 1.1 | 0.3 | 2.5 |
| Riffle Slope Ratio | 2.6 | 0.2 | 4.4 |
| Pool Slope Ratio | | | 0.1 |
| Run Slope Ratio | 3 | | 8.4 |
| Glide Slope Ratio | 0.7 | | 1.5 |
| Pool Spacing Ratio | 5.7 | 2.5 | 9.4 |

| Channel Materials | Riffle Surface | | | BkF Channel |
|---|---|---|---|---|
| D16 (mm) | 6.5 | --- | --- | 0.6 |
| D35 (mm) | 16 | --- | --- | 15 |
| D50 (mm) | 27 | --- | --- | 25 |
| D65 (mm) | 44 | --- | --- | 41 |
| D84 (mm) | 87 | --- | --- | 63 |
| D95 (mm) | 150 | --- | --- | 160 |
| mean (mm) | 23.8 | | | 6.1 |
| dispersion | 3.7 | | | 22.1 |
| skewness | -0.1 | | | -0.4 |
| Shape Factor | --- | | | |
| % Silt/Clay | 10% | --- | --- | 7% |
| % Sand | 2% | --- | --- | 9% |
| % Gravel | 63% | --- | --- | 62% |
| % Cobble | 24% | --- | --- | 13% |
| % Boulder | | --- | --- | 1% |
| % Bedrock | 1% | --- | | 8% |
| % Clay Hardpan | | --- | | |
| % Detritus/Wood | | --- | | |
| % Artificial | | --- | | |
| Largest Mobile (mm) | --- | | | |

## Cross Section R1

0 + 2.5 Back Creek - Upper Reach, Riffle




| Bankfull Dimensions | |
|---|---|
| 17.0 | x-section area (ft.sq.) |
| 10.1 | width (ft) |
| 1.7 | mean depth (ft) |
| 2.4 | max depth (ft) |
| 12.3 | wetted parimeter (ft) |
| 1.4 | hyd radi (ft) |
| 6.1 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 45.0 | W flood prone area (ft) |
| 4.4 | entrenchment ratio |
| 3.3 | low bank height (ft) |
| 1.4 | low bank height ratio |

| Materials | |
|---|---|
| 27 | D50 Riffle (mm) |
| 87 | D84 Riffle (mm) |
| 37 | threshold grain size (mm): |

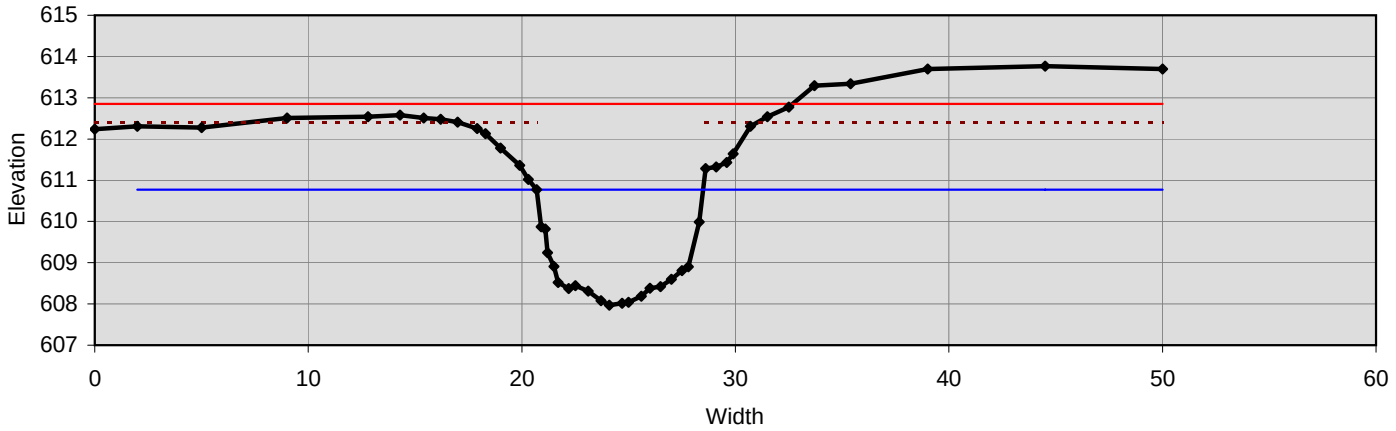
| Bankfull Flow | |
|---|---|
| 4.4 | velocity (ft/s) |
| 75.1 | discharge rate (cfs) |
| 0.66 | Froude number |

| Flow Resistance | |
|---|---|
| 0.039 | Manning's roughness |
| 0.16 | D'Arcy-Weisbach fric. |
| 7.2 | resistance factor u/u* |
| 5.9 | relative roughness |

| Forces & Power | |
|---|---|
| 0.87 | channel slope (%) |
| 0.75 | shear stress (lb/sq.ft.) |
| 0.62 | shear velocity (ft/s) |
| 4 | unit strm power (lb/ft/s) |

## Cross Section P1

0 + 46 Back Creek - Upper Reach, Pool




| Bankfull Dimensions | |
|---|---|
| 17.0 | x-section area (ft.sq.) |
| 7.8 | width (ft) |
| 2.2 | mean depth (ft) |
| 2.8 | max depth (ft) |
| 11.0 | wetted parimeter (ft) |
| 1.6 | hyd radi (ft) |
| 3.6 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 18.0 | W flood prone area (ft) |
| 2.3 | entrenchment ratio |
| 4.4 | low bank height (ft) |
| 1.6 | low bank height ratio |

| Materials | |
|---|---|
| 27 | D50 Riffle (mm) |
| 87 | D84 Riffle (mm) |
| 41 | threshold grain size (mm): |

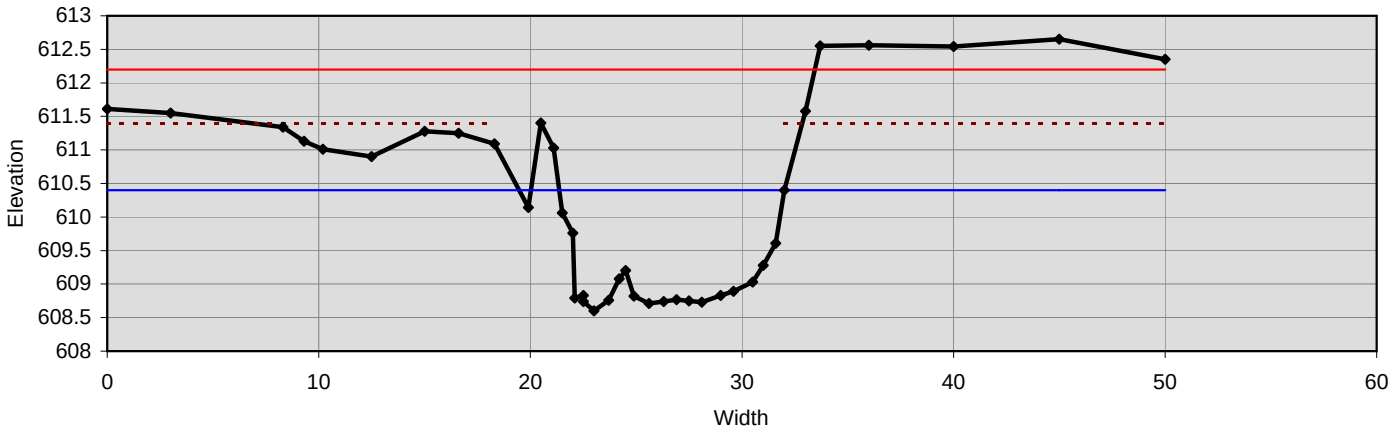
| Bankfull Flow | |
|---|---|
| 4.9 | velocity (ft/s) |
| 83.3 | discharge rate (cfs) |
| 0.69 | Froude number |

| Flow Resistance | |
|---|---|
| 0.038 | Manning's roughness |
| 0.14 | D'Arcy-Weisbach fric. |
| 7.6 | resistance factor u/u* |
| 7.7 | relative roughness |

| Forces & Power | |
|---|---|
| 0.87 | channel slope (%) |
| 0.84 | shear stress (lb/sq.ft.) |
| 0.66 | shear velocity (ft/s) |
| 5.8 | unit strm power (lb/ft/s) |

## Cross Section R2

1 + 7 Back Creek - Upper Reach, Riffle




| Bankfull Dimensions | |
|---|---|
| 15.1 | x-section area (ft.sq.) |
| 11.2 | width (ft) |
| 1.4 | mean depth (ft) |
| 1.8 | max depth (ft) |
| 13.7 | wetted parimeter (ft) |
| 1.1 | hyd radi (ft) |
| 8.3 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 40.0 | W flood prone area (ft) |
| 3.6 | entrenchment ratio |
| 2.8 | low bank height (ft) |
| 1.6 | low bank height ratio |

| Materials | |
|---|---|
| 27 | D50 Riffle (mm) |
| 87 | D84 Riffle (mm) |
| 30 | threshold grain size (mm): |

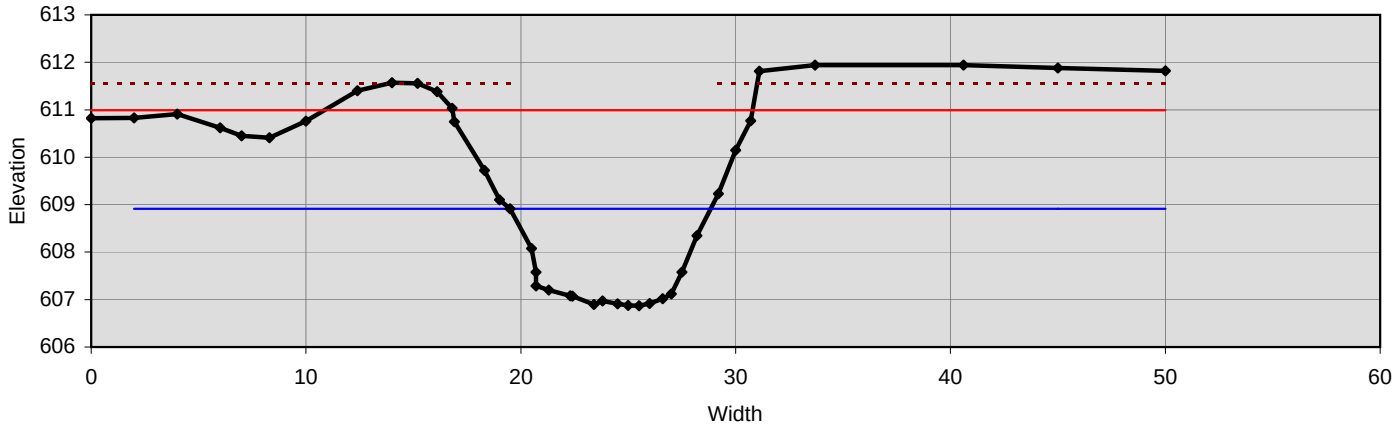
| Bankfull Flow | |
|---|---|
| 3.9 | velocity (ft/s) |
| 59.3 | discharge rate (cfs) |
| 0.66 | Froude number |

| Flow Resistance | |
|---|---|
| 0.038 | Manning's roughness |
| 0.16 | D'Arcy-Weisbach fric. |
| 6.6 | resistance factor u/u* |
| 4.7 | relative roughness |

| Forces & Power | |
|---|---|
| 0.87 | channel slope (%) |
| 0.60 | shear stress (lb/sq.ft.) |
| 0.56 | shear velocity (ft/s) |
| 2.9 | unit strm power (lb/ft/s) |

## Cross Section P2

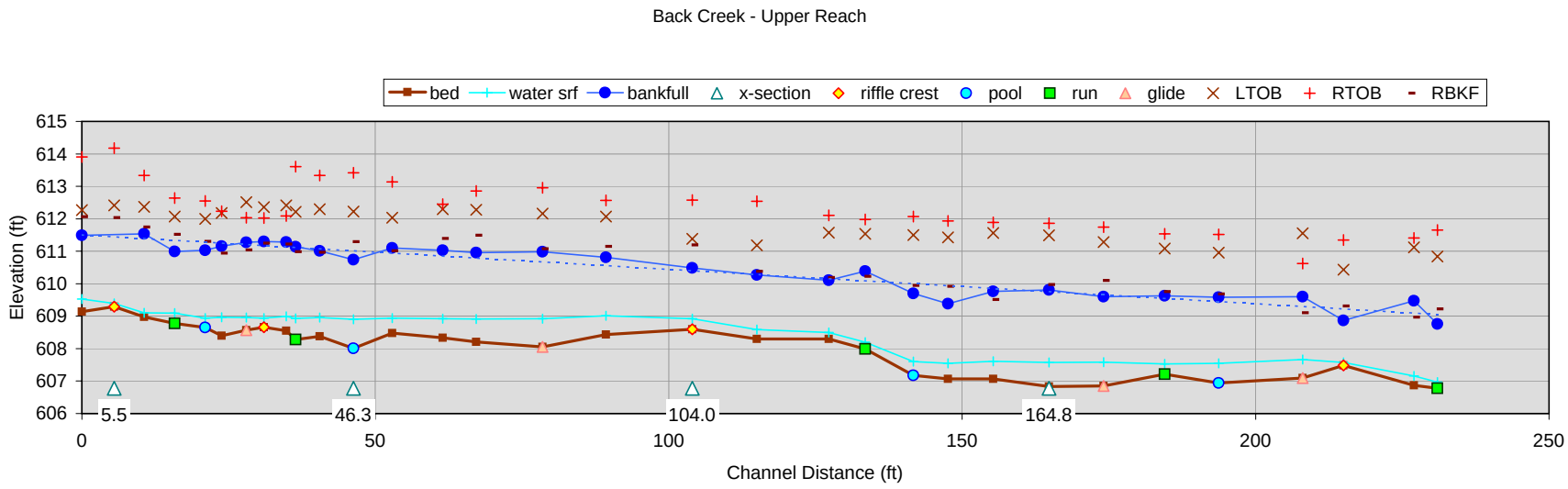
1 + 65 Back Creek - Upper Reach, Pool




| Bankfull Dimensions | | Flood Dimensions | | Materials | |
|---|---|---|---|---|---|
| 14.2 | x-section area (ft.sq.) | 14.0 | W flood prone area (ft) | 27 | D50 Riffle (mm) |
| 9.3 | width (ft) | 1.5 | entrenchment ratio | 87 | D84 Riffle (mm) |
| 1.5 | mean depth (ft) | 4.7 | low bank height (ft) | 34 | threshold grain size (mm): |
| 2.0 | max depth (ft) | 2.3 | low bank height ratio | | |
| 11.1 | wetted parimeter (ft) | | | | |
| 1.3 | hyd radi (ft) | | | | |
| 6.1 | width-depth ratio | | | | |

| Bankfull Flow | | Flow Resistance | | Forces & Power | |
|---|---|---|---|---|---|
| 4.3 | velocity (ft/s) | 0.038 | Manning's roughness | 0.87 | channel slope (%) |
| 61.6 | discharge rate (cfs) | 0.15 | D'Arcy-Weisbach fric. | 0.70 | shear stress (lb/sq.ft.) |
| 0.67 | Froude number | 7.0 | resistance factor u/u* | 0.60 | shear velocity (ft/s) |
| | | 5.3 | relative roughness | 3.6 | unit strm power (lb/ft/s) |

## Longitudinal Slope Profile




| | slope (%) | | slope ratio | | length (ft) | | length ratio | | pool-pool spacing (ft) | | p-p ratio | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| reach | 0.87 | | --- | | 231.0 | (22.9 channel widths) | --- | | --- | | --- | |
| riffle | 2.3 | (0.19 - 3.8) | 2.6 | (0.2 - 4.4) | 15.3 | (5.4 - 29.5) | 1.5 | (0.5 - 2.9) | --- | | --- | |
| pool | 0 | (0 - 0.062) | 0 | (0 - 0.1) | 21.5 | (7 - 32.4) | 2.1 | (0.7 - 3.2) | 57.6 | (25.3 - 95.4) | 5.7 | (2.5 - 9.4) |
| run | 2.6 | (0 - 7.3) | 3 | (0 - 8.4) | 8.1 | (5.2 - 9.9) | 0.8 | (0.5 - 1) | --- | | --- | |
| glide | 0.61 | (0 - 1.3) | 0.7 | (0 - 1.5) | 11.5 | (3 - 25.5) | 1.1 | (0.3 - 2.5) | --- | | --- | |

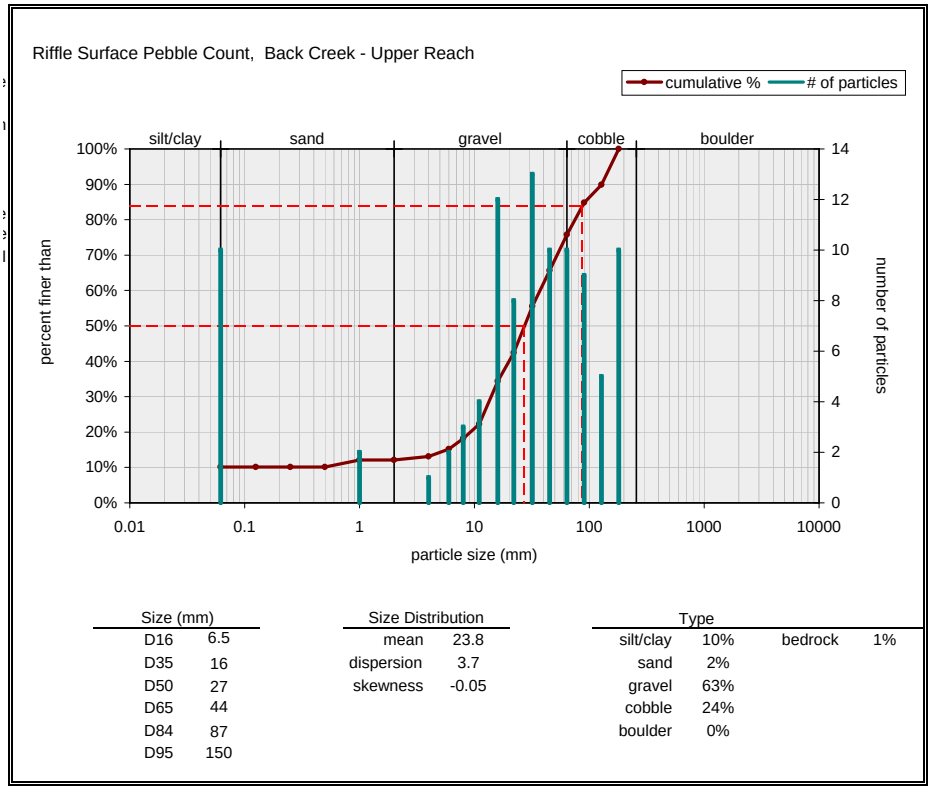
**1) Individual Pebble Count**

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

Riffle Surface

| Material | Size Range (mm) | Count |
|---|---|---|
| silt/clay | 0 - 0.062 | **10** |
| very fine sand | 0.062 - 0.125 | |
| fine sand | 0.125 - 0.25 | |
| medium sand | 0.25 - 0.5 | |
| coarse sand | 0.5 - 1 | **2** |
| very coarse sand | 1 - 2 | |
| very fine gravel | 2 - 4 | **1** |
| fine gravel | 4 - 6 | **2** |
| fine gravel | 6 - 8 | **3** |
| medium gravel | 8 - 11 | **4** |
| medium gravel | 11 - 16 | **12** |
| coarse gravel | 16 - 22 | **8** |
| coarse gravel | 22 - 32 | **13** |
| very coarse gravel | 32 - 45 | **10** |
| very coarse gravel | 45 - 64 | **10** |
| small cobble | 64 - 90 | **9** |
| medium cobble | 90 - 128 | **5** |
| large cobble | 128 - 180 | **10** |
| 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: | | 99 |
| bedrock ---------- | | **1** |
| clay hardpan ---------- | | |
| detritus/wood ---------- | | |
| artificial ---------- | | |
| total count: | | 100 |

Note:




| Size (mm) | |
|---|---|
| D16 | 6.5 |
| D35 | 16 |
| D50 | 27 |
| D65 | 44 |
| D84 | 87 |
| D95 | 150 |

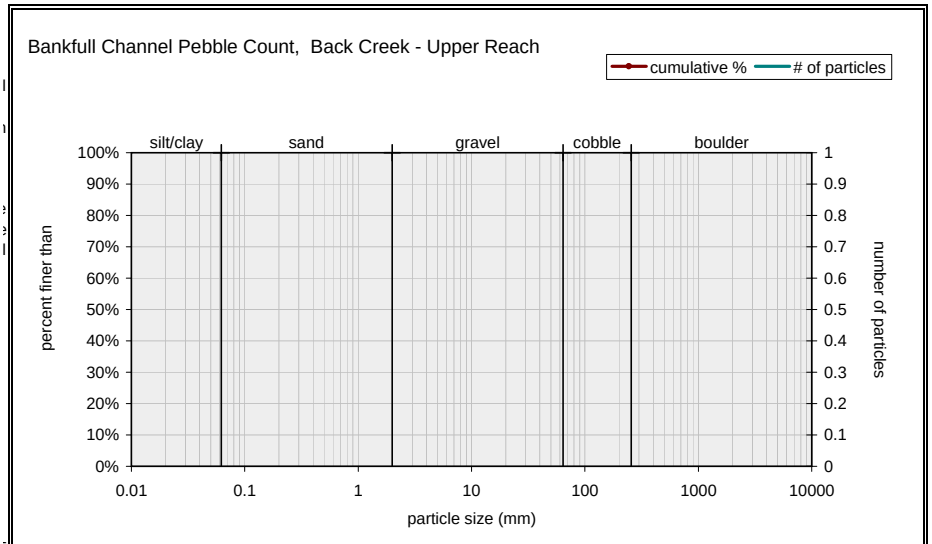
| Size Distribution | |
|---|---|
| mean | 23.8 |
| dispersion | 3.7 |
| skewness | -0.05 |

| Type | | | |
|---|---|---|---|
| silt/clay | 10% | bedrock | 1% |
| sand | 2% | | |
| gravel | 63% | | |
| 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**

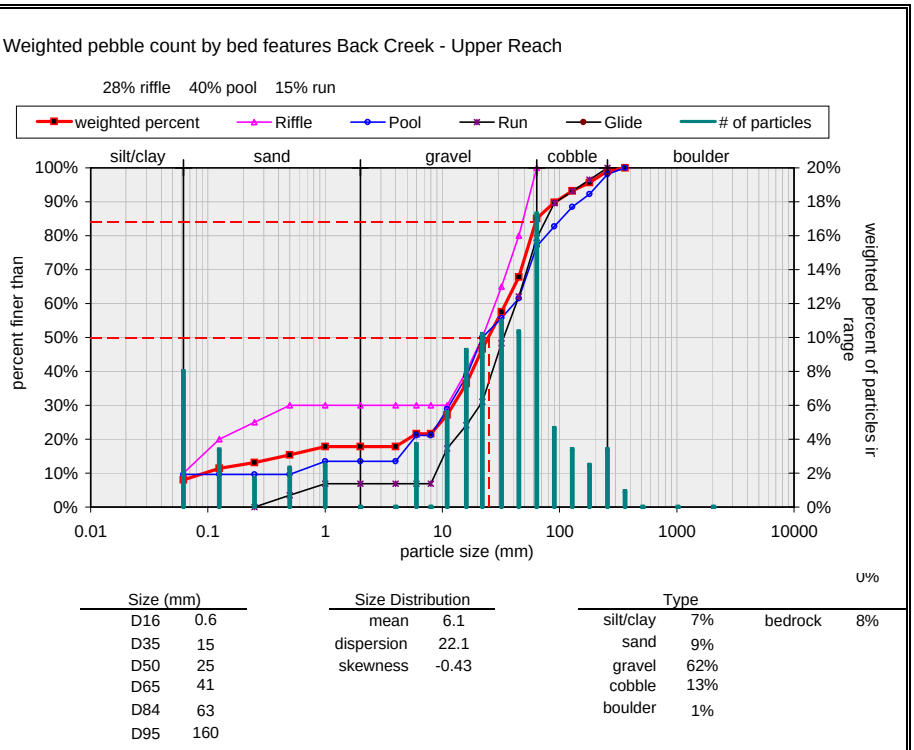
Riffle, Pool, Run, Glide

| | | | | | |
|---|---|---|---|---|---|
| Riffle | 28 | % | Run | 15 | % |
| Pool | 40 | % | Glide | | % |

**Weighted pebble count by bed features**

| Material | Size Range (mm) | weighted |
|---|---|---|
| silt/clay | 0 - 0.062 | 6.6 |
| very fine sand | 0.062 - 0.125 | 2.8 |
| fine sand | 0.125 - 0.25 | 1.4 |
| medium sand | 0.25 - 0.5 | 1.9 |
| coarse sand | 0.5 - 1 | 2.1 |
| very coarse sand | 1 - 2 | 0.0 |
| very fine gravel | 2 - 4 | 0.0 |
| fine gravel | 4 - 6 | 3.1 |
| fine gravel | 6 - 8 | 0.0 |
| medium gravel | 8 - 11 | 4.6 |
| medium gravel | 11 - 16 | 7.7 |
| coarse gravel | 16 - 22 | 8.4 |
| coarse gravel | 22 - 32 | 9.1 |
| very coarse gravel | 32 - 45 | 8.6 |
| very coarse gravel | 45 - 64 | 14.3 |
| small cobble | 64 - 90 | 3.9 |
| medium cobble | 90 - 128 | 2.8 |
| large cobble | 128 - 180 | 2.1 |
| very large cobble | 180 - 256 | 2.8 |
| small boulder | 256 - 362 | 0.8 |
| 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: | | 83 |
| bedrock | | 7.2 |
| clay hardpan | | 0.0 |
| detritus/wood | | 0.0 |
| artificial | | 0.0 |
| total weighted count: | | 90.2 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.6 |
| D35 | 15 |
| D50 | 25 |
| D65 | 41 |
| D84 | 63 |
| D95 | 160 |

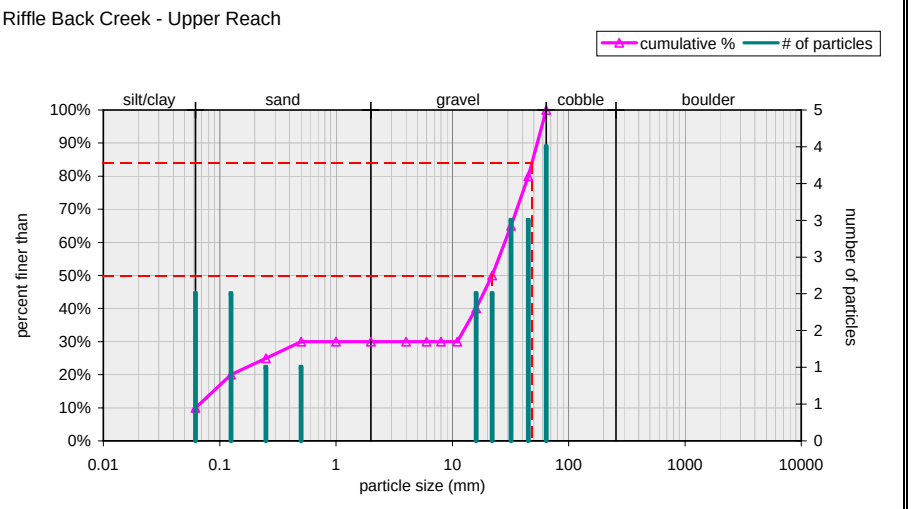
| Size Distribution | |
|---|---|
| mean | 6.1 |
| dispersion | 22.1 |
| skewness | -0.43 |

| Type | | | |
|---|---|---|---|
| silt/clay | 7% | bedrock | 8% |
| sand | 9% | | |
| gravel | 62% | | |
| cobble | 13% | | |
| boulder | 1% | | |

**Riffle**

| Material | Size Range (mm) | Count |
|---|---|---|
| silt/clay | 0 - 0.062 | 2 |
| very fine sand | 0.062 - 0.125 | 2 |
| fine sand | 0.125 - 0.25 | 1 |
| medium sand | 0.25 - 0.5 | 1 |
| 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 | 2 |
| coarse gravel | 16 - 22 | 2 |
| coarse gravel | 22 - 32 | 3 |
| very coarse gravel | 32 - 45 | 3 |
| very coarse gravel | 45 - 64 | 4 |
| 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: | | 20 |
| bedrock | | 2 |
| clay hardpan | | |
| detritus/wood | | |
| artificial | | |
| total count: | | 22 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.094 |
| D35 | 13 |
| D50 | 22 |
| D65 | 32 |
| D84 | 48 |
| D95 | 59 |

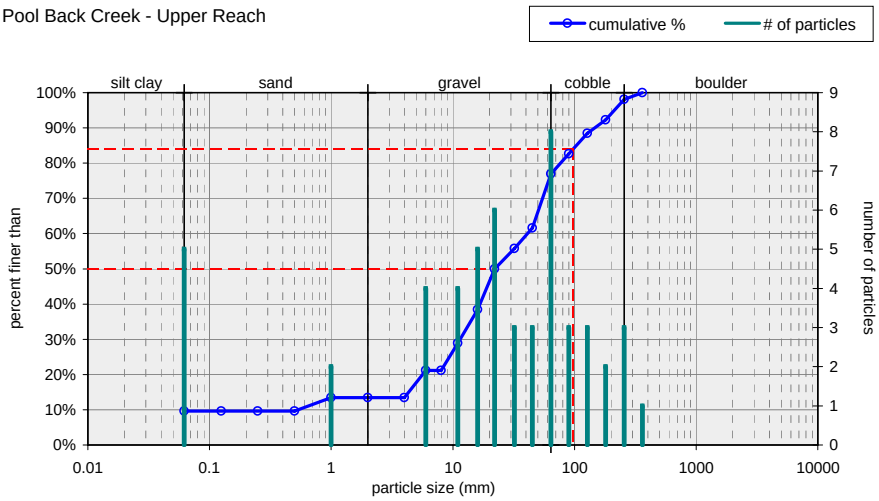
| Size Distribution | |
|---|---|
| mean | 2.1 |
| dispersion | 118.1 |
| skewness | -0.62 |

| Type | | | |
|---|---|---|---|
| silt/clay | 9% | bedrock | 9% |
| sand | 18% | | |
| gravel | 64% | | |
| cobble | 0% | | |
| boulder | 0% | | |

**Pool**

| Material | Size Range (mm) | Count |
|---|---|---|
| silt/clay | 0 - 0.062 | **5** |
| very fine sand | 0.062 - 0.125 | |
| fine sand | 0.125 - 0.25 | |
| medium sand | 0.25 - 0.5 | |
| coarse sand | 0.5 - 1 | **2** |
| very coarse sand | 1 - 2 | |
| very fine gravel | 2 - 4 | |
| fine gravel | 4 - 6 | **4** |
| fine gravel | 6 - 8 | |
| medium gravel | 8 - 11 | **4** |
| medium gravel | 11 - 16 | **5** |
| coarse gravel | 16 - 22 | **6** |
| coarse gravel | 22 - 32 | **3** |
| very coarse gravel | 32 - 45 | **3** |
| very coarse gravel | 45 - 64 | **8** |
| small cobble | 64 - 90 | **3** |
| medium cobble | 90 - 128 | **3** |
| large cobble | 128 - 180 | **2** |
| very large cobble | 180 - 256 | **3** |
| 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: | | 52 |
| bedrock ---------- | | **6** |
| clay hardpan ---------- | | |
| detritus/wood ---------- | | |
| artificial ---------- | | |
| total count: | | 58 |

Note:




| Size (mm) | |
|---|---|
| D16 | 4.6 |
| D35 | 14 |
| D50 | 22 |
| D65 | 49 |
| D84 | 97 |
| D95 | 210 |

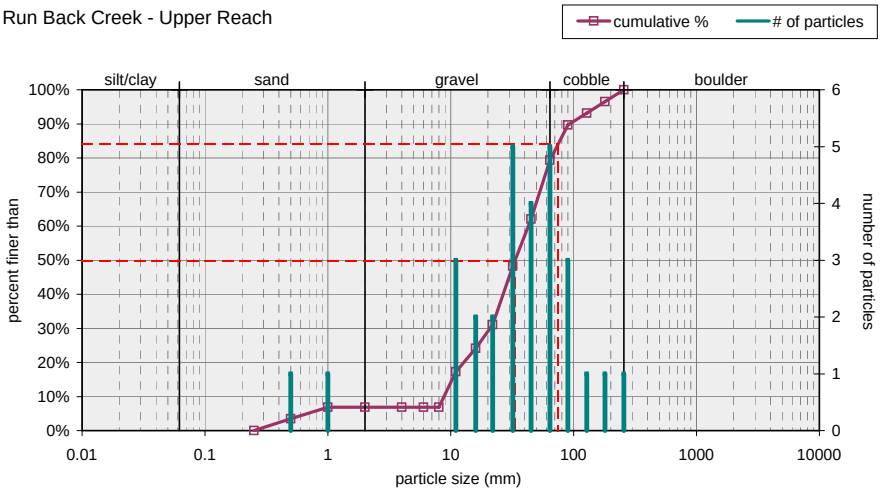
| Size Distribution | |
|---|---|
| mean | 21.1 |
| dispersion | 4.6 |
| skewness | -0.02 |

| Type | | | |
|---|---|---|---|
| silt/clay | 9% | bedrock | 10% |
| sand | 3% | | |
| gravel | 57% | | |
| cobble | 19% | | |
| boulder | 2% | | |

**Run**

| 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 | **1** |
| coarse sand | 0.5 - 1 | **1** |
| very coarse sand | 1 - 2 | |
| very fine gravel | 2 - 4 | |
| fine gravel | 4 - 6 | |
| fine gravel | 6 - 8 | |
| medium gravel | 8 - 11 | **3** |
| medium gravel | 11 - 16 | **2** |
| coarse gravel | 16 - 22 | **2** |
| coarse gravel | 22 - 32 | **5** |
| very coarse gravel | 32 - 45 | **4** |
| very coarse gravel | 45 - 64 | **5** |
| small cobble | 64 - 90 | **3** |
| medium cobble | 90 - 128 | **1** |
| large cobble | 128 - 180 | **1** |
| 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: | | 29 |
| bedrock ---------- | | |
| clay hardpan ---------- | | |
| detritus/wood ---------- | | |
| artificial ---------- | | |
| total count: | | 29 |

Note:




| Size (mm) | |
|---|---|
| D16 | 11 |
| D35 | 24 |
| D50 | 33 |
| D65 | 48 |
| D84 | 75 |
| D95 | 150 |

| Size Distribution | |
|---|---|
| mean | 28.7 |
| dispersion | 2.6 |
| skewness | -0.07 |

| Type | |
|---|---|
| silt/clay | 0% |
| sand | 7% |
| gravel | 72% |
| cobble | 21% |
| boulder | 0% |

**3) Bulk Sample Sieve Analysis**

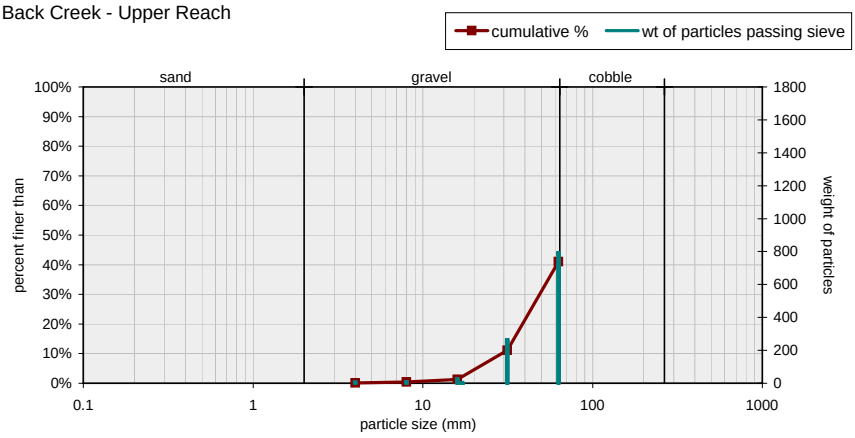
Two samples may be entered below. Select sample type for each.

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **682** | **686** | 4 | 0% | --- | --- |
| **4** | **740** | **746** | 6 | 0% | 0% | 0% |
| **8** | **739** | **762** | 23 | 1% | 0% | 0% |
| **16** | **809** | **1070** | 261 | 10% | 1% | 1% |
| **31.5** | **818** | **1607** | 789 | 30% | 10% | 11% |
| **63** | **710** | **2265** | 1555 | 59% | 30% | 41% |
| | | | 0 | 0% | 59% | 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: 2638

Note: Bar - Pav't / largest 2 particles middle axis lengths = 120 & 55 mm

Enter sieve size that passed 100% of sample.



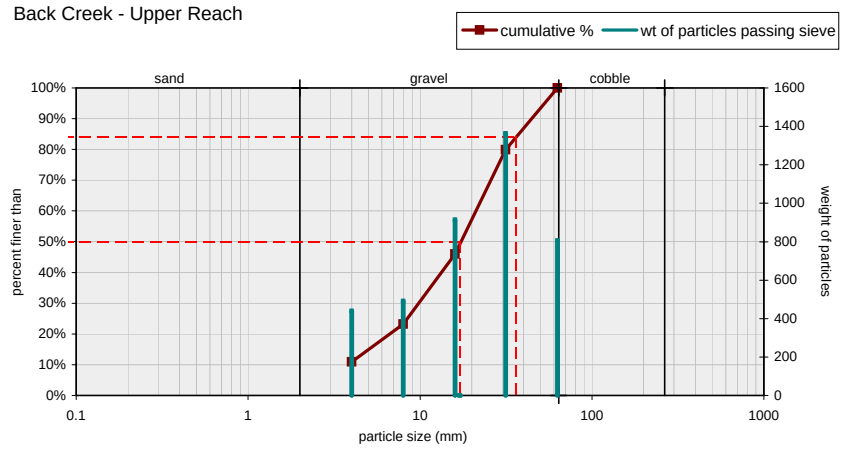

| Size (mm) | | | |
|---|---|---|---|
| D16 | 35 | D65 | #NUM! |
| D35 | 55 | D84 | #NUM! |
| D50 | #NUM! | D95 | #NUM! |

sand 100%

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **679** | **1119** | 440 | 11% | --- | --- |
| **4** | **731** | **1222** | 491 | 12% | 11% | 11% |
| **8** | **719** | **1633** | 914 | 23% | 12% | 23% |
| **16** | **807** | **2170** | 1363 | 34% | 23% | 46% |
| **31.5** | **811** | **1617** | 806 | 20% | 34% | 80% |
| **63** | **0** | **0** | 0 | 0% | 20% | 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: 4014

Note: Bar - Subpav't / largest 2 particle middle axis lengths = 60 & 45 mm




| Size (mm) | | | |
|---|---|---|---|
| D16 | 5.3 | D65 | 23 |
| D35 | 11 | D84 | 36 |
| D50 | 17 | D95 | 53 |

## Summary

| | |
|---|---|
| Stream: | Back Creek - Lower Reach |
| Watershed: | --- |
| Location: | Heath Dairy Road |
| Latitude: | --- |
| Longitude: | --- |
| State: | NC |
| County: | Randolph |
| Date: | February 16, 2006 |
| Observers: | SGG, AJW, EA, BAM, AMH |
| Channel type: | E4 |
| Drainage area (sq.mi.): | 2.5 |
| notes: | --- |

| **Dimension** | | bankfull channel typical | min | max |
|---|---|---|---|---|
| floodplain: | width flood prone area (ft) | 200.0 | --- | --- |
| | low bank height (ft) | 6.0 | 5.2 | 6.0 |
| riffle-run: | kfull (sq.ft.) | 42.3 | 40.3 | 42.3 |
| | width bankfull (ft) | 13.8 | 13.5 | 13.8 |
| | mean depth (ft) | 3.07 | 3.0 | 3.1 |
| | max depth (ft) | 4.1 | 4.1 | 4.2 |
| | hydraulic radius (ft) | 2.4 | | |
| pool: | x-area pool (sq.ft.) | 52.6 | 37.7 | 52.6 |
| | width pool (ft) | 13.4 | 10.9 | 13.4 |
| | max depth pool (ft) | 5.0 | 4.2 | 5.0 |
| | hydraulic radius (ft) | 2.5 | | |

| dimensionless ratios: | typical | min | max |
|---|---|---|---|
| width depth ratio | 4.5 | 4.5 | 4.5 |
| entrenchment ratio | 14.5 | --- | --- |
| riffle max depth ratio | 1.3 | 1.3 | 1.4 |
| bank height ratio | 1.5 | 1.3 | 1.5 |
| pool area ratio | 1.2 | 0.9 | 1.2 |
| pool width ratio | 1.0 | 0.8 | 1.0 |
| pool max depth ratio | 1.6 | 1.4 | 1.6 |

| hydraulics: | typical | min | max | |
|---|---|---|---|---|
| discharge rate (cfs) | 167.0 | 155.3 | 166.9 | |
| channel slope (%) | 0.45 | | | |
| | riffle-run | min | max | pool |
| velocity (ft/s) | 3.9 | 3.9 | 3.9 | 3.2 |
| Froude number | 0.45 | 0.45 | 0.45 | 0.13 |
| shear stress (lbs/sq.ft.) | 0.674 | 0.642 | 0.665 | 0.702 |
| shear velocity (ft/s) | 0.590 | 0.576 | 0.586 | 0.602 |
| stream power (lb/s) | 46.9 | 43.6 | 46.9 | |
| unit stream power (lb/ft/s) | 3.398 | 3.231 | 3.407 | |
| relative roughness | 146.0 | --- | --- | |
| friction factor u/u* | 6.7 | 12.1 | 12.1 | |
| threshold grain size (t*=0.06) (mm) | 32.7 | 31.6 | 32.7 | |
| Shield's parameter | 0.311 | | | |

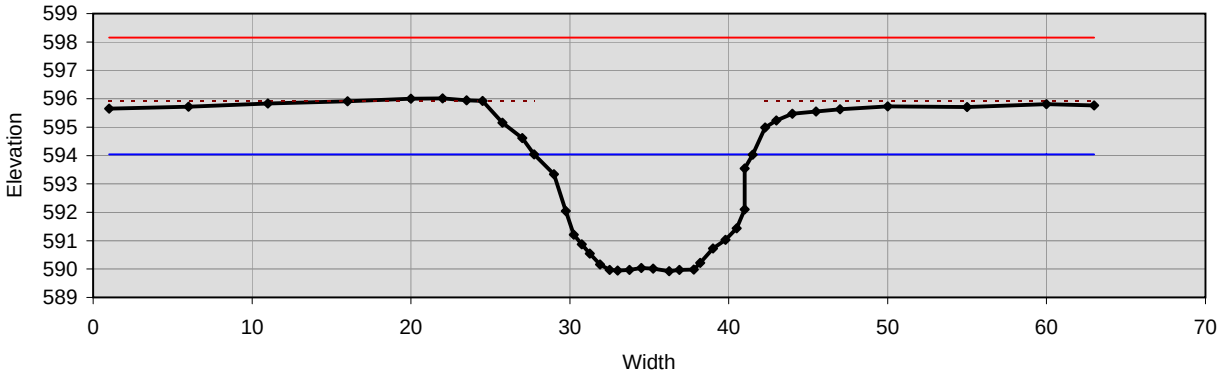
| **Pattern** | typical | min | max |
|---|---|---|---|
| meander length (ft) | --- | --- | --- |
| belt width (ft) | --- | --- | --- |
| amplitude (ft) | --- | --- | --- |
| radius (ft) | --- | --- | --- |
| arc angle (degrees) | --- | --- | --- |
| stream length (ft) | --- | | |
| valley length (ft) | --- | | |
| Sinuosity | --- | | |
| Meander Length Ratio | --- | --- | --- |
| Meander Width Ratio | --- | --- | --- |
| Radius Ratio | --- | --- | --- |

| **Profile** | typical | min | max |
|---|---|---|---|
| pool-pool spacing (ft) | 43.1 | 39.4 | 46.7 |
| riffle length (ft) | 30.6 | 16.3 | 51.5 |
| pool length (ft) | 22.0 | 5.7 | 49.5 |
| run length (ft) | 13.9 | 4.3 | 23.4 |
| glide length (ft) | 10.1 | 7.5 | 15.5 |
| channel slope (%) | 0.45 | | |
| riffle slope (%) | 0.37 | | 0.99 |
| pool slope (%) | | | |
| run slope (%) | 2.4 | 2.1 | 2.8 |
| glide slope (%) | 0.67 | | 1.4 |
| measured valley slope (%) | --- | | |
| valley slope from sinuosity (%) | --- | | |
| Riffle Length Ratio | 2.2 | 1.2 | 3.7 |
| Pool Length Ratio | 1.6 | 0.4 | 3.6 |
| Run Length Ratio | 1 | 0.3 | 1.7 |
| Glide Length Ratio | 0.7 | 0.5 | 1.1 |
| Riffle Slope Ratio | 0.8 | | 2.2 |
| Pool Slope Ratio | | | |
| Run Slope Ratio | 5.3 | 4.7 | 6.2 |
| Glide Slope Ratio | 1.5 | | 3.1 |
| Pool Spacing Ratio | 3.1 | 2.9 | 3.4 |

| **Channel Materials** | Riffle Surface | | | BkF Channel |
|---|---|---|---|---|
| D16 (mm) | 0.07 | --- | --- | 0.062 |
| D35 (mm) | 2.7 | --- | --- | 6.6 |
| D50 (mm) | 6.4 | --- | --- | 13 |
| D65 (mm) | 9.5 | --- | --- | 30 |
| D84 (mm) | 21 | --- | --- | 64 |
| D95 (mm) | 90 | --- | --- | 150 |
| mean (mm) | 1.2 | | | 2.0 |
| dispersion | 47.4 | | | 107.3 |
| skewness | -0.5 | | | -0.5 |
| Shape Factor | --- | | | |
| % Silt/Clay | 15% | --- | --- | 18% |
| % Sand | 17% | --- | --- | 10% |
| % Gravel | 60% | --- | --- | 54% |
| % Cobble | 8% | --- | --- | 15% |
| % Boulder | | --- | --- | |
| % Bedrock | | --- | | 3% |
| % Clay Hardpan | | --- | | |
| % Detritus/Wood | | --- | | |
| % Artificial | | --- | | |
| Largest Mobile (mm) | --- | | | |

## Cross Section R1

0 + 51.5 Back Creek - Lower Reach, Riffle




| Bankfull Dimensions | |
|---|---|
| 42.3 | x-section area (ft.sq.) |
| 13.8 | width (ft) |
| 3.1 | mean depth (ft) |
| 4.1 | max depth (ft) |
| 17.9 | wetted parimeter (ft) |
| 2.4 | hyd radi (ft) |
| 4.5 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 200.0 | W flood prone area (ft) |
| 14.5 | entrenchment ratio |
| 6.0 | low bank height (ft) |
| 1.5 | low bank height ratio |

| Materials | |
|---|---|
| 6.4 | D50 Riffle (mm) |
| 21 | D84 Riffle (mm) |
| 33 | threshold grain size (mm): |

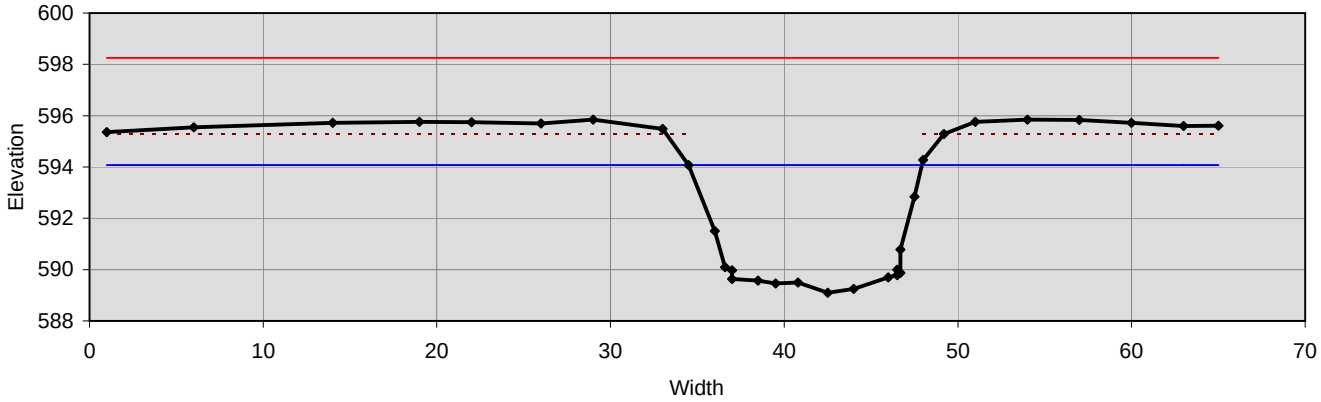
| Bankfull Flow | |
|---|---|
| 3.9 | velocity (ft/s) |
| 166.9 | discharge rate (cfs) |
| 0.45 | Froude number |

| Flow Resistance | |
|---|---|
| 0.045 | Manning's roughness |
| 0.18 | D'Arcy-Weisbach fric. |
| 12.1 | resistance factor u/u* |
| 44.6 | relative roughness |

| Forces & Power | |
|---|---|
| 0.45 | channel slope (%) |
| 0.67 | shear stress (lb/sq.ft.) |
| 0.59 | shear velocity (ft/s) |
| 3.4 | unit strm power (lb/ft/s) |

## Cross Section P1

0 + 80.5 Back Creek - Lower Reach, Pool




| Bankfull Dimensions | |
|---|---|
| 52.6 | x-section area (ft.sq.) |
| 13.4 | width (ft) |
| 3.9 | mean depth (ft) |
| 5.0 | max depth (ft) |
| 19.8 | wetted parimeter (ft) |
| 2.7 | hyd radi (ft) |
| 3.4 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 200.0 | W flood prone area (ft) |
| 14.9 | entrenchment ratio |
| 6.2 | low bank height (ft) |
| 1.2 | low bank height ratio |

| Materials | |
|---|---|
| 6.4 | D50 Riffle (mm) |
| 21 | D84 Riffle (mm) |
| 37 | threshold grain size (mm): |

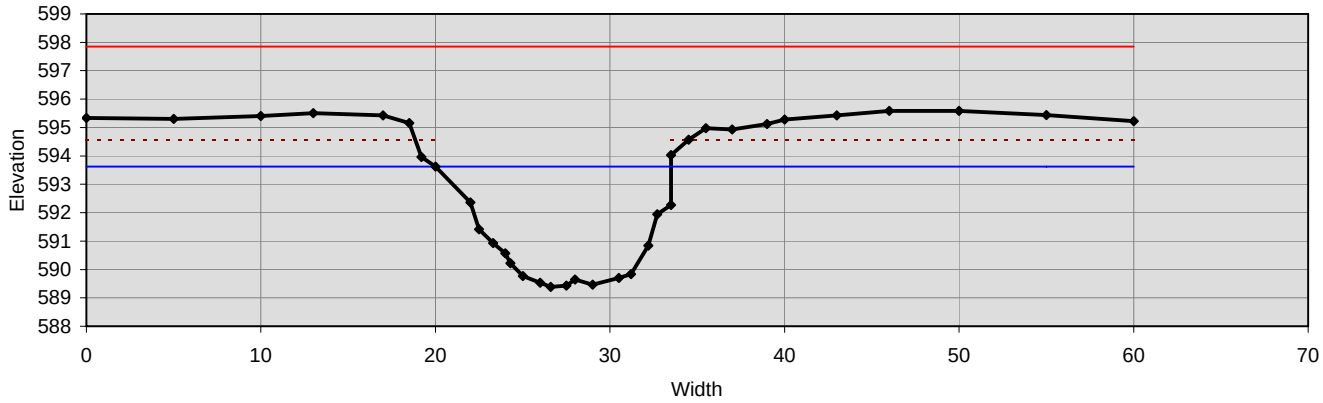
| Bankfull Flow | |
|---|---|
| 4.3 | velocity (ft/s) |
| 224.0 | discharge rate (cfs) |
| 0.46 | Froude number |

| Flow Resistance | |
|---|---|
| 0.045 | Manning's roughness |
| 0.17 | D'Arcy-Weisbach fric. |
| 12.5 | resistance factor u/u* |
| 56.8 | relative roughness |

| Forces & Power | |
|---|---|
| 0.45 | channel slope (%) |
| 0.75 | shear stress (lb/sq.ft.) |
| 0.62 | shear velocity (ft/s) |
| 4.7 | unit strm power (lb/ft/s) |

## Cross Section R2

1 + 28.5 Back Creek - Lower Reach, Riffle




| Bankfull Dimensions | |
|---|---|
| 40.3 | x-section area (ft.sq.) |
| 13.5 | width (ft) |
| 3.0 | mean depth (ft) |
| 4.2 | max depth (ft) |
| 17.6 | wetted parimeter (ft) |
| 2.3 | hyd radi (ft) |
| 4.5 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 200.0 | W flood prone area (ft) |
| 14.8 | entrenchment ratio |
| 5.2 | low bank height (ft) |
| 1.2 | low bank height ratio |

| Materials | |
|---|---|
| 6.4 | D50 Riffle (mm) |
| 21 | D84 Riffle (mm) |
| 32 | threshold grain size (mm): |

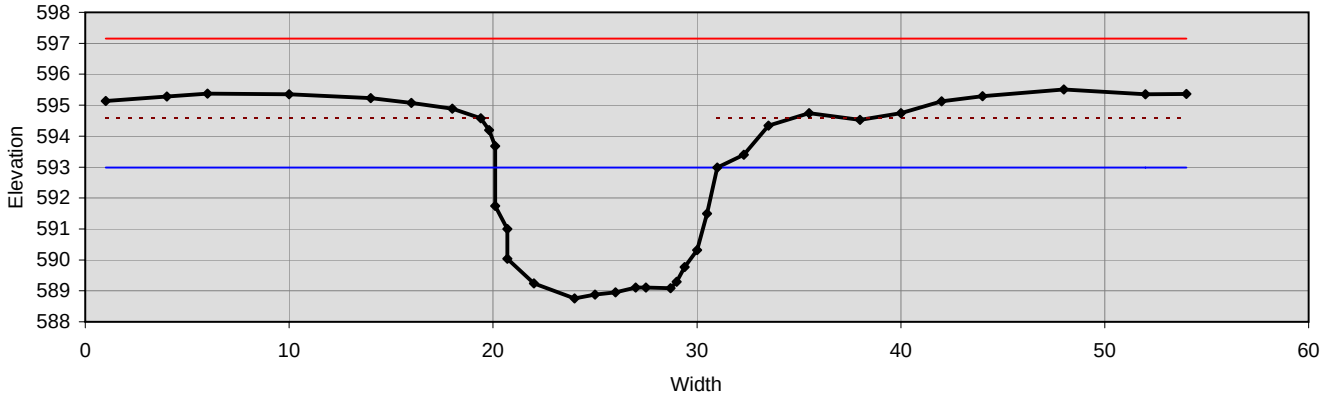
| Bankfull Flow | |
|---|---|
| 3.9 | velocity (ft/s) |
| 155.3 | discharge rate (cfs) |
| 0.45 | Froude number |

| Flow Resistance | |
|---|---|
| 0.045 | Manning's roughness |
| 0.18 | D'Arcy-Weisbach fric. |
| 12.1 | resistance factor u/u* |
| 43.3 | relative roughness |

| Forces & Power | |
|---|---|
| 0.45 | channel slope (%) |
| 0.64 | shear stress (lb/sq.ft.) |
| 0.58 | shear velocity (ft/s) |
| 3.2 | unit strm power (lb/ft/s) |

## Cross Section P2

1 + 72.5 Back Creek - Lower Reach, Pool




### Bankfull Dimensions

| | |
|---|---|
| 37.7 | x-section area (ft.sq.) |
| 10.9 | width (ft) |
| 3.5 | mean depth (ft) |
| 4.2 | max depth (ft) |
| 16.1 | wetted parimeter (ft) |
| 2.3 | hyd radi (ft) |
| 3.1 | width-depth ratio |

### Flood Dimensions

| | |
|---|---|
| 200.0 | W flood prone area (ft) |
| 18.3 | entrenchment ratio |
| 5.8 | low bank height (ft) |
| 1.4 | low bank height ratio |

### Materials

| | |
|---|---|
| 6.4 | D50 Riffle (mm) |
| 21 | D84 Riffle (mm) |
| 32 | threshold grain size (mm): |

### Bankfull Flow

| | |
|---|---|
| 3.9 | velocity (ft/s) |
| 147.8 | discharge rate (cfs) |
| 0.45 | Froude number |

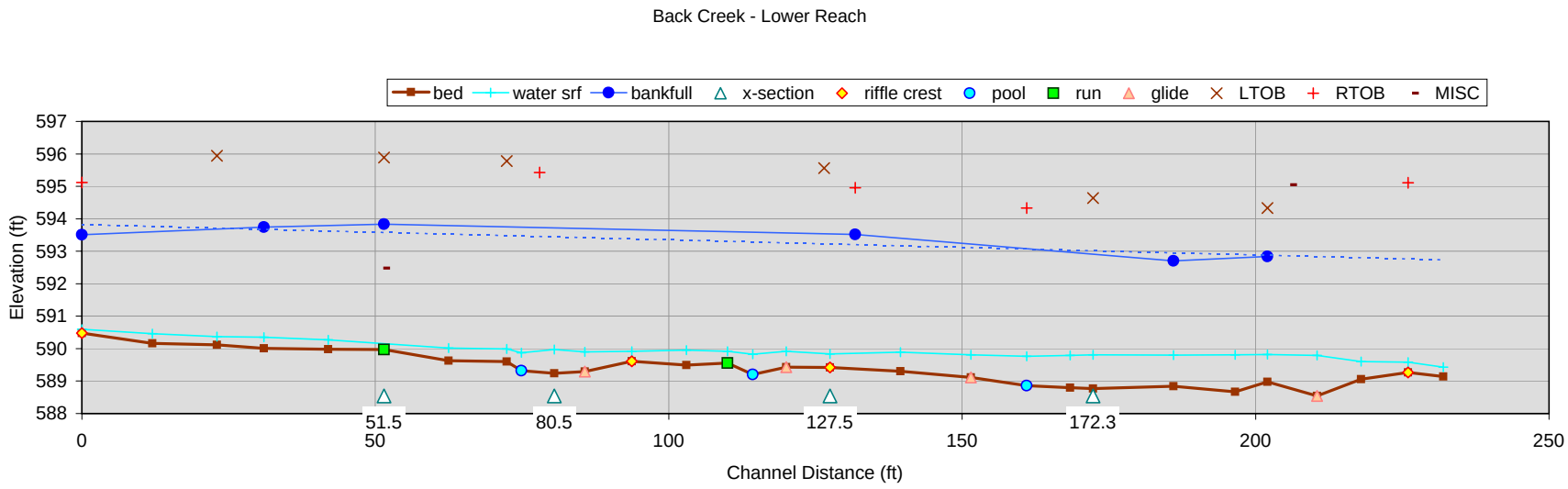
### Flow Resistance

| | |
|---|---|
| 0.045 | Manning's roughness |
| 0.18 | D'Arcy-Weisbach fric. |
| 12.2 | resistance factor u/u* |
| 50.2 | relative roughness |

### Forces & Power

| | |
|---|---|
| 0.45 | channel slope (%) |
| 0.66 | shear stress (lb/sq.ft.) |
| 0.58 | shear velocity (ft/s) |
| 3.8 | unit strm power (lb/ft/s) |

## Longitudinal Slope Profile




| | slope (%) | | slope ratio | | length (ft) | | length ratio | | pool-pool spacing (ft) | | p-p ratio | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| reach | 0.45 | | --- | | 232.0 | (16.8 channel widths) | --- | | --- | | --- | |
| riffle | 0.37 | (0 - 0.99) | 0.8 | (0 - 2.2) | 30.6 | (16.3 - 51.5) | 2.2 | (1.2 - 3.7) | --- | | --- | |
| pool | 0 | | 0 | | 22.0 | (5.7 - 49.5) | 1.6 | (0.4 - 3.6) | 43.1 | (39.4 - 46.7) | 3.1 | (2.9 - 3.4) |
| run | 2.4 | (2.1 - 2.8) | 5.3 | (4.7 - 6.2) | 13.9 | (4.3 - 23.4) | 1 | (0.3 - 1.7) | --- | | --- | |
| glide | 0.67 | (0 - 1.4) | 1.5 | (0 - 3.1) | 10.1 | (7.5 - 15.5) | 0.7 | (0.5 - 1.1) | --- | | --- | |

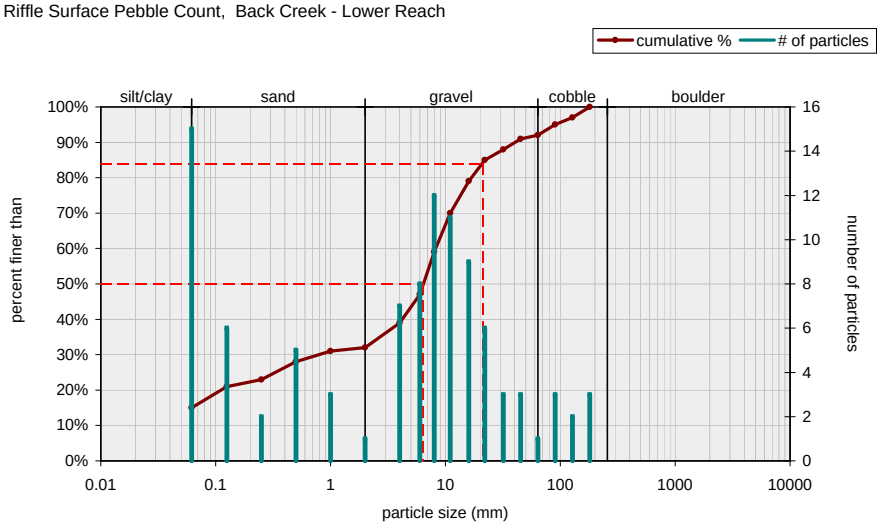
**1) Individual Pebble Count**

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 | **6** |
| fine sand | 0.125 - 0.25 | **2** |
| medium sand | 0.25 - 0.5 | **5** |
| coarse sand | 0.5 - 1 | **3** |
| very coarse sand | 1 - 2 | **1** |
| very fine gravel | 2 - 4 | **7** |
| fine gravel | 4 - 6 | **8** |
| fine gravel | 6 - 8 | **12** |
| medium gravel | 8 - 11 | **11** |
| medium gravel | 11 - 16 | **9** |
| coarse gravel | 16 - 22 | **6** |
| coarse gravel | 22 - 32 | **3** |
| very coarse gravel | 32 - 45 | **3** |
| very coarse gravel | 45 - 64 | **1** |
| small cobble | 64 - 90 | **3** |
| medium cobble | 90 - 128 | **2** |
| 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: | | 100 |
| bedrock | ---------- | |
| clay hardpan | ---------- | |
| detritus/wood | ---------- | |
| artificial | ---------- | |
| total count: | | 100 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.07 |
| D35 | 2.7 |
| D50 | 6.4 |
| D65 | 9.5 |
| D84 | 21 |
| D95 | 90 |

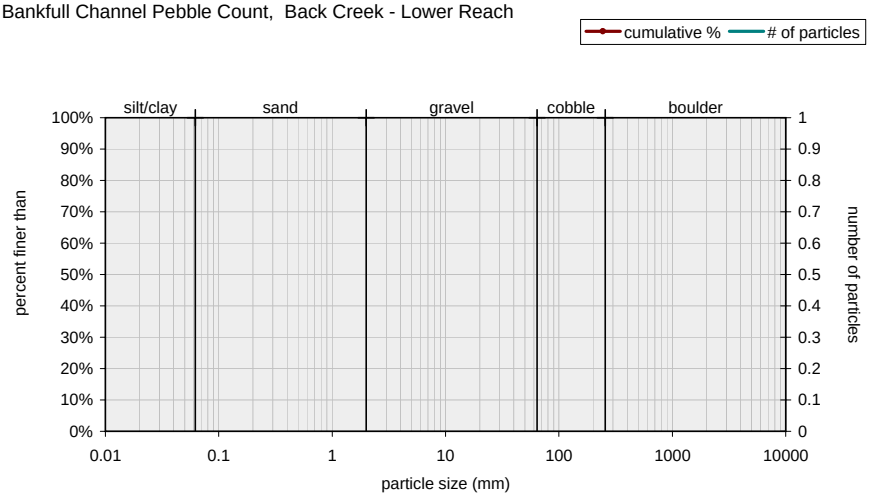
| Size Distribution | |
|---|---|
| mean | 1.2 |
| dispersion | 47.4 |
| skewness | -0.46 |

| Type | |
|---|---|
| silt/clay | 15% |
| sand | 17% |
| gravel | 60% |
| cobble | 8% |
| 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

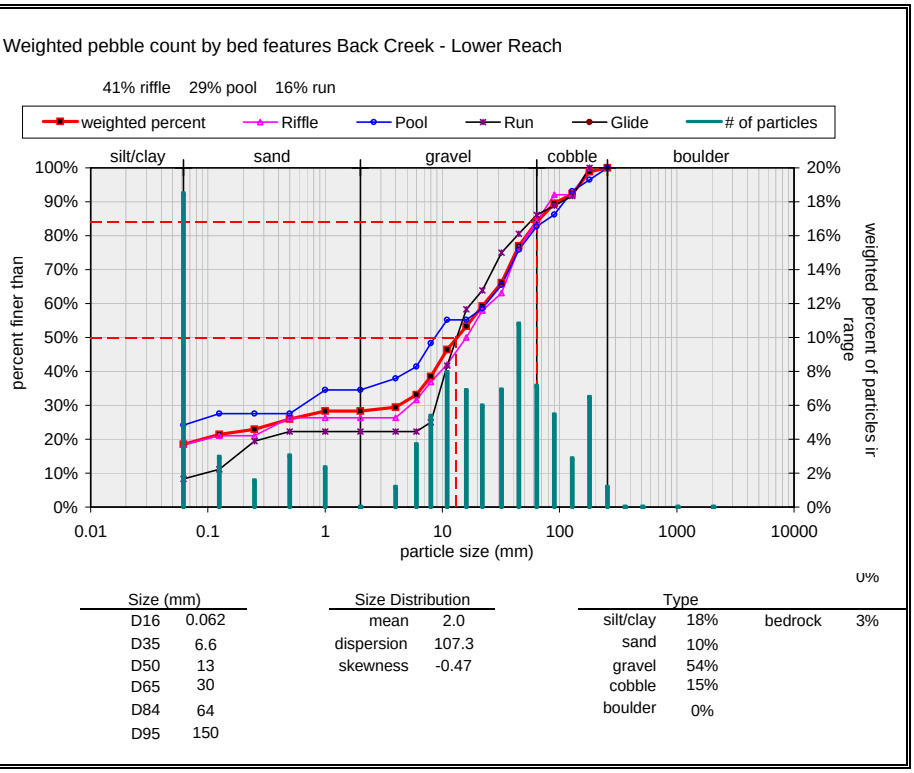
| | | | | | |
|---|---|---|---|---|---|
| Riffle | 41 | % | Run | 16 | % |
| Pool | 29 | % | Glide | | % |

**Weighted pebble count by bed features**

| Material | Size Range (mm) | weighted |
|---|---|---|
| silt/clay | 0 - 0.062 | 15.9 |
| very fine sand | 0.062 - 0.125 | 2.5 |
| fine sand | 0.125 - 0.25 | 1.3 |
| medium sand | 0.25 - 0.5 | 2.6 |
| coarse sand | 0.5 - 1 | 2.0 |
| very coarse sand | 1 - 2 | 0.0 |
| very fine gravel | 2 - 4 | 1.0 |
| fine gravel | 4 - 6 | 3.2 |
| fine gravel | 6 - 8 | 4.6 |
| medium gravel | 8 - 11 | 6.8 |
| medium gravel | 11 - 16 | 5.9 |
| coarse gravel | 16 - 22 | 5.1 |
| coarse gravel | 22 - 32 | 5.9 |
| very coarse gravel | 32 - 45 | 9.3 |
| very coarse gravel | 45 - 64 | 6.1 |
| small cobble | 64 - 90 | 4.7 |
| medium cobble | 90 - 128 | 2.4 |
| large cobble | 128 - 180 | 5.6 |
| very large cobble | 180 - 256 | 1.0 |
| 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: | 86 |
| bedrock | 3.0 |
| clay hardpan | 0.0 |
| detritus/wood | 0.0 |
| artificial | 0.0 |
| total weighted count: | 89.0 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.062 |
| D35 | 6.6 |
| D50 | 13 |
| D65 | 30 |
| D84 | 64 |
| D95 | 150 |

| Size Distribution | |
|---|---|
| mean | 2.0 |
| dispersion | 107.3 |
| skewness | -0.47 |

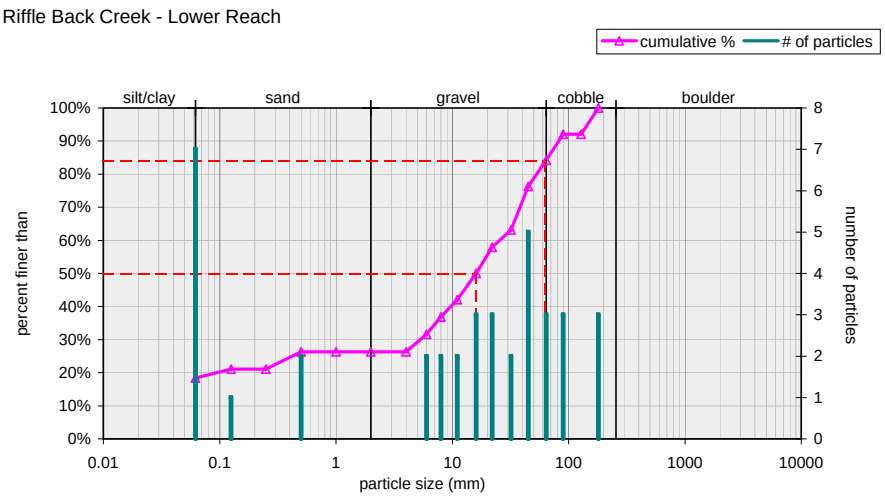
| Type | | | |
|---|---|---|---|
| silt/clay | 18% | bedrock | 3% |
| sand | 10% | | |
| gravel | 54% | | |
| cobble | 15% | | |
| boulder | 0% | | |

**Riffle**

| Material | Size Range (mm) | Count |
|---|---|---|
| silt/clay | 0 - 0.062 | **7** |
| very fine sand | 0.062 - 0.125 | **1** |
| fine sand | 0.125 - 0.25 | |
| medium sand | 0.25 - 0.5 | **2** |
| coarse sand | 0.5 - 1 | |
| very coarse sand | 1 - 2 | |
| very fine gravel | 2 - 4 | |
| fine gravel | 4 - 6 | **2** |
| fine gravel | 6 - 8 | **2** |
| medium gravel | 8 - 11 | **2** |
| medium gravel | 11 - 16 | **3** |
| coarse gravel | 16 - 22 | **3** |
| coarse gravel | 22 - 32 | **2** |
| very coarse gravel | 32 - 45 | **5** |
| very coarse gravel | 45 - 64 | **3** |
| small cobble | 64 - 90 | **3** |
| medium cobble | 90 - 128 | |
| 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: | 38 |
| bedrock | |
| clay hardpan | |
| detritus/wood | |
| artificial | |
| total count: | 38 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.062 |
| D35 | 7.2 |
| D50 | 16 |
| D65 | 34 |
| D84 | 63 |
| D95 | 150 |

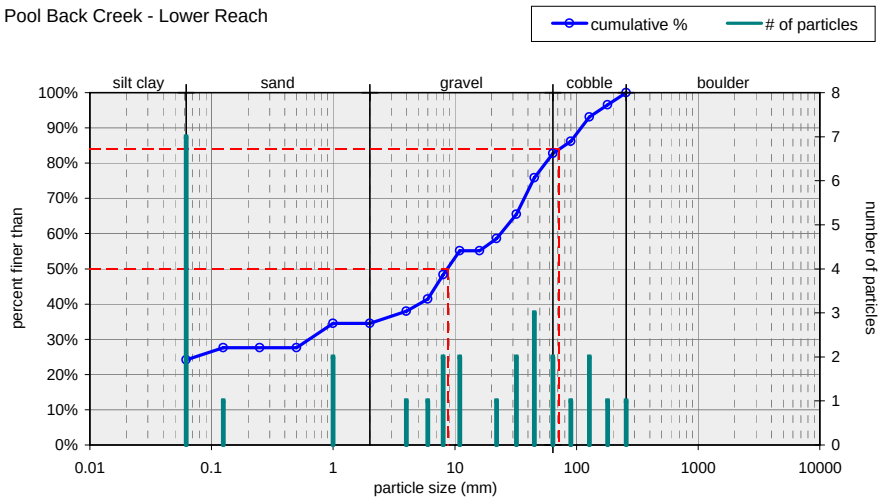
| Size Distribution | |
|---|---|
| mean | 2.0 |
| dispersion | 131.0 |
| skewness | -0.52 |

| Type | |
|---|---|
| silt/clay | 18% |
| sand | 8% |
| gravel | 58% |
| cobble | 16% |
| boulder | 0% |

**Pool**

| Material | Size Range (mm) | Count |
|---|---|---|
| silt/clay | 0 - 0.062 | **7** |
| very fine sand | 0.062 - 0.125 | **1** |
| fine sand | 0.125 - 0.25 | |
| medium sand | 0.25 - 0.5 | |
| coarse sand | 0.5 - 1 | **2** |
| very coarse sand | 1 - 2 | |
| very fine gravel | 2 - 4 | **1** |
| fine gravel | 4 - 6 | **1** |
| fine gravel | 6 - 8 | **2** |
| medium gravel | 8 - 11 | **2** |
| medium gravel | 11 - 16 | |
| coarse gravel | 16 - 22 | **1** |
| coarse gravel | 22 - 32 | **2** |
| very coarse gravel | 32 - 45 | **3** |
| very coarse gravel | 45 - 64 | **2** |
| small cobble | 64 - 90 | **1** |
| medium cobble | 90 - 128 | **2** |
| large cobble | 128 - 180 | **1** |
| 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: | | 29 |
| bedrock | ---------- | **3** |
| clay hardpan | ---------- | |
| detritus/wood | ---------- | |
| artificial | ---------- | |
| total count: | | 32 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.062 |
| D35 | 2.2 |
| D50 | 8.7 |
| D65 | 31 |
| D84 | 72 |
| D95 | 150 |

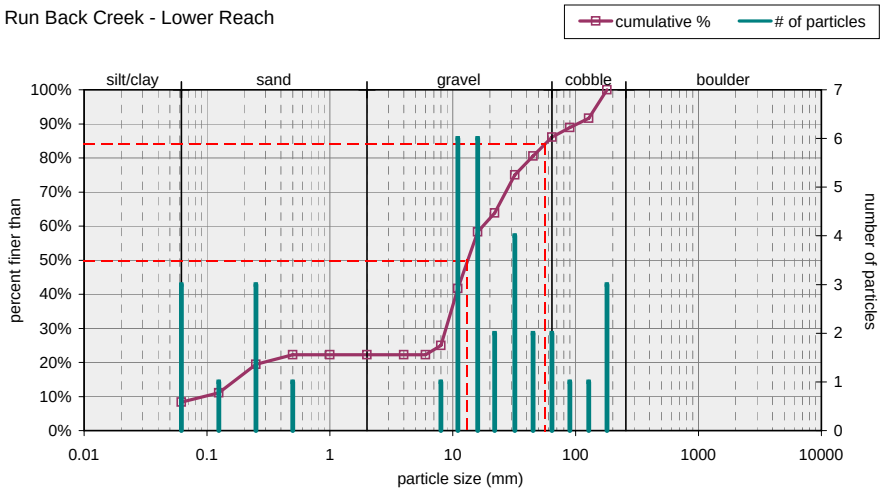
| Size Distribution | |
|---|---|
| mean | 2.1 |
| dispersion | 74.3 |
| skewness | -0.35 |

| Type | | | |
|---|---|---|---|
| silt/clay | 22% | bedrock | 9% |
| sand | 9% | | |
| gravel | 44% | | |
| cobble | 16% | | |
| boulder | 0% | | |

**Run**

| Material | Size Range (mm) | Count |
|---|---|---|
| silt/clay | 0 - 0.062 | **3** |
| very fine sand | 0.062 - 0.125 | **1** |
| fine sand | 0.125 - 0.25 | **3** |
| medium sand | 0.25 - 0.5 | **1** |
| coarse sand | 0.5 - 1 | |
| very coarse sand | 1 - 2 | |
| very fine gravel | 2 - 4 | |
| fine gravel | 4 - 6 | |
| fine gravel | 6 - 8 | **1** |
| medium gravel | 8 - 11 | **6** |
| medium gravel | 11 - 16 | **6** |
| coarse gravel | 16 - 22 | **2** |
| coarse gravel | 22 - 32 | **4** |
| very coarse gravel | 32 - 45 | **2** |
| very coarse gravel | 45 - 64 | **2** |
| small cobble | 64 - 90 | **1** |
| medium cobble | 90 - 128 | **1** |
| 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: | | 36 |
| bedrock | ---------- | |
| clay hardpan | ---------- | |
| detritus/wood | ---------- | |
| artificial | ---------- | |
| total count: | | 36 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.19 |
| D35 | 9.7 |
| D50 | 13 |
| D65 | 23 |
| D84 | 56 |
| D95 | 150 |

| Size Distribution | |
|---|---|
| mean | 3.3 |
| dispersion | 36.4 |
| skewness | -0.38 |

| Type | |
|---|---|
| silt/clay | 8% |
| sand | 14% |
| gravel | 64% |
| cobble | 14% |
| boulder | 0% |

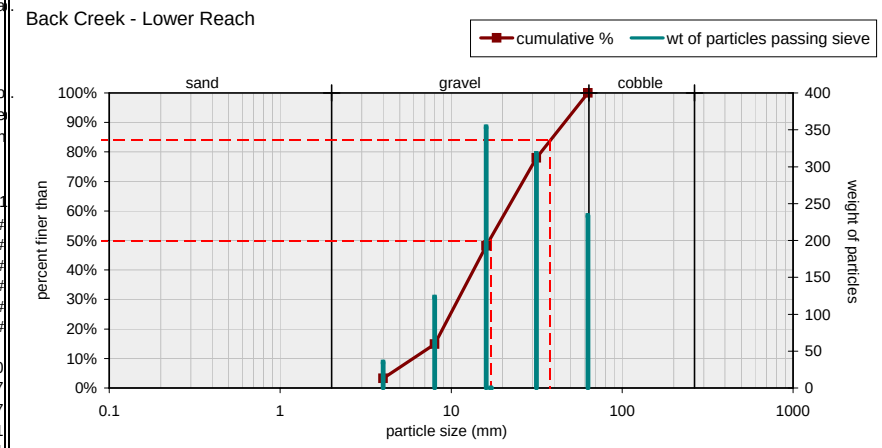
**3) Bulk Sample Sieve Analysis**

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

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **679** | **714** | 35 | 3% | --- | --- |
| **4** | **737** | **860** | 123 | 12% | 3% | 3% |
| **8** | **734** | **1088** | 354 | 33% | 12% | 15% |
| **16** | **806** | **1124** | 318 | 30% | 33% | 48% |
| **31.5** | **816** | **1050** | 234 | 22% | 30% | 78% |
| **63** | **0** | **0** | 0 | 0% | 22% | 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: 1064

Note: Riffle #1 Bed-Sub / 2 largest particle middle axis lengths = 38 & 35 mm



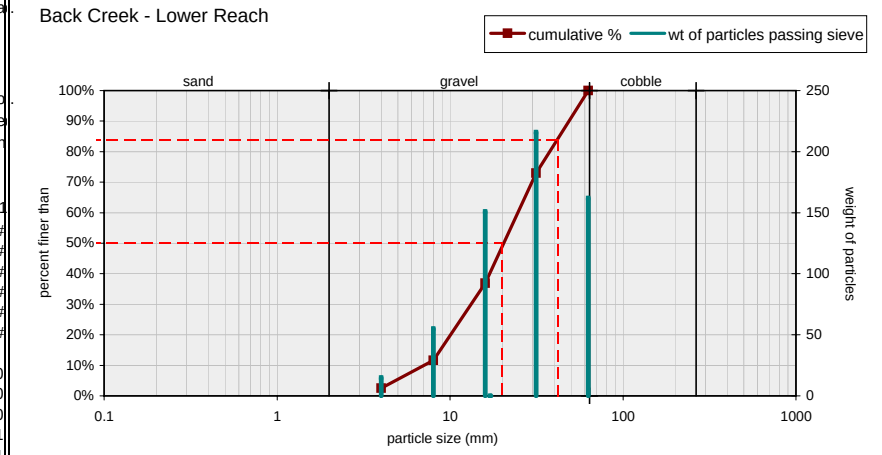

| Size (mm) | | | |
|---|---|---|---|
| D16 | 8.2 | D65 | 23 |
| D35 | 12 | D84 | 38 |
| D50 | 17 | D95 | 54 |

sand 100%

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **674** | **689** | 15 | 3% | --- | --- |
| **4** | **731** | **786** | 55 | 9% | 3% | 3% |
| **8** | **735** | **886** | 151 | 25% | 9% | 12% |
| **16** | **809** | **1025** | 216 | 36% | 25% | 37% |
| **31.5** | **812** | **974** | 162 | 27% | 36% | 73% |
| **63** | **0** | **0** | 0 | 0% | 27% | 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: 599

Note: Riffle #1 Bed Surface / 2 largest particle middle axis lengths = 46 & 36 m




| Size (mm) | | | |
|---|---|---|---|
| D16 | 9 | D65 | 27 |
| D35 | 15 | D84 | 42 |
| D50 | 20 | D95 | 55 |

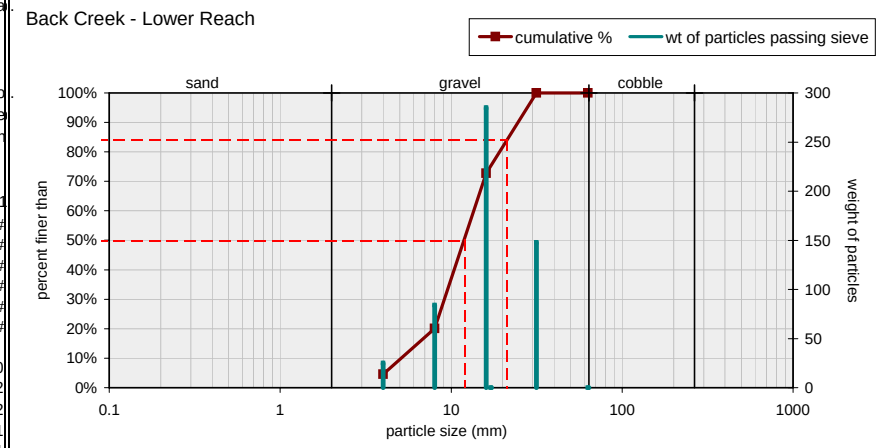
**3) Bulk Sample Sieve Analysis**

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

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **680** | **705** | 25 | 5% | --- | --- |
| **4** | **739** | **823** | 84 | 15% | 5% | 5% |
| **8** | **741** | **1026** | 285 | 53% | 15% | 20% |
| **16** | **812** | **960** | 148 | 27% | 53% | 73% |
| **31.5** | **0** | **0** | 0 | 0% | 27% | 100% |
| **63** | **0** | **0** | 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% |
| | | | 0 | 0% | 0% | 100% |

total wt retained in sieves: 542

Note: Bar - Surface / 2 largest particle middle axis lengths = 30 & 25 mm



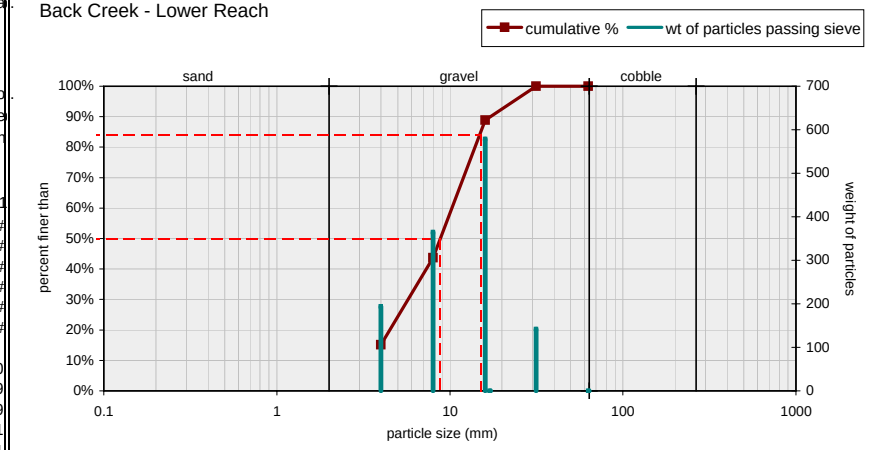

| Size (mm) | | | |
|---|---|---|---|
| D16 | 6.7 | D65 | 14 |
| D35 | 9.7 | D84 | 21 |
| D50 | 12 | D95 | 28 |

sand 100%

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **677** | **871** | 194 | 15% | --- | --- |
| **4** | **736** | **1101** | 365 | 29% | 15% | 15% |
| **8** | **732** | **1311** | 579 | 45% | 29% | 44% |
| **16** | **814** | **956** | 142 | 11% | 45% | 89% |
| **31.5** | **0** | **0** | 0 | 0% | 11% | 100% |
| **63** | **0** | **0** | 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% |
| | | | 0 | 0% | 0% | 100% |

total: 1280

Note: Bar - Sub / 2 largest particle middle axis lengths = 32 & 25 mm




| Size (mm) | | | |
|---|---|---|---|
| D16 | 4.1 | D65 | 11 |
| D35 | 6.5 | D84 | 15 |
| D50 | 8.8 | D95 | 23 |

## Summary

| | |
|---|---|
| Stream: | Upper UT to Back Creek |
| Watershed: | --- |
| Location: | Heath Dairy Road |
| Latitude: | --- |
| Longitude: | --- |
| State: | NC |
| County: | Randolph |
| Date: | February 17, 2006 |
| Observers: | SGG, AJW, EA, BAM, AMH |
| Channel type: | --- |
| Drainage area (sq.mi.): | 0.05 |
| notes: | --- |

| **Dimension** | | Bankfull channel typical | min | max | |
|---|---|---|---|---|---|
| floodplain: | width flood prone area (ft) | 5.8 | 4.7 | 7.0 | |
| | low bank height (ft) | 2.1 | 1.8 | 2.3 | |
| riffle-run: | x-area bankfull (sq.ft.) | 3.1 | 2.6 | 3.1 | |
| | width bankfull (ft) | 5.0 | 3.4 | 5.0 | |
| | mean depth (ft) | 0.62 | 0.6 | 0.9 | |
| | max depth (ft) | 0.8 | 0.8 | 1.0 | |
| | hydraulic radius (ft) | 0.6 | | | |
| pool: | x-area pool (sq.ft.) | 4.1 | 2.8 | 4.1 | |
| | width pool (ft) | 4.4 | 3.4 | 6.6 | |
| | max depth pool (ft) | 1.4 | 1.1 | 1.4 | |
| | hydraulic radius (ft) | 0.6 | | | |
| **dimensionless ratios:** | | typical | min | max | |
| | width depth ratio | 8.1 | 3.7 | 8.2 | |
| | entrenchment ratio | 1.2 | 0.9 | 1.4 | |
| | riffle max depth ratio | 1.3 | 1.2 | 1.7 | |
| | bank height ratio | 2.6 | 2.2 | 2.9 | |
| | pool area ratio | 1.3 | 0.9 | 1.3 | |
| | pool width ratio | 0.9 | 0.7 | 1.3 | |
| | pool max depth ratio | 2.3 | 1.8 | 2.2 | |
| **hydraulics:** | | typical | min | max | |
| | discharge rate (cfs) | 8.5 | 6.9 | 9.1 | |
| | channel slope (%) | 1.1 | | | |
| | | riffle-run | min | max | pool |
| | velocity (ft/s) | 2.7 | 2.7 | 3.0 | 2.1 |
| | Froude number | 0.64 | 0.65 | 0.67 | 0.23 |
| | shear stress (lbs/sq.ft.) | 0.388 | 0.362 | 0.423 | 0.394 |
| | shear velocity (ft/s) | 0.447 | 0.432 | 0.467 | 0.451 |
| | stream power (lb/s) | 5.8 | 4.7 | 6.3 | |
| | unit stream power (lb/ft/s) | 1.167 | 1.166 | 1.873 | |
| | relative roughness | 17.2 | --- | --- | |
| | friction factor u/u* | 6.1 | 8.4 | 8.9 | |
| | threshold grain size (t*=0.06) (mm) | 17.8 | 17.8 | 20.8 | |
| | Shield's parameter | 0.104 | | | |

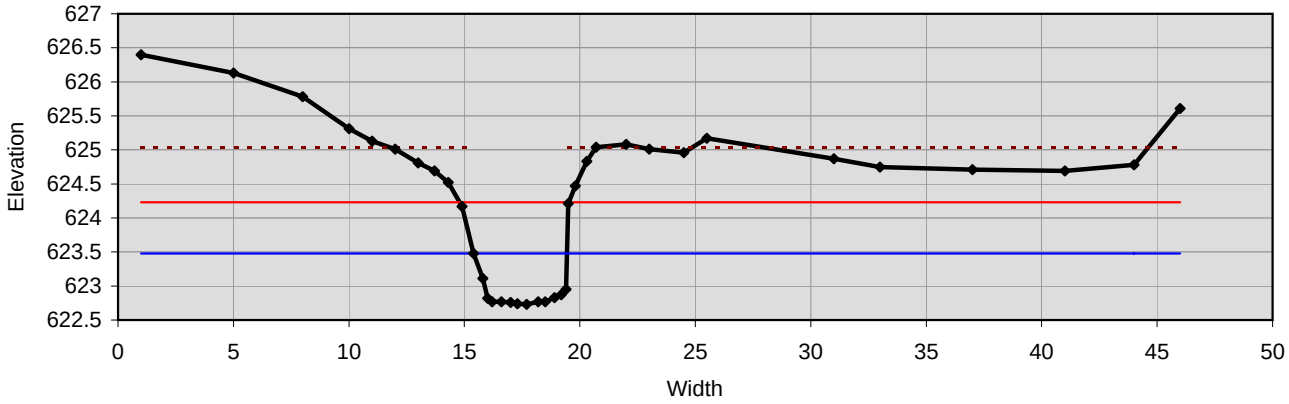
| **Pattern** | typical | min | max |
|---|---|---|---|
| meander length (ft) | --- | --- | --- |
| belt width (ft) | --- | --- | --- |
| amplitude (ft) | --- | --- | --- |
| radius (ft) | 12.0 | 9.0 | 43.0 |
| arc angle (degrees) | --- | --- | --- |
| stream length (ft) | --- | | |
| valley length (ft) | --- | | |
| Sinuosity | --- | | |
| Meander Length Ratio | --- | --- | --- |
| Meander Width Ratio | --- | --- | --- |
| Radius Ratio | 2.4 | 1.8 | 8.6 |

| **Profile** | typical | min | max |
|---|---|---|---|
| pool-pool spacing (ft) | 25.7 | 9.3 | 44.5 |
| riffle length (ft) | 9.9 | 0.2 | 18.4 |
| pool length (ft) | 9.1 | 4.1 | 22.5 |
| run length (ft) | 5.2 | 0.7 | 10.3 |
| glide length (ft) | 4.7 | 2.6 | 7.3 |
| channel slope (%) | 1.1 | | |
| riffle slope (%) | 31 | | 200 |
| pool slope (%) | | | 3 |
| run slope (%) | 6 | | 40 |
| glide slope (%) | | | 0.23 |
| measured valley slope (%) | --- | | |
| valley slope from sinuosity (%) | --- | | |
| Riffle Length Ratio | 2 | | 3.7 |
| Pool Length Ratio | 1.8 | 0.8 | 4.5 |
| Run Length Ratio | 1 | 0.1 | 2.1 |
| Glide Length Ratio | 0.9 | 0.5 | 1.5 |
| Riffle Slope Ratio | 28.2 | | 181.8 |
| Pool Slope Ratio | | | 2.7 |
| Run Slope Ratio | 5.5 | | 36.4 |
| Glide Slope Ratio | | | 0.2 |
| Pool Spacing Ratio | 5.1 | 1.9 | 8.9 |

| **Channel Materials** | Riffle Surface | | | BkF Channel |
|---|---|---|---|---|
| D16 (mm) | 8 | --- | --- | 0.76 |
| D35 (mm) | 9.5 | --- | --- | 6.1 |
| D50 (mm) | 11 | --- | --- | 9.3 |
| D65 (mm) | 14 | --- | --- | 12 |
| D84 (mm) | 20 | --- | --- | 19 |
| D95 (mm) | 37 | --- | --- | 29 |
| mean (mm) | 12.6 | | | 3.8 |
| dispersion | 1.6 | | | 7.1 |
| skewness | 0.1 | | | -0.3 |
| Shape Factor | --- | | | |
| % Silt/Clay | | --- | --- | 6% |
| % Sand | 3% | --- | --- | 17% |
| % Gravel | 94% | --- | --- | 75% |
| % Cobble | 3% | --- | --- | 1% |
| % Boulder | | --- | --- | |
| % Bedrock | | --- | | 1% |
| % Clay Hardpan | | --- | | |
| % Detritus/Wood | | --- | | |
| % Artificial | | --- | | |
| Largest Mobile (mm) | --- | | | |

## Cross Section R1

0 + 4 Upper UT to Back Creek, Riffle




| Bankfull Dimensions | |
|---|---|
| 2.6 | x-section area (ft.sq.) |
| 4.0 | width (ft) |
| 0.6 | mean depth (ft) |
| 0.8 | max depth (ft) |
| 4.9 | wetted parimeter (ft) |
| 0.5 | hyd radi (ft) |
| 6.4 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 4.7 | W flood prone area (ft) |
| 1.2 | entrenchment ratio |
| 2.3 | low bank height (ft) |
| 3.1 | low bank height ratio |

| Materials | |
|---|---|
| 11 | D50 Riffle (mm) |
| 20 | D84 Riffle (mm) |
| 18 | threshold grain size (mm): |

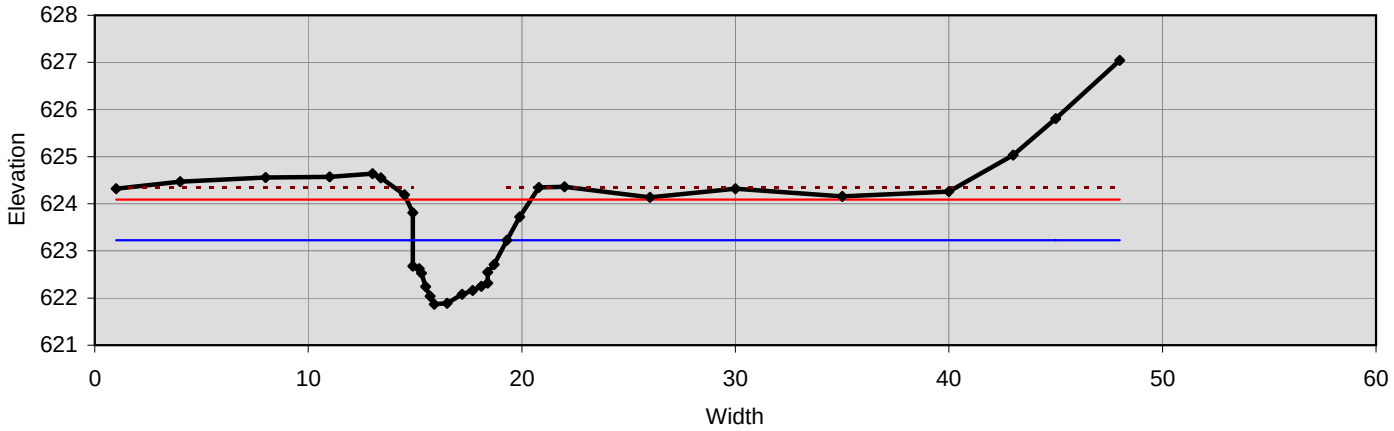
| Bankfull Flow | |
|---|---|
| 2.7 | velocity (ft/s) |
| 6.9 | discharge rate (cfs) |
| 0.65 | Froude number |

| Flow Resistance | |
|---|---|
| 0.038 | Manning's roughness |
| 0.21 | D'Arcy-Weisbach fric. |
| 8.4 | resistance factor u/u* |
| 9.7 | relative roughness |

| Forces & Power | |
|---|---|
| 1.1 | channel slope (%) |
| 0.36 | shear stress (lb/sq.ft.) |
| 0.43 | shear velocity (ft/s) |
| 1.17 | unit strm power (lb/ft/s) |

## Cross Section P1

0 + 48.5 Upper UT to Back Creek, Pool




| Bankfull Dimensions | |
|---|---|
| 4.1 | x-section area (ft.sq.) |
| 4.4 | width (ft) |
| 0.9 | mean depth (ft) |
| 1.4 | max depth (ft) |
| 5.8 | wetted parimeter (ft) |
| 0.7 | hyd radi (ft) |
| 4.7 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 24.0 | W flood prone area (ft) |
| 5.5 | entrenchment ratio |
| 2.5 | low bank height (ft) |
| 1.8 | low bank height ratio |

| Materials | |
|---|---|
| 11 | D50 Riffle (mm) |
| 20 | D84 Riffle (mm) |
| 24 | threshold grain size (mm): |

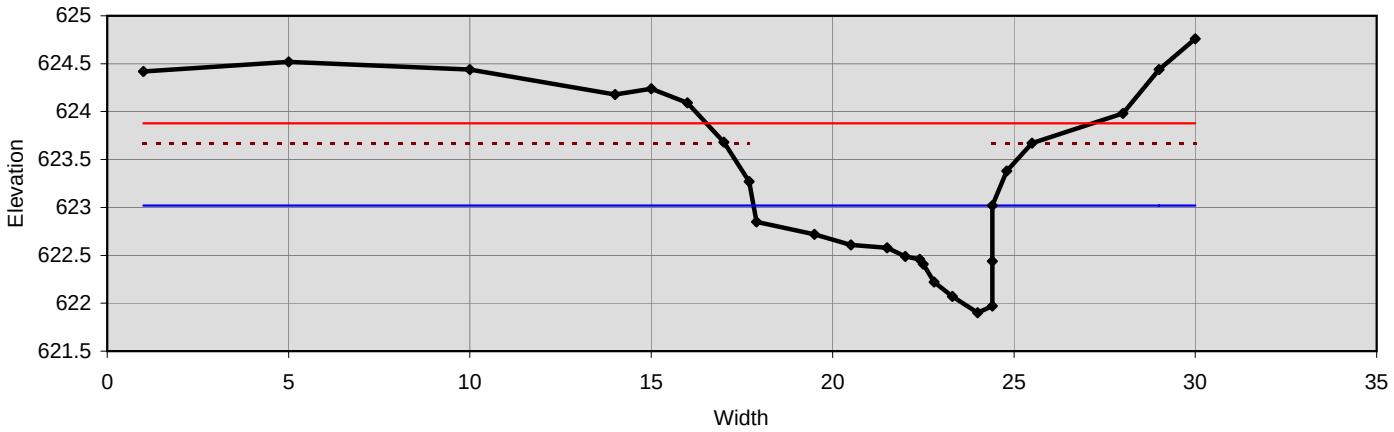
| Bankfull Flow | |
|---|---|
| 3.3 | velocity (ft/s) |
| 13.6 | discharge rate (cfs) |
| 0.69 | Froude number |

| Flow Resistance | |
|---|---|
| 0.038 | Manning's roughness |
| 0.19 | D'Arcy-Weisbach fric. |
| 9.4 | resistance factor u/u* |
| 14.4 | relative roughness |

| Forces & Power | |
|---|---|
| 1.1 | channel slope (%) |
| 0.49 | shear stress (lb/sq.ft.) |
| 0.50 | shear velocity (ft/s) |
| 2.1 | unit strm power (lb/ft/s) |

## Cross Section P2

0 + 60.5 Upper UT to Back Creek, Pool




### Bankfull Dimensions

| | |
|---|---|
| 3.5 | x-section area (ft.sq.) |
| 6.6 | width (ft) |
| 0.5 | mean depth (ft) |
| 1.1 | max depth (ft) |
| 7.9 | wetted parimeter (ft) |
| 0.4 | hyd radi (ft) |
| 12.4 | width-depth ratio |

### Flood Dimensions

| | |
|---|---|
| 12.0 | W flood prone area (ft) |
| 1.8 | entrenchment ratio |
| 1.8 | low bank height (ft) |
| 1.6 | low bank height ratio |

### Materials

| | |
|---|---|
| 11 | D50 Riffle (mm) |
| 20 | D84 Riffle (mm) |
| 15 | threshold grain size (mm): |

### Bankfull Flow

| | |
|---|---|
| 2.4 | velocity (ft/s) |
| 8.3 | discharge rate (cfs) |
| 0.63 | Froude number |

### Flow Resistance

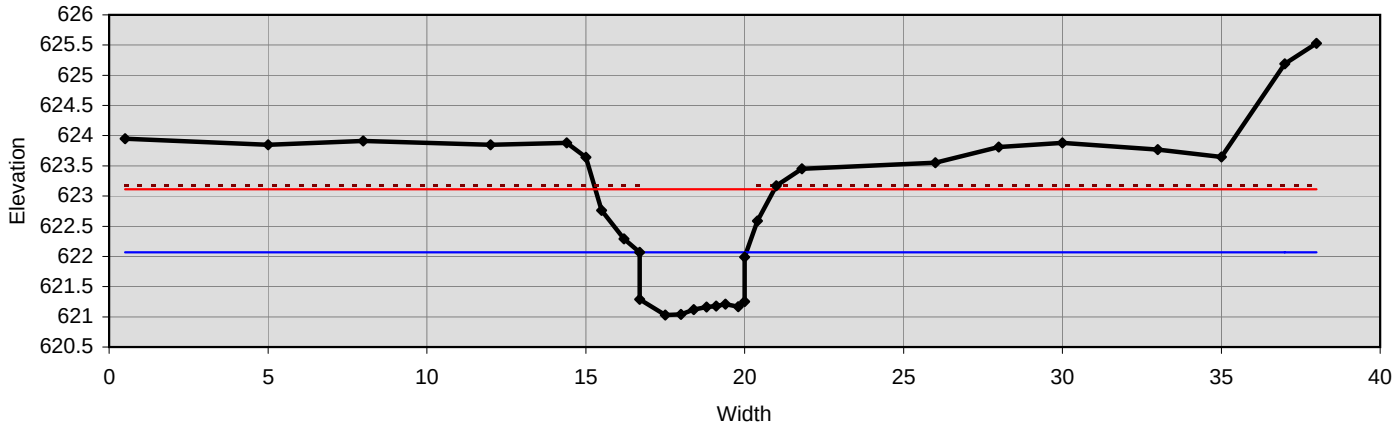
| | |
|---|---|
| 0.038 | Manning's roughness |
| 0.22 | D'Arcy-Weisbach fric. |
| 8.4 | resistance factor u/u* |
| 8.1 | relative roughness |

### Forces & Power

| | |
|---|---|
| 1.1 | channel slope (%) |
| 0.30 | shear stress (lb/sq.ft.) |
| 0.40 | shear velocity (ft/s) |
| 0.87 | unit strm power (lb/ft/s) |

## Cross Section R2

1 + 15.9 Upper UT to Back Creek, Riffle

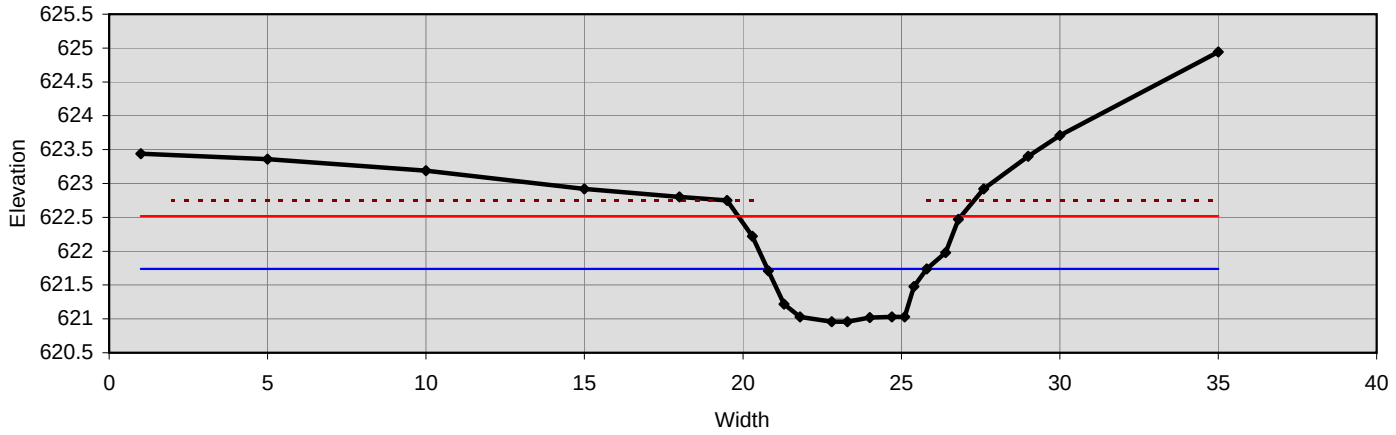



| Bankfull Dimensions | | Flood Dimensions | | Materials | |
|---|---|---|---|---|---|
| 3.1 | x-section area (ft.sq.) | 5.6 | W flood prone area (ft) | 11 | D50 Riffle (mm) |
| 3.4 | width (ft) | 1.7 | entrenchment ratio | 20 | D84 Riffle (mm) |
| 0.9 | mean depth (ft) | 2.1 | low bank height (ft) | 21 | threshold grain size (mm): |
| 1.0 | max depth (ft) | 2.1 | low bank height ratio | | |
| 5.0 | wetted parimeter (ft) | | | | |
| 0.6 | hyd radi (ft) | | | | |
| 3.7 | width-depth ratio | | | | |

| Bankfull Flow | | Flow Resistance | | Forces & Power | |
|---|---|---|---|---|---|
| 3.0 | velocity (ft/s) | 0.038 | Manning's roughness | 1.1 | channel slope (%) |
| 9.1 | discharge rate (cfs) | 0.20 | D'Arcy-Weisbach fric. | 0.42 | shear stress (lb/sq.ft.) |
| 0.67 | Froude number | 8.9 | resistance factor u/u* | 0.47 | shear velocity (ft/s) |
| | | 14.0 | relative roughness | 1.87 | unit strm power (lb/ft/s) |

## Cross Section R3

1 + 64.5 Upper UT to Back Creek, Riffle




| Bankfull Dimensions | |
|---|---|
| 3.1 | x-section area (ft.sq.) |
| 5.0 | width (ft) |
| 0.6 | mean depth (ft) |
| 0.8 | max depth (ft) |
| 5.6 | wetted parimeter (ft) |
| 0.6 | hyd radi (ft) |
| 8.2 | width-depth ratio |

| Flood Dimensions | |
|---|---|
| 7.0 | W flood prone area (ft) |
| 1.4 | entrenchment ratio |
| 1.8 | low bank height (ft) |
| 2.3 | low bank height ratio |

| Materials | |
|---|---|
| 11 | D50 Riffle (mm) |
| 20 | D84 Riffle (mm) |
| 19 | threshold grain size (mm): |

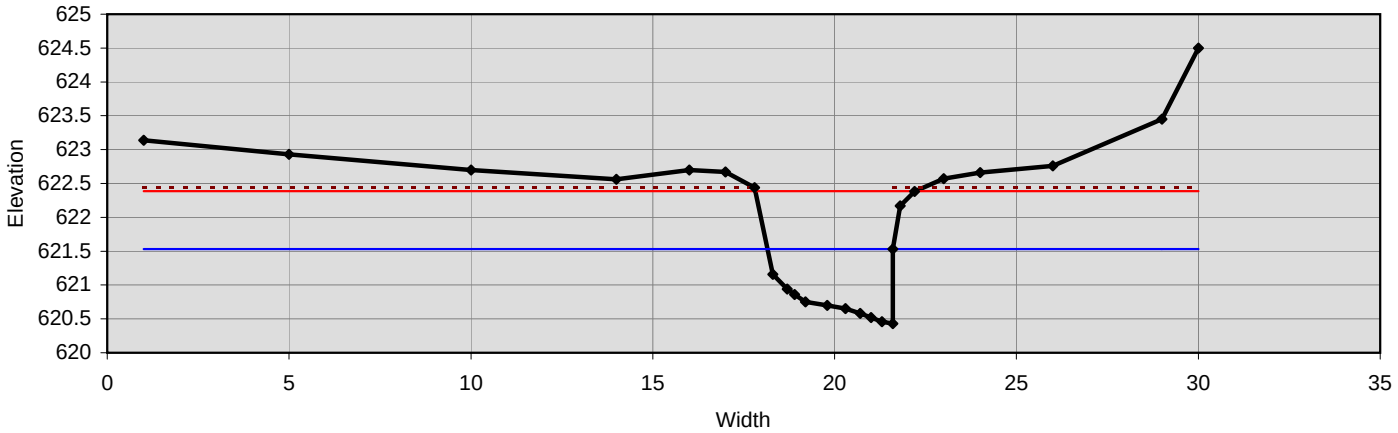
| Bankfull Flow | |
|---|---|
| 2.8 | velocity (ft/s) |
| 8.5 | discharge rate (cfs) |
| 0.66 | Froude number |

| Flow Resistance | |
|---|---|
| 0.038 | Manning's roughness |
| 0.20 | D'Arcy-Weisbach fric. |
| 8.5 | resistance factor u/u* |
| 9.4 | relative roughness |

| Forces & Power | |
|---|---|
| 1.1 | channel slope (%) |
| 0.38 | shear stress (lb/sq.ft.) |
| 0.44 | shear velocity (ft/s) |
| 1.17 | unit strm power (lb/ft/s) |

## Cross Section P3

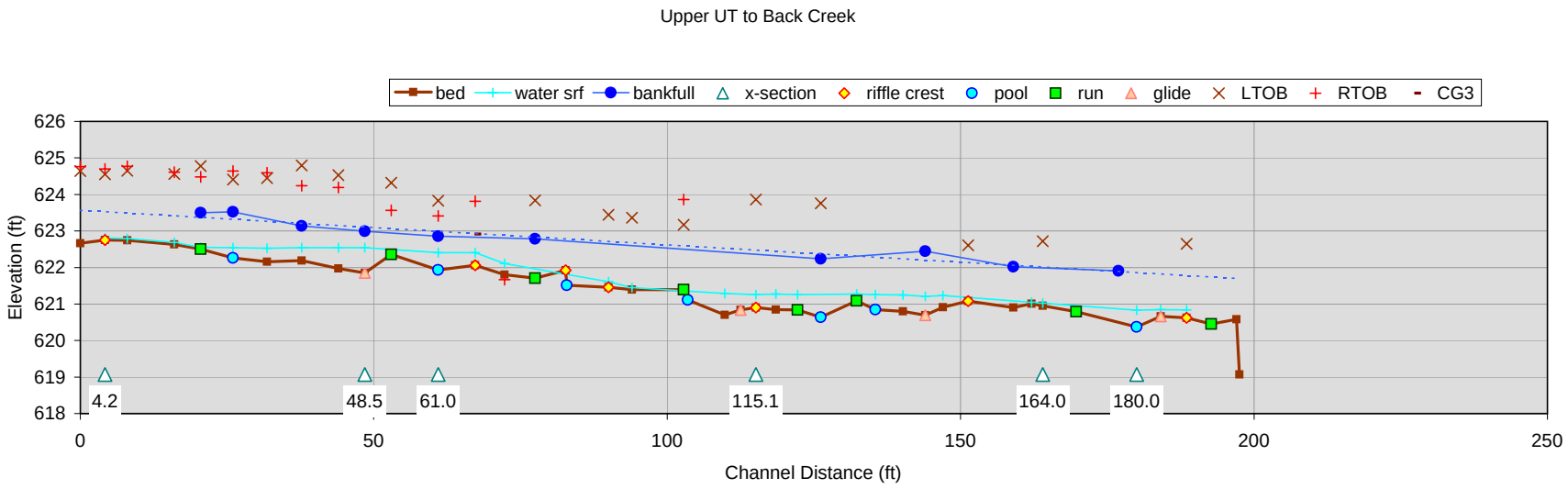
1 + 80 Upper UT to Back Creek, Pool




| Bankfull Dimensions | | Flood Dimensions | | Materials | |
|---|---|---|---|---|---|
| 2.8 | x-section area (ft.sq.) | 4.4 | W flood prone area (ft) | 11 | D50 Riffle (mm) |
| 3.4 | width (ft) | 1.3 | entrenchment ratio | 20 | D84 Riffle (mm) |
| 0.8 | mean depth (ft) | 2.0 | low bank height (ft) | 19 | threshold grain size (mm): |
| 1.1 | max depth (ft) | 1.8 | low bank height ratio | | |
| 4.9 | wetted parimeter (ft) | | | | |
| 0.6 | hyd radi (ft) | | | | |
| 4.3 | width-depth ratio | | | | |

| Bankfull Flow | | Flow Resistance | | Forces & Power | |
|---|---|---|---|---|---|
| 2.8 | velocity (ft/s) | 0.038 | Manning's roughness | 1.1 | channel slope (%) |
| 7.8 | discharge rate (cfs) | 0.20 | D'Arcy-Weisbach fric. | 0.39 | shear stress (lb/sq.ft.) |
| 0.66 | Froude number | 8.8 | resistance factor u/u* | 0.45 | shear velocity (ft/s) |
| | | 12.3 | relative roughness | 1.55 | unit strm power (lb/ft/s) |

## Longitudinal Slope Profile




| | slope (%) | | slope ratio | | length (ft) | | length ratio | | pool-pool spacing (ft) | | p-p ratio | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| reach | 1.1 | | --- | | 197.5 | (39.5 channel widths) | --- | | --- | | --- | |
| riffle | 31 | (0 - 200) | 28.2 | (0 - 181.8) | 9.9 | (0.2 - 18.4) | 2 | (0 - 3.7) | --- | | --- | |
| pool | 0 | (0 - 3) | 0 | (0 - 2.7) | 9.1 | (4.1 - 22.5) | 1.8 | (0.8 - 4.5) | 25.7 | (9.3 - 44.5) | 5.1 | (1.9 - 8.9) |
| run | 6 | (0 - 40) | 5.5 | (0 - 36.4) | 5.2 | (0.7 - 10.3) | 1 | (0.1 - 2.1) | --- | | --- | |
| glide | 0 | (0 - 0.23) | 0 | (0 - 0.2) | 4.7 | (2.6 - 7.3) | 0.9 | (0.5 - 1.5) | --- | | --- | |

## 2) Weighted Pebble Count

**Feature Percent of Reach**

Riffle, Pool, Run, Glide

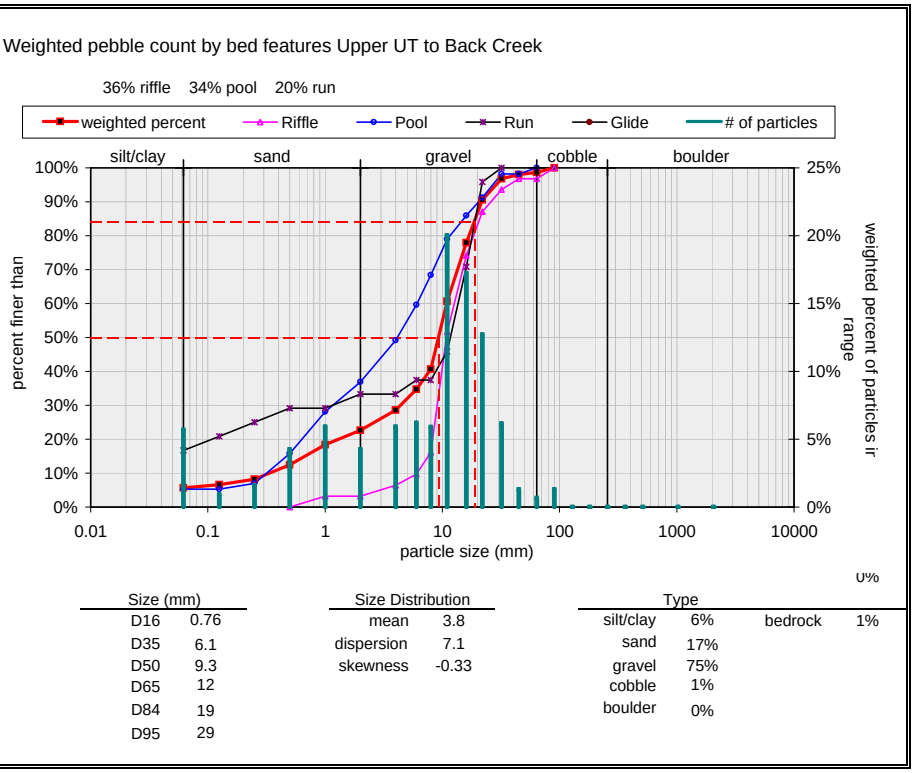
| | | | | | |
|---|---|---|---|---|---|
| Riffle | 36 | % | Run | 20 | % |
| Pool | 34 | % | Glide | | % |

**Weighted pebble count by bed features**

| Material | Size Range (mm) | weighted |
|---|---|---|
| silt/clay | 0 - 0.062 | 5.1 |
| very fine sand | 0.062 - 0.125 | 0.8 |
| fine sand | 0.125 - 0.25 | 1.4 |
| medium sand | 0.25 - 0.5 | 3.8 |
| coarse sand | 0.5 - 1 | 5.3 |
| very coarse sand | 1 - 2 | 3.8 |
| very fine gravel | 2 - 4 | 5.3 |
| fine gravel | 4 - 6 | 5.6 |
| fine gravel | 6 - 8 | 5.3 |
| medium gravel | 8 - 11 | 18.0 |
| medium gravel | 11 - 16 | 15.5 |
| coarse gravel | 16 - 22 | 11.4 |
| coarse gravel | 22 - 32 | 5.5 |
| very coarse gravel | 32 - 45 | 1.2 |
| very coarse gravel | 45 - 64 | 0.6 |
| small cobble | 64 - 90 | 1.2 |
| medium cobble | 90 - 128 | 0.0 |
| large cobble | 128 - 180 | 0.0 |
| very large cobble | 180 - 256 | 0.0 |
| small boulder | 256 - 362 | 0.0 |
| small boulder | 362 - 512 | 0.0 |
| medium boulder | 512 - 1024 | 0.0 |
| large boulder | 1024 - 2048 | 0.0 |
| very large boulder | 2048 - 4096 | 0.0 |

| | |
|---|---|
| total particle weighted count: | 90 |
| bedrock | 1.2 |
| clay hardpan | 0.0 |
| detritus/wood | 0.0 |
| artificial | 0.0 |
| total weighted count: | 91.2 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.76 |
| D35 | 6.1 |
| D50 | 9.3 |
| D65 | 12 |
| D84 | 19 |
| D95 | 29 |

| Size Distribution | |
|---|---|
| mean | 3.8 |
| dispersion | 7.1 |
| skewness | -0.33 |

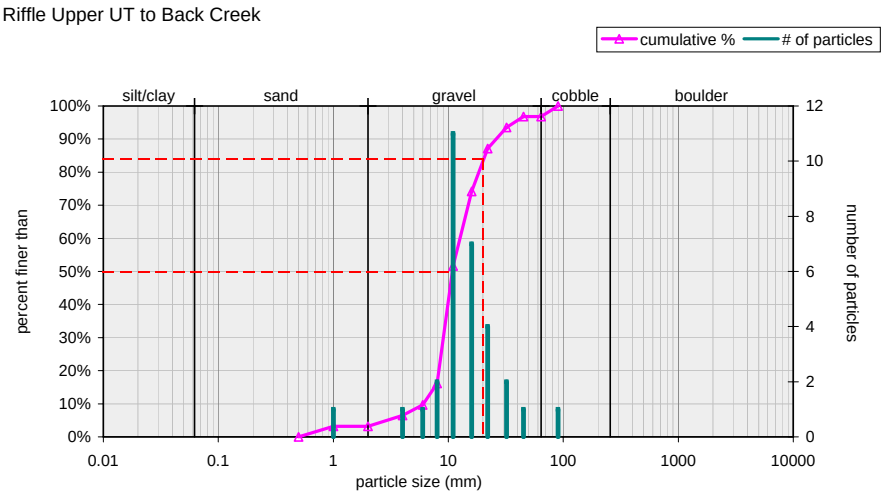
| Type | | | |
|---|---|---|---|
| silt/clay | 6% | bedrock | 1% |
| sand | 17% | | |
| gravel | 75% | | |
| cobble | 1% | | |
| boulder | 0% | | |

**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 | |
| coarse sand | 0.5 - 1 | **1** |
| very coarse sand | 1 - 2 | |
| very fine gravel | 2 - 4 | **1** |
| fine gravel | 4 - 6 | **1** |
| fine gravel | 6 - 8 | **2** |
| medium gravel | 8 - 11 | **11** |
| medium gravel | 11 - 16 | **7** |
| coarse gravel | 16 - 22 | **4** |
| coarse gravel | 22 - 32 | **2** |
| very coarse gravel | 32 - 45 | **1** |
| very coarse gravel | 45 - 64 | |
| small cobble | 64 - 90 | **1** |
| medium cobble | 90 - 128 | |
| large cobble | 128 - 180 | |
| very large cobble | 180 - 256 | |
| small boulder | 256 - 362 | |
| small boulder | 362 - 512 | |
| medium boulder | 512 - 1024 | |
| large boulder | 1024 - 2048 | |
| very large boulder | 2048 - 4096 | |

| | |
|---|---|
| total particle count: | 31 |
| bedrock | |
| clay hardpan | |
| detritus/wood | |
| artificial | |
| total count: | 31 |

Note:




| Size (mm) | |
|---|---|
| D16 | 8 |
| D35 | 9.5 |
| D50 | 11 |
| D65 | 14 |
| D84 | 20 |
| D95 | 37 |

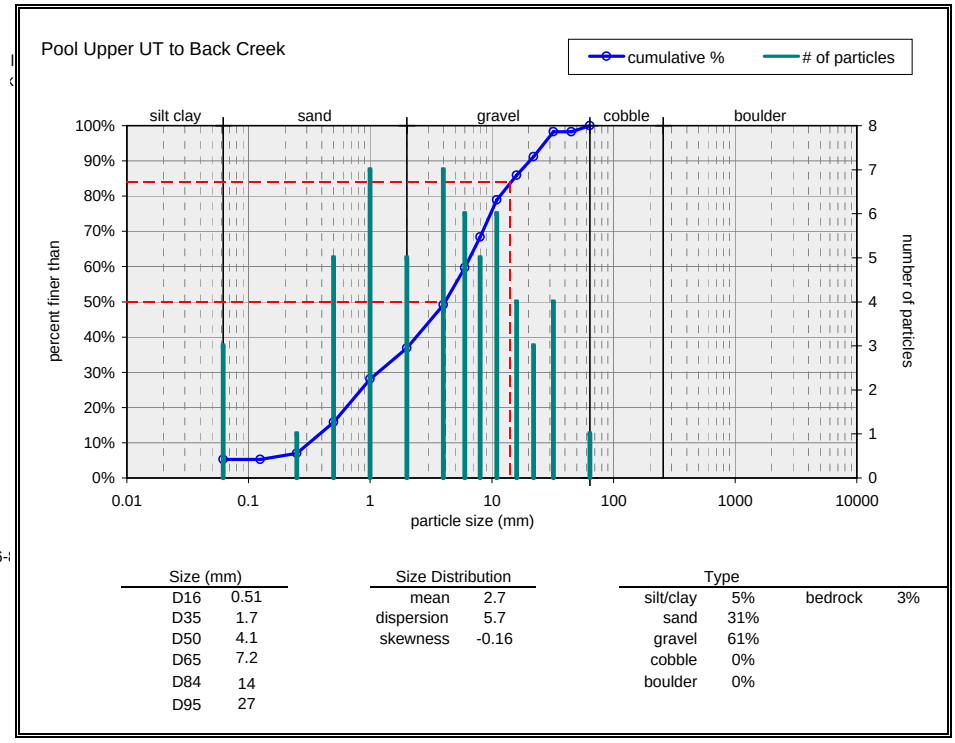
| Size Distribution | |
|---|---|
| mean | 12.6 |
| dispersion | 1.6 |
| skewness | 0.10 |

| Type | |
|---|---|
| silt/clay | 0% |
| sand | 3% |
| gravel | 94% |
| cobble | 3% |
| 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 | **1** |
| medium sand | 0.25 - 0.5 | **5** |
| coarse sand | 0.5 - 1 | **7** |
| very coarse sand | 1 - 2 | **5** |
| very fine gravel | 2 - 4 | **7** |
| fine gravel | 4 - 6 | **6** |
| fine gravel | 6 - 8 | **5** |
| medium gravel | 8 - 11 | **6** |
| medium gravel | 11 - 16 | **4** |
| coarse gravel | 16 - 22 | **3** |
| coarse gravel | 22 - 32 | **4** |
| very coarse gravel | 32 - 45 | |
| very coarse gravel | 45 - 64 | **1** |
| small cobble | 64 - 90 | |
| medium cobble | 90 - 128 | |
| large cobble | 128 - 180 | |
| very large cobble | 180 - 256 | |
| small boulder | 256 - 362 | |
| small boulder | 362 - 512 | |
| medium boulder | 512 - 1024 | |
| large boulder | 1024 - 2048 | |
| very large boulder | 2048 - 4096 | |
| total particle count: | | 57 |
| bedrock | ---------- | **2** |
| clay hardpan | ---------- | |
| detritus/wood | ---------- | |
| artificial | ---------- | |
| total count: | | 59 |

Note:




| Size (mm) | |
|---|---|
| D16 | 0.51 |
| D35 | 1.7 |
| D50 | 4.1 |
| D65 | 7.2 |
| D84 | 14 |
| D95 | 27 |

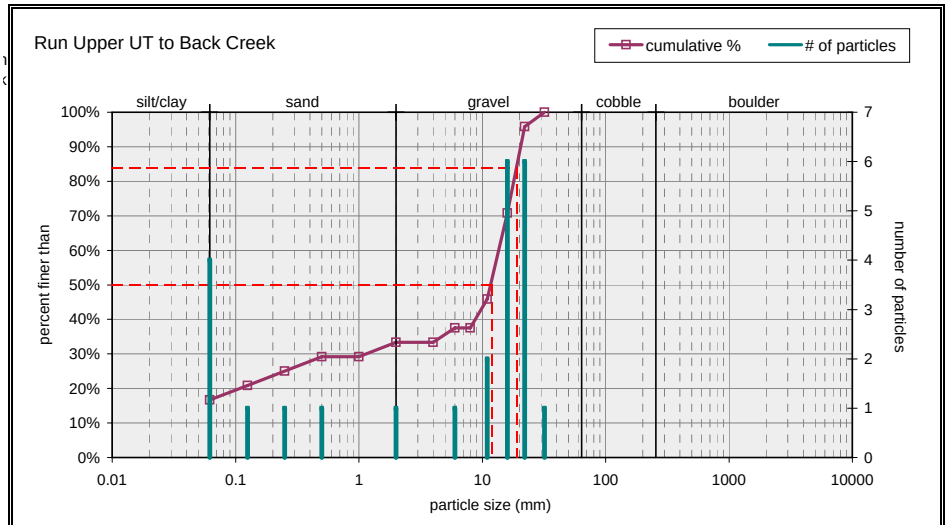
| Size Distribution | |
|---|---|
| mean | 2.7 |
| dispersion | 5.7 |
| skewness | -0.16 |

| Type | | | |
|---|---|---|---|
| silt/clay | 5% | bedrock | 3% |
| sand | 31% | | |
| gravel | 61% | | |
| cobble | 0% | | |
| boulder | 0% | | |

**Run**

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

Note:




| Size (mm) | |
|---|---|
| D16 | 0.062 |
| D35 | 4.7 |
| D50 | 12 |
| D65 | 15 |
| D84 | 19 |
| D95 | 22 |

| Size Distribution | |
|---|---|
| mean | 1.1 |
| dispersion | 97.6 |
| skewness | -0.66 |

| Type | |
|---|---|
| silt/clay | 17% |
| sand | 17% |
| gravel | 67% |
| cobble | 0% |
| boulder | 0% |

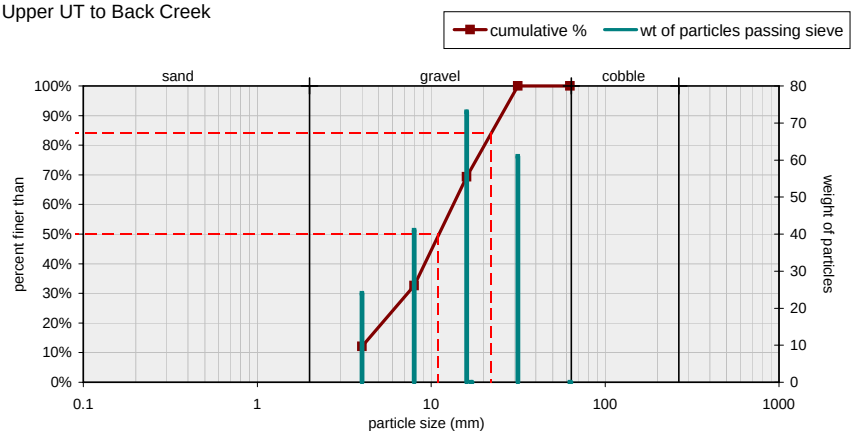
**3) Bulk Sample Sieve Analysis**

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

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **684** | **708** | 24 | 12% | --- | --- |
| **4** | **749** | **790** | 41 | 21% | 12% | 12% |
| **8** | **741** | **814** | 73 | 37% | 21% | 33% |
| **16** | **813** | **874** | 61 | 31% | 37% | 69% |
| **31.5** | **0** | **0** | 0 | 0% | 31% | 100% |
| **63** | **0** | **0** | 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: 199

Note: Bar - Pav't / largest 2 particle middle axis length = 26 & 20 mm



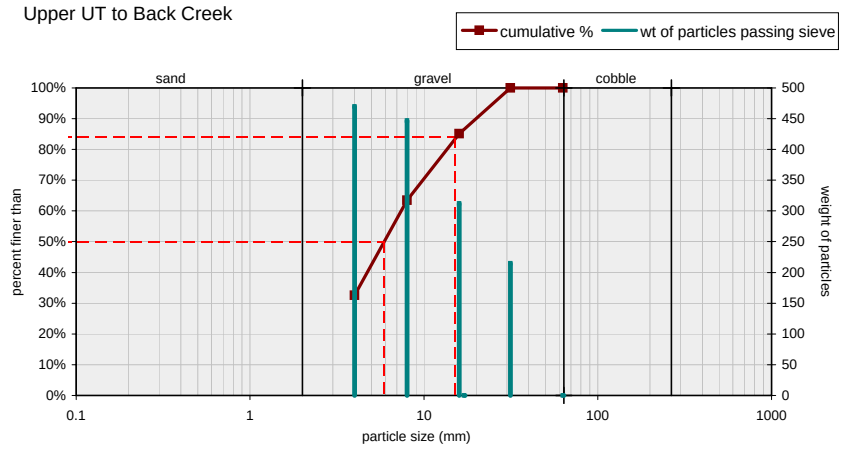

| Size (mm) | | | |
|---|---|---|---|
| D16 | 4.6 | D65 | 15 |
| D35 | 8.4 | D84 | 22 |
| D50 | 11 | D95 | 28 |

sand 100%

| Sieve Size (mm) | Sieve Weight (g) | Sieve & Sample Weight (g) | Retained on Sieve (g) | | Passing Sieve | |
|---|---|---|---|---|---|---|
| **2** | **685** | **1155** | 470 | 33% | --- | --- |
| **4** | **732** | **1179** | 447 | 31% | 33% | 33% |
| **8** | **736** | **1048** | 312 | 22% | 31% | 64% |
| **16** | **813** | **1028** | 215 | 15% | 22% | 85% |
| **31.5** | **0** | **0** | 0 | 0% | 15% | 100% |
| **63** | **0** | **0** | 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: 1444

Note: Bar - Subpav't / largest 2 particle middle axis length = 26 & 25 mm




| Size (mm) | | | |
|---|---|---|---|
| D16 | --- | D65 | 8.4 |
| D35 | 4.2 | D84 | 15 |
| D50 | 5.9 | D95 | 25 |

# APPENDIX C

## Site USACE Routine Wetland Determination Data Forms

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | | **Date:** | 4/21/09 | |
| **Applicant/Owner:** | EEP | | | | **County:** | Randolph | |
| **Investigator:** | ASM/JSD | | | | **State:** | NC | |
| **Do Normal Circumstances exist on the site?** | | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | | **Yes** | | **No** | x | **Plot ID:** | Ref. Wetland |
| **(If needed, explain on reverse)** | | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Chinese privet (*Ligustrum sinense*) | Shrub | FAC | **9.** | | | |
| **2.** | Jewelweed (*Impatiens capensis*) | Herb | FACW | **10.** | | | |
| **3.** | Stalkgrain sedge (*Carex stipata*) | Herb | OBL | **11.** | | | |
| **4.** | Japanese stiltgrass (*Microstegium vimineum*) | Herb | FAC+ | **12.** | | | |
| **5.** | Black willow (*Salix nigra*) | Tree | OBL | **13.** | | | |
| **6.** | Wild rose (*Rosa multiflora*) | Shrub | UPL | **14.** | | | |
| **7.** | Hazel alder (*Alnus serrulata*) | Shrub | FACW+ | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 6/7 = 85%

**Remarks:** Hydrophytic vegetative community - herbs dominated by stalkgrain sedge (*Carex stipata*). Fire azalea (*Rhododendron calendulaceum*) located along edge of upslope. Shrubs dominated by Chinese privet (*Ligustrum sinense*)

## 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:** 1-2 **(in.)**
- **Depth of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** ___ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Entire area is saturated, connects Wetlands A and B, surrounded by scrub/shrub, forested area with some mature trees surrounding wetland area

**Plot ID:** Ref. Wetland **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** ___ |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/1 | 10 YR 4/6 | Strong Mottling | Grey silty loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

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

**Remarks:** Hydric soils

## WETLAND DETERMINATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | ___ | **Is this Sampling Point Within a Wetland?** | **Yes** x | **No** ___ |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | ___ | | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | ___ | | | |

**Remarks**: Reference wetland connects wetlands A&B, but is outside Heath Dairy property boundary. Entire wetland (A, B, Reference) is high quality jurisdictional wetland area straddling the Heath Dairy boundary (fencing) and includes emergent and drainage flowing into Back Creek as well as scrub/shrub and forested wetlands.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | | **Date:** | 4/20/09 | |
| **Applicant/Owner:** | EEP | | | | **County:** | Randolph | |
| **Investigator:** | ASM/JSD | | | | **State:** | NC | |
| **Do Normal Circumstances exist on the site?** | | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | | **Yes** | | **No** | x | **Transect ID:** | Lower |
| **Is the area a potential Problem Area?** | | **Yes** | | **No** | x | **Plot ID:** | Wet A-In (Lower) |
| **(If needed, explain on reverse)** | | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Soft rush (*Juncus effusus*) | Herb | FACW+ | **9.** | | | |
| **2.** | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | **10.** | | | |
| **3.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 3/3 = 100%

**Remarks:** Flowing drainage out of Wet A – clear demarcation between pasture and drainage

## HYDROLOGY

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

**No Recorded Data Available**

**Field Observations:**

| | | |
|---|---|---|
| **Depth of Surface Water:** | 2-4 | **(in.)** |
| **Depth of Free Water in Pit:** | | **(in.)** |
| **Depth to Saturated Soil:** | | **(in.)** |

**Wetland Hydrology Indications:**

**Primary Indicators:**
- x **Inundated**
- **Saturated In Upper 12 Inches**
- **Water Marks**
- **Drift Lines**
- **Sediment Deposits**
- x **Drainage Patterns in Wetlands**

**Secondary Indicators (2 or more required):**
- **Oxidized Root Channels in Upper 12 Inches**
- **Water-Stained Leaves**
- **Local Soil Survey Data**
- **FAC Neutral Test**
- **Other (Explain in Remarks)**

**Remarks:** Invertebrate water species were observed within wetland: Tadpoles, green frogs, water striders

**Plot ID:** Wet A-In (Lower)
**(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | DoB – Dogue Sandy Loam, 2-6% Slope | **Drainage Class:** Moderately well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Aquic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-12" | A | 10 YR 4/1 | | No Mottling | Dark gray sediment, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** Hydric soil

## WETLAND DETERMINATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | **Is this Sampling Point Within a Wetland?** | **Yes** | x | **No** | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | | | | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | | | | | | |

**Remarks**: Flowing drainage downstream end of Wetland A. Clearly a jurisdictional wetland transitioning from palustrine to riverine – continuing downstream narrowing to an intermittent stream adjoining Back Creek just upstream of concrete dam at Heath Dairy Road.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | | **Date:** | 4/20/09 | |
| **Applicant/Owner:** | EEP | | | | **County:** | Randolph | |
| **Investigator:** | ASM/JSD | | | | **State:** | NC | |
| **Do Normal Circumstances exist on the site?** | | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | | **Yes** | | **No** | x | **Transect ID:** | Upper |
| **Is the area a potential Problem Area?** | | **Yes** | | **No** | x | **Plot ID:** | Wet A-In Upper |
| **(If needed, explain on reverse)** | | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Hazel alder (*Alnus serrulata*) | Shrub | FACW+ | **9.** | | | |
| **2.** | Watercress (*Nasturtium officinale*) | Herb | OBL | **10.** | | | |
| **3.** | Jewelweed (*Impatiens capensis*) | Herb | FACW | **11.** | | | |
| **4.** | Stalk sedge (*Carex stipata*) | Herb | OBL | **12.** | | | |
| **5.** | Chinese privet (*Ligustrum sinese*) | Shrub | FAC | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 5/5 = 100%

**Remarks:** Clearly a scrub/schrub hydrophytic vegetative community, large amounts of stalk sedge (*Carex stipata*). Wetland A continues off the Heath Dairy site (across barb wire fence) and connects with Wetland B.

## HYDROLOGY

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

___ **No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** 0-1 **(in.)**
- **Depth of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** ___ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- x **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Standing water at ground level across majority of Wetland area. Southern border of Wetland A is a steep forested slope.

**Plot ID:** Wet A-In (Upper)
**(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 4/3 | 10 YR 5/6 | Strong Mottling | Dark gray silty loam, saturated with oxidized rhizospheres |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** Hydric soil, marginal chroma but strong mottling.

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | **Is this Sampling Point Within a Wetland?** | **Yes** x **No** |

**Remarks**: Clearly a scrub/shrub (almost forested due to some mature trees) jurisdictional wetland receives stream flow from the south. Standing water is common throughout Wetland A. Vegetative community is clearly hydrophytic. Wetland continues off-site (across a barb wire fence) off the Heath Dairy site and reconnects to Wetland B.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | | **Date:** | 4/20/09 | |
| **Applicant/Owner:** | EEP | | | | **County:** | Randolph | |
| **Investigator:** | ASM/JSD | | | | **State:** | NC | |
| **Do Normal Circumstances exist on the site?** | | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | | **Yes** | | **No** | x | **Plot ID:** | Wet A-Out Lower |
| **(If needed, explain on reverse)** | | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | White clover (*Trifolium repens)* | Herb | FACU | **9.** | | | |
| **2.** | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | **10.** | | | |
| **3.** | | | | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/2 = 50%

**Remarks:** Pasture area downstream end of Wetland A (out of drainage) – small amounts of soft rush (*Juncus effusus*)

## HYDROLOGY

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

**No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** (in.)
- **Depth of Free Water in Pit:** (in.)
- **Depth to Saturated Soil:** 0 (in.)

**Wetland Hydrology Indications:**

**Primary Indicators:**
- **Inundated**
- x **Saturated In Upper 12 Inches**
- **Water Marks**
- **Drift Lines**
- **Sediment Deposits**
- **Drainage Patterns in Wetlands**

**Secondary Indicators (2 or more required):**
- **Oxidized Root Channels in Upper 12 Inches**
- **Water-Stained Leaves**
- **Local Soil Survey Data**
- **FAC Neutral Test**
- **Other (Explain in Remarks)**

**Remarks:** Marginal – rainfall within 24 hrs

**Plot ID:** Wet A-Out (Lower)
**(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | DoB – Dogue Sandy Loam, 2-6% Slope | **Drainage Class:** Moderately well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Aquic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/6 | | No mottling | Yellowish brown silty loam |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** x | **No** ____ | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |
| **Wetland Hydrology Present?** | **Yes** x | **No** ____ | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | | |

**Remarks**: Downstream area of Wetland A out of drainage – disturbed pasture. Vegetation marginal, hydrology marginal due to significant rains within 48 hours, soils are not hydric.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | | | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | | | | | **County:** | Randolph |
| **Investigator:** | ASM/JSD | | | | | **State:** | NC |
| **Do Normal Circumstances exist on the site?** | | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | | **Yes** | | **No** | x | **Plot ID:** | Wet A-Out Upper |
| **(If needed, explain on reverse)** | | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Tulip poplar (*Liriodendron tulipifera*) | Tree | FAC | **9.** | | | |
| **2.** | Blue beech (*Carpinus caroliniana*) | Tree | FAC | **10.** | | | |
| **3.** | | | | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 2/2 = 100%

**Remarks:** Wetland A is bordered by steep forested slope to the south and east

## HYDROLOGY

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

**____ No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** >12 **(in.)**
- **Depth of Free Water in Pit:** ____ **(in.)**
- **Depth to Saturated Soil:** ____ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** Transitions from hazel alder (*Alnus serrulata*) and awlfruit Sedge (*Carex stipata*) upslope to tulip poplars (*Liriodendron tulipifera*) and blue beech (*Carpus caroliniana*) community.

**Plot ID:** Wet A-Out (Upper)
**(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/6 | | No mottling | Yellowish brown silty loam, dry |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** x | **No** ____ | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | | |

**Remarks**: Upland area – steep forested slope borders southern edge of Wetland A

# DATA FORM
# ROUTINE WETLAND DETERMINATION
# (1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet B-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Soft rush (*Juncus effusus*) | Herb | FACW+ | **9.** | | | |
| **2.** | American sycamore (*Platanus occidentalis*) | Tree | FACW- | **10.** | | | |
| **3.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 3/3 = 100%

**Remarks:** Clearly a hydrophytic vegetative community, dominated by soft rush (*Juncus effusus*) and lurid sedge (*Carex lurida*).

## HYDROLOGY

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

___ **No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** 0 **(in.)**
- **Depth of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** ___ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Wetland hydrology present, amphibious life within wetland

**Plot ID:** Wet B-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/2 | | Slight | Grayish brown silty loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Marginal hydric soil

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** x | **No** ___ | **Is this Sampling Point Within a Wetland?** | **Yes** x | **No** ___ |
| **Wetland Hydrology Present?** | **Yes** x | **No** ___ | | | |
| **Hydric Soils Present?** | **Yes** x | **No** ___ | | | |

**Remarks**: Area has standing water, clear hydrophytic vegetative community. Wetland B is a continuation of Wetland A that continues off site (Reference wetlands) and reconnects to Wetland B. Wetland B transitions gradually upslope to non-jurisdictional pastureland.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | |
|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | | | **County:** | Randolph |
| **Investigator:** | ASM/JSD | | | **State:** | NC |
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** x | **Plot ID:** | Wet B-Out |
| **(If needed, explain on reverse)** | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| 1. | White clover (*Trifolium repens*) | Herb | FACU | 9. | | | |
| 2. | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | 10. | | | |
| 3. | | | | 11. | | | |
| 4. | | | | 12. | | | |
| 5. | | | | 13. | | | |
| 6. | | | | 14. | | | |
| 7. | | | | 15. | | | |
| 8. | | | | 16. | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/2 = 50%

**Remarks:** Vegetative community transitions to pasture containing hairy buttercup (*Ranunculus sardous*) and white clover (*Trifolium repens*). Soft rush (*Juncus effusus*) and lurid sedge (*Carex lurida*) were absent.

## HYDROLOGY

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

**____ No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** >12 **(in.)**
- **Depth of Free Water in Pit:** ____ **(in.)**
- **Depth to Saturated Soil:** ____ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** Transitions to non-wetland hydrology upslope to the east in pasture.

**Plot ID:** Wet B-Out **(Cont'd)**

## SOILS

**Map Unit Name (Series and Phase):** BtC2, Badin-Tarrus Complex, 8-15% Slope

**Drainage Class:** Well drained

**Taxonomy (Subgroup):** Fine, mixed, semiactive, thermic Typic Hapludults

**Field Observations Confirm Mapped Type?** **Yes** x **No** ___

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/6 | | No mottling | Yellowish brown silty loam, moist |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

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

**Remarks:** High chroma non-hydric soil.

## WETLAND DETERMINATION

**Hydrophytic Vegetation Present?** **Yes** x **No** ___
**Wetland Hydrology Present?** **Yes** ___ **No** x
**Hydric Soils Present?** **Yes** ___ **No** x

**Is this Sampling Point Within a Wetland?** **Yes** ___ **No** x

**Remarks**: Located within a lowland area with presence of hairy buttercup (*Ranunculus sardous*), but not a wetland because the absence of a hydric soil.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet B-Out2 |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **9.** | | | |
| **2.** | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | **10.** | | | |
| **3.** | Soft rush (*Juncus effusus*) | Herb | FACW+ | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 3/3 = 100%

**Remarks:** Similar vegetative community as portion of wetland B. Hairy buttercup (*Ranunculus sardous*) is facultative+ (observed throughout the Heath Dairy site growing in both dry and wet areas).

## HYDROLOGY

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

___ **No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** 0-1 **(in.)**
- **Depth of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** ___ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Wetland Hydrology Present, significant rain within 24 hours.

**Plot ID:** Wet B-Out2
**(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 4/3 | | Slight mottling | Brown silty loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Marginal soil – not hydric due to chroma 3 and very marginal mottling. Wetland B is defined to the north as it gradually transitions upslope to pasture land by higher chroma soils.

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** x | **No** ____ | | | |
| **Wetland Hydrology Present?** | **Yes** x | **No** ____ | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |

**Remarks**: Area B gradually slopes up to pasture, transitions to non-hydric soil even though vegetation is similar. Area would probably not be saturated during dryer climatic conditions.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | | **Date:** | 4/20/09 | |
| **Applicant/Owner:** | EEP | | | | **County:** | Randolph | |
| **Investigator:** | ASM/JSD | | | | **State:** | NC | |
| **Do Normal Circumstances exist on the site?** | | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | | **Yes** | | **No** | x | **Plot ID:** | Wet C-In |
| **(If needed, explain on reverse)** | | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Soft rush (*Juncus effusus*) | Herb | FACW+ | **9.** | | | |
| **2.** | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | **10.** | | | |
| **3.** | White clover (*Trifolium repens)* | Herb | FACU | **11.** | | | |
| **4.** | Black willow (*Salix nigra*) | Tree | OBL | **12.** | | | |
| **5.** | Chinese privet (*Ligustrum sinense*) | Shrub | FAC | **13.** | | | |
| **6.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **14.** | | | |
| **7.** | Ground Ivy (*Glechoma hederacea*) | Herb | FACU | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 5/7 = 71%

**Remarks:** Marginal area-- heavily impacted from grazing, mixture of hydrophytic and FACU/FAC plants

## HYDROLOGY

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

**No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** (in.)
- **Depth of Free Water in Pit:** (in.)
- **Depth to Saturated Soil:** 0 (in.)

**Wetland Hydrology Indications:**

**Primary Indicators:**
- **Inundated**
- x **Saturated In Upper 12 Inches**
- **Water Marks**
- **Drift Lines**
- **Sediment Deposits**
- **Drainage Patterns in Wetlands**

**Secondary Indicators (2 or more required):**
- **Oxidized Root Channels in Upper 12 Inches**
- **Water-Stained Leaves**
- **Local Soil Survey Data**
- **FAC Neutral Test**
- **Other (Explain in Remarks)**

**Remarks:** Rain within 24 hours. Area is saturated with some standing water. Adjacent to the Eastern Branch tributary of Back Creek.

**Plot ID:** Wet C-In **(Cont'd)**

## SOILS

**Map Unit Name (Series and Phase):** BtC2, Badin-Tarrus Complex, 8-15% Slope

**Drainage Class:** Well drained

**Taxonomy (Subgroup):** Fine, mixed, semiactive, thermic Typic Hapludults

**Field Observations Confirm Mapped Type?** **Yes** x **No** ___

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 4/3 | 10 YR 4/6 | Strong mottling | Brown clayey loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

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

**Remarks:** Marginal hydric soil

## WETLAND DETERMINATION

**Hydrophytic Vegetation Present?** **Yes** x **No** ___
**Wetland Hydrology Present?** **Yes** x **No** ___
**Hydric Soils Present?** **Yes** x **No** ___

**Is this Sampling Point Within a Wetland?** **Yes** x **No** ___

**Remarks**: Soils are marginal, but observations of other wet areas indicates that hydric soils may be chroma three with mottling. Area is low quality disturbed wetland with invasive species (mostly Chinese privet (*Ligustrum sinense*)). Small area between creek and pasture.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet C-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| 1. | Wild rose (*Rosa multiflora*) | Shrub | UPL | 9. | | | |
| 2. | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | 10. | | | |
| 3. | White clover (*Trifolium repens)* | Herb | FACU- | 11. | | | |
| 4. | | | | 12. | | | |
| 5. | | | | 13. | | | |
| 6. | | | | 14. | | | |
| 7. | | | | 15. | | | |
| 8. | | | | 16. | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/3 = 33%

**Remarks:** Upgradient pasture – not a hydrophytic vegetative community

## HYDROLOGY

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

**No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** >12 **(in.)**
- **Depth of Free Water in Pit:** **(in.)**
- **Depth to Saturated Soil:** **(in.)**

**Wetland Hydrology Indications:**

**Primary Indicators:**
- **Inundated**
- **Saturated In Upper 12 Inches**
- **Water Marks**
- **Drift Lines**
- **Sediment Deposits**
- **Drainage Patterns in Wetlands**

**Secondary Indicators (2 or more required):**
- **Oxidized Root Channels in Upper 12 Inches**
- **Water-Stained Leaves**
- **Local Soil Survey Data**
- **FAC Neutral Test**
- **Other (Explain in Remarks)**

**Remarks:** Dry upslope moving east of the creek into disturbed pasture

**Plot ID:** Wet C-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 7.5 YR 5/6 | | No mottling | Strong brown silty loam, dry |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | | |

**Remarks**: Not a wetland – upland area. Wetland C is small area between creek and disturbed pasture to the east.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | |
|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | | | **County:** | Randolph |
| **Investigator:** | ASM/JSD | | | **State:** | NC |
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** x | **Plot ID:** | Wet D-In |
| **(If needed, explain on reverse)** | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| 1. | Black walnut (*Juglans nigra*) | Tree | FACU | 9. | | | |
| 2. | Common chickweed (*Stellaria media)* | Herb | FACU | 10. | | | |
| 3. | | | | 11. | | | |
| 4. | | | | 12. | | | |
| 5. | | | | 13. | | | |
| 6. | | | | 14. | | | |
| 7. | | | | 15. | | | |
| 8. | | | | 16. | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 0/2 = 0 %

**Remarks:** Vegetative appears not to be hydrophytic. Some japanese stiltgrass (*Microstegium vimineum*) was observed but dominant plants were young walnut and common chickweed (*Stellaria media)* – both FACU plants.

## 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 of Free Water in Pit:** (in.)
- **Depth to Saturated Soil:** 0-6” (in.)

**Wetland Hydrology Indications:**

**Primary Indicators:**
- **Inundated**
- **Saturated In Upper 12 Inches**
- **Water Marks**
- **Drift Lines**
- **Sediment Deposits**
- **Drainage Patterns in Wetlands**

**Secondary Indicators (2 or more required):**
- **Oxidized Root Channels in Upper 12 Inches**
- **Water-Stained Leaves**
- **Local Soil Survey Data**
- **FAC Neutral Test**
- **Other (Explain in Remarks)**

**Remarks:** Hydrology marginal. Significant rain within 24 hours.

**Plot ID:** Wet D-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-12" | A | 10 YR 5/6 | 7.5 YR 4/6 | Strong Mottling | Yellowish brown silty loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** Soil is not hydric based on high chroma.

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | | **No** | x | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | **Is this Sampling Point Within a Wetland?** **Yes** **No** x |
| **Hydric Soils Present?** | **Yes** | | **No** | x | |

**Remarks**: This area did not meet wetland criteria in accordance with USACE 1987 Wetland Delineation Manual based on lack of hydrophytic vegetation and lack of hydric soils. Soils were saturated but significant rain had occurred within 24 hours.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet D-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Poison ivy (*Toxicodendron radicans*) | Herb | FAC | **9.** | | | |
| **2.** | Red maple (*Acer rubrum*) | Tree | FAC | **10.** | | | |
| **3.** | Wild rose (*Rosa multiflora*) | Shrub | UPL | **11.** | | | |
| **4.** | Chinese privet (*Ligustrum sinense*) | Shrub | FAC | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 3/4 = 75%

**Remarks:** If FAC neutral test is used, vegetation is not hydrophytic. All 4 species are poor indicators. Wetland is bounded by steep slope clearly not jurisdictional.

## HYDROLOGY

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

**____ No Recorded Data Available**

**Field Observations:**

| | | |
|---|---|---|
| **Depth of Surface Water:** | >12 | **(in.)** |
| **Depth of Free Water in Pit:** | | **(in.)** |
| **Depth to Saturated Soil:** | | **(in.)** |

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** Dryer upslope area, steep grade

**Plot ID:** Wet D-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 7.5 YR 5/8 | 5 YR 5/8 | Moderate mottling | Strong brown silty loam, dry |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | |
|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | |

**Remarks**: Upslope area borders marginal wetland

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet E-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Soft rush (*Juncus effusus*) | Herb | FACW+ | **9.** | | | |
| **2.** | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | **10.** | | | |
| **3.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 3/3 = 100%

**Remarks:** Area receiving groundwater seepage adjoining stream, Rock at 6-8", hear heavily grazed area.

## HYDROLOGY

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

**No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** 1 **(in.)**
- **Depth of Free Water in Pit:** **(in.)**
- **Depth to Saturated Soil:** **(in.)**

**Wetland Hydrology Indications:**

**Primary Indicators:**
- x **Inundated**
- **Saturated In Upper 12 Inches**
- **Water Marks**
- **Drift Lines**
- **Sediment Deposits**
- **Drainage Patterns in Wetlands**

**Secondary Indicators (2 or more required):**
- **Oxidized Root Channels in Upper 12 Inches**
- **Water-Stained Leaves**
- **Local Soil Survey Data**
- **FAC Neutral Test**
- **Other (Explain in Remarks)**

**Remarks:** Wetland Hydrology Present, Seepage creates small indentation adjoining stream.

**Plot ID:** Wet E-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-8" | A | 2.5 YR 4/1 | 10 YR 4/4 | Heavy mottling | Dark gray silty loam-saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| x | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** Clearly hydric soil based on low chomas and mottling.

## WETLAND DETERMINATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | | | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | **Is this Sampling Point Within a Wetland?** | **Yes** | x | **No** |

**Remarks**: Small, obvious jurisdictional wetland fed by groundwater seepage adjoining stream.

# DATA FORM
# ROUTINE WETLAND DETERMINATION
# (1987 COE Wetlands Delineation Manual)

| | | | | | |
|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | | | **County:** | Randolph |
| **Investigator:** | ASM/JSD | | | **State:** | NC |
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet E-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| 1. | White clover (*Trifolium repens)* | Herb | FACU | 9. | | | |
| 2. | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | 10. | | | |
| 3. | Tall fescue (*Festuca arundinacea*) | Grass | FAC- | 11. | | | |
| 4. | Wild onion (*Allium canadense)* | Herb | FAC- | 12. | | | |
| 5. | | | | 13. | | | |
| 6. | | | | 14. | | | |
| 7. | | | | 15. | | | |
| 8. | | | | 16. | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/4 = 25%

**Remarks:** Grazed upgradient area

## HYDROLOGY

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

**____ No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** >12 **(in.)**
- **Depth of Free Water in Pit:** _____ **(in.)**
- **Depth to Saturated Soil:** _____ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** No Wetland Hydrology Present, upland area between wetland E seep and stream

**Plot ID:** Wet E-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/6 | | No mottling | Yellowish brown silty loam, moist |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | | |

**Remarks**: Upland area clearly separate from channelized groundwater seep joining stream

# DATA FORM
# ROUTINE WETLAND DETERMINATION
# (1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet F-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Tearthumb (*Polygonum sagittatum*) | Herb | OBL | **9.** | | | |
| **2.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **10.** | | | |
| **3.** | Elderberry (*Sambucus canadensis)* | Shrub | FACW- | **11.** | | | |
| **4.** | Hazel alder (*Alnus serrulata*) | Shrub | FACW | **12.** | | | |
| **5.** | Bedstraw (*Gallium tinctorium*) | Herb | FACW | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 5/5 = 100%

**Remarks:** Strong hydrophytic vegetative community

## 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 of Free Water in Pit:** _____ **(in.)**
- **Depth to Saturated Soil:** 0 **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** Saturated to ground level, significant rain within 24 hours, wet area adjacent to stream (West Branch Back Creek)

**Plot ID:** Wet F-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 4/1 | | Slight Mottling | Dark grey silty loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** clearly hydric soils

## WETLAND DETERMINATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | | | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | **Is this Sampling Point Within a Wetland?** | **Yes** | x | **No** |

**Remarks**: Obvious jurisdictional wetland area – grades up to pastureland and fence

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet F-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Japanese honeysuckle (*Lonicera japonica*) | Herb | FAC- | **9.** | | | |
| **2.** | | | | **10.** | | | |
| **3.** | | | | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 0/1 = 0%

**Remarks:** Dominated by Japanese honeysuckle (*Lonicera japonica)*

## 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 of Free Water in Pit:** ____ **(in.)**
- **Depth to Saturated Soil:** >12 **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Dry upslope area

**Plot ID:** Wet F-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-12" | A | 10 YR 4/4 | | Slight mottling | Dark yellowish brown silty loam, dry |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Upland soil

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | | |

**Remarks**: Upslope area – dominated by Japanese honeysuckle (*Lonicera japonica*)

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet G-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Poison ivy (*Toxicodendron radicans*) | Herb | FAC | **9.** | | | |
| **2.** | Japanese stiltgrass (*Microstegium vimineum*) | Herb | FAC+ | **10.** | | | |
| **3.** | | | | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 2/2 = 100%

**Remarks:** Marginal hydrophytic community – Japanese stiltgrass (*Microstegium vimineum*) generally favors stream banks that are not inundated.

## HYDROLOGY

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

**____ No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** ____ **(in.)**
- **Depth of Free Water in Pit:** ____ **(in.)**
- **Depth to Saturated Soil:** >12 **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** Hydrology is marginal, adjacent to stream – West Branch of Back Creek

**Plot ID:** Wet G-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/2 | 10 YR 4/6 | Moderate mottling | Grayish brown silty loam, wet |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** Chroma 2 with mottling

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | |
| **Wetland Hydrology Present?** | **Yes** | | **No** | x | |
| **Hydric Soils Present?** | **Yes** | x | **No** | | **Is this Sampling Point Within a Wetland?** **Yes** **No** x |

**Remarks**: Wetland G is a marginal wetland due to marginal hydrology

# DATA FORM
# ROUTINE WETLAND DETERMINATION
# (1987 COE Wetlands Delineation Manual)

| | | | | | |
|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | | | **County:** | Randolph |
| **Investigator:** | ASM/JSD | | | **State:** | NC |
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet G-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Red maple (*Acer rubrum*) | Tree | FAC | **9.** | | | |
| **2.** | Tulip poplar (*Liriodendron tulipifera*) | Tree | FACU | **10.** | | | |
| **3.** | Japanese honeysuckle (*Lonicera japonica*) | Herb | FAC- | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/3 = 33%

**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 of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** >12 **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Slopes away from creek

**Plot ID:** Wet G-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/8 | | No mottling | Yellowish brown silty loam, dry |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| ____ | **Histosoil** | ____ | **Concretions** |
| ____ | **Histic Epipedon** | ____ | **High Organic Content in Surface Layer in Sandy Soils** |
| ____ | **Sulfide Odor** | ____ | **Organic Streaking in Sandy Soils** |
| ____ | **Aquic Moisture Regime** | ____ | **Listed on Local Hydric Soils List** |
| ____ | **Reducing Conditions** | ____ | **Listed on National Hydric Soils List** |
| ____ | **Gleyed or Low-Chroma Colors** | ____ | **Other (Explain in Remarks)** |

**Remarks:** Not an hydric soil

## WETLAND DETERMINATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | **Is this Sampling Point Within a Wetland?** | **Yes** | **No** x |
| **Wetland Hydrology Present?** | **Yes** | | **No** | x | | | |
| **Hydric Soils Present?** | **Yes** | | **No** | x | | | |

**Remarks**: Upslope area - forested

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet H-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Chinese privet (*Ligustrum sinense*) | Shrub | FAC | **9.** | | | |
| **2.** | Green ash (*Fraxinus Pennsylvania*) | Tree | FACW | **10.** | | | |
| **3.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **11.** | | | |
| **4.** | Japanese stiltgrass (*Microstegium vimineum*) | Herb | FAC+ | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 4/4 = 100%

**Remarks:** Marginal hydrophytic vegetative community. Japanese stiltgrass (*Microstegium vimineum*) generally favors stream banks that are not inundated.

## 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 of Free Water in Pit:** ____ **(in.)**
- **Depth to Saturated Soil:** >12 **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Soil is wet, but not saturated

**Plot ID:** Wet H-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-12" | A | 10 YR 4/3 | 10 YR 4/6 | Strong Mottling | Brown silty loam, wet |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Marginal wetland soils

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** x | **No** ____ | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | | |

**Remarks**: Wetland H is marginal based on lack of hydrology, 1.5 days after significant rains, chroma 3 soils w/strong mottling and marginal vegetative community

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet H-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Tall fescue (*Festuca arundinacea*) | Grass | FAC- | **9.** | | | |
| **2.** | Chinese privet (*Ligustrum sinense)* | Shrub | FAC | **10.** | | | |
| **3.** | Wild strawberry (*Fragaria virginiana*) | Herb | FAC- | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/3 = 33%

**Remarks:** Upslope away from drainage, wild strawberry (*Fragaria virginiana*) indicates upland vegetative community.

## 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:** >12 **(in.)**
- **Depth of Free Water in Pit:** _____ **(in.)**
- **Depth to Saturated Soil:** _____ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Dryer upslope area

**Plot ID:** Wet H-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 5 YR 4/6 | | No mottling | Yellowish red silty loam, dry |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | |
|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | |

**Remarks**: Upslope area

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet I-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **9.** | | | |
| **2.** | Chinese privet (*Ligustrum sinense*) | Shrub | FAC | **10.** | | | |
| **3.** | | | | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 2/2 = 100%

**Remarks:** Marginal hydrophytic vegetative community

## 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:** 0.5 **(in.)**
- **Depth of Free Water in Pit:** ____ **(in.)**
- **Depth to Saturated Soil:** ____ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Small overflow channel of existing intermittent stream

**Plot ID:** Wet I-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-8" | A | G1 410Y | | No mottling | Gleyed, mixed sandy coarse stream bed material, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** Hydric soil based on gleyed condition

## WETLAND DETERMINATION

| | | | | | | |
|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | **Is this Sampling Point Within a Wetland?** | **Yes** | x **No** |

**Remarks**: Marginal wetland drainage – vegetation is community is marginal – Chinese privet (*Ligustrum sinese*) also located on adjacent upland area.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet I-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Poison Ivy (*Toxicodendron radicans*) | Herb | FAC | **9.** | | | |
| **2.** | Chinese privet (*Ligustrum sinense)* | Shrub | FAC | **10.** | | | |
| **3.** | Japanese honeysuckle (*Lonicera japonica*) | Herb | FAC- | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 2/3 = 66%

**Remarks:** Vegetative community dominated by invasive species

## 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 of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** >12 **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Dry upslope area

**Plot ID:** Wet I-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/3 | 7.5 YR 4/6 | Strong mottling | Brown silty loam, dry |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil.

## WETLAND DETERMINATION

| | | | | |
|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** x | **No** ____ | **Is this Sampling Point Within a Wetland?** | **Yes** ____ **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | |

**Remarks**: Upslope area

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet J-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Tearthumb (*Polygonum sagittatum)* | Herb | OBL | **9.** | | | |
| **2.** | Japanese honeysuckle (*Lonicera japonica*) | Herb | FAC- | **10.** | | | |
| **3.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 2/3 = 66%

**Remarks:** Hydrophytic vegetation, some Chinese privet (*Ligustrum sinense*) located upslope to herb species

## HYDROLOGY

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

**No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** (in.)
- **Depth of Free Water in Pit:** (in.)
- **Depth to Saturated Soil:** 0 (in.)

**Wetland Hydrology Indications:**

**Primary Indicators:**
- **Inundated**
- x **Saturated In Upper 12 Inches**
- **Water Marks**
- **Drift Lines**
- **Sediment Deposits**
- **Drainage Patterns in Wetlands**

**Secondary Indicators (2 or more required):**
- x **Oxidized Root Channels in Upper 12 Inches**
- **Water-Stained Leaves**
- **Local Soil Survey Data**
- **FAC Neutral Test**
- **Other (Explain in Remarks)**

**Remarks:** Wetland Hydrology Present, saturated throughout—adjacent to intermittent drainage

**Plot ID:** Wet J-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/1 | 5 YR 5/6 | Strong Mottling | Grey silty loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** A hydric soil with low-chroma and strong mottling

## WETLAND DETERMINATION

| | | | | | | |
|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | **Is this Sampling Point Within a Wetland?** | **Yes** x | **No** |

**Remarks**: Wetland area between pasture and West Branch Back Creek

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | | | |
|---|---|---|---|---|---|
| **Project/Site:** | Heath Dairy | | | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | | | **County:** | Randolph |
| **Investigator:** | ASM/JSD | | | **State:** | NC |
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet J-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Tall fescue (*Festuca arundinacea)* | Grass | FAC- | **9.** | | | |
| **2.** | Japanese honeysuckle (*Lonicera japonica*) | Herb | FAC- | **10.** | | | |
| **3.** | | | | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 0/2 = 0%

**Remarks:**

## HYDROLOGY

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

**____ No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** >12 **(in.)**
- **Depth of Free Water in Pit:** _____ **(in.)**
- **Depth to Saturated Soil:** _____ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** Dryer upslope area

**Plot ID:** Wet J-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** ___ |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 4/4 | | No mottling | Dark yellowish brown silty loam, wet |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

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

**Remarks:** no mottling, high chroma

## WETLAND DETERMINATION

| | | | | |
|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ___ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ___ **No** x |
| **Wetland Hydrology Present?** | **Yes** ___ | **No** x | | |
| **Hydric Soils Present?** | **Yes** ___ | **No** x | | |

**Remarks**: Upslope area – clear break in vegetative community

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet K-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Soft rush (*Juncus effusus*) | Herb | FACW+ | **9.** | | | |
| **2.** | Duck weed (*Lemna gibba*) | Herb | OBL | **10.** | | | |
| **3.** | Lurid sedge (*Carex lurida*) | Herb | OBL | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 3/3 = 100%

**Remarks:** Hydrophytic vegetation, amphibian species within wetland (tadpoles, frogs)

## HYDROLOGY

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

___ **No Recorded Data Available**

**Field Observations:**
- **Depth of Surface Water:** 2-10 **(in.)**
- **Depth of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** ___ **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Wetland Hydrology Present, lowland area, inundated. Wetland K is a small pond.

**Plot ID:** Wet K-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 7.5 YR 4/1 | | mottling | Dark gray silty loam-saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** A hydric soil

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** x | **No** | **Is this Sampling Point Within a Wetland?** | **Yes** x | **No** |
| **Wetland Hydrology Present?** | **Yes** x | **No** | | | |
| **Hydric Soils Present?** | **Yes** x | **No** | | | |

**Remarks**: Wetland K is a small pond containing hydrophytic vegetation and is habitat for amphibians.

# DATA FORM
# ROUTINE WETLAND DETERMINATION
# (1987 COE Wetlands Delineation Manual)

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/20/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet K-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | White clover (*Trifolium repens)* | Herb | FACU- | **9.** | | | |
| **2.** | Hairy buttercup (*Ranunculus sardous*) | Herb | FAC+ | **10.** | | | |
| **3.** | Tall fescue (*Festuca arundinacea*) | Grass | FAC- | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/3 = 33%

**Remarks:** Grazed upgradient area

## HYDROLOGY

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

**____ No Recorded Data Available**

**Field Observations:**

| | | |
|---|---|---|
| **Depth of Surface Water:** | >12 | **(in.)** |
| **Depth of Free Water in Pit:** | | **(in.)** |
| **Depth to Saturated Soil:** | | **(in.)** |

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- **___ Oxidized Root Channels in Upper 12 Inches**
- **___ Water-Stained Leaves**
- **___ Local Soil Survey Data**
- **___ FAC Neutral Test**
- **___ Other (Explain in Remarks)**

**Remarks:** Wetland K is a small pond. Hydrology is obvious with clear boundaries of standing water.

**Plot ID:** Wet K-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 4/4 | | No mottling | Dark yellowish brown silty loam |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | |
|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | |

**Remarks**: Boundary of Wetland K is obvious due to standing water

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet L-In |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Japanese stiltgrass (*Microstegium vimineum*) | Herb | FAC+ | **9.** | | | |
| **2.** | | | | **10.** | | | |
| **3.** | | | | **11.** | | | |
| **4.** | | | | **12.** | | | |
| **5.** | | | | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 1/1 = 100%

**Remarks:** Surrounded by red maple (*Acer rubrum*), sweet gum (*Liquidambar styaciflua*), some Chinese privet (*Ligustrum sinense*). Marginal vegetative community.

## 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 of Free Water in Pit:** ___ **(in.)**
- **Depth to Saturated Soil:** 0 **(in.)**

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** Saturated near ground level, wet area adjacent to stream

**Plot ID:** Wet L-In **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-12" | A | 10 YR 5/2 | 10 YR 4/6 | Strong Mottling | Grayish brown silty loam, saturated |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | | | |
|---|---|---|---|
| | **Histosoil** | | **Concretions** |
| | **Histic Epipedon** | | **High Organic Content in Surface Layer in Sandy Soils** |
| | **Sulfide Odor** | | **Organic Streaking in Sandy Soils** |
| | **Aquic Moisture Regime** | | **Listed on Local Hydric Soils List** |
| | **Reducing Conditions** | | **Listed on National Hydric Soils List** |
| x | **Gleyed or Low-Chroma Colors** | | **Other (Explain in Remarks)** |

**Remarks:** Low chroma hydric soils with mottling

## WETLAND DETERMINATION

| | | | | | |
|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** | x | **No** | | |
| **Wetland Hydrology Present?** | **Yes** | x | **No** | | |
| **Hydric Soils Present?** | **Yes** | x | **No** | **Is this Sampling Point Within a Wetland?** | **Yes** x **No** |

**Remarks**: Marginal vegetative community. Wetland L is in a saturated area between stream and hill/pasture.

**DATA FORM**
**ROUTINE WETLAND DETERMINATION**
**(1987 COE Wetlands Delineation Manual)**

| | | | |
|---|---|---|---|
| **Project/Site:** | Heath Dairy | **Date:** | 4/21/09 |
| **Applicant/Owner:** | EEP | **County:** | Randolph |
| **Investigator:** | ASM/JSD | **State:** | NC |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Do Normal Circumstances exist on the site?** | **Yes** | x | **No** | | **Community ID:** | |
| **Is the site significantly disturbed (A typical Situation)?** | **Yes** | | **No** | x | **Transect ID:** | |
| **Is the area a potential Problem Area?** | **Yes** | | **No** | x | **Plot ID:** | Wet L-Out |
| **(If needed, explain on reverse)** | | | | | | |

## VEGETATION

| | Dominant Plant Species | Stratum | Indicator | | Dominant Plant Species | Stratum | Indicator |
|---|---|---|---|---|---|---|---|
| **1.** | Poison ivy (*Toxicodendron radicans*) | Herb | FAC | **9.** | | | |
| **2.** | Red maple (*Acer rubrum*) | Tree | FAC | **10.** | | | |
| **3.** | Japanese honeysuckle (*Lonicera japonica*) | Herb | FAC- | **11.** | | | |
| **4.** | Southern red oak (*Quercus falcata*) | Tree | FACU- | **12.** | | | |
| **5.** | American beech (*Fagus grandifolia*) | Tree | FACU | **13.** | | | |
| **6.** | | | | **14.** | | | |
| **7.** | | | | **15.** | | | |
| **8.** | | | | **16.** | | | |

**Percent of Dominant Species that are OBL, FACW or FAC (excluding FAC-)** 2/5 = 40%

**Remarks:** Upslope non-hydrophytic vegetative community

## 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 of Free Water in Pit:** | | **(in.)** |
| **Depth to Saturated Soil:** | >12 | **(in.)** |

**Wetland Hydrology Indications:**

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

**Secondary Indicators (2 or more required):**
- ___ **Oxidized Root Channels in Upper 12 Inches**
- ___ **Water-Stained Leaves**
- ___ **Local Soil Survey Data**
- ___ **FAC Neutral Test**
- ___ **Other (Explain in Remarks)**

**Remarks:** steep upslope

**Plot ID:** Wet L-Out **(Cont'd)**

## SOILS

| | | | |
|---|---|---|---|
| **Map Unit Name (Series and Phase):** | BtC2, Badin-Tarrus Complex, 8-15% Slope | **Drainage Class:** Well drained | |
| **Taxonomy (Subgroup):** | Fine, mixed, semiactive, thermic Typic Hapludults | **Field Observations Confirm Mapped Type?** | **Yes** x **No** |

**Profile Description**

| Depth (inches) | Horizon | Matrix Color (Munsell Moist) | Mottle Colors (Munsell Moist) | Mottle Abundance/Contrast | Texture, Concretions, Structure, etc. |
|---|---|---|---|---|---|
| 0-10" | A | 10 YR 5/4 | 5 YR 4/6 | | Yellowish brown silty loam, dry with mottling |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Hydric Soil Indicators:**

| | |
|---|---|
| ____ **Histosoil** | ____ **Concretions** |
| ____ **Histic Epipedon** | ____ **High Organic Content in Surface Layer in Sandy Soils** |
| ____ **Sulfide Odor** | ____ **Organic Streaking in Sandy Soils** |
| ____ **Aquic Moisture Regime** | ____ **Listed on Local Hydric Soils List** |
| ____ **Reducing Conditions** | ____ **Listed on National Hydric Soils List** |
| ____ **Gleyed or Low-Chroma Colors** | ____ **Other (Explain in Remarks)** |

**Remarks:** Not a hydric soil

## WETLAND DETERMINATION

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Hydrophytic Vegetation Present?** | **Yes** ____ | **No** x | **Is this Sampling Point Within a Wetland?** | **Yes** ____ | **No** x |
| **Wetland Hydrology Present?** | **Yes** ____ | **No** x | | | |
| **Hydric Soils Present?** | **Yes** ____ | **No** x | | | |

**Remarks**: Upslope area

# APPENDIX D

## Site NCDWQ Stream Identification Forms

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | | |
|---|---|---|---|
| **Date:** 6-23-06 | **Project:** HEATH DAIRY | **Latitude:** 35.85333 | |
| **Evaluator:** GRANT GINN | **Site:** UT TO POLECAT CR. | **Longitude:** 79.77833 | |
| **Total Points:** Stream is at least intermittent if ≥ 19 or perennial if ≥ 30 — 45 | **County:** RANDOLPH | **Other** e.g. Quad Name: | |

| A. Geomorphology (Subtotal = 25) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity | 0 | 1 | 2 | (3) |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | (3) |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | 1 | (2) | 3 |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | (2) | 3 |
| 9[a] Natural levees | (0) | 1 | 2 | 3 |
| 10. Headcuts | (0) | 1 | 2 | 3 |
| 11. Grade controls | 0 | 0.5 | 1 | (1.5) |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | (Yes = 3) | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 10) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season | 0 | 1 | (2) | 3 |
| 16. Leaflitter | (1.5) | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | (1) | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | (1) | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | (Yes = 1.5) | |

| C. Biology (Subtotal = 10) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish | (0) | 0.5 | 1 | 1.5 |
| 23. Bivalves | (0) | 1 | 2 | 3 |
| 24. Fish | 0 | (0.5) | 1 | 1.5 |
| 25. Amphibians | 0 | (0.5) | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | 0 | 0.5 | (1) | 1.5 |
| 27. Filamentous algae; periphyton | 0 | 1 | (2) | 3 |
| 28. Iron oxidizing bacteria/fungus. | (0) | 0.5 | 1 | 1.5 |
| 29[b]. Wetland plants in streambed | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0 | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 3-2-06 | **Project:** HEATH DAIRY | **Latitude:** 35.67157 |
| **Evaluator:** GRANT GINN | **Site:** FORK CREEK | **Longitude:** 79.74500 |
| **Total Points:** Stream is at least intermittent if ≥ 19 or perennial if ≥ 30: 44 | **County:** RANDOLPH | **Other** e.g. Quad Name: |

| A. Geomorphology (Subtotal = 22) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity | 0 | (1) | 2 | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | (3) |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | 1 | 2 | (3) |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | (1) | 2 | 3 |
| 9[a] Natural levees | (0) | 1 | 2 | 3 |
| 10. Headcuts | (0) | 1 | 2 | 3 |
| 11. Grade controls | 0 | (0.5) | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | (Yes = 3) | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 10) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season | 0 | 1 | (2) | 3 |
| 16. Leaflitter | (1.5) | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | (1) | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | (1) | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | (Yes = 1.5) | |

| C. Biology (Subtotal = 12) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish | 0 | (0.5) | 1 | 1.5 |
| 23. Bivalves | (0) | 1 | 2 | 3 |
| 24. Fish | 0 | 0.5 | 1 | (1.5) |
| 25. Amphibians | 0 | 0.5 | (1) | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | 0 | 0.5 | 1 | (1.5) |
| 27. Filamentous algae; periphyton | 0 | (1) | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0 | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** A. WAZENEGGER | **Site:** UPPER BACK CR. - @ WET. E | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 44.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 25.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity | 0 | 1 | (2) | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | (3) |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | 1 | (2) | 3 |
| 7. Braided channel | 0 | (1) | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | (2) | 3 |
| 9[a] Natural levees | 0 | (1) | 2 | 3 |
| 10. Headcuts | (0) | 1 | 2 | 3 |
| 11. Grade controls | 0 | 0.5 | (1) | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | (Yes = 3) | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 11.5) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | (1.5) | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | (1) | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | (1.5) |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | (Yes = 1.5) | |

| C. Biology (Subtotal = 7.5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish * | 0 | (0.5) | 1 | 1.5 |
| 23. Bivalves * | (0) | 1 | 2 | 3 |
| 24. Fish * | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians * | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) * | 0 | (0.5) | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Sketch:

Notes: (use back side of this form for additional notes.)

* WATER QUALITY DEGRADED DUE TO CATTLE

LAST RAIN WAS EARLY MORNING 12/3/06

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** UPPER BACK CR @ CREST GAGE | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 44.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 25) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity | 0 | 1 | (2) | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | (3) |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches IMPACT BY CATTLE | 0 | (1) | 2 | 3 |
| 7. Braided channel | 0 | (1) | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | (2) | 3 |
| 9[a] Natural levees IMPACT BY CATTLE | 0 | (1) | 2 | 3 |
| 10. Headcuts | 0 | (1) | 2 | 3 |
| 11. Grade controls | 0 | (0.5) | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | (Yes = 3) | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 12) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | (1.5) | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | 1 | (1.5) |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | (1.5) |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | (Yes = 1.5) | |

| C. Biology (Subtotal = 7.5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish* | (0) | 0.5 | 1 | 1.5 |
| 23. Bivalves* | (0) | 1 | 2 | 3 |
| 24. Fish * | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians* | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance)* | (0) | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | 0 | (1) | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

* VERY POOR WATER QUALITY DUE TO CATTLE IMPACT

LAST RAIN WAS EARLY AM 12/3/06

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** BACK CREEK - JUST BELOW CONFLUENCE W/ WEST BRANCH | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 41 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 23) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank* IMPACTED BY CATTLE | 0 | 1 | 2 | (3) |
| 2. Sinuosity - straightened channel | 0 | (1) | 2 | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | (3) |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches – hard to distinguish w/ cattle impact | 0 | (1) | 2 | 3 |
| 7. Braided channel | 0 | (1) | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | (2) | 3 |
| 9[a] Natural levees | 0 | (1) | 2 | 3 |
| 10. Headcuts | (0) | 1 | 2 | 3 |
| 11. Grade controls | 0 | (0.5) | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | (Yes = 3) | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 11.5) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | (1.5) | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | (1) | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | (1.5) |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | (Yes = 1.5) | |

| C. Biology (Subtotal = 6.5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish* | (0) | 0.5 | 1 | 1.5 |
| 23. Bivalves* | (0) | 1 | 2 | 3 |
| 24. Fish* | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians* | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance)* | (0) | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0 | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

* THIS REACH HAS A LOT OF CATTLE IMPACTS ON BANKS, VERY POOR WATER QUALITY DUE TO CATTLE

LAST RAIN WAS EARLY AM 12/3/06

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** PT 01 ON GPS |
| **Evaluator:** AJW | **Site:** LOWER BACK CR., JUST D/S OF CONFLUENCE W/ EAST BRANCH | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 45.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 26) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity - straightened channel | 0 | (1) | 2 | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting - backwater from dam | 0 | 1 | (2) | 3 |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | 1 | 2 | (3) |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | 2 | (3) |
| 9[a] Natural levees - backwater from dam | 0 | (1) | 2 | 3 |
| 10. Headcuts | 0 | (1) | 2 | 3 |
| 11. Grade controls | 0 | 0.5 | 1 | (1.5) |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 11.5) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | 1.5 | (1) | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | 1 | (1.5) |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | (1.5) |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | Yes = (1.5) | |

| C. Biology (Subtotal = 8) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish | 0 | 0.5 | 1 | (1.5) |
| 23. Bivalves * | (0) | 1 | 2 | 3 |
| 24. Fish * | 0 | (0.5) | 1 | 1.5 |
| 25. Amphibians * | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) * | 0 | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton * | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. * | (0) | 0.5 | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

* VERY POOR WATER QUALITY DUE TO CATTLE ACCESS TO STREAM. ALSO, THIS REACH DOES GET BACKWATER FROM DAM ON HEATH DAIRY RD.
LAST RAIN WAS EARLY AM 12/3/06

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** @ CREST GAGE, JUST D/S OF NORTH BR. |
| **Evaluator:** AJW | **Site:** BACK CREEK - BTWN CONFLUENCE W/ EAST BRANCH AND CONFL W/ NORTH BRANCH | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 48.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 28) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity - straightened channel | 0 | 1 | (2) | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | (3) |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | 1 | 2 | (3) |
| 7. Braided channel | 0 | (1) | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | 2 | (3) |
| 9[a] Natural levees | 0 | (1) | 2 | 3 |
| 10. Headcuts | 0 | (1) | 2 | 3 |
| 11. Grade controls | 0 | (0.5) | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | (Yes = 3) | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 11) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | (1.5) | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | (0.5) | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | (1.5) |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | (Yes = 1.5) | |

| C. Biology (Subtotal = 9.5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish | 0 | 0.5 | (1) | 1.5 |
| 23. Bivalves * | (0) | 1 | 2 | 3 |
| 24. Fish * | 0 | (0.5) | 1 | 1.5 |
| 25. Amphibians * | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance)* | 0 | (0.5) | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | (0) | 0.5 | 1 | 1.5 |
| 29[b]. Wetland plants in streambed | FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0 | | | |

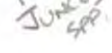
[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

* VERY POOR WATER QUALITY DUE TO CATTLE

LAST RAIN WAS EARLY AM 12/3/06

Sketch:



## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** PT # EB-UP |
| **Evaluator:** AJW | **Site:** UPPER EAST BRANCH - ABOVE WET C | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 32.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 18) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity | 0 | 1 | (2) | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | (2) | 3 |
| 4. Soil texture or stream substrate sorting | 0 | 1 | (2) | 3 |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | (1) | 2 | 3 |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | (1) | 2 | 3 |
| 9[a] Natural levees | 0 | (1) | 2 | 3 |
| 10. Headcuts | 0 | (1) | 2 | 3 |
| 11. Grade controls | 0 | 0.5 | (1) | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | (1) | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | (No = 0) | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 9.5) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | (2) | 3 |
| 15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | 1.5 | (1) | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | (1) | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | (1) | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | Yes = 1.5 | |

| C. Biology (Subtotal = 5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | 3 | (2) | 1 | 0 |
| 22. Crayfish * | (0) | 0.5 | 1 | 1.5 |
| 23. Bivalves * | (0) | 1 | 2 | 3 |
| 24. Fish * | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians * | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) * | (0) | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | (0) | 0.5 | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

* MODERATE TO POOR WATER QUALITY DUE TO CATTLE IMPACT

LAST RAIN WAS EARLY AM 12/3/06

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** PT #02 |
| **Evaluator:** AJW | **Site:** EAST BRANCH, LOWER - BELOW CATTLE BRIDGE | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 37 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 10.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity - straightened channel | 0 | (1) | 2 | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | (2) | 3 |
| 4. Soil texture or stream substrate sorting - backwater from dam | 0 | 1 | (2) | 3 |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | 1 | (2) | 3 |
| 7. Braided channel | 0 | (1) | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | (2) | 3 |
| 9[a] Natural levees | 0 | (1) | 2 | 3 |
| 10. Headcuts | (0) | 1 | 2 | 3 |
| 11. Grade controls | 0 | (0.5) | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | (1) | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | (No = 0) | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 11) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel -- dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | 1.5 | (1) | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | 1 | (1.5) |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | (1) | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | Yes = 1.5 | |

| C. Biology (Subtotal = 7.5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | 3 | (2) | 1 | 0 |
| 22. Crayfish ** | (0) | 0.5 | 1 | 1.5 |
| 23. Bivalves** | (0) | 1 | 2 | 3 |
| 24. Fish ** | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians** | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance)* | 0 | (0.5) | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed | FAC = 0.5; FACW = 0.75; OBL = 1.5; SAV = 2.0; Other = 0 | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Sketch: Juncus spp.

Notes: (use back side of this form for additional notes.)

* few stoneflies/mayflies under rocks

** POOR WATER QUALITY DUE TO CATTLE

LAST RAIN WAS EARLY AM 12/3/06

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** @ U/S-MOST PT W/IN |
| **Evaluator:** AJW | **Site:** NORTH BRANCH | **Longitude:** SITE BOUNDARY |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 45.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 26.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity | 0 | 1 | 2 | (3) |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | (3) |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | (3) |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | 1 | (2) | 3 |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | (2) | 3 |
| 9[a] Natural levees | 0 | (1) | 2 | 3 |
| 10. Headcuts | 0 | (1) | 2 | 3 |
| 11. Grade controls | 0 | 0.5 | (1) | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | (1.5) |
| 13. Second or greater order channel on existing (USGS) or NRCS map or other documented evidence. | No = 0 | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 11) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | (3) |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | (1.5) | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | (0.5) | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | (1.5) |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | Yes = 1.5 | |

| C. Biology (Subtotal = 8) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish | 0 | 0.5 | (1) | 1.5 |
| 23. Bivalves * | (0) | 1 | 2 | 3 |
| 24. Fish * | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians * | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) * | 0 | (0.5) | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed – NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

Sketch:

* POOR WATER QUALITY DUE TO CATTLE

LAST RAIN WAS EARLY MORNING 12/3/06

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** UT TO WEST BR- UP END | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 35.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 21.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | (3) |
| 2. Sinuosity | 0 | 1 | (2) | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | (1) | 2 | 3 |
| 4. Soil texture or stream substrate sorting | 0 | 1 | (2) | 3 |
| 5. Active/relic floodplain | 0 | 1 | 2 | (3) |
| 6. Depositional bars or benches | 0 | (1) | 2 | 3 |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | (2) | 3 |
| 9[a] Natural levees | 0 | 1 | (2) | 3 |
| 10. Headcuts | 0 | 1 | 2 | (3) |
| 11. Grade controls | 0 | 0.5 | 1 | (1.5) |
| 12. Natural valley or drainageway | 0 | 0.5 | (1) | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | (No = 0) | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 9.5) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | (2) | 3 |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | 0 | 1 | 2 | (3) |
| 16. Leaflitter | 1.5 | 1 | (0.5) | 0 |
| 17. Sediment on plants or debris | 0 | (0.5) | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | (1) | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | Yes = 1.5 | |

| C. Biology (Subtotal = 5.5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | 3 | 2 | (1) | 0 |
| 22. Crayfish | 0 | (0.5) | 1 | 1.5 |
| 23. Bivalves | (0) | 1 | 2 | 3 |
| 24. Fish | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | 0 | (0.5) | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

LAST RAIN WAS EARLY AM 12/3/06

Sketch:

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** WEST BRANCH - NR. WET L | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 39 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 22) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | 3 |
| 2. Sinuosity | 0 | 1 | 2 | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | 3 |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | 3 |
| 5. Active/relic floodplain | 0 | 1 | 2 | 3 |
| 6. Depositional bars or benches | 0 | 1 | 2 | 3 |
| 7. Braided channel | 0 | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | 2 | 3 |
| 9[a] Natural levees | 0 | 1 | 2 | 3 |
| 10. Headcuts | 0 | 1 | 2 | 3 |
| 11. Grade controls | 0 | 0.5 | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 9) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | 3 |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | 0 | 1 | 2 | 3 |
| 16. Leaflitter | 1.5 | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | Yes = 1.5 | |

| C. Biology (Subtotal = 9) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | 3 | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | 3 | 2 | 1 | 0 |
| 22. Crayfish | 0 | 0.5 | 1 | 1.5 |
| 23. Bivalves | 0 | 1 | 2 | 3 |
| 24. Fish | 0 | 0.5 | 1 | 1.5 |
| 25. Amphibians | 0 | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | 0 | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | 0 | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | 0.5 | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0 | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

LAST RAIN WAS EARLY AM 12/3/06

Sketch:

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 12/6/06 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** WEST BRANCH NR. WET. G | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 42 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 25) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | 2 | 3 |
| 2. Sinuosity | 0 | 1 | 2 | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | 1 | 2 | 3 |
| 4. Soil texture or stream substrate sorting | 0 | 1 | 2 | 3 |
| 5. Active/relic floodplain | 0 | 1 | 2 | 3 |
| 6. Depositional bars or benches | 0 | 1 | 2 | 3 |
| 7. Braided channel | 0 | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | 1 | 2 | 3 |
| 9[a] Natural levees | 0 | 1 | 2 | 3 |
| 10. Headcuts | 0 | 1 | 2 | 3 |
| 11. Grade controls | 0 | 0.5 | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | 1 | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | No = 0 | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 9) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | 0 | 1 | 2 | 3 |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | 0 | 1 | 2 | 3 |
| 16. Leaflitter | 1.5 | 1 | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | 0.5 | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | 0 | 0.5 | 1 | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | No = 0 | | Yes = 1.5 | |

| C. Biology (Subtotal = 8) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | 3 | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | 3 | 2 | 1 | 0 |
| 22. Crayfish | 0 | 0.5 | 1 | 1.5 |
| 23. Bivalves | 0 | 1 | 2 | 3 |
| 24. Fish | 0 | 0.5 | 1 | 1.5 |
| 25. Amphibians | 0 | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | 0 | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | 0 | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | 0.5 | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; Other = 0 | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

LAST RAIN WAS EARLY AM 12/3/06

Sketch:

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 11/24/08 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** WEST BRANCH @ WETLAND J (US END) | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 24 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 14.5) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | (2) | 3 |
| 2. Sinuosity | 0 | 1 | 2 | (3) |
| 3. In-channel structure: riffle-pool sequence | 0 | (1) | 2 | 3 |
| 4. Soil texture or stream substrate sorting | 0 | (1) | 2 | 3 |
| 5. Active/relic floodplain | 0 | 1 | (2) | 3 |
| 6. Depositional bars or benches | 0 | 1 | (2) | 3 |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | 0 | (1) | 2 | 3 |
| 9[a] Natural levees | (0) | 1 | 2 | 3 |
| 10. Headcuts | 0 | (1) | 2 | 3 |
| 11. Grade controls | 0 | (0.5) | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | (1) | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | (No = 0) | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 3.5) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | (0) | 1 | 2 | 3 |
| 15. Water in channel and > 48 hrs since rain, or Water in channel – dry or growing season | 0 | 1 | (2) | 3 |
| 16. Leaflitter | 1.5 | (1) | 0.5 | 0 |
| 17. Sediment on plants or debris | 0 | (0.5) | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | (0) | 0.5 | 1 | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | (No = 0) | | Yes = 1.5 | |

| C. Biology (Subtotal = 6) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | 3 | (2) | 1 | 0 |
| 22. Crayfish | 0 | (0.5) | 1 | 1.5 |
| 23. Bivalves | (0) | 1 | 2 | 3 |
| 24. Fish | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | (0) | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Sketch:

Notes: (use back side of this form for additional notes.)

- LAST RAIN WAS > 1 WK. AGO. (11/15/08)
- ONLY ~1 WK TO 10 DAYS SINCE LEAVES FELL FROM TREES W/ NO SIGNIFICANT RAIN SINCE, THEREFORE, LEAF LITTER COULD BE DECEPTIVE.
- MODERATE WATER QUALITY IMPACT DUE TO ADJACENT AG. OPERATION.

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 11/24/08 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** WEST BRANCH U/S OF WBT J (35'-50' U/S?) | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 21 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 13) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | 0 | 1 | (2) | 3 |
| 2. Sinuosity | 0 | 1 | (2) | 3 |
| 3. In-channel structure: riffle-pool sequence | 0 | (1) | 2 | 3 |
| 4. Soil texture or stream substrate sorting | 0 | (1) | 2 | 3 |
| 5. Active/relic floodplain | 0 | (1) | 2 | 3 |
| 6. Depositional bars or benches | 0 | (1) | 2 | 3 |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | (0) | 1 | 2 | 3 |
| 9[a] Natural levees | (0) | 1 | 2 | 3 |
| 10. Headcuts | 0 | 1 | 2 | (3) |
| 11. Grade controls | 0 | 0.5 | (1) | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | (1) | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | (No = 0) | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 1) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | (0) | 1 | 2 | 3 |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | (0) | 1 | 2 | 3 |
| 16. Leaflitter | 1.5 | (1) | 0.5 | 0 |
| 17. Sediment on plants or debris | (0) | 0.5 | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | (0) | 0.5 | 1 | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | (No = 0) | | Yes = 1.5 | |

| C. Biology (Subtotal = 7) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | (3) | 2 | 1 | 0 |
| 22. Crayfish | 0 | (0.5) | 1 | 1.5 |
| 23. Bivalves | (0) | 1 | 2 | 3 |
| 24. Fish | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | (0) | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | 0 | (0.5) | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Sketch:

Notes: (use back side of this form for additional notes.)

- LAST RAIN WAS > 1 WK. AGO (11/15/08)
- ONLY ~1 WK. TO 10 DAYS SINCE LEAVES FELL FROM TREES W/ NO SIGNIFICANT RAIN SINCE, THEREFORE, LEAF LITTER COULD BE DECEPTIVE.
- MODERATE WATER QUALITY IMPACT DUE TO ADJACENT AG. OPERATION
- CEDAR TREE / ANOTHER ~8" DIA. TREE ON LEFT BANK, ORANGE FLAGGING ON 8" DIA. TREE LABELED AS "ORIGIN OF WEST BRANCH", AT TOP OF HEADCUT

## North Carolina Division of Water Quality – Stream Identification Form; Version 3.1

| | | |
|---|---|---|
| **Date:** 11/24/08 | **Project:** HEATH DAIRY | **Latitude:** |
| **Evaluator:** AJW | **Site:** WEST BRANCH @ U/S LIMIT OF CONSERVATION EASEMENT | **Longitude:** |
| **Total Points:** *Stream is at least intermittent if ≥ 19 or perennial if ≥ 30* 9.5 | **County:** RANDOLPH | **Other** *e.g. Quad Name:* |

| A. Geomorphology (Subtotal = 4) | Absent | Weak | Moderate | Strong |
|---|---|---|---|---|
| 1[a]. Continuous bed and bank | (0) | 1 | 2 | 3 |
| 2. Sinuosity | 0 | 1 | (2) | 3 |
| 3. In-channel structure: riffle-pool sequence | (0) | 1 | 2 | 3 |
| 4. Soil texture or stream substrate sorting | (0) | 1 | 2 | 3 |
| 5. Active/relic floodplain | 0 | (1) | 2 | 3 |
| 6. Depositional bars or benches | (0) | 1 | 2 | 3 |
| 7. Braided channel | (0) | 1 | 2 | 3 |
| 8. Recent alluvial deposits | (0) | 1 | 2 | 3 |
| 9[a] Natural levees | (0) | 1 | 2 | 3 |
| 10. Headcuts | (0) | 1 | 2 | 3 |
| 11. Grade controls | (0) | 0.5 | 1 | 1.5 |
| 12. Natural valley or drainageway | 0 | 0.5 | (1) | 1.5 |
| 13. Second or greater order channel on existing USGS or NRCS map or other documented evidence. | (No = 0) | | Yes = 3 | |

[a] Man-made ditches are not rated; see discussions in manual

| B. Hydrology (Subtotal = 0.5) | | | | |
|---|---|---|---|---|
| 14. Groundwater flow/discharge | (0) | 1 | 2 | 3 |
| 15. Water in channel and > 48 hrs since rain, **or** Water in channel – dry or growing season | (0) | 1 | 2 | 3 |
| 16. Leaflitter | 1.5 | 1 | (0.5) | 0 |
| 17. Sediment on plants or debris | (0) | 0.5 | 1 | 1.5 |
| 18. Organic debris lines or piles (Wrack lines) | (0) | 0.5 | 1 | 1.5 |
| 19. Hydric soils (redoximorphic features) present? | (No = 0) | | Yes = 1.5 | |

| C. Biology (Subtotal = 5) | | | | |
|---|---|---|---|---|
| 20[b]. Fibrous roots in channel | (3) | 2 | 1 | 0 |
| 21[b]. Rooted plants in channel | 3 | (2) | 1 | 0 |
| 22. Crayfish | (0) | 0.5 | 1 | 1.5 |
| 23. Bivalves | (0) | 1 | 2 | 3 |
| 24. Fish | (0) | 0.5 | 1 | 1.5 |
| 25. Amphibians | (0) | 0.5 | 1 | 1.5 |
| 26. Macrobenthos (note diversity and abundance) | (0) | 0.5 | 1 | 1.5 |
| 27. Filamentous algae; periphyton | (0) | 1 | 2 | 3 |
| 28. Iron oxidizing bacteria/fungus. | (0) | 0.5 | 1 | 1.5 |
| 29[b]. Wetland plants in streambed NONE | FAC = 0.5; FACW = 0.75; OBL = 1.5 SAV = 2.0; (Other = 0) | | | |

[b] Items 20 and 21 focus on the presence of upland plants, Item 29 focuses on the presence of aquatic or wetland plants.

Notes: (use back side of this form for additional notes.)

- LAST RAIN WAS >1 WK. AGO (11/15/08)
- ONLY ~1 WK TO 10 DAYS SINCE LEAVES FELL FROM TREES W/ NO SIGNIFICANT RAIN SINCE, THEREFORE, LEAF LITTER COULD BE DECEPTIVE.
- IMPACT TO WATER QUALITY(?) DUE TO ADJACENT AG. OPERATION?

Sketch:

# APPENDIX E

## Reference Reach Photographs



**Fork Creek: Riffle 1**



**Fork Creek: Pool 1**



**Fork Creek: Pool 2**



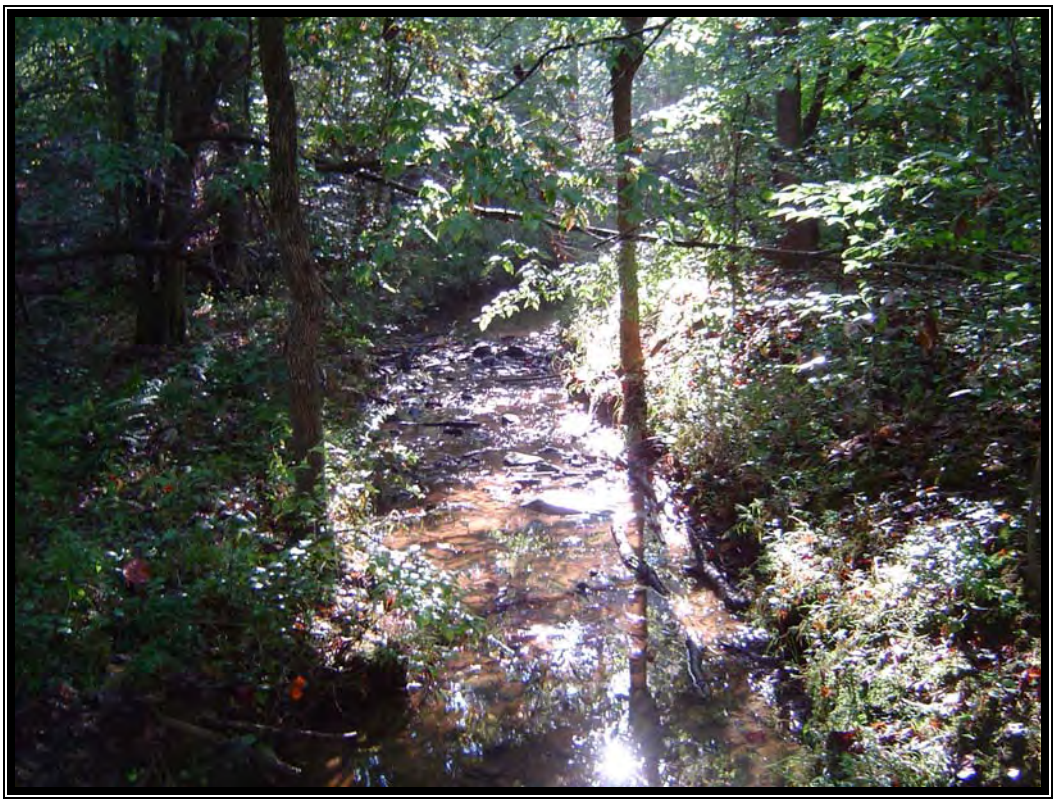
**Fork Creek: Riffle 3**



**Fork Creek: Pool 3**



**Fork Creek: Ford**



**UT to Polecat Creek: Riffle 1**



**UT to Polecat Creek: Pool 1**



**UT to Polecat Creek: Bed at Head of Riffle 2**



**UT to Polecat Creek: Pool 2**



**UT to Polecat Creek: Upstream of Survey**



**UT to Polecat Creek: Upstream of Survey**

# APPENDIX F

## 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: | --- |

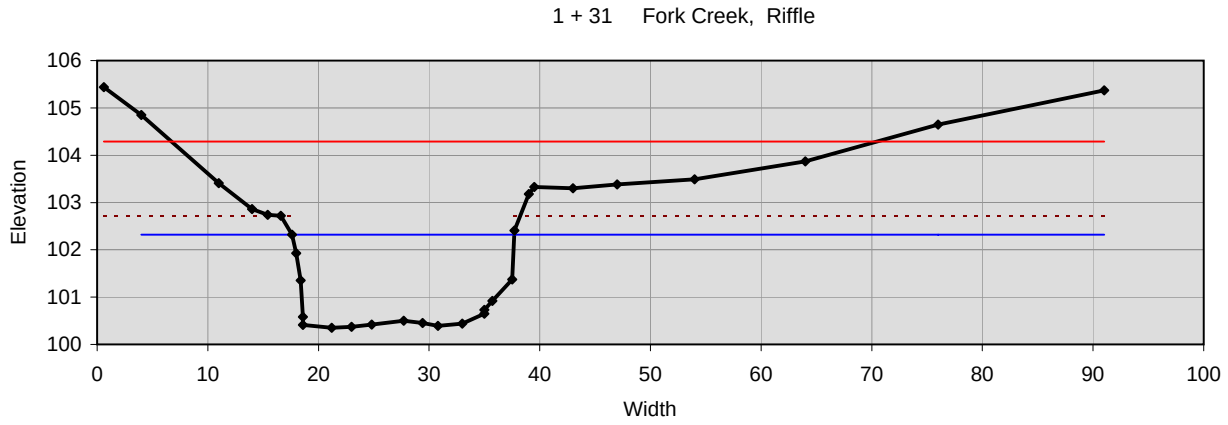
| Dimension | | ınkfull chanr typical | min | max | |
|---|---|---|---|---|---|
| floodplain: | width flood prone area (ft) | 63.0 | 54.0 | 63.0 | |
| | low bank height (ft) | 2.4 | 2.3 | 2.4 | |
| riffle-run: | x-area bankfull (sq.ft.) | 34.8 | 34.8 | 39.7 | |
| | width bankfull (ft) | 20.1 | 20.1 | 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) | --- | | | |

## 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): |

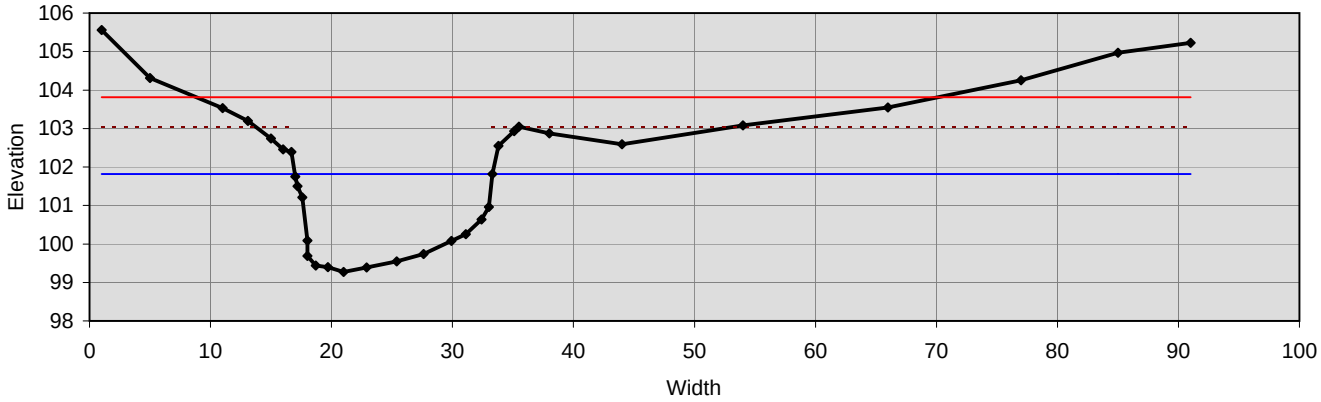
| Bankfull Flow | |
|---|---|
| 4.7 | velocity (ft/s) |
| 163.6 | discharge rate (cfs) |
| 0.66 | Froude number |

| 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): |

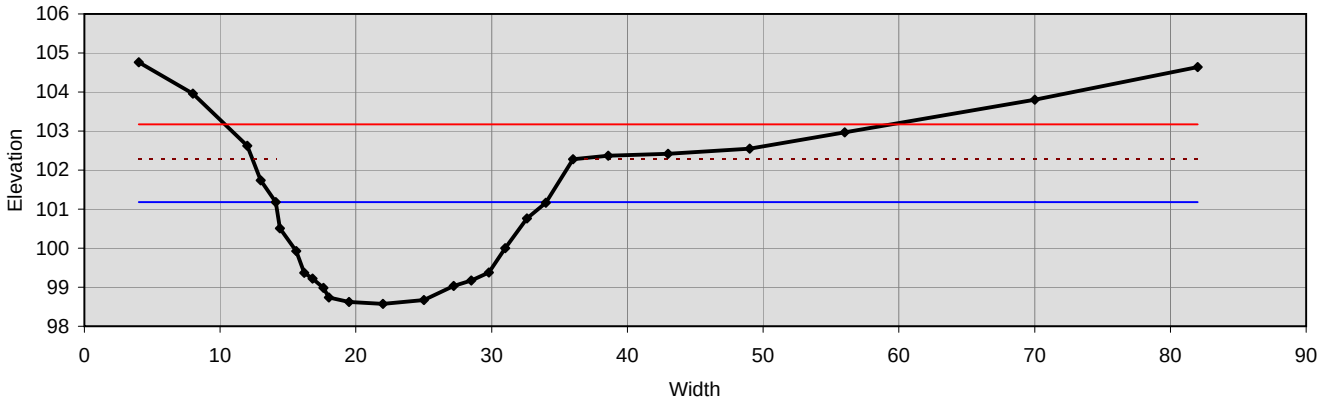
| Bankfull Flow | |
|---|---|
| 5.0 | velocity (ft/s) |
| 161.6 | discharge rate (cfs) |
| 0.67 | Froude number |

| 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): |

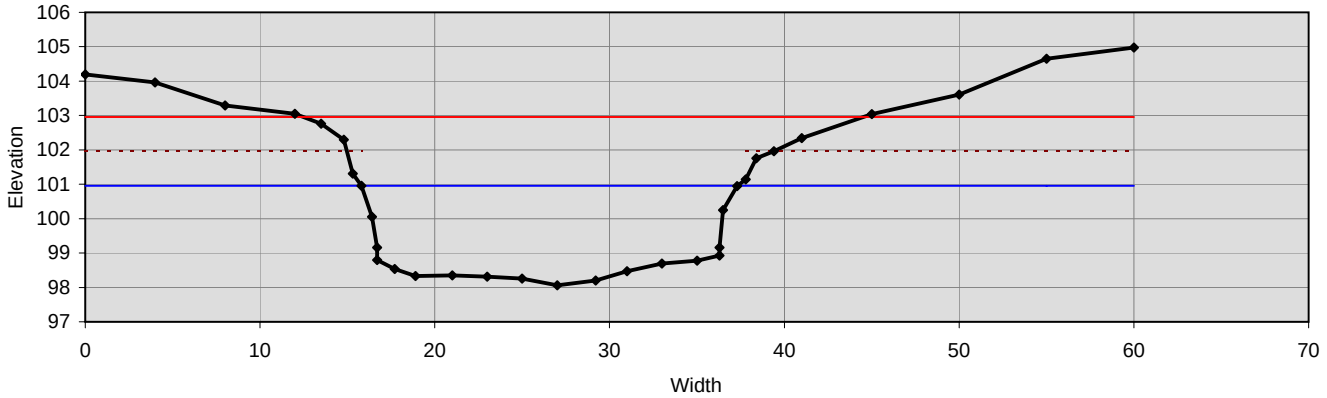
| Bankfull Flow | |
|---|---|
| 2.4 | velocity (ft/s) |
| 90.8 | discharge rate (cfs) |
| 0.32 | Froude number |

| 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): |

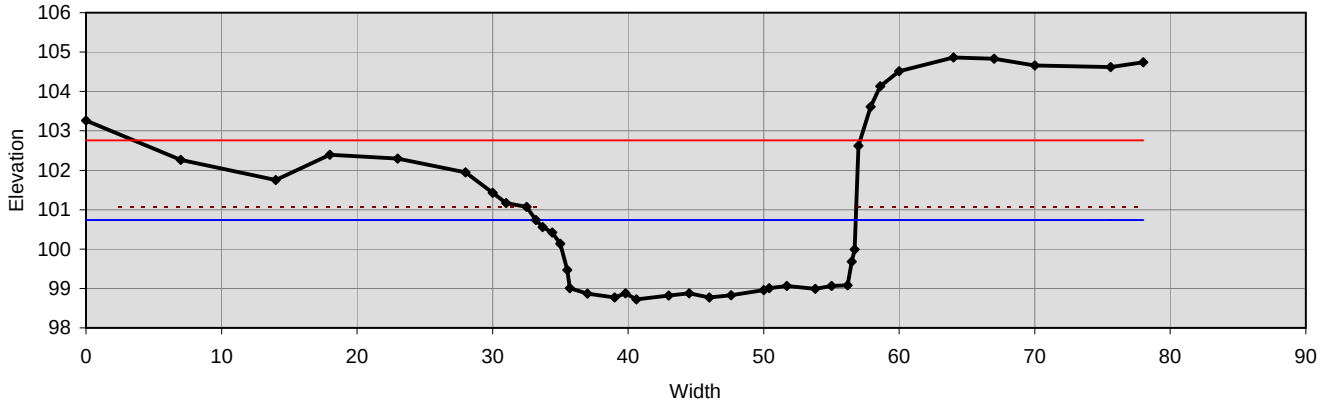
| Bankfull Flow | |
|---|---|
| 2.7 | velocity (ft/s) |
| 138.8 | discharge rate (cfs) |
| 0.33 | Froude number |

| 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 |

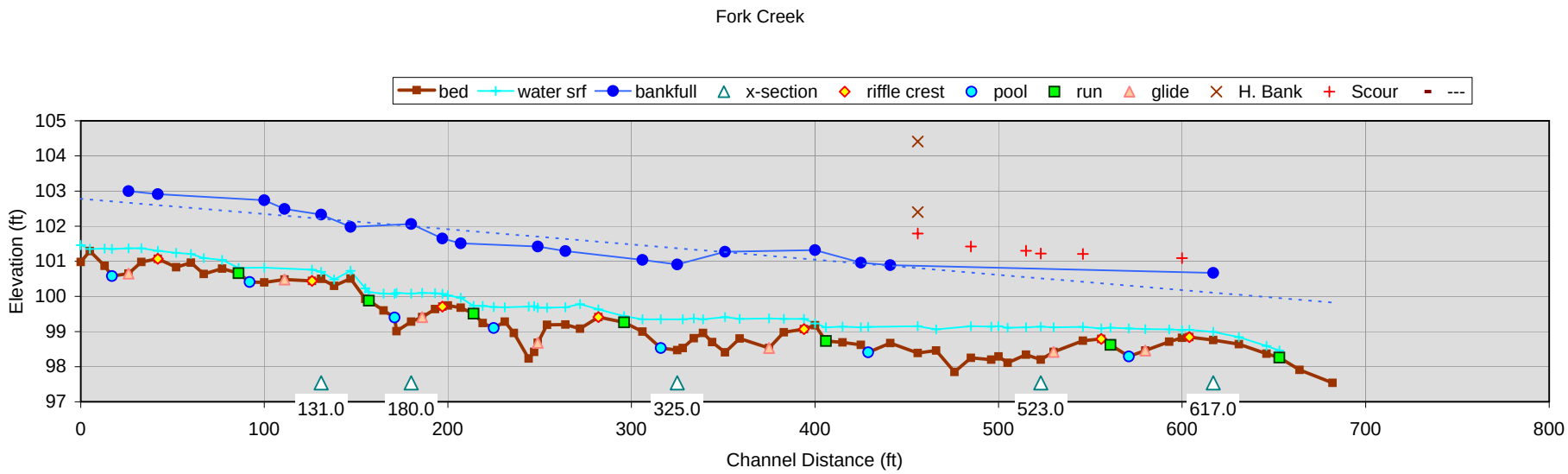
| Materials | |
|---|---|
| 33 | D50 Riffle (mm) |
| 90 | D84 Riffle (mm) |
| 9 | threshold grain size (mm): |

| 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) |

## 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) | --- | | --- | |

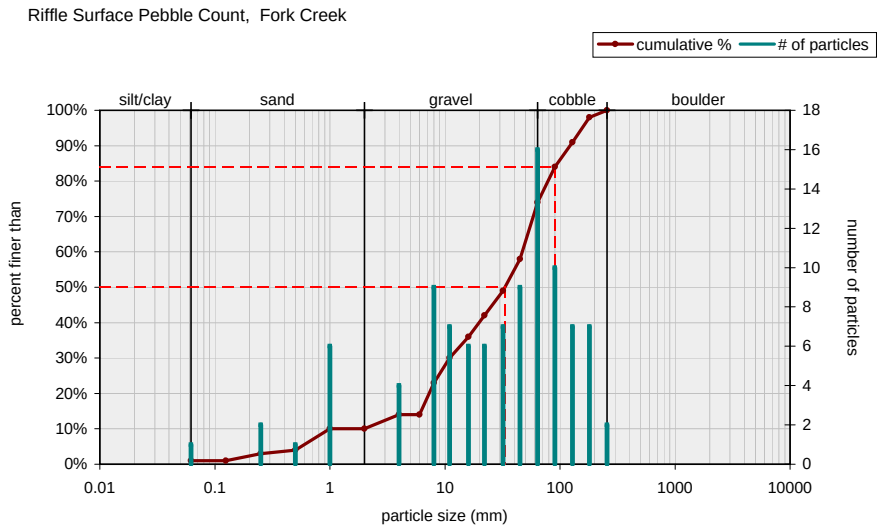
**1) Individual Pebble Count**

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 |

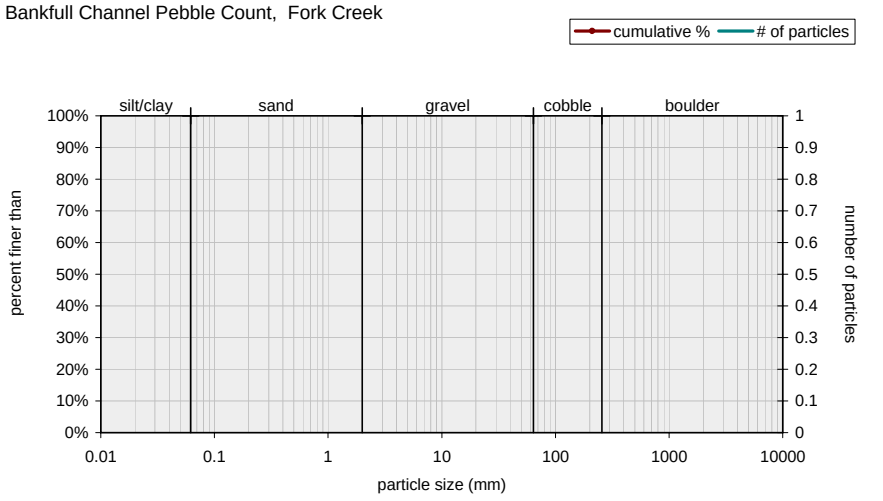
| Size Distribution | |
|---|---|
| mean | 24.0 |
| dispersion | 3.9 |
| skewness | -0.13 |

| 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

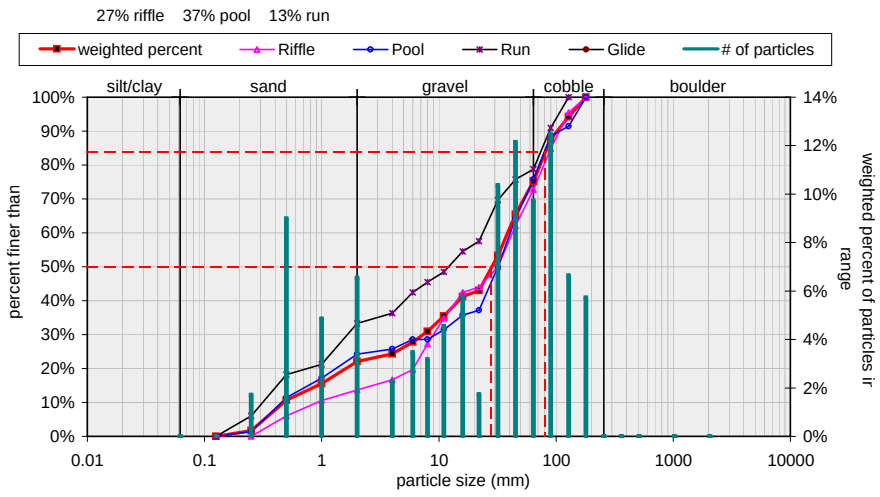
| | | | | | |
|---|---|---|---|---|---|
| Riffle | 27 | % | Run | 13 | % |
| Pool | 37 | % | Glide | | % |

### 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 |

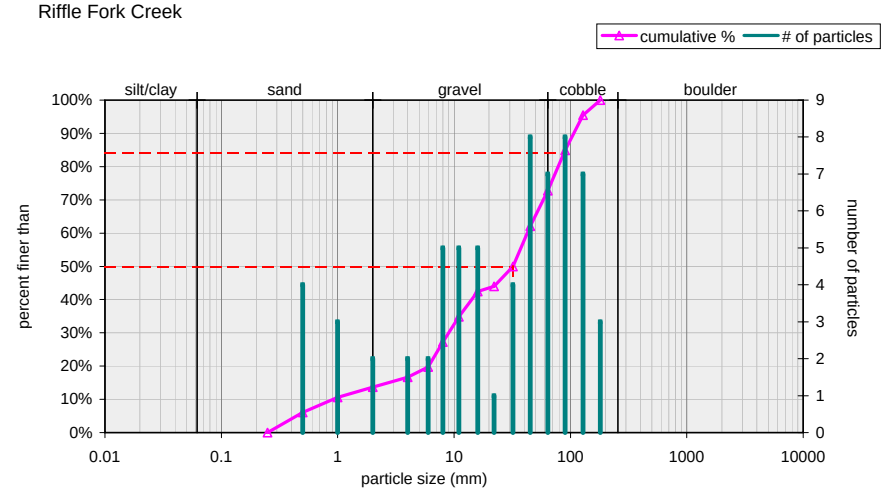
| Type | | | |
|---|---|---|---|
| silt/clay | 0% | bedrock | 9% |
| sand | 20% | | |
| gravel | 48% | | |
| cobble | 23% | | |
| boulder | 0% | | |

### 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 |

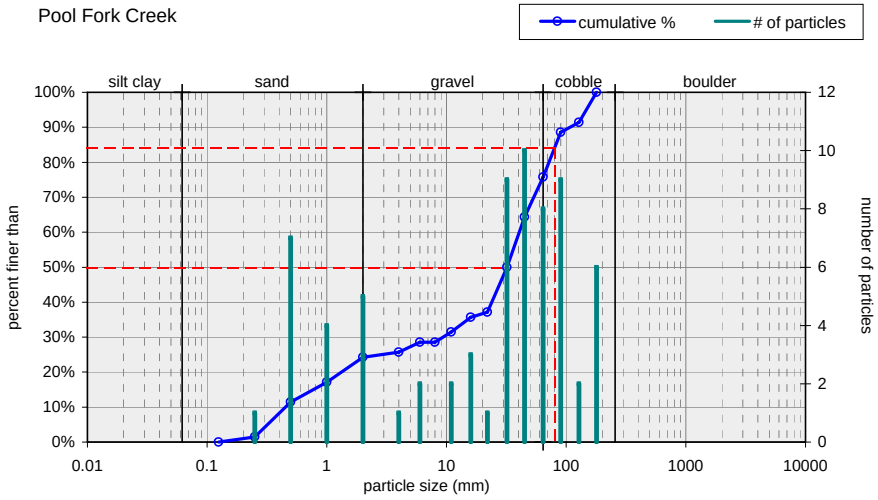
| Size Distribution | |
|---|---|
| mean | 17.3 |
| dispersion | 6.1 |
| skewness | -0.22 |

| 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 |

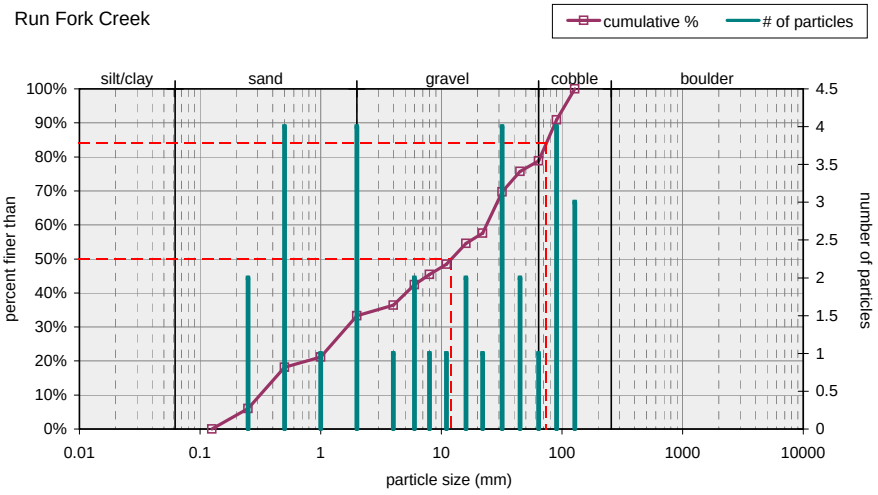
| Size Distribution | |
|---|---|
| mean | 8.3 |
| dispersion | 19.6 |
| skewness | -0.42 |

| 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

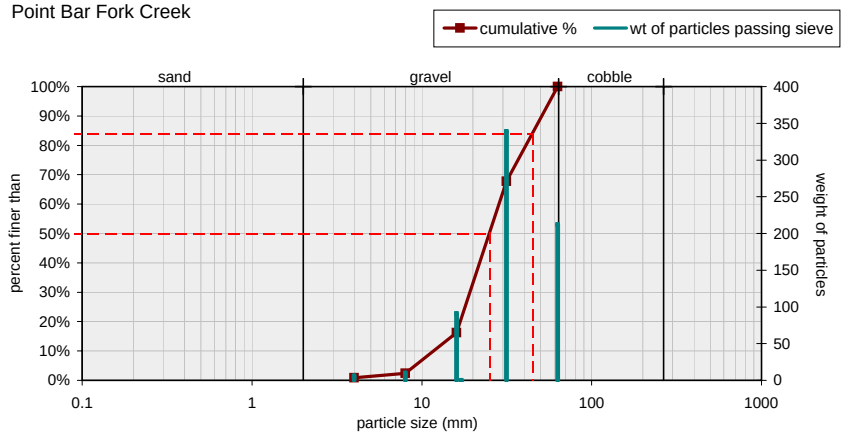
Two samples may be entered below. Select sample type for each.

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 |

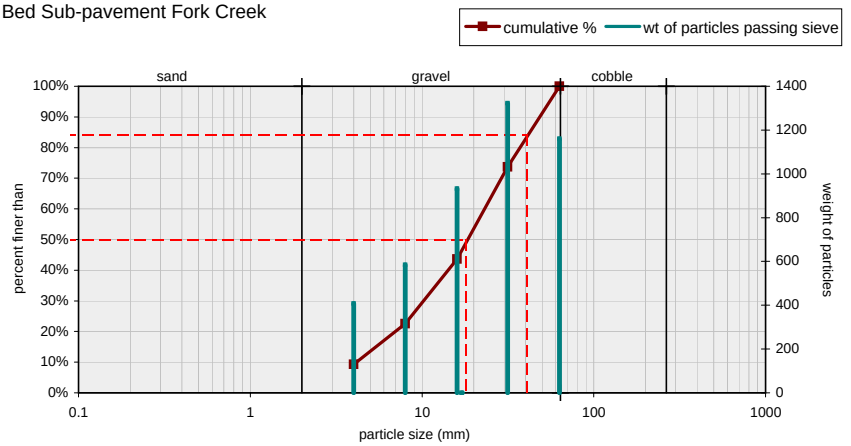
sand 100%

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% |
| | | | 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 | | | |

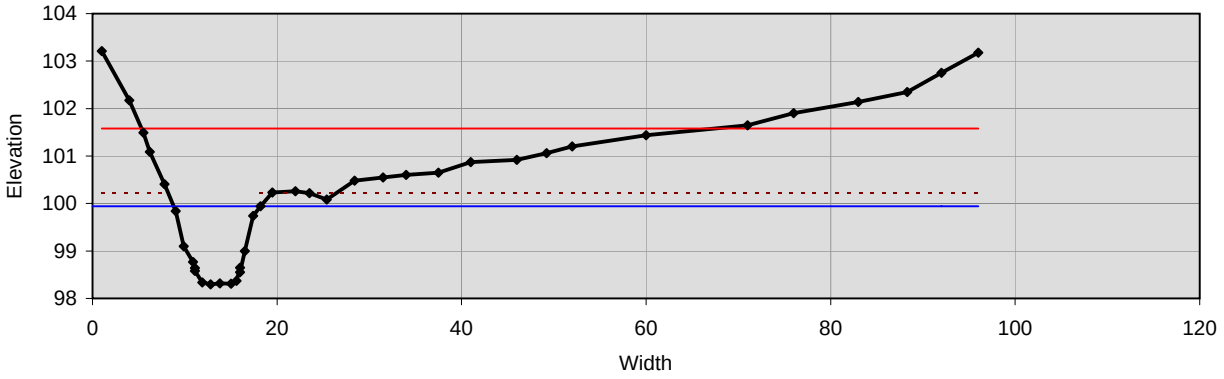
| **Pattern** | typical | min | max |
|---|---|---|---|
| meander length (ft) | 62.0 | 56.0 | 85.0 |
| belt width (ft) | 30.0 | 28.0 | 50.0 |
| amplitude (ft) | --- | --- | --- |
| radius (ft) | 20.0 | 19.0 | 50.0 |
| arc angle (degrees) | --- | --- | --- |
| stream length (ft) | 425.0 | | |
| valley 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) | --- | | | |

## 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): |

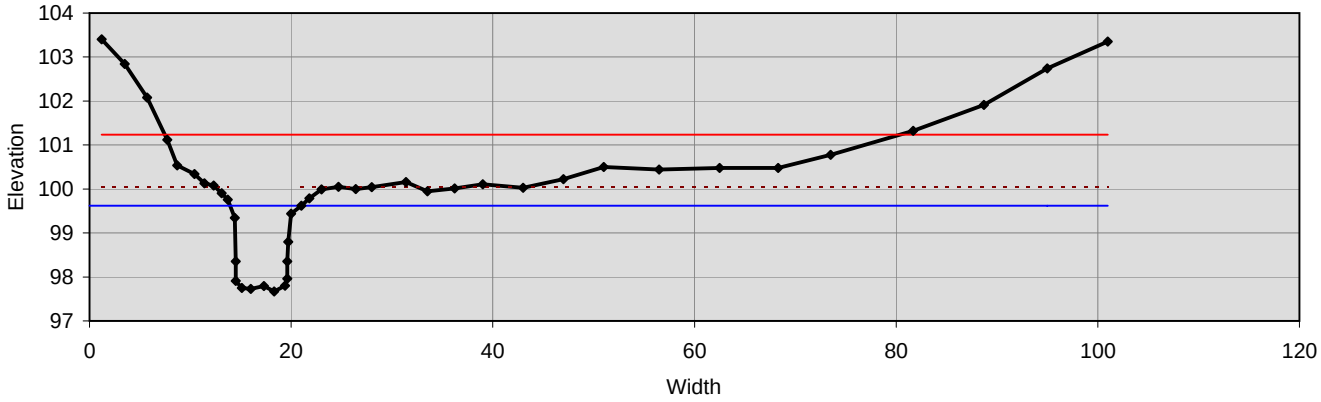
| Bankfull Flow | |
|---|---|
| 3.5 | velocity (ft/s) |
| 37.5 | discharge rate (cfs) |
| 0.62 | Froude number |

| 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): |

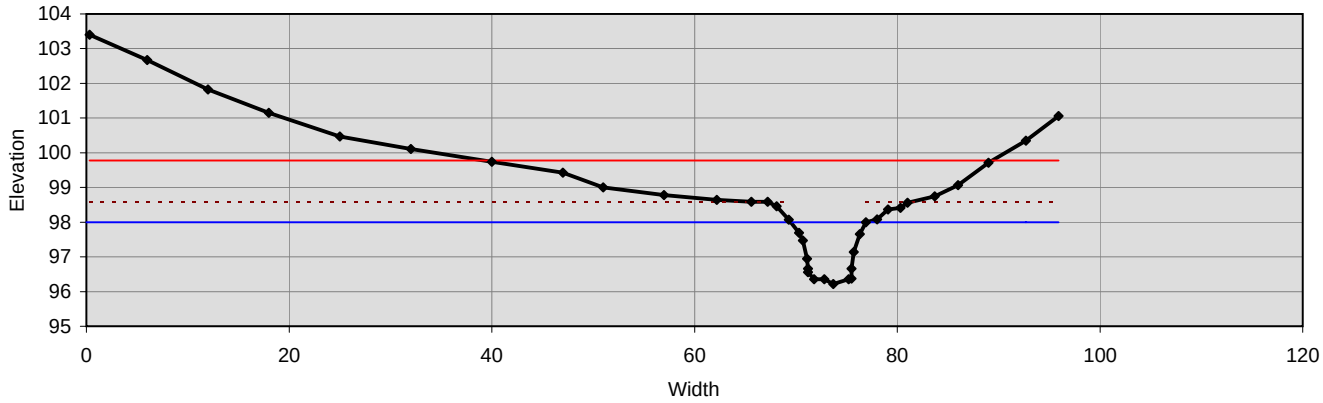
| Bankfull Flow | |
|---|---|
| 3.6 | velocity (ft/s) |
| 35.6 | discharge rate (cfs) |
| 0.62 | Froude number |

| 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): |

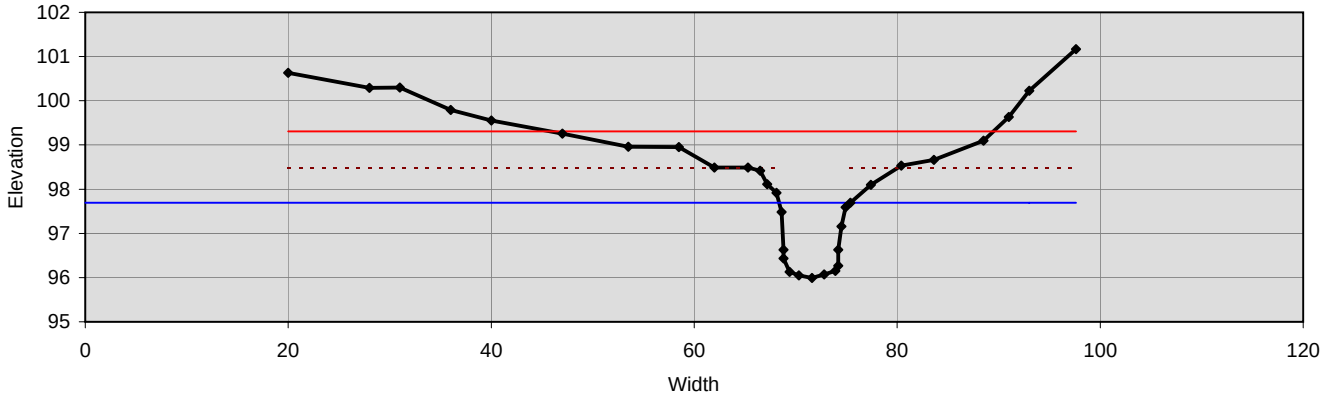
| Bankfull Flow | |
|---|---|
| 3.4 | velocity (ft/s) |
| 29.1 | discharge rate (cfs) |
| 0.61 | Froude number |

| 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): |

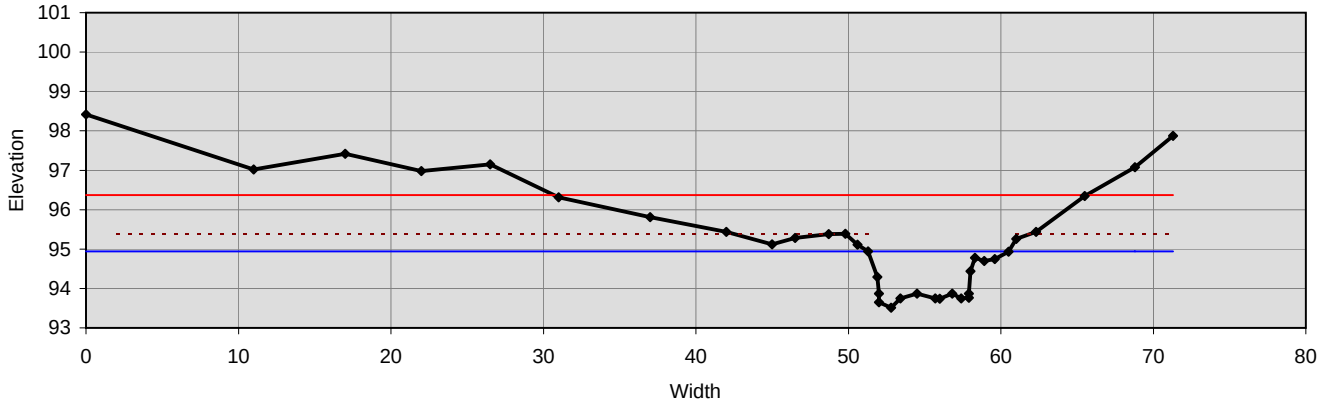
| Bankfull Flow | |
|---|---|
| 3.6 | velocity (ft/s) |
| 32.7 | discharge rate (cfs) |
| 0.62 | Froude number |

| 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): |

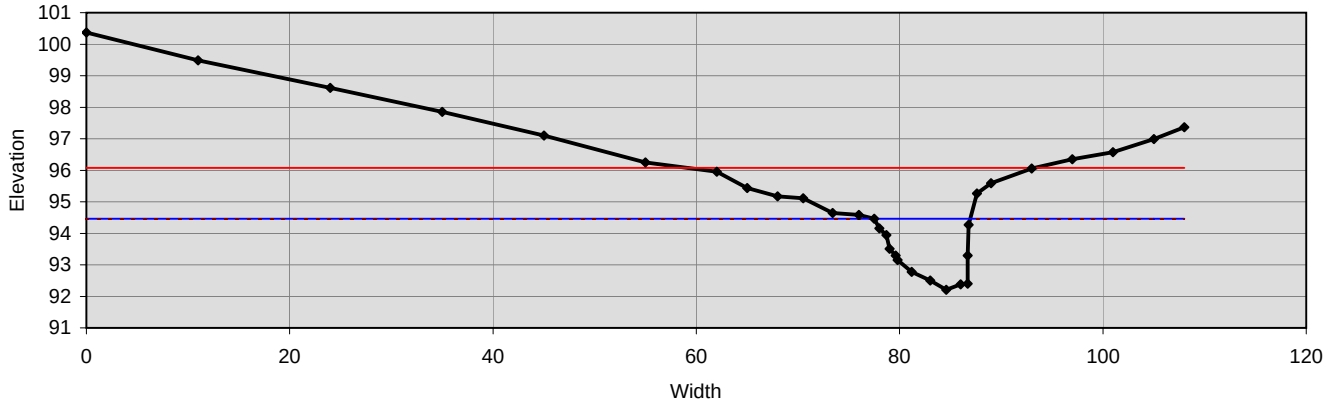
| Bankfull Flow | |
|---|---|
| 3.5 | velocity (ft/s) |
| 27.4 | discharge rate (cfs) |
| 0.73 | Froude number |

| 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 |

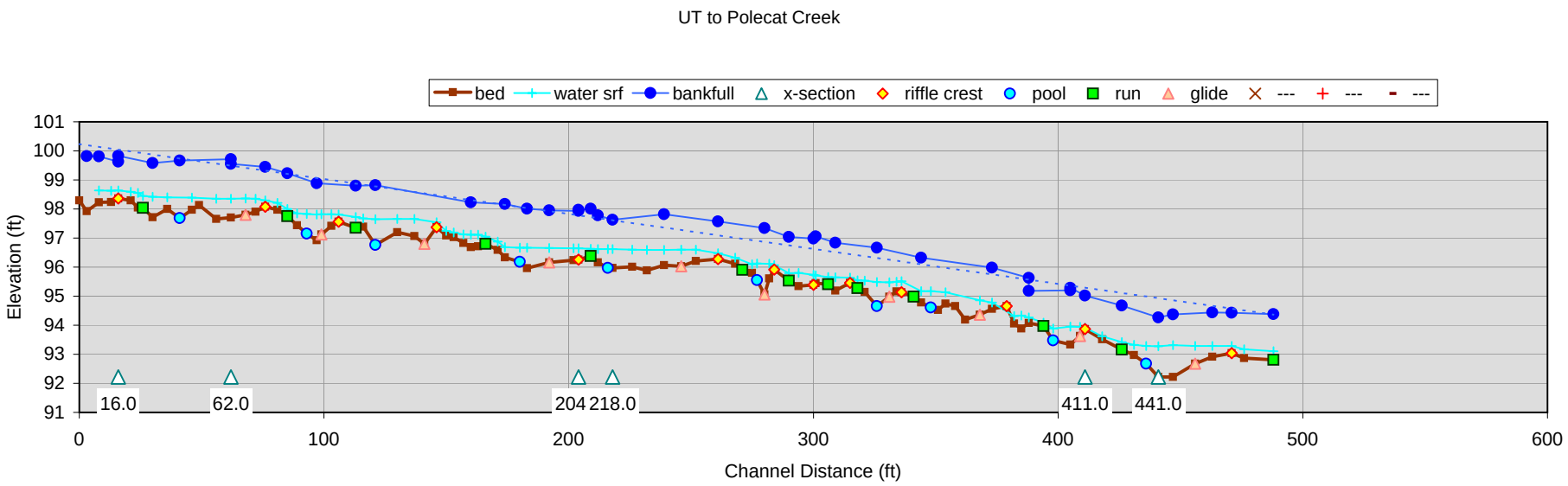
| Materials | |
|---|---|
| 7.1 | D50 Riffle (mm) |
| 93 | D84 Riffle (mm) |
| 58 | threshold grain size (mm): |

| 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) |

## 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) | --- | | --- | |

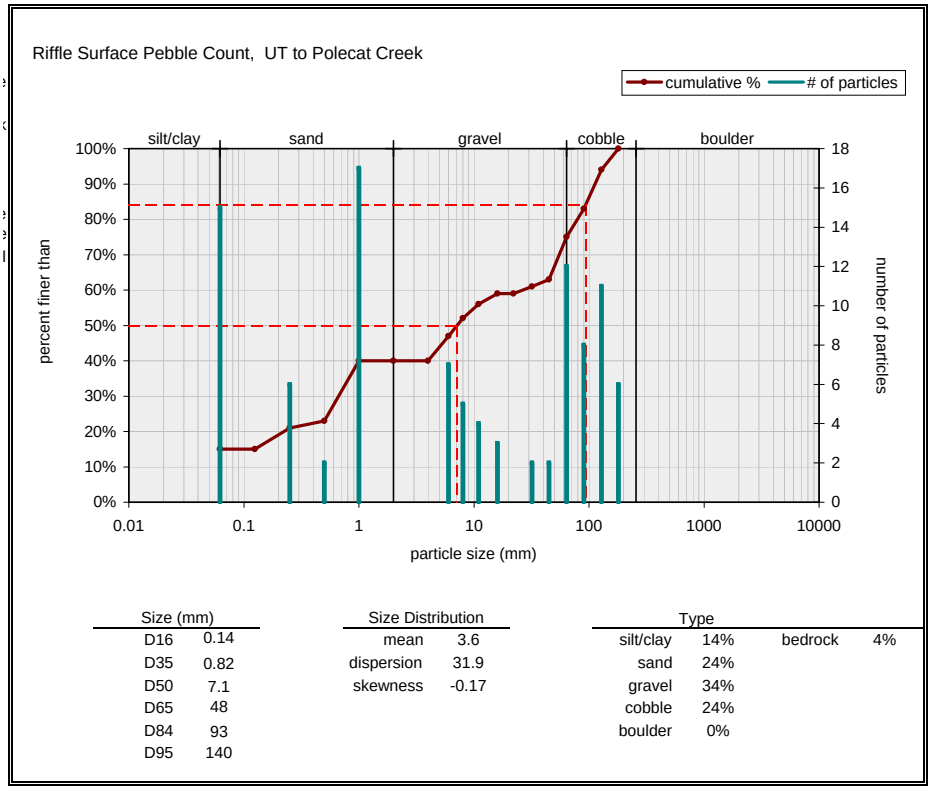
**1) Individual Pebble Count**

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 |

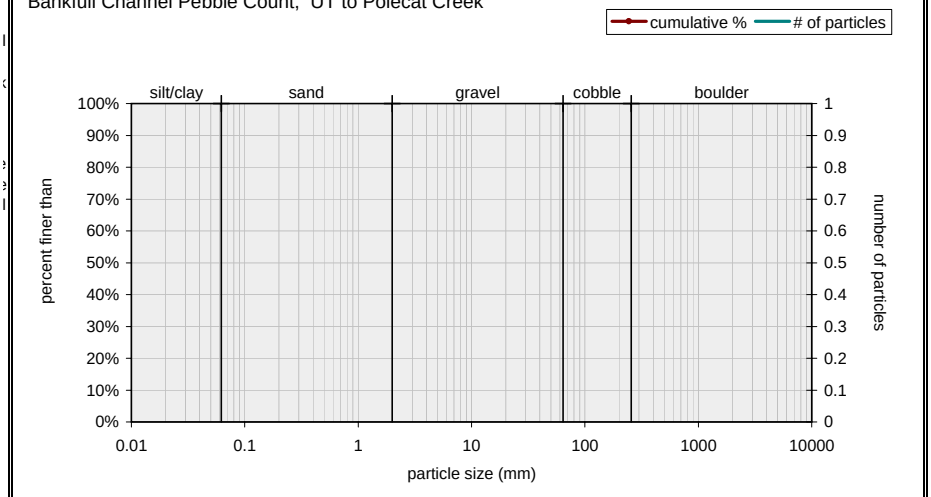
| Size Distribution | |
|---|---|
| mean | 3.6 |
| dispersion | 31.9 |
| skewness | -0.17 |

| 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

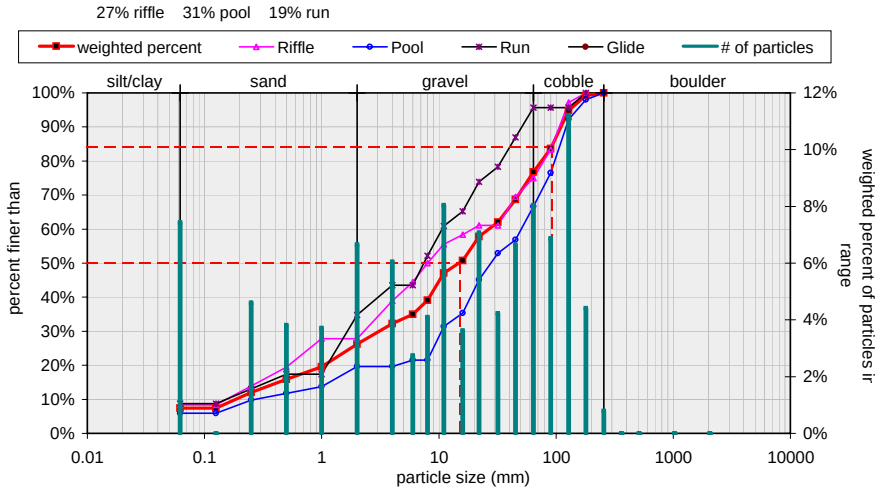
| | | | | | |
|---|---|---|---|---|---|
| Riffle | 27 | % | Run | 19 | % |
| Pool | 31 | % | Glide | | % |

**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 |

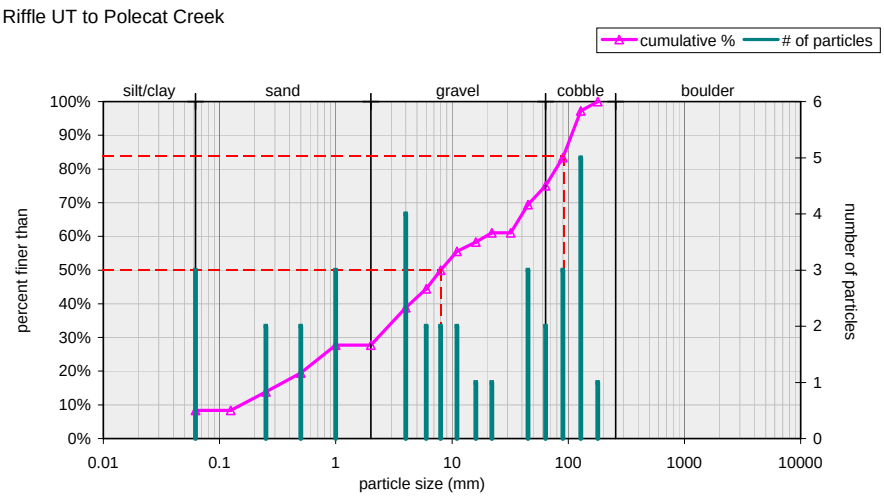
| Type | | | |
|---|---|---|---|
| silt/clay | 7% | bedrock | 5% |
| sand | 18% | | |
| gravel | 48% | | |
| cobble | 22% | | |
| boulder | 0% | | |

**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 |

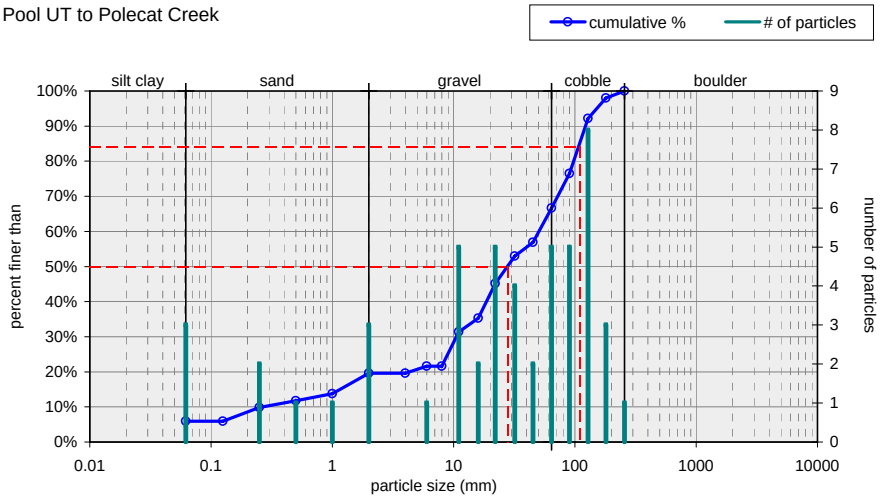
| Size Distribution | |
|---|---|
| mean | 5.5 |
| dispersion | 17.9 |
| skewness | -0.10 |

| 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 |

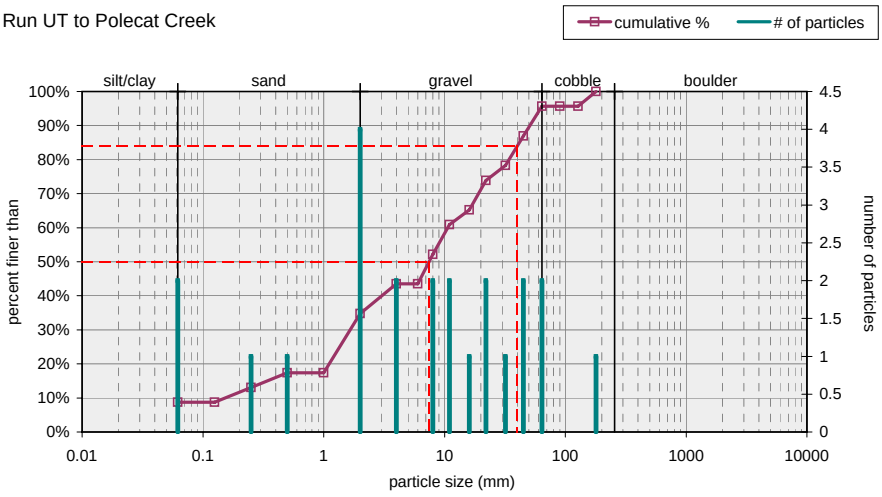
| Size Distribution | |
|---|---|
| mean | 12.0 |
| dispersion | 12.7 |
| skewness | -0.27 |

| 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.

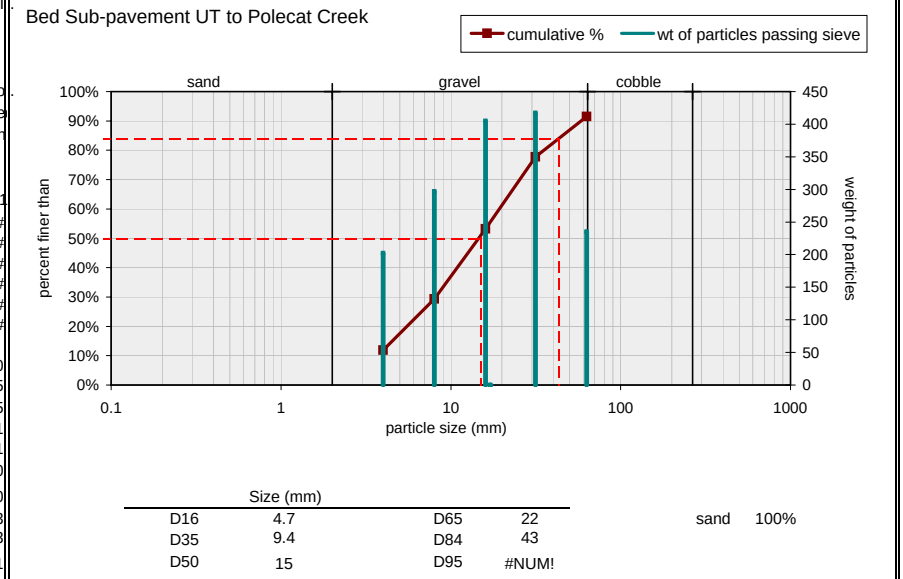
Bed Sub-pavement

| 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 | |
| D35 | 9.4 | D84 | 43 | |
| D50 | 15 | D95 | #NUM! | |

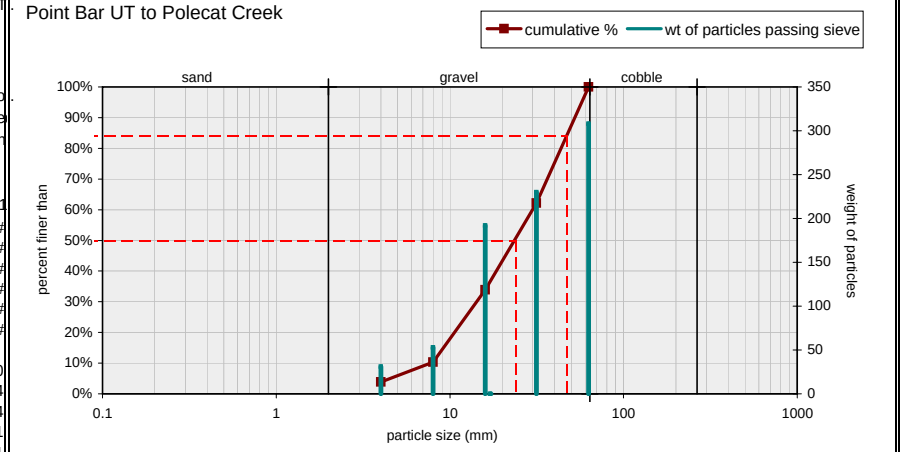
sand 100%

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 |

# APPENDIX G

## Design Calculations

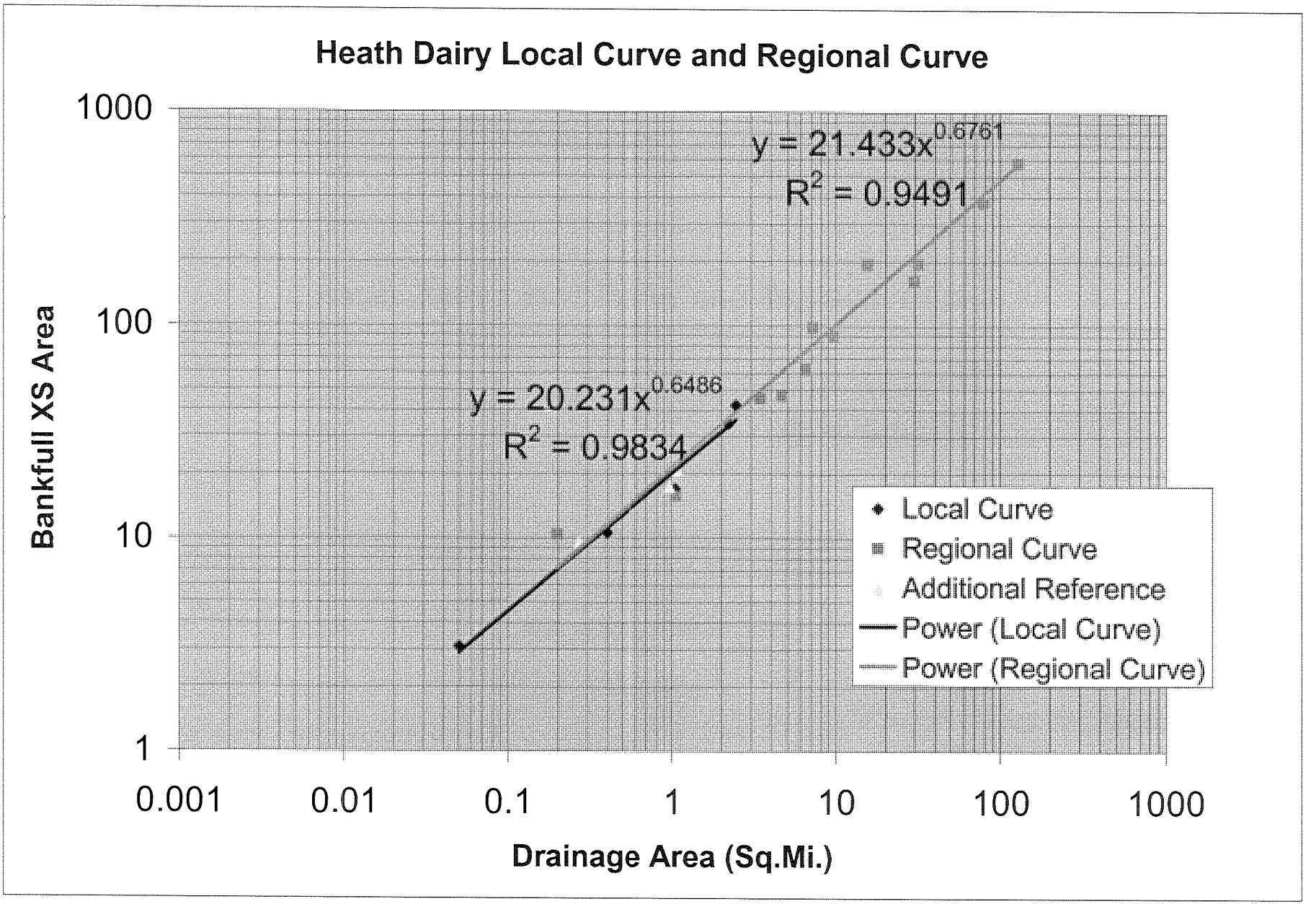
| | |
|---|---|
| Project: | Heath Dairy Road Restoration Site<br>Randolph Co., NC |
| Project No: | 1006-HDRS |

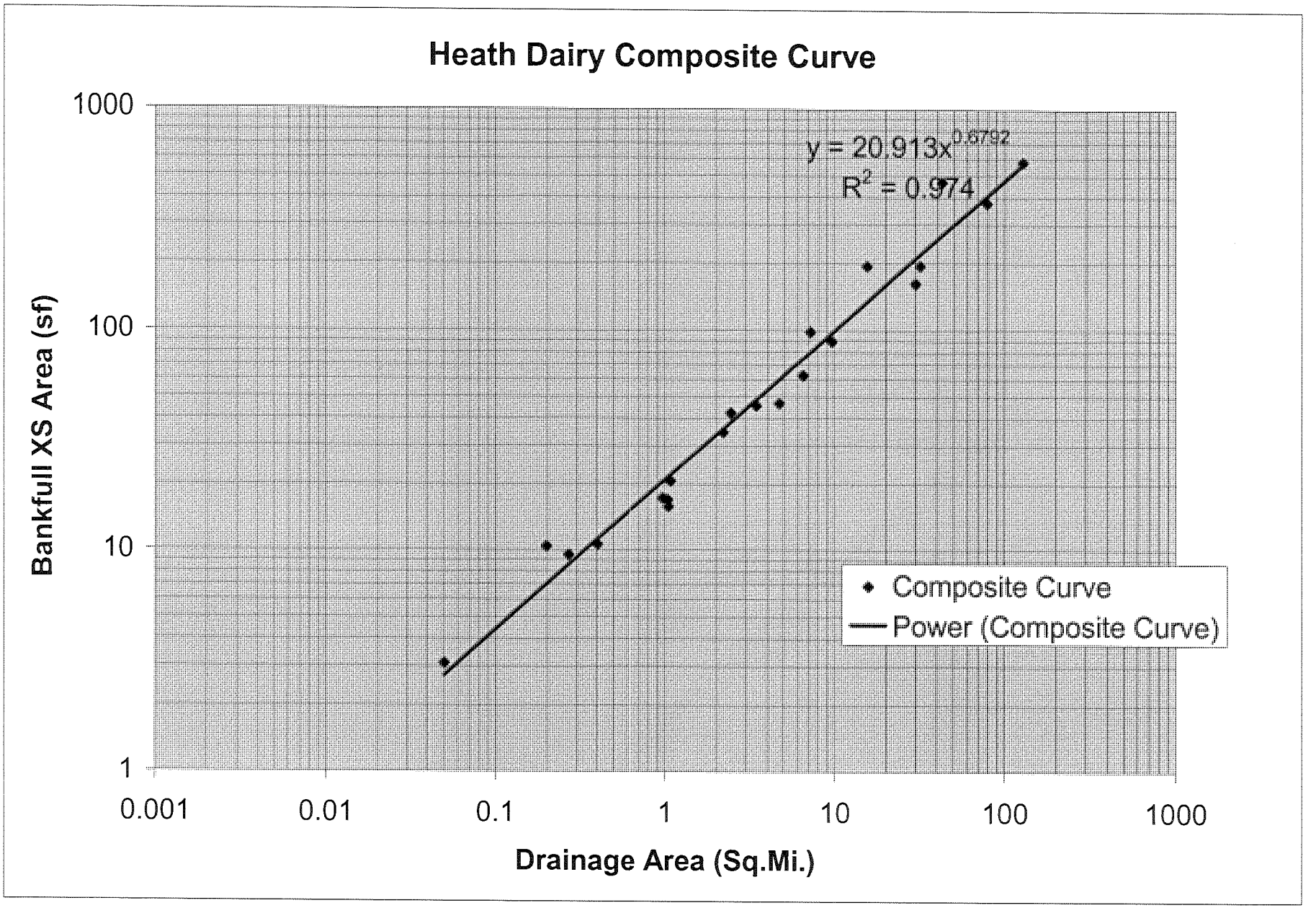
| | | | NC Regional Curves (Rural Piedmont) | | | |
|---|---|---|---|---|---|---|
| Location | Hec-Ras Station | D.A. ($mi^2$) | $Area_{bkf}$ ($ft^2$) | $Width_{bkf}$ (ft) | $Depth_{bkf}$ (ft) | $Q_{bkf}$ (cfs) |
| Back Creek - U/s End of Site | | 0.94 | 20.55 | 11.58 | 1.47 | 85.16 |
| Back Creek - Reach 1a (10+10 to 14+67) | | 1.04 | 22.01 | 12.09 | 1.52 | 91.59 |
| Back Creek - Reach 1b (14+67 to 18+50) | | 1.04 | 22.01 | 12.09 | 1.52 | 91.59 |
| Back Creek - Reach 2a (18+50 to 23+20) | | 1.08 | 22.58 | 12.29 | 1.54 | 94.11 |
| Back Creek - Reach 2b (23+20 to 30+80) | | 1.08 | 22.58 | 12.29 | 1.54 | 94.11 |
| Back Creek - Reach 3 (30+80 to 48+30) | | 1.3 | 25.62 | 13.31 | 1.63 | 107.55 |
| Back Creek - Reach 4 (48+30 to 57+20) | | 1.34 | 26.15 | 13.48 | 1.65 | 109.93 |
| Back Creek - Reach 5a (57+20 to 60+47) | | 1.34 | 26.15 | 13.48 | 1.65 | 109.93 |
| Back Creek - Reach 5b (60+47 to 63+45) | | 2.69 | 42.00 | 18.20 | 2.06 | 181.55 |
| West Branch - Reach 1a (10+00 to 12+00) | | 0.05 | 2.79 | 3.28 | 0.58 | 10.30 |
| West Branch - Reach 1b (12+00 to 13+80) | | 0.05 | 2.79 | 3.28 | 0.58 | 10.30 |
| West Branch - Reach 2a (13+80 to 18+00) | | 0.06 | 3.16 | 3.55 | 0.61 | 11.75 |
| West Branch - Reach 2b (18+00 to 19+55) | | 0.06 | 3.16 | 3.55 | 0.61 | 11.75 |
| UT to West Branch | | 0.05 | 2.79 | 3.28 | 0.58 | 10.30 |
| West Branch - Reach 3a (19+55 to 20+00) | | 0.14 | 5.63 | 5.11 | 0.80 | 21.62 |
| West Branch - Reach 3b (20+00 to 25+30) | | 0.14 | 5.63 | 5.11 | 0.80 | 21.62 |
| West Branch - Reach 3c (25+30 to 26+17) | | 0.14 | 5.63 | 5.11 | 0.80 | 21.62 |
| North Branch - Reach 1a (10+31 to 19+00) | | 1.14 | 23.43 | 12.58 | 1.56 | 97.85 |
| North Branch - Reach 1b (19+00 to 22+24) | | 1.14 | 23.43 | 12.58 | 1.56 | 97.85 |
| East Branch - Reach 1a (9+20 to 10+20\) | | 0.25 | 8.35 | 6.55 | 0.96 | 32.82 |
| East Branch - Reach 1b (10+20 to 14+00) | | 0.25 | 8.35 | 6.55 | 0.96 | 32.82 |
| East Branch - Reach 1c (14+00 to 15+48) | | 0.25 | 8.35 | 6.55 | 0.96 | 32.82 |

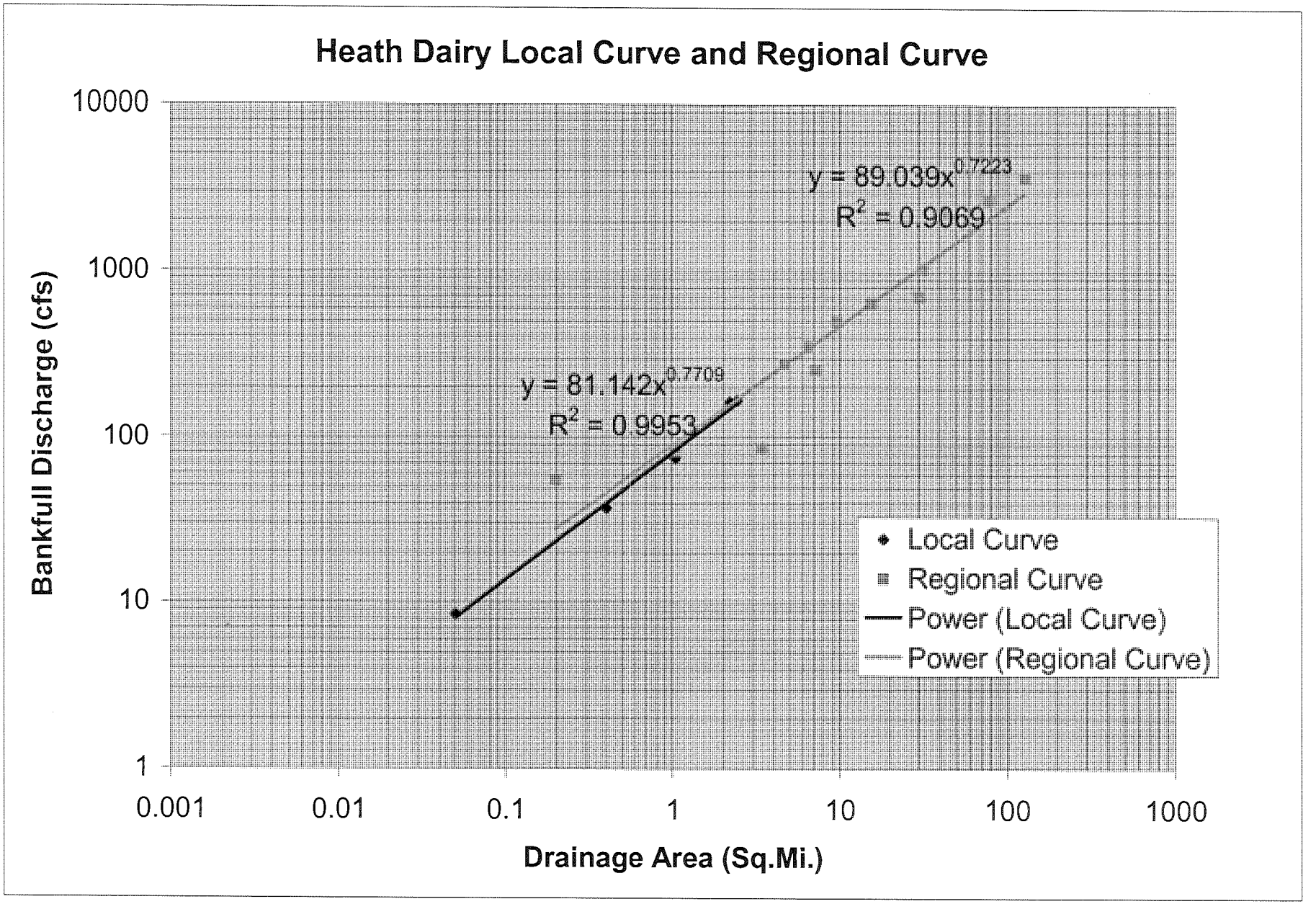
| | | | Composite Curves | | | |
|---|---|---|---|---|---|---|
| Location | Hec-Ras Station | D.A. ($mi^2$) | $Area_{bkf}$ ($ft^2$) | $Width_{bkf}$ (ft) | $Depth_{bkf}$ (ft) | $Q_{bkf}$ (cfs) |
| Back Creek - U/s End of Site | 0 | 0.94 | 20.05 | | | 79.69 |
| Back Creek - Reach 1a (10+10 to 14+67) | 0 | 1.04 | 21.48 | | | 85.91 |
| Back Creek - Reach 1b (14+67 to 18+50) | 0 | 1.04 | 21.48 | | | 85.91 |
| Back Creek - Reach 2a (18+50 to 23+20) | 0 | 1.08 | 22.04 | | | 88.36 |
| Back Creek - Reach 2b (23+20 to 30+80) | 0 | 1.08 | 22.04 | | | 88.36 |
| Back Creek - Reach 3 (30+80 to 48+30) | 0 | 1.3 | 24.99 | | | 101.42 |
| Back Creek - Reach 4 (48+30 to 57+20) | 0 | 1.34 | 25.51 | | | 103.73 |
| Back Creek - Reach 5a (57+20 to 60+47) | 0 | 1.34 | 25.51 | | | 103.73 |
| Back Creek - Reach 5b (60+47 to 63+45) | 0 | 2.69 | 40.95 | | | 174.21 |
| West Branch - Reach 1a (10+00 to 12+00) | 0 | 0.05 | 2.73 | | | 8.99 |
| West Branch - Reach 1b (12+00 to 13+80) | 0 | 0.05 | 2.73 | | | 8.99 |
| West Branch - Reach 2a (13+80 to 18+00) | 0 | 0.06 | 3.09 | | | 10.29 |
| West Branch - Reach 2b (18+00 to 19+55) | 0 | 0.06 | 3.09 | | | 10.29 |
| UT to West Branch | 0 | 0.05 | 2.73 | | | 8.99 |
| West Branch - Reach 3a (19+55 to 20+00) | 0 | 0.14 | 5.50 | | | 19.33 |
| West Branch - Reach 3b (20+00 to 25+30) | 0 | 0.14 | 5.50 | | | 19.33 |
| West Branch - Reach 3c (25+30 to 26+17) | 0 | 0.14 | 5.50 | | | 19.33 |
| North Branch - Reach 1a (10+31 to 19+00) | 0 | 1.14 | 22.86 | | | 91.98 |
| North Branch - Reach 1b (19+00 to 22+24) | 0 | 1.14 | 22.86 | | | 91.98 |
| East Branch - Reach 1a (9+20 to 10+20\) | 0 | 0.25 | 8.16 | | | 29.75 |
| East Branch - Reach 1b (10+20 to 14+00) | 0 | 0.25 | 8.16 | | | 29.75 |
| East Branch - Reach 1c (14+00 to 15+48) | 0 | 0.25 | 8.16 | | | 29.75 |

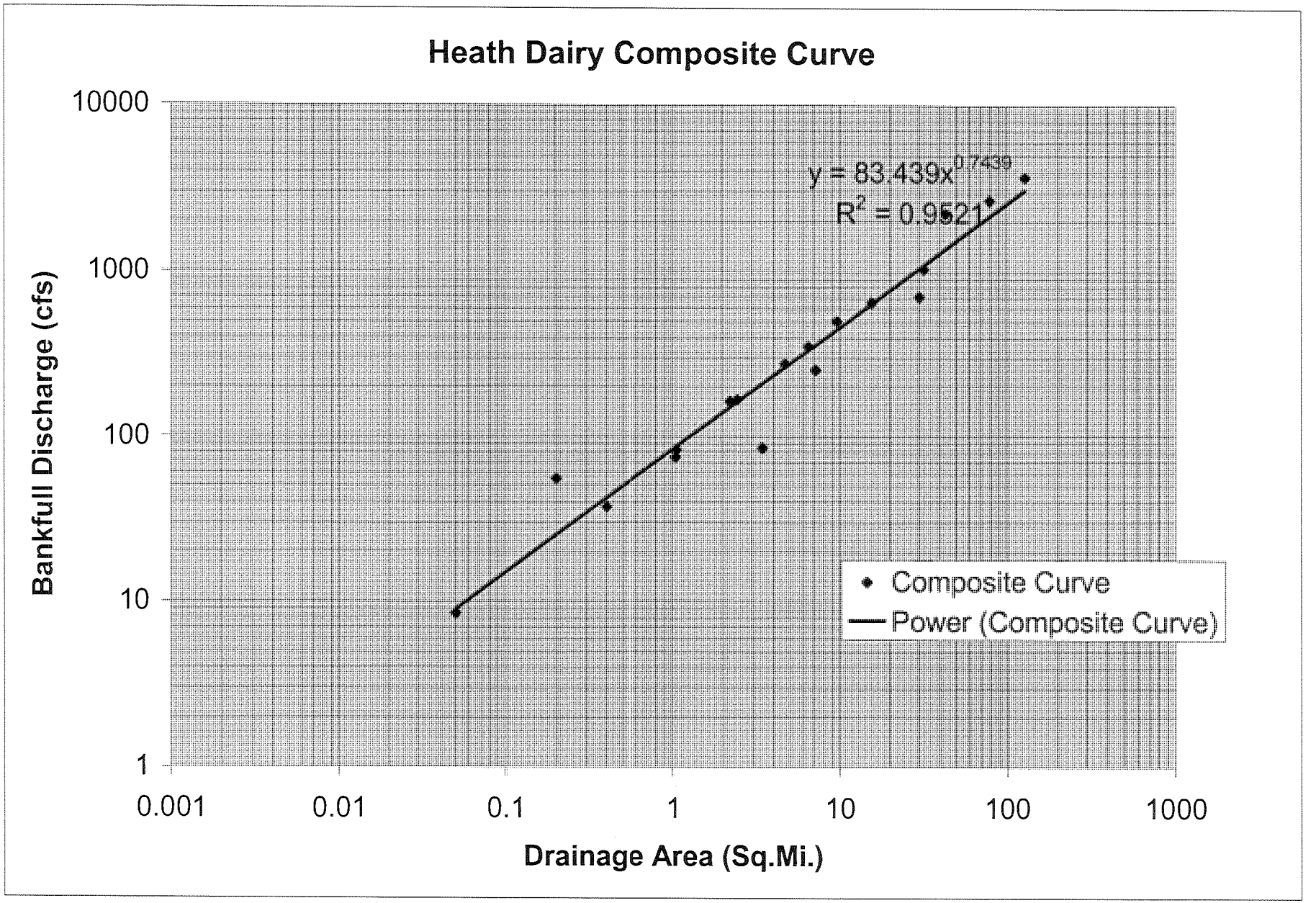
| | | | USGS Regression Equations (Piedmont) | | | |
|---|---|---|---|---|---|---|
| Location | Hec-Ras Station | D.A. ($mi^2$) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) |
| Back Creek - U/s End of Site | 0 | 0.94 | 237.90 | 328.38 | 598.26 | 744.96 |
| Back Creek - Reach 1a (10+10 to 14+67) | 0 | 1.04 | 254.62 | 350.93 | 637.54 | 792.99 |
| Back Creek - Reach 2a (18+50 to 23+20) | 0 | 1.08 | 261.16 | 359.74 | 652.85 | 811.70 |
| Back Creek - Reach 3 (30+80 to 48+30) | 0 | 1.3 | 295.82 | 406.34 | 733.60 | 910.24 |
| Back Creek - Reach 4 (48+30 to 57+20) | 0 | 1.34 | 301.90 | 414.51 | 747.72 | 927.45 |
| Back Creek - Reach 5a (57+20 to 60+47) | 0 | 1.34 | 301.90 | 414.51 | 747.72 | 927.45 |
| Back Creek - Reach 5b (60+47 to 63+45) | 0 | 2.69 | 482.22 | 655.20 | 1159.06 | 1426.68 |
| West Branch - Reach 1a (10+00 to 12+00) | 0 | 0.05 | 33.13 | 47.78 | 94.50 | 121.54 |
| West Branch - Reach 1b (12+00 to 13+80) | 0 | 0.05 | 33.13 | 47.78 | 94.50 | 121.54 |
| West Branch - Reach 2a (13+80 to 18+00) | 0 | 0.06 | 37.44 | 53.86 | 105.99 | 136.03 |
| West Branch - Reach 2b (18+00 to 19+55) | 0 | 0.06 | 37.44 | 53.86 | 105.99 | 136.03 |
| UT to West Branch | 0 | 0.05 | 33.13 | 47.78 | 94.50 | 121.54 |
| West Branch - Reach 3a (19+55 to 20+00) | 0 | 0.14 | 66.17 | 93.98 | 180.59 | 229.64 |
| West Branch - Reach 3b (20+00 to 25+30) | 0 | 0.14 | 66.17 | 93.98 | 180.59 | 229.64 |
| West Branch - Reach 3c (25+30 to 26+17) | 0 | 0.14 | 66.17 | 93.98 | 180.59 | 229.64 |
| North Branch - Reach 1a (10+31 to 19+00) | 0 | 1.14 | 270.83 | 372.75 | 675.43 | 839.28 |
| North Branch - Reach 1b (19+00 to 22+24) | 0 | 1.14 | 270.83 | 372.75 | 675.43 | 839.28 |
| East Branch - Reach 1a (9+20 to 10+20\) | 0 | 0.25 | 97.69 | 137.55 | 260.07 | 328.60 |
| East Branch - Reach 1b (10+20 to 14+00) | 0 | 0.25 | 97.69 | 137.55 | 260.07 | 328.60 |

| Location | Wetted Perimeter | Hyd. Radius | Channel Slope | Shear Stress | Particle Range | |
|---|---|---|---|---|---|---|
| Back Creek - U/s End of Site | 17.2 | 1.03 | 0.004 | 0.26 | 11.67 | 52 |
| Back Creek - Reach 1a (10+10 to 14+67) | 17.8 | 1.09 | 0.00563 | 0.38 | 17.49 | 82 |
| Back Creek - Reach 1b (14+67 to 18+50) | 17.8 | 1.09 | 0.00563 | 0.38 | 17.49 | 82 |
| Back Creek - Reach 2a (18+50 to 23+20) | 17.9 | 1.09 | 0.00563 | 0.38 | 17.53 | 82 |
| Back Creek - Reach 2b (23+20 to 30+80) | 17.9 | 1.09 | 0.00546 | 0.37 | 16.99 | 80 |
| Back Creek - Reach 3 (30+80 to 48+30) | 19.0 | 1.15 | 0.00645 | 0.46 | 21.38 | 74 |
| Back Creek - Reach 4 (48+30 to 57+20) | 19.2 | 1.19 | 0.00364 | 0.27 | 12.27 | 55 |
| Back Creek - Reach 5a (57+20 to 60+47) | 19.0 | 1.15 | 0.00949 | 0.68 | 31.64 | 152 |
| Back Creek - Reach 5b (60+47 to 63+45) | 24.4 | 1.49 | 0.00949 | 0.88 | 40.94 | 222 |
| West Branch - Reach 1a (10+00 to 12+00) | 6.3 | 0.38 | 0.01275 | 0.30 | 13.63 | 62 |
| West Branch - Reach 1b (12+00 to 13+80) | 6.3 | 0.38 | 0.02639 | 0.62 | 28.64 | 129 |
| West Branch - Reach 2a (13+80 to 18+00) | 6.7 | 0.41 | 0.01738 | 0.44 | 20.28 | 97 |
| West Branch - Reach 2b (18+00 to 19+55) | 6.7 | 0.41 | 0.02675 | 0.68 | 31.44 | 150 |
| UT to West Branch | 6.5 | 0.40 | 0.0315 | 0.79 | 36.55 | 189 |
| West Branch - Reach 3a (19+55 to 20+00) | 8.8 | 0.54 | 0.02675 | 0.90 | 41.73 | 228 |
| West Branch - Reach 3b (20+00 to 25+30) | 8.8 | 0.54 | 0.01075 | 0.36 | 16.53 | 77 |
| West Branch - Reach 3c (25+30 to 26+17) | 8.8 | 0.54 | 0.02744 | 0.92 | 42.81 | 236 |
| North Branch - Reach 1a (10+31 to 19+00) | 18.2 | 1.13 | 0.00357 | 0.25 | 11.37 | 51 |
| North Branch - Reach 1b (19+00 to 22+24) | 18.2 | 1.13 | 0.00995 | 0.70 | 32.40 | 157 |
| East Branch - Reach 1a (9+20 to 10+20\) | 10.7 | 0.66 | 0.0205 | 0.84 | 39.15 | 208 |
| East Branch - Reach 1b (10+20 to 14+00) | 10.7 | 0.66 | 0.00803 | 0.33 | 15.09 | 70 |
| East Branch - Reach 1c (14+00 to 15+48) | 10.7 | 0.66 | 0.02834 | 1.17 | 54.28 | 323 |
| | | | | | | |
| | | | | | | |
| Back Creek - Reach 4 (E) | 18.5 | 1.37 | 0.002 | 0.17 | 8.56 | 31 |


Heath Dairy Local Curve and Regional Curve
1000
100
10
1
Bankfull XS Area
y = 21.433x^0.6761
R^2 = 0.9491
y = 20.231x^0.6486
R^2 = 0.9834
Local Curve
Regional Curve
Additional Reference
Power (Local Curve)
Power (Regional Curve)
0.001
0.01
0.1
1
10
100
1000
Drainage Area (Sq.Mi.)

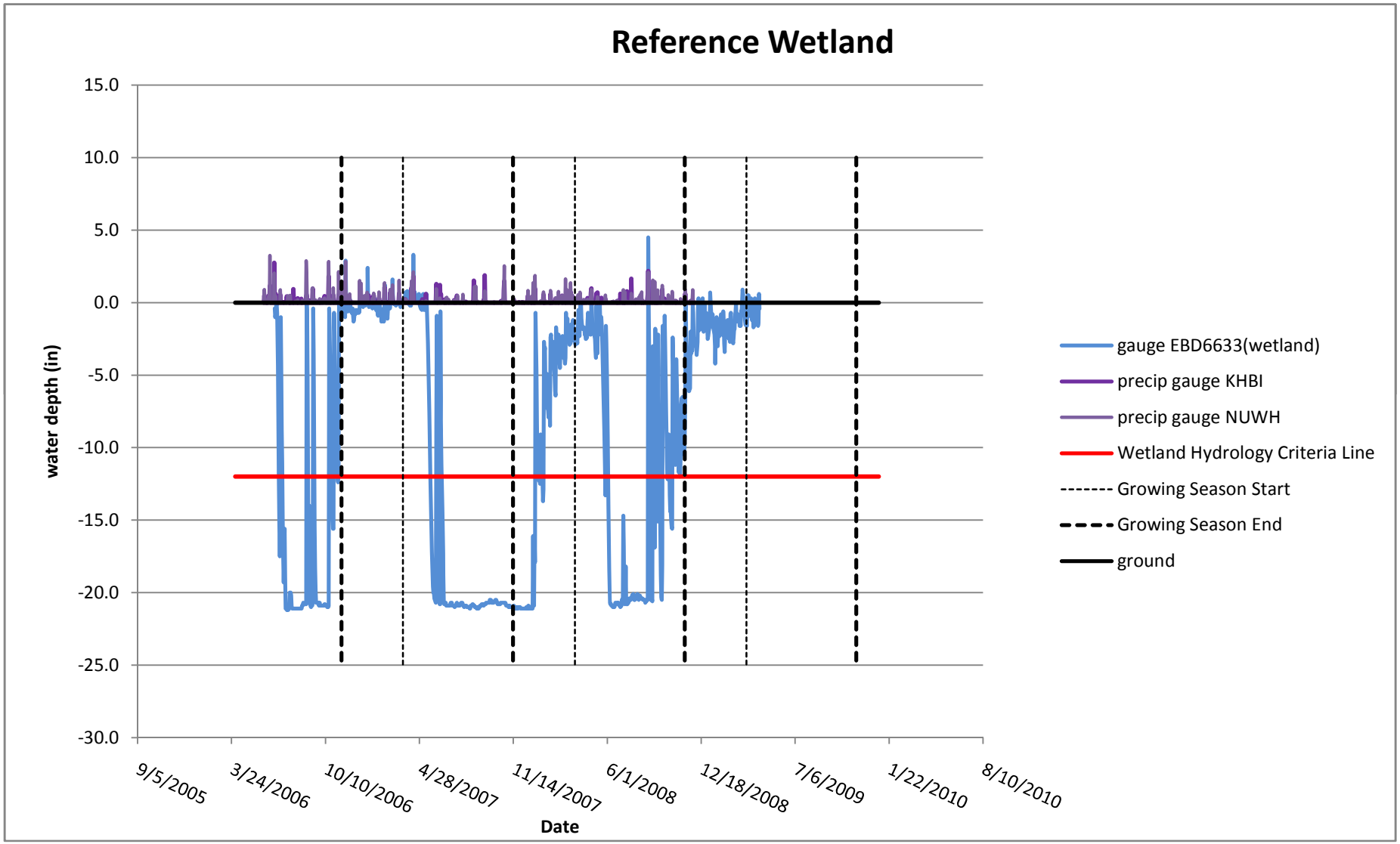

Heath Dairy Composite Curve
y = 20.913x^0.6792
R² = 0.974
Bankfull XS Area (sf)
1000
100
10
1
0.001
0.01
0.1
1
10
100
1000
Drainage Area (Sq.Mi.)
Composite Curve
Power (Composite Curve)

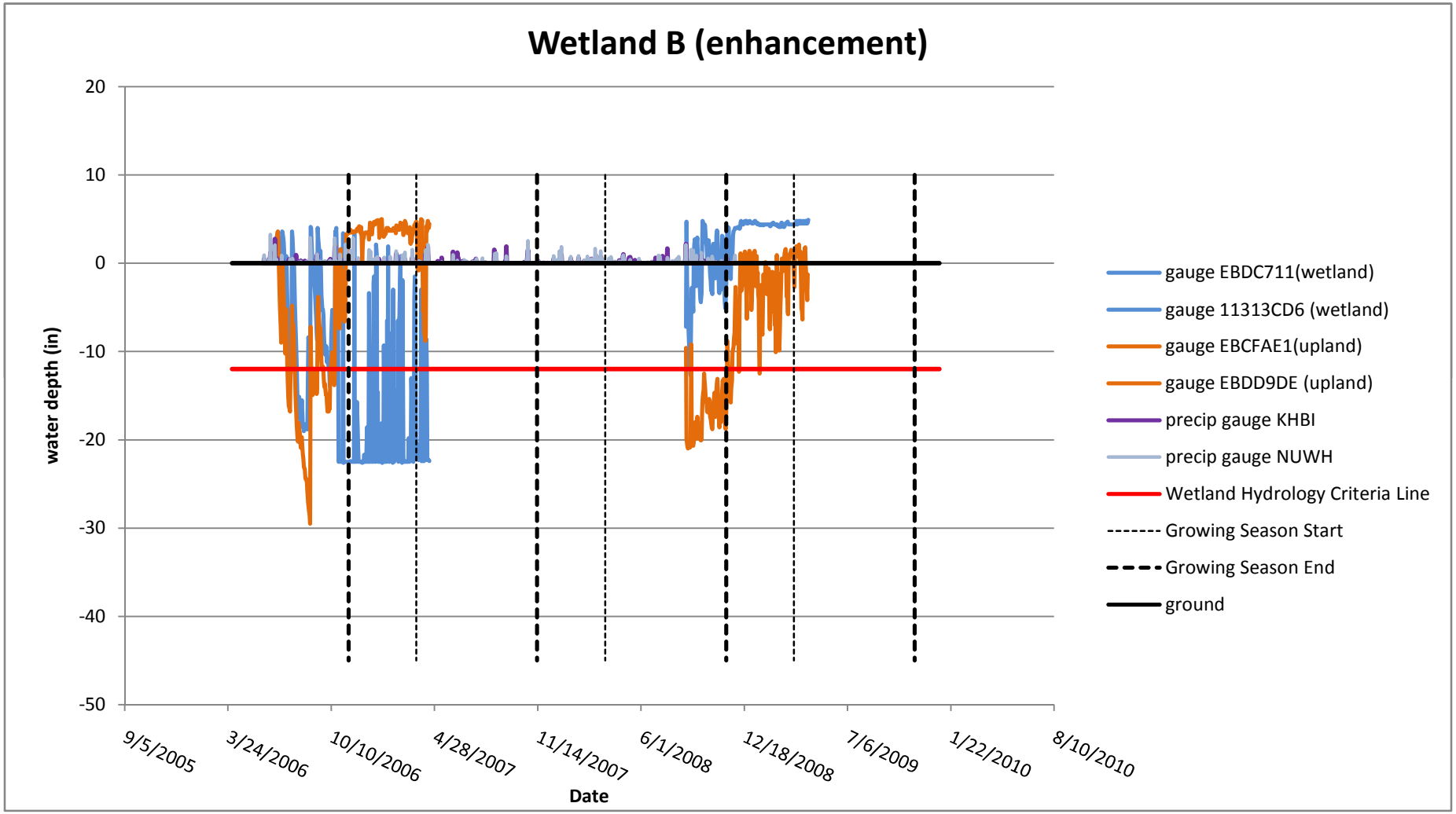

Heath Dairy Local Curve and Regional Curve
Bankfull Discharge (cfs)
10000
1000
100
10
1
0.001
0.01
0.1
1
10
100
1000
Drainage Area (Sq.Mi.)
y = 89.039x^0.7223
R² = 0.9069
y = 81.142x^0.7709
R² = 0.9953
Local Curve
Regional Curve
Power (Local Curve)
Power (Regional Curve)

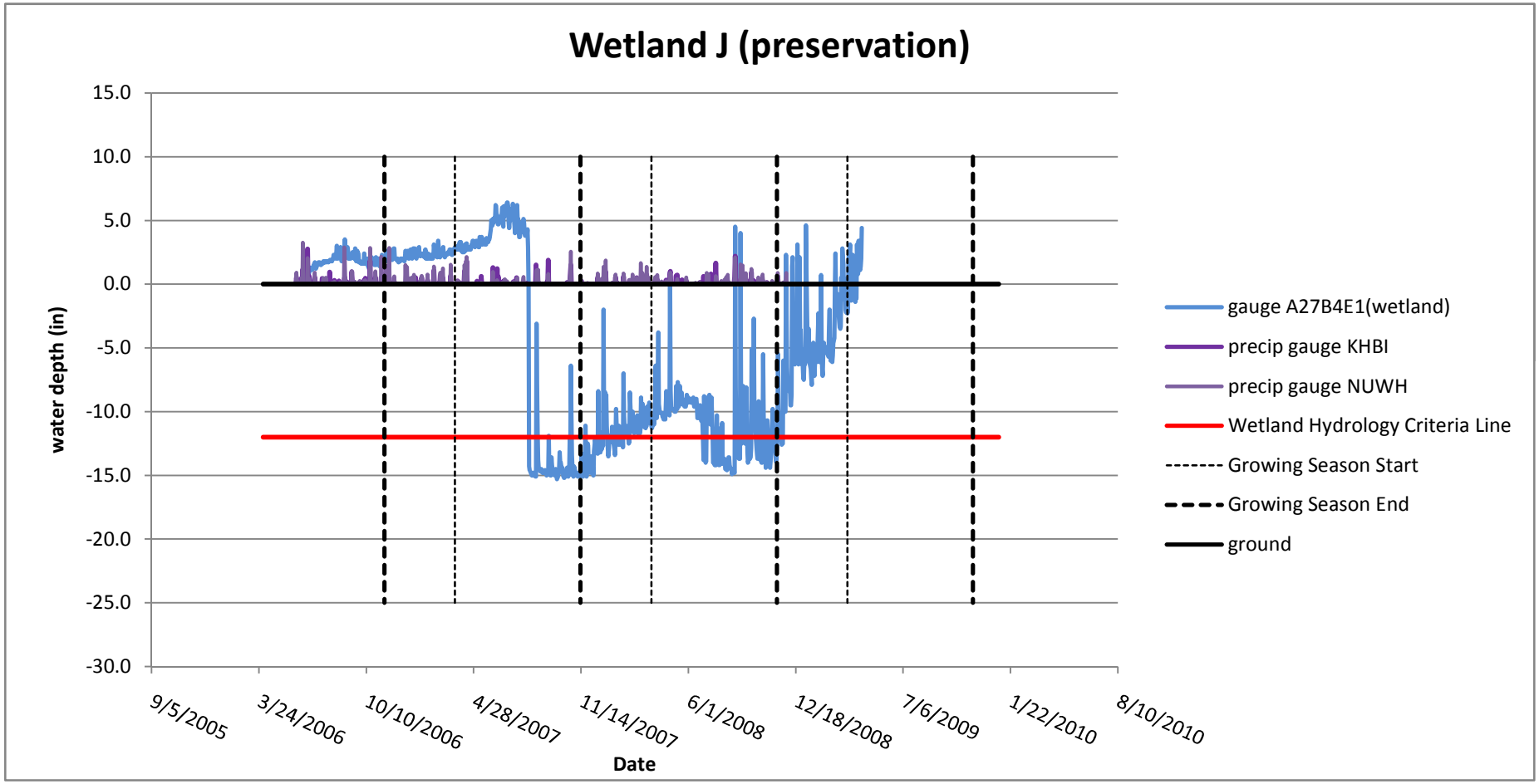

Heath Dairy Composite Curve
Bankfull Discharge (cfs)
10000
1000
100
10
1
0.001
0.01
0.1
1
10
100
1000
Drainage Area (Sq.Mi.)
y = 83.439x^0.7439
R^2 = 0.9521
Composite Curve
Power (Composite Curve)

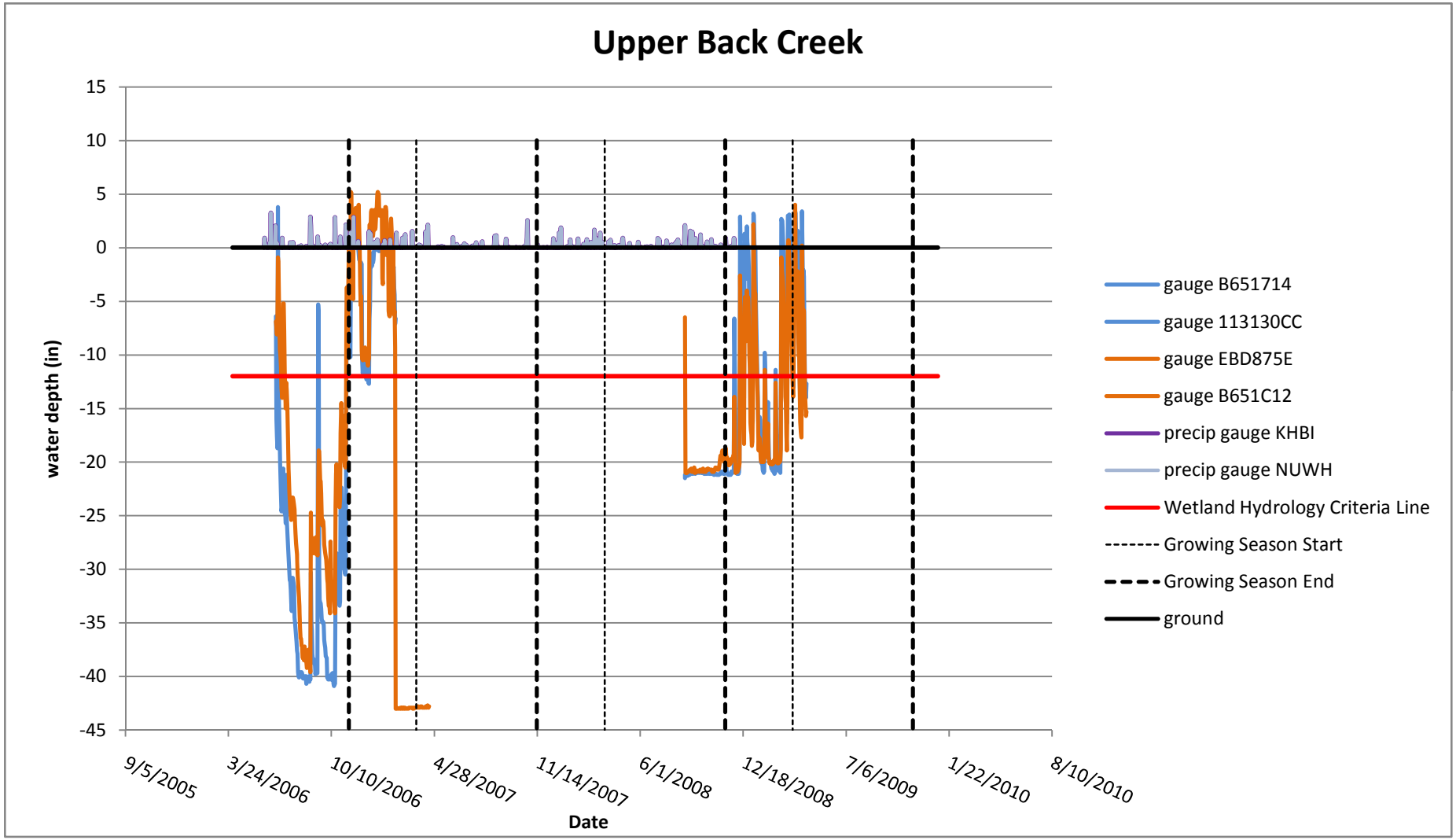
# APPENDIX H

## Hydrologic Gauge Data Summary


Reference Wetland
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
water depth (in)
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
6/1/2008
12/18/2008
7/6/2009
1/22/2010
8/10/2010
Date
gauge EBD6633(wetland)
precip gauge KHBI
precip gauge NUWH
Wetland Hydrology Criteria Line
Growing Season Start
Growing Season End
ground


Wetland B (enhancement)
water depth (in)
20
10
0
-10
-20
-30
-40
-50
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
6/1/2008
12/18/2008
7/6/2009
1/22/2010
8/10/2010
Date
gauge EBDC711(wetland)
gauge 11313CD6 (wetland)
gauge EBCFAE1(upland)
gauge EBDD9DE (upland)
precip gauge KHBI
precip gauge NUWH
Wetland Hydrology Criteria Line
Growing Season Start
Growing Season End
ground


Wetland J (preservation)
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
water depth (in)
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
6/1/2008
12/18/2008
7/6/2009
1/22/2010
8/10/2010
Date
gauge A27B4E1(wetland)
precip gauge KHBI
precip gauge NUWH
Wetland Hydrology Criteria Line
Growing Season Start
Growing Season End
ground


Upper Back Creek
water depth (in)
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
9/5/2005
3/24/2006
10/10/2006
4/28/2007
11/14/2007
6/1/2008
12/18/2008
7/6/2009
1/22/2010
8/10/2010
Date
gauge B651714
gauge 113130CC
gauge EBD875E
gauge B651C12
precip gauge KHBI
precip gauge NUWH
Wetland Hydrology Criteria Line
Growing Season Start
Growing Season End
ground

# APPENDIX I

## Hydraulic Analysis of Surface Water

HSMM
ARCHITECTS ENGINEERS PLANNERS

# MEMO

**DATE:** December 20, 2006

**RE: Comm. No.** 30127

**TO:** Heath Dairy Road Mitigation Project Folder

**FROM:** HSMM, Inc.

## Hydraulic Analysis

As part of the preliminary design process, HSMM personnel developed a detailed hydraulic model of the Heath Dairy Stream Restoration project site using HEC-RAS version 3.1.3. The primary purpose of the model was to determine what backwater elevations may be reasonably anticipated on the project site during a range of discharges, and to ensure that mitigation activities will not result in hydraulic trespass onto adjacent properties.

## Existing Condition

Using the steady-state HEC-RAS modeling approach, it was determined that under existing conditions, the historical dam and culvert structure at Heath Dairy Road will overtop with a discharge less than the calculated Q2. This confirms the preliminary evaluation performed by Ecoscience Corporation in their Mitigation Feasibility Report for the Heath Dairy Road Project Site dated August 2003. Upon further investigation, it was determined that a steady-state model such as HEC-RAS was not appropriate for conditions specific to this site. A standard-step backwater calculation will not account for the surface water storage potential of the site or the attenuated peak discharges that will likely be produced when routing a storm hydrograph through the structures at the Heath Dairy Road Bridge. Therefore, it was determined that a storage-indication routing procedure should be performed to more accurately describe the hydraulic performance of the system.

Using the input hydrograph development procedures developed by H. Rooney Malcolm (Elements of Urban Stormwater Design, NCSU, 1989) and standard storage-indication routing methods, an unsteady-flow model was developed for the Heath Dairy Road Project Site. Hydraulic routing predicts that the dam will overtop in the 10-year design storm with a peak input discharge of approximately 650cfs (i.e. – less frequently than the HEC-RAS model indicated). The minimum flow that will pass with no significant impact from the structure was determined to be approximately 100cfs. For comparison, bankfull discharge was calculated at 174cfs. Refer to the attached figures for a plan view illustration of the hydraulic routing results.

The shaded areas on figures 1, 2 and 3 illustrate the limits of flooding predicted by storage-indication routing methods for the bankfull discharge, Q2 and Q10, respectively. This is the area which may be expected to be inundated for the corresponding storm event.

The information presented on figures 1, 2 and 3 appear to confirm data produced by FEMA and documented on the National Flood Insurance Rate Map for Randolph County, North Carolina, Community Panel Number 370195 0200 B, Effective July 16, 1981. The area of concern is listed as Flood Hazard Zone A. FEMA Flood Hazard Zone A indicates that this area is subject to inundation by the 1% annual chance flood, but no base flood elevations (BFE) have been established.

**Proposed Condition**

Upon completion of final design, a set of proposed conditions models were produced to determine the post construction backwater elevations throughout the project site, and potential flood hazards, if any produced by restoration efforts.

Using the steady-state HEC-RAS modeling approach, it was determined that under proposed conditions, the historical dam and culvert structure at Heath Dairy Road will overtop with a discharge less than the calculated Q2. Comparison of the existing and proposed conditions models demonstrates that the 100yr water surface elevations at the upstream most cross sections of each reach will be slightly lowered in the proposed model. In every instance, the difference in water surface elevation was less than one foot from the existing. Furthermore, this analysis demonstrates that the proposed construction activities will not result in hydraulic trespass onto any adjacent properties.

As in the existing condition analysis, it was determined that a more appropriate modeling approach for site-specific conditions was to develop an unsteady state hydraulic model using the storage-indication curve routing method. For this model, stage-discharge relationships remain unchanged from existing conditions, while a proposed contour file was used to develop proposed stage-storage relationships. Overall, the culvert, dam and bridge located at the downstream most end of the property controls the hydraulic performance of the site for the bankfull discharge and all greater events. Water surface elevations and peak discharge rates computed for the proposed condition remain unchanged compared to the existing condition. The minimum flow that will pass with no significant impact from the structure was determined to be approximately 100cfs, as compared to a computed bankfull discharge of 174cfs. Again, this analysis confirms that the proposed construction activities will not result in hydraulic trespass onto any adjacent properties.

LIMITS OF FLOODING

EAST BRANCH

NORTH BRANCH

BACK CREEK

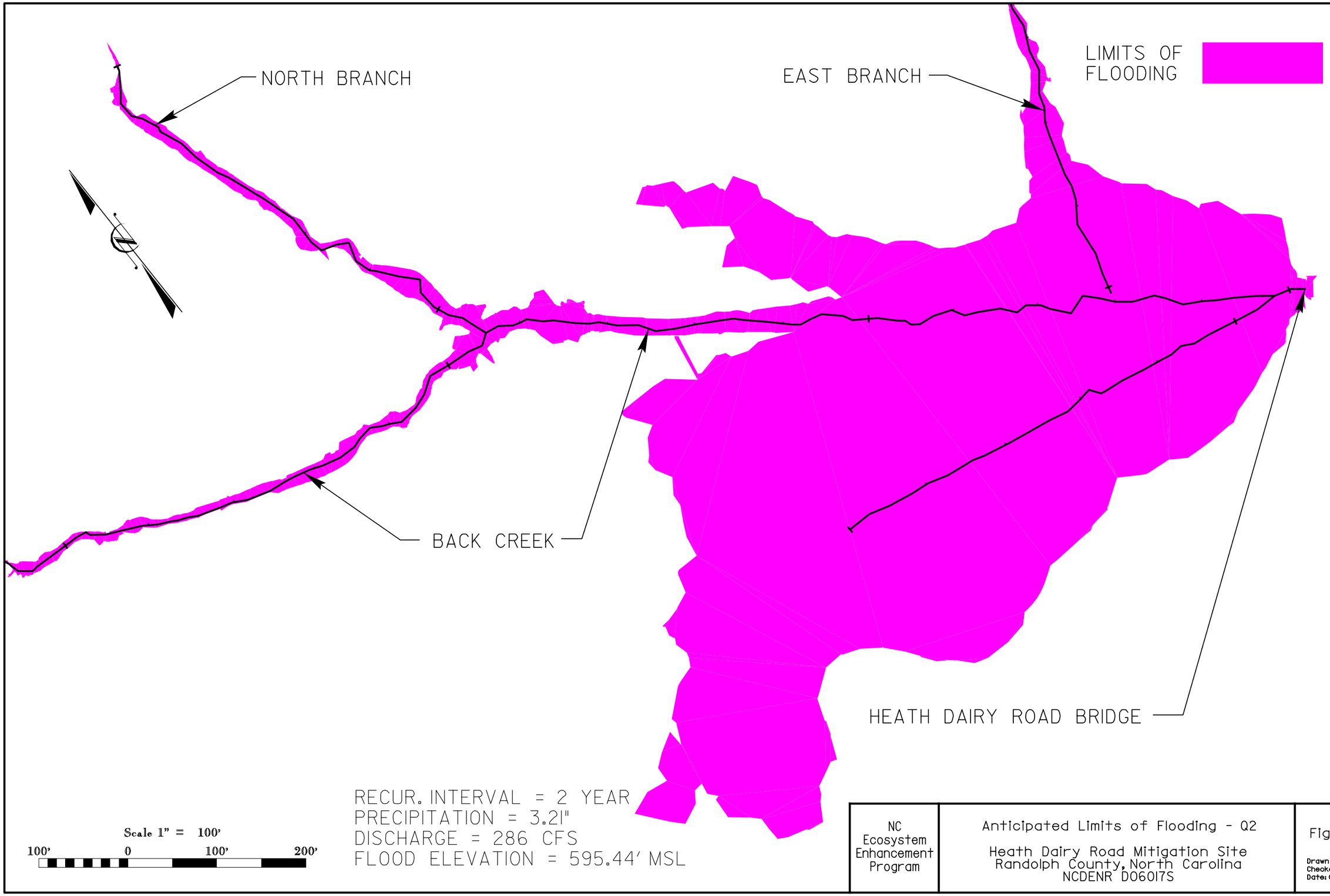
HEATH DAIRY ROAD BRIDGE

Scale 1" = 100'

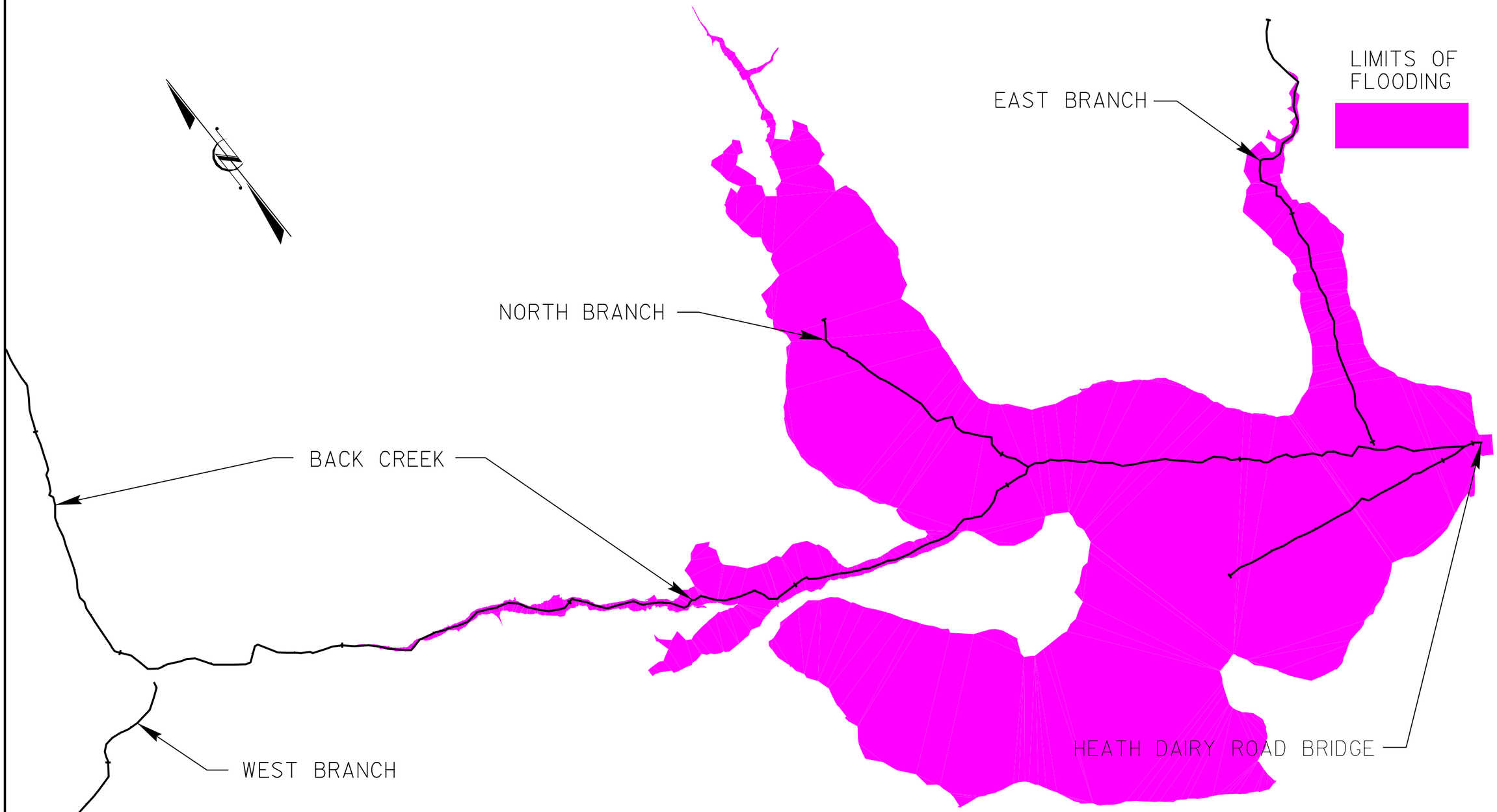
100' 0 100' 200'

RECUR. INTERVAL = BANKFULL
PRECIPITATION = 2.48"
DISCHARGE = 174 CFS
FLOOD ELEVATION = 593.20' MSL

| | | |
|---|---|---|
| NC Ecosystem Enhancement Program | Anticipated Limits of Flooding - QBkf<br>Heath Dairy Road Mitigation Site<br>Randolph County, North Carolina<br>NCDENR D06017S | Figure 1<br>Drawn By: AMH<br>Checked By: AJW<br>Date: 07/28/2006 |




| | | |
|---|---|---|
| NC Ecosystem Enhancement Program | Anticipated Limits of Flooding - Q2<br>Heath Dairy Road Mitigation Site<br>Randolph County, North Carolina<br>NCDENR D06017S | Figure 2<br>Drawn By: AMH<br>Checked By: AJW<br>Date: 07/28/2006 |




Scale 1" = 200'

200' 0 200' 400'

RECUR. INTERVAL = 10 YEAR
PRECIPITATION = 5.01"
DISCHARGE = 647 CFS
FLOOD ELEVATION = 599.70' MSL

| | | |
|---|---|---|
| NC Ecosystem Enhancement Program | Anticipated Limits of Flooding - Q10<br>Heath Dairy Road Mitigation Site<br>Randolph County, North Carolina<br>NCDENR D06017S | Figure 3<br>Drawn By: AMH<br>Checked By: AJW<br>Date: 07/28/2006 |

# APPENDIX J

## Cultural Resources Information

HSMM

December 13, 2006

Renee Gledhill-Earley
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 27699-4617

Re: Heath Dairy Restoration Site
Randolph County, NC

Dear Ms. Gledhill-Earley,

The Ecosystem Enhancement Program (EEP) requests review and comment on issues that might emerge with respect to archaeological or cultural resources associated with a stream restoration project on the attached site. The Heath Dairy Rd. site has been identified for the purpose of providing in-kind mitigation for unavoidable stream channel impacts. Several reaches of stream have been identified as significantly degraded.

Coastal Carolina Research, Inc. investigated two structures of potential archaeological significance. Please reference Figure 3 in the attached report for locations of these structures by number. Site 31RD1440 is the remains of a stacked stone dam and is not eligible for the NRHP. Site 31RD1330 is a previously recorded stone dam that has been incorporated into the bridge structure on Heath Dairy Rd. over Back Creek. Please find two copies of "Archaeological Survey Portions of the Proposed Heath Dairy Road Stream Restoration Project." Work will not take place inside the footprint of the stacked stone dam, (31RD1330). The remainder of the site has historically been disturbed due to agricultural practices such as tilling and the presence of livestock.

We ask that you review this site based on the attached information to determine if this project shall be considered to have no impact on cultural resources.

We thank you in advance for your timely response and cooperation. Please feel free to contact us with any questions that you may have concerning the extent of site disturbance associated with this project.

If you require any additional information, please advise.

Sincerely,

HSMM

Brian A. Mazzochi

Brian A. Mazzochi, E.I.
Project Engineer

Enclosures: North Carolina Archaeological Site Form VI for Site 31RD1440
Archaeological Survey- Portions of the Proposed Heath Dairy Road Stream Restoration Project (2)

cc: Wyatt L. Brown, CPESC, Licensed Soil Scientist
Sedimentation and Erosion Control Engineer
North Carolina Ecosystem Enhancement Program
N.C. Department of Environment and Natural Resources
1652 Mail Service Center
Raleigh, NC 27699-1652

The North Carolina Ecosystem Enhancement Program (EEP) plans to restore a degraded reach of Back Creek, several unnamed tributaries, and preserve associated floodplain wetlands located in Randolph County, North Carolina. The Heath Dairy Road Restoration Site encompasses approximately 7,695 linear feet of degraded channels and 1.649 acres of degraded wetlands. The restoration work will include relocation of channels and associated floodplain grading. The site includes two structures of potential historical significance; both are stacked stone dams. Of the two, the one under Heath Dairy Rd. (31 RD 1330) appears to be suitable for listing in the National Register of Historic places. The other dam (31 RD 1440) is partially collapsed and does not meet the requirements. There will be no work inside the footprint of either structure.

# NORTH CAROLINA ARCHAEOLOGICAL SITE FORM VI
## Office of State Archaeology/Division of Archives & History

1. STATE SITE NUMBER: **31RD1440**
2. SITE NAME(S): **Stone Dam**
3. OTHER SITE NUMBER:
4. INSTITUTION ASSIGNING: **45 Coastal Carolina Research**
5. PROJECT SITE NUMBER: **06-04-01**
6. SITE COMPONENT: **4 - Historic, w/ Above-Ground Remains**
7. QUAD MAP: **Randleman 1970 (81PR)** MAP CODE: **R90**
8. UTMs: ZONE: **17** NORTHING: **3960214** EASTING: **060375**
9. COUNTY: **Randolph** 10. DATE RECORDED: **5/2/06**

RECORDED BY: **L. Lautzenheiser**

PROJECT NAME: **Archaeological Survey of Portions of the Proposed Back Creek Stream Restoration Project, Randolph County, North Carolina**

11. RESULT OF COMPLIANCE PROJECT: **1 - Yes**
12. ER/CH/GRANT#: **ER 03-1801**
13. CODING DATE: **5/4/06** CODED BY: **D. Haynes**

***14-18. OFFICE OF STATE ARCHAEOLOGY USE ONLY***

14. Register Status: _____
1 DETERMINED ELIGIBLE
2 PLACED ON STUDY
3 APPROVED FOR
4 LISTED IN NRHP
5 REMOVED FROM NRHP
6 NOT ELIGIBLE
7 UNASSESSED
8 NC ARCH REC. PROG

14A. Register Criterion _____
A SIGNIFICANT - CRITERION A
B SIGNIFICANT - CRITERION B
C SIGNIFICANT - CRITERION C
D SIGNIFICANT - CRITERION D

15. Type of Form: _____
11 SITE FORM VI

16. Recorder Status _____
1 NCAC MEMBER
2 AMATEUR
3 UNKNOWN
4 OTHER
5 STUDENT

17. Form Reliability: _____
1 CODING COMPLETE
2 CODING INCOMPLETE
3 CODING UNRELIABLE

18. Locational Reliability: _____
1 ACCURATE
2 WITHIN 100M RADIUS
3 UNRELIABLE
4 UNKNOWN LOC.
5 W/in 500M RADIUS
6 W/in 1KM RADIUS

DIRECTIONS TO SITE: **From Randleman, take Bowman Meadow Rd. south to Heath Dairy Rd. south. Turn right onto Spero Rd. The dam is located north of Spero Rd. along an unnamed tributary to Back Creek.**

*ATTACH USGS OR OTHER DETAILED SITE MAP*

19. RESEARCH POTENTIAL: None
20. POTENTIAL IMPACTS ARTIFICIAL: 9 - Other unknown
21. POTENTIAL IMPACTS ENVIRONMENTAL: 9 - Other unknown
22. EXPLANATION OF IMPACTS:
23. RECOMMENDATIONS: 1 - No Further Work
24. EXPLAIN RECOMMENDATIONS: This site does not appear eligible for the National Register of Historic places, and no additional archaeological work is recommended.
25. DATE ON REGISTER: 26. EXCAVATION DATE:
27. INSTITUTION EXCAVATING:
28. EXCAVATION RESULTS:
29. PERCENT DESTROYED: 30. DATE DESTROYED:

31. CAUSES OF DESTRUCTION:

## ENVIRONMENTAL INFORMATION

32. TOPOGRAPHIC SITUATION: **26 - Streambank**

33. ELEVATION: **698** FT. AMSL

34. SLOPE PERCENT: **8** %

35. SLOPE FACE DIRECTION: **2 - Northeast**

36. SOIL COMPOSITION: **99 - Other**

37. SCS SOIL TYPE CODE: **BTC2** SERIES NAME: **Badin-Tarrus Complex 8-15% Slopes Moderately Eroded**

ASSOCIATION: **BTB2 Badin-Tarrus Complex 2-8% Slopes Moderately Eroded**

38. MODERN VEGETATION: **4 - Forested**

39. DISTANCE TO WATER: **0** (Meters) 40. **0** (Yards)

41. TYPE OF NEAREST PERMANENT WATER: **2 - River, Creek, Stream** NAME: Back Creek

42. STREAM RANK: **3** [Strahler System - 1-6]

43. DRAINAGE BASIN: **2 - Cape Fear**

## SITE EVALUATION AND CONDITION

44. SITE CONDITION NATURAL: **8 - Streambank/Shoreline Erosion (general)**

45. SITE CONDITION ARTIFICIAL:

46. GROUND VISIBILITY: %

47. COLLECTION MADE: **2 - No**

48. COLLECTION STRATEGY:

49. AREA COVERED SQ. METERS: **0**

50. SUBSURFACE TESTING: **2 - No**

51. TESTING METHODS:

52. SUBSURFACE TEST RESULTS:

53. SITE SIZE: **2 - 11-25 sq. meters**

## PREHISTORIC SITE INFORMATION

**54. - 66. N/A - NO PREHISTORIC COMPONENT**

## HISTORIC SITE INFORMATION

67. PERIOD OF OCCUPATION BEGIN:

68. PERIOD OF OCCUPATION END:

69. REFINED DATE FROM:

70. REFINED DATE TO:

71. HISTORIC CULTURAL AFFILIATIONS: **0 - Unknown**

72. HISTORIC SITE DEFINITION: **99 - Other** Erosion Control

73. HISTORIC REMAINS DESCRIPTION: This site is the remains of a stacked-stone dam. The structural integrity of dam has been breached, but partial ruins remain. It has a sloped spillway across the center where a drain was placed in the spillway so as not to impe the normal flow of the stream. This drain was constructed with a large ston lintel across the top and obviously represents original construction.

74. MAIN STRUCTURE FUNCTION: **3 - Dam**

75. NUMBER OF OUTBUILDINGS:

76. OUTBUILDING DISTANCE(S):

77. OUTBUILDING FUNCTIONS:

78. OUTBUILDING DESCRIPTION:

79. KITCHEN GROUP:
- ☐ 1 - Ceramics
- ☐ 2 - Wine Bottle
- ☐ 3 - Case Bottle
- ☐ 4 - Tumbler
- ☐ 5 - Pharmaceutical Bottle
- ☐ 6 - Glassware
- ☐ 7 - Tableware
- ☐ 8 - Kitchenware
- ☐ 9 - Other

80. ARCHITECTURAL GROUP:
- ☐ 1 - Window Glass
- ☐ 2 - Nails
- ☐ 3 - Spikes
- ☐ 4 - Construction Hardware
- ☐ 5 - Door Lock Parts
- ☐ 9 - Other

81. ARMS GROUP:
- ☐ 1 - Musket Balls, Shot, Sprue
- ☐ 2 - Gun Flints, Gunspalls
- ☐ 3 - Gun Parts, Bullet Molds
- ☐ 9 - Other

82. MILITARY OBJECTS:
- ☐ 1 - Swords
- ☐ 2 - Insignia
- ☐ 3 - Bayonets
- ☐ 4 - Artillery Shot & Shell
- ☐ 9 - Other

83. CLOTHING GROUP:
- ☐ 1 - Buckles
- ☐ 2 - Thimbles
- ☐ 3 - Buttons
- ☐ 4 - Scissors
- ☐ 5 - Straight Pins
- ☐ 6 - Hook & Eye Fasteners
- ☐ 7 - Bale Seals
- ☐ 8 - Glass Beads
- ☐ 9 - Other

84. PERSONAL GROUP:
- ☐ 1 - Coins
- ☐ 2 - Keys
- ☐ 3 - Personal Items
- ☐ 9 - Other

85. TOBACCO PIPE GROUP:
- ☐ 1 - Tobacco Pipe
- ☐ 2 - Stub-Stemmed Pipes
- ☐ 9 - Other

86. ACTIVITIES GROUP:
- ☐ 1 - Construction Tools
- ☐ 2 - Farm Tools
- ☐ 3 - Toys
- ☐ 4 - Fishing Gear
- ☐ 5 - Colonial-Indian Pottery
- ☐ 6 - Storage Items
- ☐ 7 - Ethnobotanical
- ☐ 8 - Associated With Stable Or Barn
- ☐ 9 - Other

87. HISTORIC MISC:
- ☐ 1 - Bone Fragment
- ☐ 2 - Furniture Hardware
- ☐ 3 - Button Manufacturing Blanks
- ☐ 4 - Silversmithing Debris
- ☐ 9 - Other

88. DATEABLE CERAMICS:

## ADDITIONAL SITE INFORMATION

89. ARTIFACT INVENTORY: **2 - No**

90. CURATION FACILITY: **N/A**

91. ACCESSION NUMBER(S): **N/A**

92. ACCESSION DATE(S):

93. OTHER CURATION FACILITY:

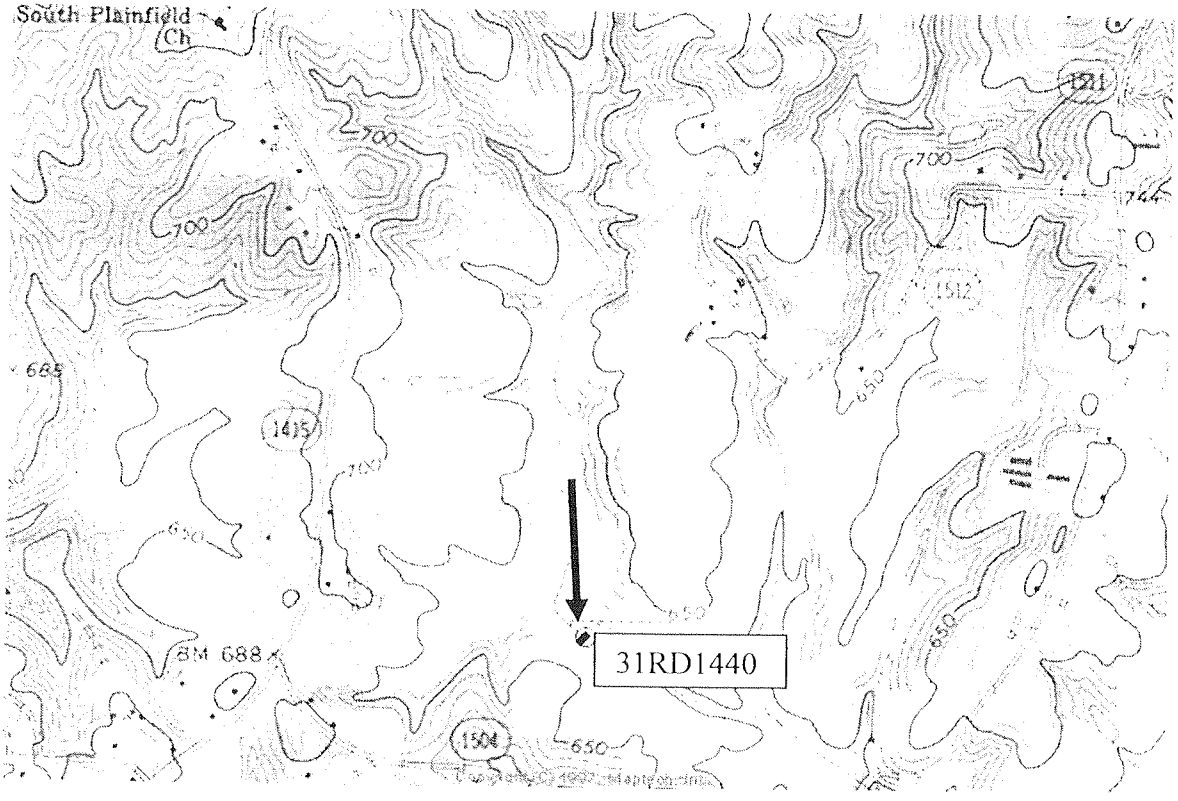
94. OTHER ACCESSION NUMBER(S):

95. OWNER/TENANT INFORMATION: Mr. Ridge

96. BIBLIOGRAPHIC REFERENCE #'S:

97. COMMENTS/NOTES: Lautzenheiser, L.

2006 Archaeological Survey of Portions of the Proposed Back Creek Stream Restoration Project, Randolph County, North Carolina. Ms. on file, Office of State Archaeology, Raleigh




# 31RD1440
# Stone Dam
# Randolph County
# Randleman Quad

# ARCHAEOLOGICAL SURVEY
# PORTIONS OF THE PROPOSED HEATH DAIRY ROAD STREAM RESTORATION PROJECT
# RANDOLPH COUNTY, NORTH CAROLINA

**ER-03-1801**

**PREPARED FOR:**
**HAYES, SEAY, MATTERN & MATTERN**
**1305 NAVAHO DRIVE**
**RALEIGH, NORTH CAROLINA 27609**


**PREPARED BY:**
**LORETTA LAUTZENHEISER**
*Principle Investigator*
**And**
**DAWN BRADLEY**

**COASTAL CAROLINA RESEARCH, INC.**
**P.O. BOX 1198**
**407 TRADE STREET**
**TARBORO, NORTH CAROLINA 27886**


**JUNE 2006**

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# ARCHAEOLOGICAL SURVEY
# PORTIONS OF THE PROPOSED HEATH DAIRY ROAD STREAM RESTORATION PROJECT
# RANDOLPH COUNTY, NORTH CAROLINA

**ER-03-1801**

## MANAGEMENT SUMMARY

### Introduction

Coastal Carolina Research, Inc. (CCR) conducted an archaeological survey of portions of the proposed Heath Dairy Road Stream Restoration Project along Back Creek in Randolph County, North Carolina. The project is part of the Ecosystem Enhancement Program administrated by the Department of Natural Resources. The program is part of a reciprocal arrangement with the North Carolina Department of Transportation.

The project involves the restoration of approximately 10,000 linear feet of stream, most of which is remaining in the existing channel. With the exception of one section that is deeply incised between high banks, movements outside the existing channel will still remain in the low floodplain.

### Results of the Investigations

The archaeological survey of the stream restoration of Back Creek considered three areas within the APE; the bridge carrying Heath Dairy Road over Back Creek, the ruins of a stone dam, and an area where the creek is deeply incised with high banks. The APE ends at, but includes the bridge. The area with the high banks had surface visibility, and the subsoil was exposed at the surface. No archaeological remains were noted in this area. The stone dam was recorded as a site, and the area at the bridge contained a stone dam incorporated into the bridge that had been previously recorded as a site.

### Summary

During the survey of portions of the Back Creek stream restoration project, one archaeological site was recorded, and one previously recorded site was revisited. Site 31RD1440 is the ruins of a stacked-stone dam. It is recommended as not eligible for the NRHP. Site 31RD1330 is a previously recorded resource that has been recommended as eligible for the NRHP as an architectural resource. If it is impacted by the undertaking, it will be necessary to mitigate any adverse effects to the resource. No additional work is recommended for site 31RD1440.

# ARCHAEOLOGICAL SURVEY
# PORTIONS OF THE PROPOSED HEATH DAIRY ROAD STREAM RESTORATION PROJECT
# RANDOLPH COUNTY, NORTH CAROLINA
**ER-03-1801**

## INTRODUCTION

Coastal Carolina Research, Inc. (CCR) conducted an archaeological survey of portions of the proposed Heath Dairy Road Stream Restoration Project along Back Creek in Randolph County, North Carolina (Figure 1). The project is part of the Ecosystem Enhancement Program administrated by the Department of Natural Resources. The program is part of a reciprocal arrangement with the North Carolina Department of Transportation.

The project involves the restoration of approximately 10,000 linear feet of stream, most of which is remaining in the existing channel. With the exception of one section that is deeply incised between high banks, movements outside the existing channel will still remain in the low floodplain. The scope for this project involved the survey of three areas of concern. They are the crossing of Heath Dairy Road over Back Creek, the deeply incised area, and the area with the remains of stone dam (Figure 2).

These investigations were conducted for HSMM in compliance with Section 106 of the National Historic Preservation Act, 1966 as amended and 31CFR 800, the regulations governing the Section 106 process. The purpose of the survey was to determine if the project area contained archaeological resources that are on, or recommended as eligible for inclusion in, the National Register of Historic Places (NRHP).

The scope of the investigations was consistent with the guidelines issued by the Advisory Council on Historic Preservation and the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation Projects* (Federal Register, Vol. 48, No. 190, September 1983, P. 44716-44742, et seq.). This report conforms to the guidelines issued by the Office of State Archaeology (OSA) and the State Historic Preservation Office (SHPO).

Background research for the project was conducted at the Office of State Archaeology (OSA) in Raleigh; the State Library, and at the library of CCR in Tarboro. Dolores Hall of the OSA, Paul Mohler, Archaeologist with the North Carolina Department of Transportation, and Penne Sandbeck, Architectural Historian with the North Carolina Department of Transportation, provided information on site 31RD1330. The purpose of the background research was to identify any previously recorded archaeological sites in or adjacent to the project area and to develop a historic context for the project. CCR has conducted

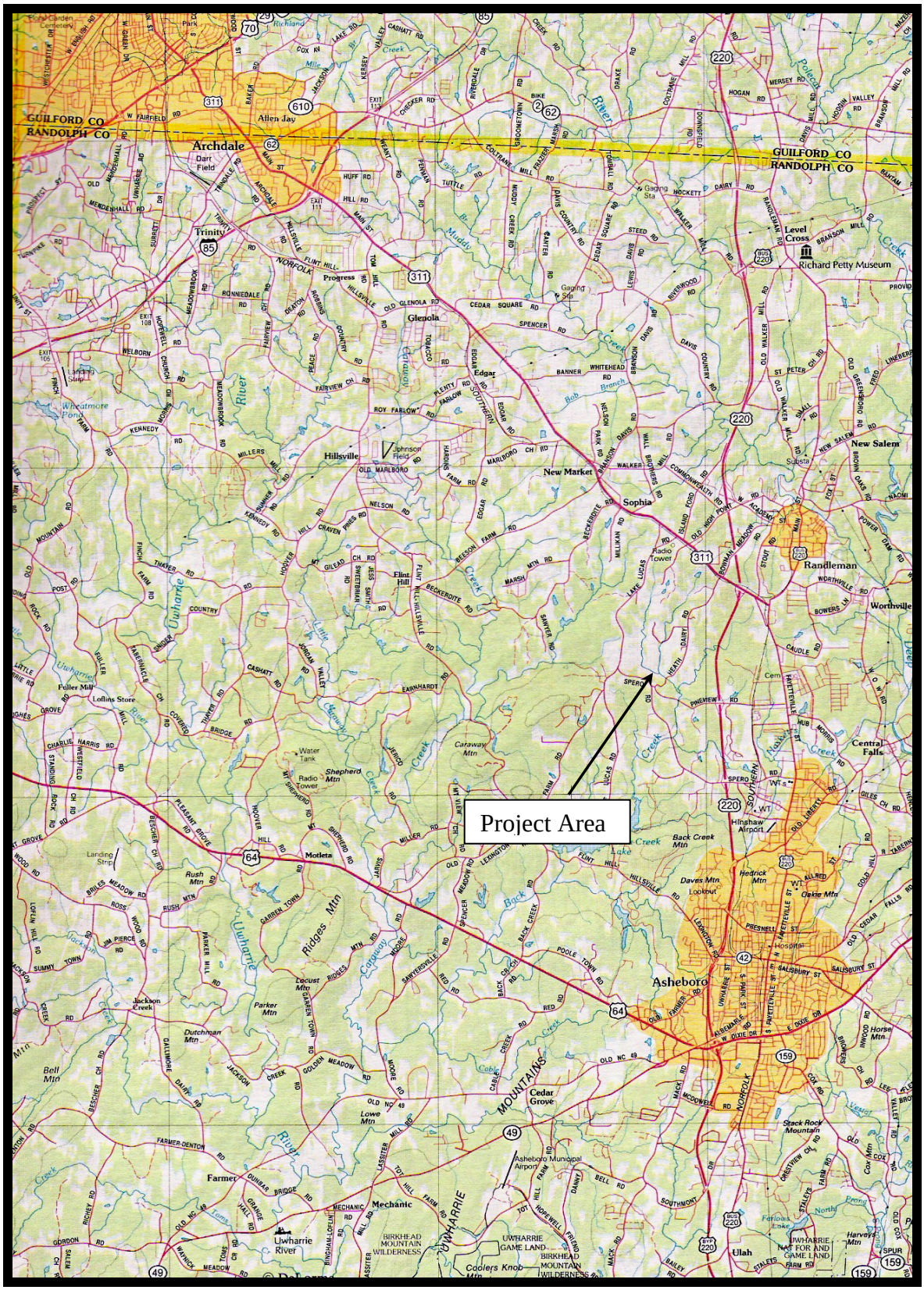


Figure 1: General Location of the Project Area.




Figure 2: Location of Survey Areas Shown on an Aerial Map.

extensive research in the project area, and background information obtained for those studies was used to the extent possible.

Fieldwork was conducted on May 2 and 3, 2006. Loretta Lautzenheiser served as principal investigator and field director, and Dawn Bradley assisted in the field and prepared portions of the report. Bill Hall was the project historian and authored portions of the report. Denise Haynes prepared the site forms. Graphic illustrations were prepared by Bill Hall.

The property owner, Mr. Ridge, assisted with access to the upper dam site, and rescued us from the marauding cows.

# NATURAL SETTING

## Physiography and Regional Geology

The study area is broken into three specific survey areas located along the drainages of Back Creek in central North Carolina. Broadly, the areas of interest fall within the Piedmont Physiographic Province, one of three provinces existing in North Carolina (NCGS 1985). Specifically, these areas lie within the Carolina Slate Belt, one of several northeast to southwest trending belts which make up the Piedmont. The Carolina Slate Belt is predominantly low-grade metavolcanic and meta-epiclastic rock (NCGS 1988).

The study area falls within a contact area of two rock units within the Carolina Slate Belt- the Felsic Metavolcanic Unit and the Metamudstone and Meta-argillite Unit (NCGS 1985). The Felsic Metavolcanic unit is divided into two sub-units. The first sub-unit is described as "felsic rock with euhedral to subhedral feldspar crystals or lithic fragments in a dense, fine-grained matrix" (NCGS 1988). Lithology of this sub-unit typically includes three types of tuff (felsic, crystal and lithic), flow and tuff breccia and some minor epiclastic and mafic volcanic rock (NCGS 1988). The Metamudstone and Meta-argillite unit in the study area is described as a fine-grained argillite with well-developed bedding (NCGS, 1988).

## Soils

Randolph County has a published soil survey available online at www.co.randolph.nc.us . Soils for the survey areas fall into two categories: Badin-Tarrus complex and the Georgeville silty clay loam 2 to 8 percent slope (Wyatt 2002).

***Badin-Tarrus Complex (BtB2 and BtC2)*:** The landscape for this complex is described as Piedmont uplands, with moderate erosion and either 2-8 percent slopes (BtB2) or 8-15 percent slopes (BtC2) (Wyatt 2002). Soils are well-drained, moderately permeable with medium to rapid surface runoff. Soil profiles for both slope percentage types are the identical, while composition percentages vary slightly. Compositionally, BtB2 is 44 percent Badin or similar soils, 40 percent Tarrus or similar soils and 16 percent contrasting inclusions. Composition for BtC2 is 62 percent Badin or similar soils, 33 percent Tarrus or similar soils and 5 percent contrasting inclusions. The typical Badin soil profile consists of a strong brown silty clay loam at the surface and subsoil of yellowish red silty clay loam transitioning into red clay then into red silty clay loam. The typical Tarrus soil profile consists of a red silty clay loam at the surface and red silty clay subsoil transitioning a red silty clay loam. The bedrock in both soil profile types is a weathered, moderately fractured argillite (Wyatt 2002). Contrasting inclusions refers to limited, random areas of other soil types such as Goldston, Georgeville, Callison, and Lignum (Wyatt 2002).

Land management is mostly for cropland, pasture, hayland or woodland. Corn, soybean, small grains and tobacco are the major crops grown in this complex (Wyatt

2002). The Tarrus soils are better suited for crop growth than the Badin soils, although erodibility and soil fertility are a concern. Both soils are well-suited for pasture, hayland and woodland use although again, erodibility and soil fertility could be a problem (Wyatt 2002).

***Georgeville silty clay loam 2 to 8 percent slope (GeB2):*** The landscape in this area is described as Piedmont Slate Belt, with moderate erosion and 2 to 8 percent slopes as the name implies (Wyatt 2002). Soils are well-drained, with moderate permeability and surface runoff. Compositionally, soils are 97 percent Georgeville or similar soils and 3 percent contrasting inclusions. A typical soil profile consists of yellowish red silty clay loam at the surface and a subsoil of red clay transitioning into red silty clay loam with reddish yellow mottles. Underlying material is described as red silt loam saprolite with light reddish brown and pale brown mottles (Wyatt 2002). Contrasting inclusions refers to Tarrus soils found on ridge shoulders and Badin soils found on more sloping parts (Wyatt 2002).

Land use consists mostly of cropland, pasture, woodland or urban development (Wyatt 2002). The soil is well-suited for growing corn, soybeans, small grains and tobacco; as with the Badin-Tarrus complex, erodibility and soil fertility are a concern here. The soil is moderately suited for urban development, although restricted permeability, corrosivity and low strength are areas of concern (Wyatt 2002).

The Southern Piedmont Province, as a whole, is one of the most severely eroded in the United States, with at least 5.5 inches of soil lost since European settlement (Trimble 1974). In his research, Trimble (1974) defined five basic types of Erosive Land Use (ELU) practices and correlated them to soil loss. Amount of soil erosion in each ELU varied due to the different varieties of crops grown and different conservation practices used. This study area falls into Region V(A) or Mixed Farming Area. Trimble (1974) could not determine any definite trends across this region, although he did observe that mean ELU intensities of this region continuously remained at levels below the mean ELU intensities of other regions.

By 1860, portions of Region V(A) in North Carolina were showing definite signs of land abuse, with ELU reaching an intensity of 35-45 percent (Trimble 1974). Relatively large increases occurred in the western portions of Region V(A) as tobacco cultivation increased. Intensity of ELU continued to grow after 1860 as tobacco cultivation expanded. A marked decrease in ELU became apparent after the 1920s partly due to land abandonment (leading to reforesting) and partly due to the implementation of basic soil conservation methods (Trimble 1974).

**Vegetation**

The project area is located within the Oak-Pine Forest Region which exists more or less coextensive with the Piedmont throughout the Carolinas (Braun 1950). In this region, oak and hickory trees are the most commonly found and generally the most

widespread. Aside from areas with poor or more arid soils, pine tree growth is usually temporary, ultimately replaced by deciduous species (Braun 1950).

Mixed hardwood bottomland communities develop where the flats are wide enough and old enough. The principal species found are sweet gum, willow oak, white and winged elm, red maple, tulip tree, as and water oak (Braun 1950).

**Hydrology**

This study area falls along the northern headwaters of the Back Creek, well north of Back Creek Lake. Back Creek is a major tributary in the Yadkin-Pee Dee River Subbasin, a subdivision of the Yadkin Basin. This creek trends north to south, with a low gradient averaging 0.2 feet/mile. In some areas, the creek passes through more resistant bedrock, resulting in a steeper channel or a poorly developed floodplain. Other areas travel through softer rock, allowing the creek to meander laterally and resulting in well-developed floodplains and terraces. Both bed and bank form of Back Creek have been changed by agricultural and pasture activity. Removing vegetative cover for both activities would increase stream flow, resulting in a straighter channel bed, steeper banks and carrying of a heavier load (more soil) downstream. Modern soil conservation techniques implemented in the area would lessen the effect of such activity, but would also influence the character of the creek bed and bank.

# HISTORIC BACKGROUND

## Paleoindian Period

Native American occupation of North America dates to at least the Paleoindian period, which is thought to have begun by approximately 12,000 to 11,000 B.C. (Anderson and Faught 1998). The evidence for Paleoindian occupations at this time includes fluted projectile points (i.e., Clovis and Cumberland points) (Griffin 1967; Justice 1987). These points are generally scarce and often come from disturbed surface contexts. The points were part of a mobile subsistence pattern based upon hunting and gathering in a boreal forest environment.

Unfluted trianguloid projectile points such as Dalton and Hardaway Side-Notched mark the end of the Paleoindian period and the transition to the Early Archaic period (ca. 8000 B.C.) (Justice 1987; Daniel 1998). These points have been recovered from stratified Paleoindian to Archaic contexts in eastern North America and appear to represent a technological link to the side- and corner-notched traditions of the Early Archaic period.

## Archaic Period

The Archaic period (8000-1000 B.C.) was apparently a time of climatic change. A shift from boreal forests to northern hardwoods occurred around the time of the Early Archaic period (8000-5000). During the early part of this time, a cool, moist climate prompted the expansion of species-rich Mixed Hardwood Forest in the eastern United States. During the Hypsithermal phase, the Oak-Chestnut Forest became dominant in the central and southern Appalachians, oak and hickory were replaced by southern pine on the Coastal Plain, and the Oak-Hickory-Southern Pine Forest covered the Piedmont (Delcourt and Delcourt 1981; Delcourt and Delcourt 1985). These changes were probably accompanied by an increase in population, as seen in the greater number of sites with Archaic components (Phelps 1983). It is generally thought that in the Archaic period there was a continuation of the hunting and gathering lifestyle, with a possible round of seasonal movement between base camps and hunting camps.

The Early Archaic Palmer phase is typified by a small corner-notched blade with a straight, ground base and pronounced serrations (Coe 1964). During the Kirk phase the points increased in size and basal grinding declined. A broad-stemmed, deeply serrated point gradually replaced the earlier corner-notched style. The decrease in basal grinding characteristic of later Kirk projectile points is indicative of cultural affiliations to the west (Coe 1964).

The Middle Archaic Stanly phase appears to have developed out of the preceding phases and is the earliest clearly documented occupation at the stratified Doerschuk site (31MG22) in Montgomery County (Coe 1964; Phelps 1983). The Morrow Mountain and Guilford phases also appear during the Middle Archaic period (5500-3000 B.C.). Morrow Mountain projectile points are relatively small with a short, tapering stem.

Davis and Daniel (1990) date these points to about 5500-5000 B.C. The analysis of material from the Haw River sites suggests that the Morrow Mountain I and II type points may actually represent the continuation of the stemmed point tradition (Claggett and Cable 1982).

Guilford projectile points, which represent "a potentially anomalous situation in the overall Piedmont sequence" (Claggett and Cable 1982:39), are found in two forms: a lanceolate variety, the most commonly recovered, and a form with a weakly developed stem. According to Davis and Daniel (1990), these date to about 5000-4000 B.C. The Guilford type has been described as "a thick, lanceolate bifacial cutting or piercing implement that apparently interrupts the Archaic development trend from notched to stemmed points (Claggett and Cable 1982:39). The apparent deviation in development is all the more noteworthy when the Late Archaic Savannah River projectile point, which represents clear evidence of a return to the Archaic developmental continuum, is considered. A recent study, however, has used mixed deposits and transitional forms from the Lowder's Ferry site (31ST7) to question the interpretation of Guilford and Morrow Mountain points as representing intrusive traditions (Drye 1997). Even more recently, the recovery of Savannah River, Morrow Mountain, and Guilford points from the same undisturbed strata at a site in Randolph County (31RD1166) provides some evidence of cultural continuity during the Archaic period (Lautzenheiser et al. 1999).

The Halifax phase was identified from the Gaston site (31HX7) on the Roanoke River, but did not appear at either the Hardaway or Doerschuk sites (Coe 1964). The Halifax point type, usually made of vein quartz, is a slender blade with shallow side notches. The base and side notches were usually ground.

The end of the Archaic, or terminal Archaic, is marked by the Savannah River phase. During this time, there is evidence for larger sites containing steatite bowls, human burials, and prepared hearths. This evidence suggests a more settled lifestyle (Ward 1983). The Savannah River projectile point is a large, heavy, triangular blade with a broad stem (Coe 1964). In the Southeast, the Savannah River phase is associated with a riverine, shellfish-oriented adaptation. The full complement of Savannah River projectile points, steatite bowls and netsinkers, engraved bone pins, grooved axes, and atlatl weights is usually recovered from riparian sites.

**Woodland Period**

During the Woodland period (1000 B.C.-A.D. 1650), the beginnings of regional differences are noted. The introduction of the bow and arrow and of ceramic manufacture generally defines the beginning of the Early Woodland (1000-300 B.C.) in eastern North America. Other common Early Woodland traits include the cultivation of plants and the construction of burial mounds. The cultivation of maize probably dates to around A.D. 1000 in the Piedmont. Burial mound complexes are essentially absent from the northern Piedmont (Hargrove et al. 1986).

The earliest expression of the Woodland tradition in the Piedmont is the Badin culture. It is characterized by hard, sandy ceramics and large, crude triangular projectile points. The differences between the southern and northern Piedmont traditions became more pronounced through time, and Badin assemblages are more commonly southern Piedmont phenomena. In general there is increasing diversity in the ceramic materials by the Late Woodland period (Ward 1983).

The Middle Woodland Yadkin phase was defined from the Doerschuk site. The ceramics appear to have evolved from the previous Badin type. The temper changed to a crushed quartz that, in some cases, constituted 30 to 40 percent of the paste. The surface finishes were cord-marked or fabric-impressed. It was during this phase that influences from the southern coastal region first appear, with clay temper mixed with the quartz (Coe 1964). The projectile point type was the Yadkin Large Triangular point, which differed from the previous Badin style in that it was better made.

The Uwharrie ceramic series in the central and southern Piedmont represents a late Middle Woodland/early Late Woodland outgrowth of the Badin and Yadkin ceramic traditions (Coe 1952; Eastman 1994). Uwharrie ceramics are marked by abundant fragments of crushed quartz temper. Portions of a Uwharrie vessel, recovered from a feature at the Donnaha site (31YD9) in northern Yadkin County, were found in association with charcoal fragments that provided a C-14 date of A.D. 1480 (Woodall 1984). The Uwharrie projectile point type is a small, slender triangle.

Late Woodland Dan River ceramics in the central and southern Piedmont probably developed out of the preceding Uwharrie phase (Coe 1964). The Dan River wares may contain both crushed quartz and coarse river sand inclusions.

During the Late Woodland period, a group of people from present-day South Carolina or northern Georgia migrated into the upper Pee Dee Basin, bringing with them a more complex cultural tradition, similar to that of the great southeastern Mississippian cultures (Ward and Davis 1999). The ceramic tradition of these new residents consisted of smoothed, burnished, and complicated-stamped vessels with a well-mixed paste including fine quartz sand (Coe 1964). Very little residual influence is found in the area following the withdrawal of these southern people around A.D. 1500.

Just before early European contact, the Caraway tradition developed in the central and southern Piedmont from the preceding Uwharrie-Dan River tradition. The series is represented by plain and stamped wares with a compact paste. Some Pee Dee influence is apparent. Caraway ceramics are tempered with very fine sand, and the plain wares are finished by smoothing, burnishing, and smudging (Coe 1964). Late Woodland and later historic period Caraway projectile points are small and isosceles-triangular.

By the time of European exploration, the Catawba Indians occupied much of the southern Piedmont, including the region around the current project area. The Catawba were a Siouan-speaking group who later formed a confederacy with groups such as the Sugeree and the Waxhaw (Hudson 1970). Late Woodland and early historic Catawba

ceramics are similar to Caraway ceramics but are more thoroughly burnished. By the time of John Lawson's journey in 1701, the Catawba were middlemen in the Virginia trade, supplying groups in the southern Carolina backcountry and probably the Cherokee as well.

**Early Settlement**

Settlement of the area by Europeans began in the early 1700s. These settlers were mostly from Pennsylvania and included people of Scotch-Irish, German, and English descent. As settlement in the eastern counties accelerated, people began moving west. Settlers also continued to move into the area down the Trading Path from Virginia and Pennsylvania. The colony at this time was still held by the Lords Proprietors. During the 66 years of proprietary rule, the titles passed through nearly 50 hands (Powell 1963).

In 1728, seven of the Proprietors sold out to the crown and Carolina became a royal colony. The sole holdout was Lord Carteret, who left his holdings to his son, the Earl of Granville. In 1744, the Granville District was laid off along the North Carolina-Virginia line and included a strip 60 miles wide. The western boundary was Bath in 1744, the Haw River in 1746, and the Rocky River in 1766 (Lefler and Newsome 1963). The early settlers in the area of Guilford and Randolph counties purchased their land from Lord Granville or his agents rather than the crown. The current Randolph and Moore county line follows the original Granville Grant line. Deeds in the Granville Grant were recorded from about 1730 to 1750 (Burgess 1924).

**Formation of Randolph County**

Randolph County was originally part of Guilford County. In 1770, the county was divided in half, with the southern part becoming Randolph. The county was named for Peyton Randolph, who was then president of the Continental Congress (Burgess 1924). The tax list in 1779 showed 879 taxables and approximately 4,500 persons in the county. The first courthouse was built at Cross Roads, where the Trading Path crossed the road from Cross Creek to Salem. The town of Johnstonville was authorized and was built around the courthouse square (Randolph County Historical Society 1980).

This courthouse location proved inconvenient, and in 1793, the court was moved to Randolph Court House on land deeded by Jesse Handley. The little village changed its name to Asheborough in 1796 to honor Governor Samuel Ashe. The first town, which stood two miles south of Randleman near Brown's Cross Roads, is now a plowed field (Randolph County Historical Society 1980).

**The Revolution**

Events of the Revolutionary War in Randolph County centered around the depredations of Colonel David Fanning and other Whig and Tory disputes. Fanning lived in Chatham County and was named a Colonel of the Royal Militia. With his

followers, he practiced guerrilla warfare, marauding throughout the area, with house burning, pillaging, and murder marking his path (Blair 1890).

Captain William Clark was the acknowledged leader of the Whig Party in Randolph County. He lived on the south side of the Deep River near where the Naomi Factory was built. Clark captured and killed John Elrod and Samuel Still, two notorious Tories who lived in the fork of the Yadkin River. Their deaths were in retaliation for a raid into Randolph County during which they had murdered Henry Johnson. William Millikan, a Quaker who lived on the west side of the road south of New Market, saw his house burned by the Tories. Although Millikan, in true Quaker fashion, did not take up arms, he was an active advocate of liberty. Col. Thomas Dougan, who lived at the Cross Roads and had a store there, was captured by Fanning, who was prepared to hang him. Some of Fanning's men, friends of Dougan's, intervened and gained his release (Blair 1890). Another leader of the Whig party in Randolph and Chatham counties was Herman Husbands of Sandy Creek. Although raised as a Quaker, Husbands commanded the Regulators at the battle of Alamance in 1771. He was later a member of the legislature and owned a large tract of land on the Deep River near the Buffalo Ford (Blair 1890).

**The Antebellum Period**

In 1843, the County Court ordered that mile posts were to be erected on all main roads. All measurements began at the Courthouse in Asheborough. The markers were made of wood or stone. At one time more than 50 covered bridges stood on county roads (Randolph County Historical Society 1980); the last remaining bridge stood below Coltrane Mill.

In the 1850s, Randolph County had five textile mills. Holland Thompson wrote in 1906 that

> upon Deep River in Randolph County, where five mills were built before 1850, conditions were somewhat peculiar. . . . These mills were in a section where the Quaker influence was strong. Slavery was not widespread and was unpopular. The mills were built by stock companies composed of substantial citizens of the neighborhood. There was little or no prejudice against mill labor as such, and the farmer's daughters gladly came to work in the mills. They lived at home, walking the distance morning and evening [Randolph County Historical Society 1980:78].

By 1850, wheat was a major crop in the Central Piedmont, with Randolph County being a major producer (Lefler and Newsome 1963). According to the 1860 *Census of Manufacturing*, Randolph County had an impressive 45 grist mills and 19 saw mills. A number of these mills had been established in the eighteenth century. The first mill privilege was granted to Samuel Walker in 1756 for a grist mill on Sandy Creek (Martin 1993). John Barton had a mill on Stinking Quarter; Andrew Hoover had a mill in the forks of the Uwharrie; Elisha Mendenhall's mill on the Deep River was known as Coltrane's Mill; Samuel Walker owned a mill on Sandy Creek; Soloman Fuller's mill on Caraway Creek was at the Rough Shoals; Thomas Cox had a mill on the Deep River; and

John Henly's mill was also on the Uwharrie River. All of these mills were in existence prior to 1787 (Blair 1890).

The first cotton mill in the county was built at Cedar Falls in 1836 by Benjamin Elliott, Phillip Horney, Alfred Marsh, and Henry Elliott. The land where the mill and village developed was granted to Herman Husbands in 1755 by Lord Granville. A grist and flour mill was operated on the site for a number of years before the factory was built (Blair 1890).

**The Civil War**

Early on during the Civil War a large number of deserters fled to the county. The central region of the state, Guilford, Forsyth, Randolph, Moore, and Davidson counties, harbored a large number of deserters. Deserters came to the area in part because of the presence of the Quaker population, who because of their opposition to the war would not turn them in to the authorities. Some of these deserters would band together and for a rather intimidating force. These men often brought their weapons with them from their units making them better armed than the local militia. A band of 300 to 400 such deserters reportedly roamed Randolph County (Barrett 1963).

The regular troops dispatched to the county to round up the deserters often brought the law-abiding residents as much trouble as the deserters. General R. F. Hoke entered the area in the fall of 1863 to round up deserters. Residents complained that troops visiting local farms plundered the farms families of deserters as well as loyal Confederates (Barrett 1963).

**Postbellum Period**

In the period after the Civil War, the people of the town and county attempted to return to normal. A journalist on a tour of the South in late 1865 described the area around Greensboro as "sterile in appearance." Cornelia Spencer also described the conditions for many of the families in central North Carolina who "lived for months on cornbread, sorghum, and peas; where meat was seldom on the table, tea and coffee never (Robinson 1980:113).

Although Union and Confederate armies did not battle in Randolph County, the county still had to contend with the loss of many of its young men in the war. The county had also suffered the ravages of the deserters that took refuge in the county, as well as the Confederate authorities sent to catch them. However, Randolph County was fortunate enough that when the war ended the county's limited industrial infrastructure, particularly the mills.

According to the 1904 *North Carolina Year Book and Business Directory*, Randolph County had made great strides in increasing the number of industries operating in the county during the postbellum period. The directory listed four cotton gins located in the county and at least eight cotton mills. The county also boasted other industries

such as brick manufacturers, furniture manufacturers, a foundry, and numerous merchants (News and Observer 1904).

The textile industry continued to grow in Randolph County. By 1938, a total of 24 textile mills were in operation. These mills employed over 4,500 people. The next largest industry in the county during the late 1930s was furniture and finished wood products manufacturing. This industry employed nearly 700 people. Farming continued to make up a significant part of the county's economy with over 4,800 farms in operation as of 1935, with tobacco listed as the largest money-making crop (North Carolina Department of Conservation and Development 1938).

In recent years, southeastern Randolph County has experienced a growth in tourism. The North Carolina Zoological Park and Botanical Gardens located at Purgatory Mountain in 1971. This section of the county also attracts tourists shopping for the fine pottery still produced there. The community of Coleridge also attracts visitors interested in learning about life in a nineteenth century industrial village (Randolph County Historical Society 1980).

# PREVIOUS RESEARCH

Some of the most extensive research in Randolph County has been conducted for the proposed Randleman Reservoir. Archaeological work on the proposed reservoir was initiated in the 1970s by the Research Laboratories of Anthropology at the University of North Carolina at Chapel Hill (UNC-CH). The survey was conducted over portions of Guilford, Randolph, and Moore Counties in preparation for the construction of two reservoirs along the Deep River (Coe and Wilson 1976). In addition to using topographic maps and previous site reports, personnel from UNC-CH utilized aerial maps to locate previously recorded sites and locations likely to yield additional sites. Survey areas were confined to open fields or other locations with surface visibility. One hundred and twenty one prehistoric sites were located during the intensive surface survey. The majority of the Woodland sites were located along the floodplain of the Deep River, and Archaic sites were located primarily at middle and upper elevations. Coe and Wilson (1976) also noted a sharp decline in the number of sites from Archaic to Woodland times and suggested that this was due to the paucity of wide bottomland tracts favored by Woodland peoples. No historic sites were recorded.

Over the years plans for the Randleman Reservoir changed from a large, recreational lake to a smaller lake to serve as a water supply for the City of Greensboro. Wake Forest University conducted a survey of portion of the proposed Randleman Reservoir using "a multistage sampling design, involving environmental stratification and clustering of sample survey units along Deep River and its major tributaries" (Woodall 1977:iii). The Muddy Creek drainage and the Deep River drainage were divided into sub-units, or clusters, which were "defined so as to include as complete a 'set' of microenvironments as possible" (Woodall 1977:10). Woodall (1977:12) reported that because historic sites were "sorely under-represented" in the sampled areas, other sites noted outside the sampled areas were also recorded. Eighty-five prehistoric sites and seven historic structures were recorded during this survey. Information gathered from this survey allowed the researchers to estimate that the total number of sites in the project area was 603$\pm$96 (Woodall 1977).

In 1983, Archaeological Research Consultants, Inc. (ARC) conducted a survey of 320 acres at the site of the proposed Randleman Reservoir Dam (Lewarch et al. 1983). In the uplands, exposed areas were intensively surface surveyed, and areas with limited visibility were shovel tested at 30-meter intervals. During this survey, 33 prehistoric and 11 historic sites were recorded. The majority of the prehistoric sites were upland lithic scatters with few diagnostic artifacts. No evidence of intact prehistoric sites was located in the narrow floodplains of the project area.

ARC recorded a much higher density of sites than previous surveys of the region (Lewarch et al. 1983), in part because the floodplains in the area of their survey tended to be broader than those in other areas, and the region may have been one of higher natural productivity. The survey conducted by ARC was also more intensive than other surveys. Leward et al. (1983:81) suggested that additional intensive surveys of the region be

conducted in order to determine "whether the dam survey site density is the result of prehistoric cultural ecology or of archaeological survey technique.

As part of the cultural resources planning conducted for the Randleman Reservoir, Garrow and Associates reviewed the previous research and analyzed a database constructed from information in the state files on previously recorded sites in the area. As a result of this review, they noted a "lack of information on the boundaries of land surveyed," as well as "a significant shortfall of survey within floodplains, and a general neglect of historic archaeological sites" (Gunn et al. 1993). Although Garrow researchers found that the approximate number of sites in the project area had been adequately estimated, they noted that future investigations needed to place more emphasis on documenting the "integrity and habitats of each site," as well as site size, time, and function (Gunn et al. 1993:44). The researchers then devised a plan for the completion of the cultural resources inventory for the reservoir, including deep testing of the floodplains utilizing backhoes.

The final survey of the proposed reservoir, now including only the pool area and not the buffer zones or access points, was conducted by CCR (Lautzenheiser et al. 1997). During this study, which included deep trenching of floodplain deposits, 81 sites were recorded. This study also resulted in a geoarchaeological model for Piedmont drainage basins. Among the sites recorded were three water mills with substantial remains, a dam and remains of some cribbing from an Antebellum mill, and the remains of a blacksmith shop that had been operated from a water source at a dam, also recorded as a site. A final water-powered industry was the remains of a small dam that reportedly was part of a gun-smith operation.

Evaluative testing was conducted at seven historic sites in the proposed reservoir, including the water-powered sites (Lautzenheiser and Lynch 1998). In addition, data recovery was conducted at the Freeman's Mill (31GF373) that had been determined eligible for the NRHP at the survey stage (Lautzenheiser and Lovett 1998). Two of the larger mills, Coltrane's Mill (31RD1183) and the Walker Mill (31RD1141) retained portions of the later buildings and machinery, but neither retained significant information on the history of water-powered industries in the region.

The Freeman's Mill, however, did yield important information. The data recovery was approached from a multi-disciplinary perspective. In addition to the archaeological investigations, a review of the technology was undertaken in the collapsed "layer-cake" of the three floors of the building. The mill was founded in the late eighteenth century and operated first as a gristmill. The mill saw its major use as a textile factory and was later operated as an ice plant, hydroelectric generator, and an automobile repair shop (Lautzenheiser and Lovett 1998).

Only one archaeological site has been previously recorded in the current project area. Site 31RD1330 is discussed in the Results section. The other previously recorded sites closest to the project area were recorded by an avocational archaeologist. The three sites were originally defined as a single large site, but were assigned three site numbers

upon review. Located about a mile from the current project area, the three sites yielded ceramics, Guilford, Randolph, Morrow Mountain, and Savannah River projectile points. They also yielded unidentified points, possibly Kirk points.

Two surveys have been conducted in the general project vicinity. One for the US 220 Business improvements resulted in the recording of 13 archaeological sites (Idol and Webb 2005). All of the 13 sites were located on upland soils that had been eroded. Although the combined total of lithic artifacts from the site represented a fairly high percentage of high-quality rhyolite flakes, there was no context to the collection. All of the sites were recommended as not eligible for the NRHP.

A second survey, slightly closer to the study area covered an 8.9-mile corridor for the proposed relocation of US 311. Seventy-five archaeological sites were recorded in the APE (Kirchen et al. 2002). Ten of the sites had historic components; however none of these retained significant deposits. Of the prehistoric sites, only one was recommend as eligible for the NRHP.

Archaeological surveys are underway for the proposed Asheboro Bypass; however information on that survey was not available when the research was conducted for this project.

# METHODS

## Introduction

The purpose of the survey and evaluation was to determine if cultural resources that are on, or eligible for, the NRHP are located within the project APE. These resources were assessed against the criteria for the NRHP in order to determine their potential for eligibility. These criteria require that the quality of significance in American history, architecture, culture, and archaeology should be present in buildings, structures, objects, sites, or districts that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that the buildings, structures, objects, sites, or districts:

A) are associated with events that have made a significant contribution to the broad patterns of our history; or
B) are associated with the lives of persons significant in our past; or
C) embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
D) have yielded, or may be likely to yield, information important in prehistory or history (Federal Register 1997).

## Background Research

Background research was conducted at the:

- Randolph County Public Library, Asheboro
- North Carolina Office of State Archaeology, Raleigh
- North Carolina State Library, Raleigh

Additional information was obtained from the library at CCR. The purpose of the background research was to identify any previously recorded archaeological sites in or adjacent to the project area, to obtain information on project-specific natural characteristics and cultural patterns, and to review the results of cultural resource investigations in the region.

## Archaeological Field Methods

The study area consisted of three areas, two of which had standing remains. The third area had sufficient ground exposure that shovel testing was not necessary.

Black-and-white and color photographs were used to document the general conditions of the project area and the sites that were encountered. All survey areas were plotted on the project field map and USGS 7.5-minute quadrangles.

Archaeological sites were defined by the recovery of three or more artifacts in reasonable association or the presence of surface or subsurface structural remains. If a site was identified during surface survey, additional pedestrian transects at 5-m (16-ft) intervals or less were used to identify the site boundaries and obtain full survey coverage of the site area.

# RESULTS OF THE SURVEY

## Introduction

The archaeological survey of the stream restoration of Back Creek considered three areas within the APE; the bridge carrying Heath Dairy Road over Back Creek, the ruins of a stone dam, and an area where the creek is deeply incised with high banks. The APE ends at, but includes the bridge. The area with the high banks had surface visibility, and the subsoil was exposed at the surface. No archaeological remains were noted in this area. The stone dam was recorded as a site, and the area at the bridge contained a stone dam incorporated into the bridge that had been previously recorded as a site (Figure 3). These resources are described below.

*SITE NUMBER*: 31RD1330
*SITE TYPE*: Stone Dam
*COMMENTS*: Site 31RD1330 is a previously recorded stone dam incorporated into the bridge structure of Heath Dairy Road (SR 1712) over Back Creek (Figure 4). The site was originally recorded by NCDOT archaeologists and given a state site number, however, no site form was completed. The site was also visited in 2003 by Penne Sandbeck, Architectural Historian with the North Carolina Department of Transportation. Ms. Sandbeck concluded that the dam was associated with a mill; however no remnants of any mill were included in the site description.

This site is similar in construction to site 31RD1440 (described below) with a sloped spillway across the center of the dam, although the dam at 31RD1330 is in good condition. A drain located at the base of the dam allows the stream to flow normally (Figure 5), and the dam currently acts as a culvert.

Historic maps reviewed by CCR did not note any mills in this area; however, that does not preclude their presence. The research by NCDOT did note that a mill was operated at the ford on Back Creek. It is possible that a ford may have been in this location as Heath Dairy Road currently crosses the creek at this point. There is no evidence of a race or flume at this dam to carry water to the wheel. It is possible that the race could have been destroyed during improvements to Heath Dairy Road and the incorporation of the dam into the bridge structure. Investigations immediately below the dam did not note any mill remains, however, survey did not continue down stream outside the APE.

*RECOMMENDATIONS*: The site was recommended as potentially eligible for the NRHP by NCDOT (Faquin 2003). There are no boundaries associated with the dam except for the footprint of the resource. The dam has been recommended as eligible as an architectural resource, and no archaeological components are present in the project APE.

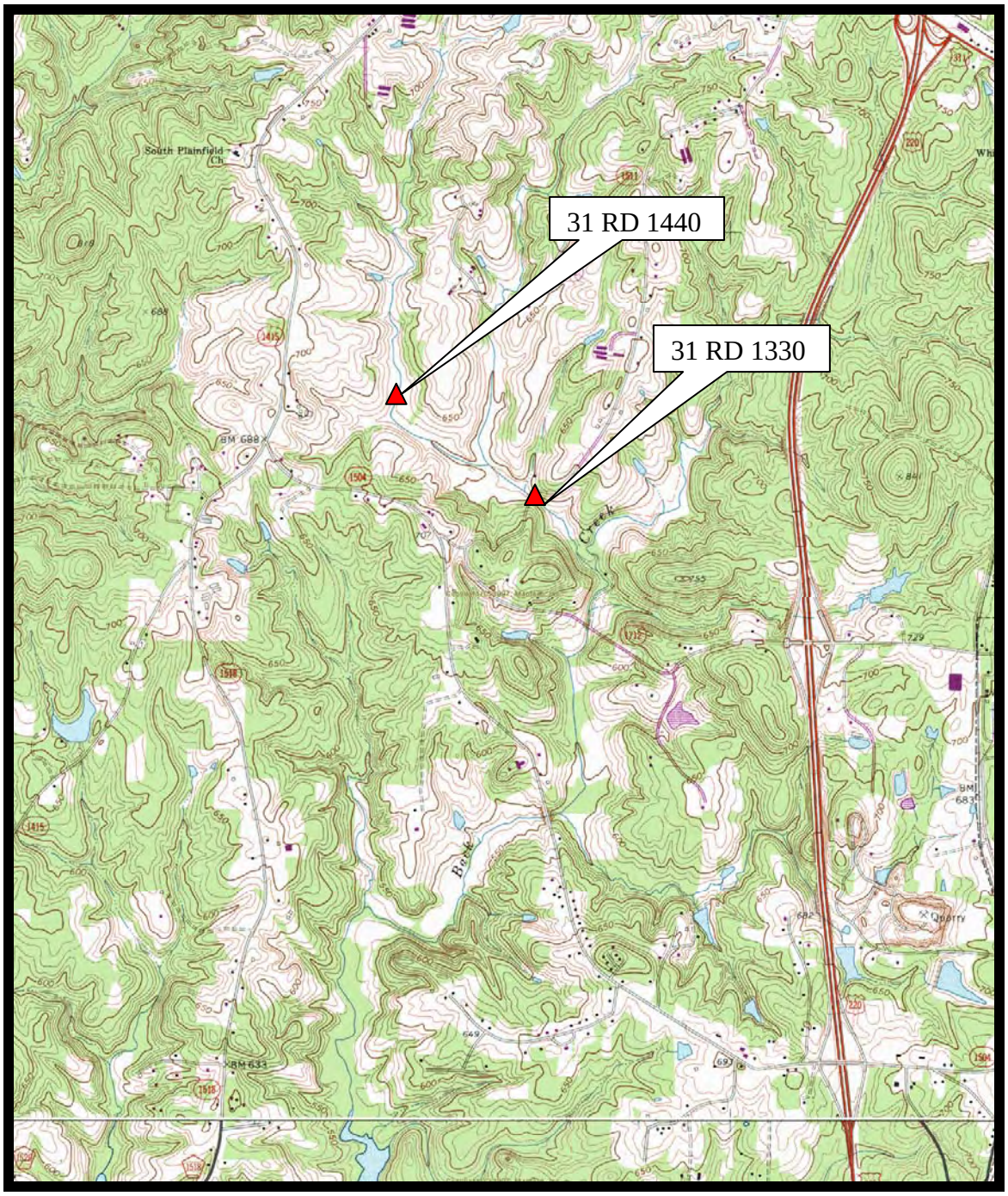

Figure 3: Locations of Archaeological Resources in the Back Creek Project Area.



Figure 4:  View of Site 31RD1330.



Figure 5:  Base of Dam at 31RD1330 Showing the Discharge at the Base.



Figure 6: Site 31RD1440.



Figure 7: View of Downstream Side of Dam at 31RD1440 Showing Discharge Similar to Site 31RD1330.

*SITE NUMBER*: 31RD1440
*SITE TYPE*: Stone Dam
*COMMENTS*: This site is the remains of a stacked-stone dam. It is located along the northern headwaters of Back Creek, approximately 2600 feet (.49 miles) upstream from site 31RD1330. The structural integrity of this dam has been breached, but partial ruins remain (Figure 6). According to Mr. Ridge, the property owner, the dam was breached in 1954 during Hurricane Hazel.

This site is similar to site 31RD1330, the previously recorded stone dam incorporated into the bridge structure of Heath Dairy Road (SR 1712). Both sites are similarly constructed with a sloped spillway across the center of the dam. As in site 31RD1330, a drain is located at the base of the dam so that the stream is unimpeded during periods of normal flow (Figure 7). In both dams these drains were formed using a large stone lintel across the top, obviously placed during the original dam construction. This would negate the use of the dam to store water to operate a water wheel or turbine. If there was a mill at this site, it is possible it operated only periodically, and the drain was closed at periods of operation.

White it is possible that these dams were associated with mills, it is also possible that they were constructed not to store water, but to slow the flow of water during periods of flood, preventing the erosion of topsoil and limiting flooding downstream. Site 31RD1330 provides a better example as it is completely intact and still functional. The close proximity of the two dams could imply a series of erosion control dams used along the bank creek. Mr. Ridge, the property owner, does not know of any mills associated with the dams, but had heard that they were for erosion control.
*RECOMMENDATIONS*: Regardless of its original function, this dam is in ruins and does not retain the ability to yield significant information. This site does not appear eligible for the NRHP, and no additional archaeological work is recommended.

# RECOMMENDATIONS

During the survey of portions of the Back Creek stream restoration project, one archaeological site was recorded and one previously recorded site was revisited. Site 31RD1440 is the ruins of a stacked-stone dam. It is recommended as not eligible for the NRHP. Site 31RD1330 is a previously recorded resource that has been recommended as eligible for the NRHP as an architectural resource. If it is impacted by the undertaking, it will be necessary to mitigate any adverse effects to the resource. No additional work is recommended for site 31RD1440.

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# APPENDIX A

# PROPOSAL TO PERFORM ARCHAEOLOGICAL SERVICES COASTAL CAROLINA RESEARCH, INC.

**PROJECT:** Archaeological Survey of Portions of the Proposed Heath Dairy Road Stream Restoration Project, Randolph County, North Carolina

**DATE:** May 3, 2005

## INTRODUCTION

Coastal Carolina Research, Inc.(CCR), proposes to perform the following archaeological services for HSMM in partial compliance with Sections 106 and 110 of the National Historic Preservation Act of 1966, and the Advisory Council on Historic Preservation's regulations for compliance with Section 106, codified as 36 CFR Part 800. The survey of the selected areas will be consistent with the Secretary of the Interior's *Standards and Guidelines for Archaeology and Historic Preservation*. The archaeological report will conform to the report guidelines issued by the Office of State Archaeology (OSA) of the State Historic Preservation Office (SHPO).

This proposal is being prepared in response to a request from HSMM to conduct an archaeological survey of portions of the proposed Heath Dairy Road Stream Restoration. The stream restoration covers approximately 10,000 linear feet of stream in a corridor 100 feet wide (50 feet each side of the stream). The Area of Potential Effects (APE) for the study has been defined by the Ecosystem Enhancement Program (EEP) of the Division of Natural Resources (DNR) as two areas containing known historic resources and one five-acre area of uplands adjacent to the stream.

This project is subject to a permit from the US Army Corps of Engineers (USACE). Section 106 of the National Historic Preservation Act (NHPA) requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings. The Agency official should consult with the State Historic Preservation Officer (SHPO) in a manner appropriate to the agency planning process and to the nature of the undertaking and its effects on historic properties. The agency official should identify the APE in consultation with the SHPO and make a reasonable and good-faith effort to carry out appropriate identification efforts. As the agency has not consulted with the SHPO in advance of the survey, the APE may be expanded requiring survey of additional areas. Any additional survey will require a supplemental agreement.

If archaeological sites are recorded in the three survey areas that appear to be potentially eligible for the National Register of Historic Places (NRHP), the report will

make recommendations for any needed additional work or management options. If properties that are potentially eligible for the NRHP are located in the survey area, additional evaluation may be necessary. Evaluations will require a supplemental agreement.

## DESCRIPTION OF THE SURVEY AREA

The project area is located in northern Randolph County west of US 220 along a tributary of Back Creek. The majority of the area is in pasture. The three areas defined for survey include a bridge (approximately one acre), stone structure that may be the remains of a dam (approximately one acre), and an area of high banks where the stream bed is deeply incised (approximately five acres).

## PLAN OF WORK

**Background Research**. Background research will be conducted at the Office of State Archaeology, the state library, the library of CCR, and possibly the UNC-Charlotte library. All previously recorded resources in the project area will be noted on the project maps. The information on the site forms will also be recorded. All cultural resources reports from the counties as well as regional studies will be reviewed. In addition to the archival research, knowledgeable individuals will be sought out for local information. The background review will include project-specific natural characteristics and cultural patterns, and will synthesize the results of cultural resources investigations in the region to assess and update the existing documentation.

If previously recorded archaeological sites are located within the project corridor but not within the defined APE, they will be noted on project maps as not having been revisited.

**Archaeological Survey.** The survey will be designed to identify the archaeological resources within the defined APE, and if possible, to determine whether or not the identified resources are potentially eligible for listing in the NRHP. The level of effort will be to the extent needed to identify the sites and assess the *potential* for eligibility of a site to the NRHP. It is often not possible to evaluate archaeological sites without an intensive testing program. Evaluative testing to determine eligibility is not included in the current proposal.

In areas of sufficient surface visibility a surface survey will be conducted supplemented by shovel tests. Surface survey will be the survey method of choice when appropriate. Shovel tests will be placed in sites identified by surface survey to view the soil profiles. Shovel tests will also be utilized in areas of poor surface visibility, and will be placed on no greater than 30 m intervals in areas of moderate and well drained soils. Survey intervals will be greater in areas of somewhat poorly drained soils and will be placed judgmentally depending on the soil conditions. Disturbed and wet areas will not be shovel-tested. Shovel tests will be on closer intervals in defined historic areas.

Shovel tests are usually 30 x 30 cm and will be excavated into the subsoil or sterile soil. Occasionally larger tests will be utilized. Fill from the tests will be screened through 0.25-inch mesh screen. In the event that the soil cannot be screened, the fill will be hand and trowel sorted.

An archaeological site will be defined by the recovery of three artifacts in reasonable association. Historic sites are also defined by the presence of surface or subsurface structural remains. Diagnostic isolated finds are given a site number for management purposes. On occasion, an isolated find will be defined as a site, particularly in those instances where the find is recovered from an area of low visibility or heavy erosion and in an area where the presence of a site would be expected.

When an archaeological site is identified, the approximate horizontal and vertical extent of the site, as well as the internal configuration of the site, will be defined to the extent possible.

**Management Summary.** The management summary will be submitted to HSMM within ten working days following the completion of fieldwork. This summary is a preliminary evaluation of the results of the fieldwork. The summary will discuss the results of the fieldwork and present a preliminary assessment of the identified archaeological sites.

All sites recorded will be given a permanent site number obtained from the Office of State Archaeology. This site number may not be available for the management summary, but will be used in the final report.

**Evaluation.** Recommendations for sites that appear to not be eligible for the NRHP or for sites requiring additional work to determine eligibility for the NRHP will be based on the criteria of eligibility for the NRHP. These criteria require that the quality of significance in American history, architecture, culture, and archaeology should be present in sites that possess integrity of location, design, setting, materials, workmanship, feeling and association, and that the sites:

A. are associated with events that have made a significant contribution to the broad patterns of our history; or

B. are associated with the lives of persons significant in our past; or

C. embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. have yielded, or may be likely to yield, information important in prehistory or history (NPS 1986).

In assessing the significance of the resource, the integrity of the resource will be considered. Also considered will be the degree of redundancy contained in the resource. Evaluations of the local and regional significance will be guided by the statewide plan for archaeological research in the state of North Carolina.

In general, sites which lack sub-plow zone artifact-bearing deposits, have low-density artifact distribution, contain evidence of deep plowing, lack spatial integrity, lack artifact concentrations, or exhibit signs of earth-disturbing activities do not appear to be good candidates for inclusion in the NRHP. Sites which contain concentrations of artifacts, which contain large ceramic sherds, especially those with fresh breaks, which appear to have spatial integrity, or which contain evidence of intact deposits are recommended for additional evaluation to determine if they are eligible for inclusion in the NRHP.

**Analysis.** At the completion of the fieldwork, the recovered artifacts will be analyzed. This information will be included in the final report.

All artifacts will be cleaned and labeled with an accession number provided by the Office of State Archaeology. At the completion of the project, all artifacts will be submitted to the OSA for curation. Fees for curation are included in the budget.

Prehistoric lithic artifacts will be defined using Coe (1964) as the primary authority on typology and temporal placement. Lithic raw material will also be determined. Fire-cracked rocks and unmodified cobbles will be noted, but generally not retained for curation. Prehistoric ceramics will be defined as to type and temporal placement using the appropriate typologies. The regional typologies and listing of references will be those detailed in Eastman and Lautzenheiser (1993). Clay impressions of surface treatments will be taken where possible to determine the twist and size of cordage and weaves of fabric.

Historic artifacts will be analyzed using standard source books and typologies. Ceramics and glassware will be typed and temporally assigned where possible. Where collection size warrants, an assessment of status will be attempted. Brick debris will be sampled but not intensively collected. Recent artifacts will be noted but generally not collected. Metal items will be cleaned and kept dry, and electrolysis may be conducted on selected artifacts.

**Reports.** A report will be prepared which will detail the results of the archaeological survey, and one will be prepared detailing the results of the evaluation. The survey report will contain a map showing the locations of recorded sites in the APE along with a table of the sites and the recommendations for eligibility. The report will be prepared following the guidelines prepared by the Office of State Archaeology.

For each phase of the project, reports will be provided in the following manner. Initially, a single copy of a preliminary Draft Report will be provided for comments. Once any comments have been addressed, five copies of the Draft Report will be

provided. Once any agency comments have been addressed, the Consultant will provide seven copies of the revised Final Report.

Seven copies of the Final Report will be submitted to HSMM within 30 days of receiving comments on the Draft Report.

## OTHER CONDITIONS

1. No work will begin without a mutually acceptable, fully executed contract. This proposal will form the basis of the consultant contract.

2. Compensation. Invoices for the percentage of work completed will be submitted monthly to HSMM.

3. Schedule. The schedule will depend upon the receipt of maps, contracts, and permission to proceed. No work will be initiated without a mutually acceptable executed contract. The schedule will be negotiated with HSMM.

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# North Carolina Department of Cultural Resources

## State Historic Preservation Office

Peter B. Sandbeck, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director


February 1, 2007

Brian A. Mazzochi, E. I.
Hayes, Seay Mattern & Mattern, Inc.
4141 Parklake Avenue, Suite 100
Raleigh, NC 27612

Re: Heath Dairy Road Restoration Site, Randolph County, ER 03-1801

Dear Mr. Mazzochi:

Thank you for your letter of December 13, 2007, transmitting the archaeological survey report by Coastal Carolina Research, Inc. for the above project. We apologize for the delay in our response, although we did not received the archaeological site form for 31RD1330** from NC DOT until January 31, 2007. Thus, our information was not complete until then.

During the course of the survey, one new archaeological site (31RD1440**) was recorded and one previously recorded site (31RD1330**) was revisited. Both of these sites are stacked stone dams. The dam at 31RD1440** does not retain any integrity and no associated remains were located during the investigation. Ms. Lautzenheiser of Coastal Carolina Research, Inc. has recommended the site as not eligible for the National Register of Historic Places and we concur with this recommendation.

Site 31RD1330**, also a stacked stone dam, was recorded by NC DOT in 2003. The site form submitted by NC DOT recommended preservation of 31RD1330 by avoidance and additional historic research and testing to determine its eligibility for inclusion in the National Register. The report by Coastal Carolina Research, Inc. states that this dam was determined eligible as an architectural resource, but the dam will not be affected by the proposed wetland mitigation project.

It is our opinion that additional information is needed prior to a determination of eligibility for 31RD1330**. However, since the dam will not be affected by the proposed project, additional investigation and research is not warranted in connection with this project.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, please contact Renee Gledhill-Earley, environmental review coordinator, at 919/733-4763. In all future communication concerning this project, please cite the above referenced tracking number.

Sincerely,

Renee Gledhill-Earley

Peter Sandbeck

cc: Matt Wilkerson, NCDOT
Loretta Lautzenheiser, Coastal Carolina Research, Inc.

# APPENDIX K

## Federally Protected Species

# Cape Fear Shiner

**Name:** *Notropis mekistocholas* (Cape Fear shiner)

**Family:** Cyprinidae

**Federal Status:** Endangered

**Date Listed:** September 26, 1987

*Characteristics:*
The Cape Fear shiner is a small (approximately 2 inches long), yellowish minnow with a black band along the sides of its body. The shiner's fins are yellow and somewhat pointed. It has a black upper lip, and the lower lip bears a thin black bar along its margin.

*Distribution and Habitat:*
The Cape Fear shiner's habitat occurs in streams with gravel, cobble, or boulder substrates. It is most often observed inhabiting slow pools, riffles, and slow runs associated with water willow (*Justicia americana*) beds. Juveniles can be found inhabiting slackwater, among large rock outcrops and in flooded side channels and pools. The Cape Fear shiner is thought to feed on bottom detritus, diatoms, and other periphytes. Captive specimens feed readily on plant and animal material.

The Cape Fear shiner is limited to three populations in North Carolina. The strongest population of the Cape Fear shiner is in Chatham and Lee counties from the Locksville dam upstream to Rocky River and Bear Creek. Another population is located above the Rocky River Hydroelectric Dam in Chatham County, and the third population is found in the Deep River system in Randolph and Moore counties.

*Threats to Species:*
Segmentation or separation of small populations by dams and loss of riverine habitat to impoundments are major concerns. Potential threats to the species and its habitat come from such activities as changes in stream flow, runoff from agriculture and communities, road construction, impoundments, wastewater discharge, and other development projects in the watershed.

# Schweinitz's sunflower

**Name:** *Helianthus schweinitzii* (Schweinitz's sunflower)

**Family:** Asteraceae

**Federal Status:** Endangered

**Date Listed:** May 7, 1991

*Characteristics:*
Schweinitz's sunflower is a long-lived perennial, flowering from late August to frost. The yellow disk and ray flowers are formed on small heads (involucre less than 0.6 in across). The leaves are rather thick and stiff in texture. The upper leaf surface is scabrous (rough) while the lower surface is covered with distinctive dense, soft white hairs. The leaves are opposite on the lower stem and alternate near the flowers. Lower stem leaves average 3.9 to 7.9 in long and 0.6 to 1.0 in wide while upper leaves are half this size. The leaves are five to ten times as long and wide, and sessile to short petiolate. The plants have purple stems that grow to an average height of 6.6 ft with the top one-third of the stem branching. The stems are at least sparsely strigose or hirsute below the inflorescence. Reproduction is accomplished both sexually (by seed) and asexually (by tuberous rhizome).

*Distinctive characteristics:*
Purple stem, scabrous upper leaf surface, dense, soft, white hairs on the lower leaf surface, small < 0.6 in flower head (not counting petal width), yellow disk and ray flowers.

*Distribution and Habitat:*
Schweinitz’s sunflower is endemic to the Piedmont Physiographic Province of North Carolina and South Carolina. Charlotte, NC is considered the center of this species' distribution. It is believed that this species formerly occupied prairie-like habitats or post oak-blackjack oak savannas that were maintained by fire. Current habitats for this species include roadsides, power line clearings, old pastures, woodland openings, and other sunny or semi-sunny situations. Schweinitz's sunflower is known for a variety of soil types but is generally found growing on shallow, poor, clayey and/or rocky soils, especially those derived from mafic rocks. In the few sites where Schweinitz's sunflower occurs in relatively natural vegetation, the natural community would be considered a Xeric Hardpan Forest (Schafale and Weakley 1990).

*Threats to Species:*
Schweinitz’s sunflower is threatened by fire suppression, urbanization such as residential and industrial development, highway construction and roadside and utility right of way maintenance.

*Roadside populations:*
In 1988, the NCNHP initiated a cooperative effort with NCDOT and the USFWS to prevent the mowing of *H. schweinitzii* populations during the flowering and fruiting period of August through October. Additionally, these populations should not be mowed during any part of the growing season extending from April through October.

# APPENDIX L

## BEHI/ NBS Data Collection Forms

# BEHI Form

Stream: Lower Bark Reach: (01) LT & RT Cross Section: Date: 12/6/06 Crew: AJW/BAM/AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 5.2 | MOD |
| 5.5 | 4.0 | 1.4 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 3.9 | LOW |
| 2.25 | 0.5 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 8.5 | V. HIGH |
| 20 | 10 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.0 | Mod |
| 70 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 7.9 | High |
| 15 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 30.5 | High |

Top Down

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

*Section from East Branch Confluence to HDR Bridge. LT Bank measured, apply to both LT & RT. So, Length x 2



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# Estimating Near-Bank Stress (NBS)

Stream: Lower Back Location: (01) LT&RT Date: 12/6/06 Crew: AJW BAM/AMH

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 4.0 | 3.9 | 1.03 | Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

Bankfull Ht. Sw Toe

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: East Branch Reach: (02) LT+RT Cross Section: Date: 12/6/00 Crew: AMH/BAM

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | | |
| 3.0 | 1.75 | 1.71 | 6.5 | High |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | | |
| 0.75 | 0.25 | | 7.0 | High |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | | |
| 15 | 3.75 | | 10 | Extreme |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | | |
| 65 | | | 4.5 | Mod |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | | |
| 05 | | | 3.0 | Low |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 31 | High |

**Bank Erosion Hazard Index**

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | Value | | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

East Branch from Confluence w/ Lower. Back up to ~ 60' upstream. Both sides of stream evaluated.



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# Estimating Near-Bank Stress (NBS)

Stream: East Branch Location: (02) LT&RT Date: 12/6/06 Crew: AMH/BAM

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.75 | 1.50 | 1.17 | Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: East Branch Reach: (03) CURRY Cross Section: Date: 12/6/06 Crew: JMH/BAM

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 1.0 | Very Low |
| 1.3 | 1.3 | 1.0 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 3.0 | Low |
| 1.0 | 0.77 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 6.5 | High |
| 35 | 26.95 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.9 | Mod. |
| 80 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 2.5 | Low |
| 60 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 18.9 | Low |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

Next stream of East Branch after (02). Both sides of reach. Extends past cattle Bridge to ~~Intermittent~~ ~~WL3. Vet 6~~ GPS Pt. EB01.



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# Estimating Near-Bank Stress (NBS)

Stream: East Branch Location: (03) LT; RT Date: 12/6/06 Crew: AMH/BAM

| | | |
|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme |

| | | | | | |
|---|---|---|---|---|---|
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 1.3 | 1.4 | 0.93 | V. Low |

| Dominant Near-Bank Stress |
|---|
| 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level III | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |

| | | | |
|---|---|---|---|
| Level IV | 7 | Velocity Gradient (ft/s/ft) | Near-Bank Stress |
| | | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI rorm

Stream: East Branch Reach: (4) LT & RT Cross Section: Date: 12/6/00 Crew: AMH/BAM

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 6.0 | High |
| 1.4 | 0.9 | 1.6 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 3.0 | Low |
| 1.0 | 0.7 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 05 | 3.5 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 3.5 | Low |
| 50 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extrem |
| 0'L | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 32.5 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

East Branch above section 2, beginning @ ~~wet~~ GPS Pt. EB01.

MEASURED @ GPS PT. 04



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | |
|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme |

| | | | | | |
|---|---|---|---|---|---|
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 0.9 | 0.95 | 0.95 | V. Low |

| Dominant Near-Bank Stress |
|---|
| 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level III | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: EAST BRANCH Reach: 05 Lt ~~Rt~~ Cross Section: Date: 12/6/06 Crew: BAM & AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | | |
| 3.0 | 0.8 | 3.75 | 10 | Extreme |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | | |
| 2.7 | 0.9 | | 1.9 | V. Low |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | | |
| 12.5 | 11.25 | | 8.5 | V. High |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | | |
| 80 | | | 5.9 | Mod. |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | | |
| 20 | | | 7.5 | High |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 33.8 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

E.B. from GPS PT ~~05~~ EB02 to EB03

@ GPS PT 05



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | |
|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme |

| | | | | | |
|---|---|---|---|---|---|
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 0.8 | 0.85 | 0.94 | V. Low |

| Dominant Near-Bank Stress |
|---|
| 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level III | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |

| | | | |
|---|---|---|---|
| Level IV | 7 | Velocity Gradient (ft/s/ft) | Near-Bank Stress |
| | | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: EAST BRANCH Reach: 05 RT Cross Section: Date: 12/6/05 Crew: BAM & AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.0 | Very High |
| 1.3 | 0.6 | 2.2 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 6.5 | High |
| 0.3 | 0.23 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 10 | 2.3 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 2.2 | Low |
| 25 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 9 | V. High |
| 10 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 35.7 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM GPS PT EB02 to EB03

@ GPS PT 05



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | |
|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme |

| | | | | | |
|---|---|---|---|---|---|
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 0.6 | 0.65 | 0.92 | V. Low |

| Dominant Near-Bank Stress |
|---|
| 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level III | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |

| | | | |
|---|---|---|---|
| Level IV | 7 | Velocity Gradient (ft/s/ft) | Near-Bank Stress |
| | | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very Low | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| Low | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| Moderate | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| High | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| Very High | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| Extreme | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: Lower Back Reach: 06 Both Cross Section: Date: 12/6/06 Crew: BAM + AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | | |
| 5.4 | 2.5 | 2.2 | 8.0 | V. Low |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | | |
| 2.7 | 0.5 | | 3.9 | Low |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | | |
| 15 | 7.5 | | 5.8 | V. High |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | | |
| 60 | | | 3.9 | Low |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | | |
| 10 | | | 9.0 | V. High |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 33.6 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM CONFLUENCE W/ E.B. TO CREST GAGE #1 (GPS PT 06)
MEASURED AT 60' D.S. OF CREST GAGE



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | |
|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 2.5 | 2.7 | 0.93 | V. Low |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: LOWER BACK Reach: 07 LT+RT Cross Section: Date: 12/6/06 Crew:

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8 | V. High |
| 2.7 | 1.3 | 2.1 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 3 | Low |
| 2.0 | 0.7 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 7.5 | High |
| 25 | 17.5 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.9 | Mod. |
| 80 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 5.9 | Mod |
| 30 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 30.3 | High |

**Bank Erosion Hazard Index**

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)
Boulders (Banks composed of boulders have low bank erosion potential)
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM CREST GAGE 01 TO CONFLUENCE W/N. BRANCH



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 (6) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 2.7 | 2.9 | 0.93 | V. Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

**Converting Values to a Near-Bank Stress Rating**

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very Low | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| Low | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| Moderate | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| High | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| Very High | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| Extreme | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

**Methods for Estimating Near-Bank Stress**

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: North Branch Reach: 08 LT & RT Cross Section: Date: 12/6/06 Crew: BAM + AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.2 | V. High |
| 4.5 | 2.0 | 2.3 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 3.0 | Low |
| 3.0 | 0.7 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 7.5 | High |
| 25 | 17.5 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 4.5 | Mod. |
| 65 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 5.9 | Mod. |
| 30 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 29.1 | Mod. |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM CONFLUENCE W/ BACK CREEK TO ~~MS~~ GPS PT NB 01



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | |
|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | (5) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 2 | 2.5 | 0.8 | V. Low |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) |
| | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | |
| | | | | | |

| Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
|---|---|---|---|
| | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

**Converting Values to a Near-Bank Stress Rating**

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

**Methods for Estimating Near-Bank Stress**

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: N. Branch Reach: 01 RT Cross Section: Date: 12/6/06 Crew: BM + AM H

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.2 | V. High |
| 4.4 | 2.0 | 2.2 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 4.5 | Mod. |
| 2.0 | 0.45 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 10 | 4.5 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 6.5 | High |
| 85 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extreme |
| 5 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 39.2 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

NB01 TO FENCE



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

**Level I**

| | |
|---|---|
| 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme |

**Level II**

| | | | | |
|---|---|---|---|---|
| 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | |
| 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | |
| 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

**Level III**

| | | | | |
|---|---|---|---|---|
| (5) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | 2.0 | 2.0 | 1.0 | Low |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | |

**Level IV**

| | | |
|---|---|---|
| 7 | Velocity Gradient (ft/s/ft) | Near-Bank Stress |
| | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very Low | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| Low | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| Moderate | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| High | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| Very High | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| Extreme | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: N. BRANCH Reach: ~~TS~~ 09 LT Cross Section: Date: 12/6/06 Crew: AM JJ

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.5 | V. High |
| 9.6 | 1.7 | 2.4 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 8.2 | V. High |
| 0.5 | 0.13 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 5 | 0.7 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5 | Mod. |
| 70 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extreme |
| 5 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 5 | |
| **TOTAL SCORE:** | | | 46.7 | Extreme |

**Bank Erosion Hazard Index**

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM ~~X~~ GPS PT NBOL U/S TO FENCE.



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.7 | 1.9 | 0.89 | V. Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: L. Back Creek Reach: 10 LT&RT Cross Section: Date: Crew:

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8 | V. High |
| 3.0 | 1.4 | 2.1 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 1 | V. Low |
| 3.0 | 1.0 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 8.5 | V. High |
| 10% | 10 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 7.9 | High |
| 90 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extreme |
| 5 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 35.4 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | Value | | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM CONFLUENCE W/ N. BRANCH U/S TO GPS PT LB01



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 (6) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.4 | 1.5 | 0.93 | V. Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

**Converting Values to a Near-Bank Stress Rating**

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very Low | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| Low | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| Moderate | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| High | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| Very High | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| Extreme | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

**Methods for Estimating Near-Bank Stress**

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: L. BACK CREEK Reach: 11 LT Cross Section: Date: 12/6/06 Crew: BAM / AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | | |
| 5 | 2 | 2.5 | 8.5 | V. High |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | | |
| 0.5 | 0.10 | | 8.5 | V. High |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | | |
| 5 | 0.5 | | 10 | Extreme |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | | |
| 85 | | | 7 | High |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | | |
| 5 | | | 10 | Extreme |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 44 | V. High |

**Bank Erosion Hazard Index**

| Erodibility Variable | | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM LB01 TO LB02



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | (5) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 2.0 | 2.1 | 0.95 | V. Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

**Converting Values to a Near-Bank Stress Rating**

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very Low | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| Low | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| Moderate | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| High | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| Very High | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| Extreme | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

**Methods for Estimating Near-Bank Stress**

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: L. BACK CREEK Reach: 11 & RT Cross Section: Date: 12/6/06 Crew: BAM / AMH

| Erodibility Variable/Value | | Index | Bank Erosion Potential |
|---|---|---|---|
| *Bank Height/Bankfull Height* | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | |
| 3.5 | 1.7 | 2.9 | 10 Extreme |
| *Root Depth/Bank Height* | | | |
| Root Depth (ft) C | C/A | | |
| 1.6 | 0.29 | 6 | High |
| *Weighted Root Density* | | | |
| Root Density (%) D | D*(C/A) | | |
| 20 | 5.8 | 8.9 | V. High |
| *Bank Angle* | | | |
| Bank Angle (degrees) | | | |
| 70 | | 5 | Mod. |
| *Surface Protection* | | | |
| Surface Protection (%) | | | |
| 35 | | 5.5 | Mod |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | 0 | |
| **TOTAL SCORE:** | | 35.4 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM LB01 US TO LB02



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | ⑤ | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.2 | 2.2 | 0.5 | V. Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

**Converting Values to a Near-Bank Stress Rating**

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Very Low | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| Low | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| Moderate | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| High | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| Very High | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| Extreme | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

**Methods for Estimating Near-Bank Stress**

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: L. BACK CREEK Reach: 12 LT +RT Cross Section: Date: 12/6/06 Crew:

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.5 | V. High |
| 3.0 | 1.2 | 2.5 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 6.2 | High |
| 0.8 | 0.27 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 10 | 2.7 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.5 | Mod |
| 75 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 7.5 | High |
| 20 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 37.7 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

LB 02 TO STACKED STONE DAM @ BLOWOUT



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | |
|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 1.2 | 1.25 | 0.96 | V. Low |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) |
| | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | |
| | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

| Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
|---|---|---|---|
| | | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 |
| Very Low | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| Low | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| Moderate | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| High | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| Very High | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| Extreme | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (e.g., Level I - **General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profile and/or Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: LB Reach: 12 LT & RT Cross Section: Date: 12/6/06 Crew: BAM / AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.4 | V. High |
| 3.0 | 1.3 | 2.3 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 5.8 | Mod. |
| 1.0 | 0.33 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 9 | V. High |
| 15% | 5 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.9 | Mod. |
| 80 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 6.5 | High |
| 25 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | -10 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 5 | |
| **TOTAL SCORE:** | | | 30.6 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | Value | | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

LB
STACKED DAM @ BLOWOUT TO LB03



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | |
|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme |

| | | | | | |
|---|---|---|---|---|---|
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 1.3 | 1.5 | 0.87 | V. Low |

| Dominant Near-Bank Stress |
|---|
| 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level III | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |

| | | | |
|---|---|---|---|
| Level IV | 7 | Velocity Gradient (ft/s/ft) | Near-Bank Stress |
| | | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: L. BACK CREEK Reach: 13 RT & LT Cross Section: Date: 12/6/06 Crew: BAM & AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.2 | V. High |
| 3 | 1.3 | 2.3 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 7.8 | High |
| .5 | 0.17 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 7.5 | 1.3 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.9 | Mod. |
| 80 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extrem |
| 5 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 10 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 41.9 | V. High |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM CB03 TO CONFLUENCE WITH W. BRANCH



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | (5) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.3 | 1.5 | 0.87 | V. Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: U. BACK CREEK Reach: 14 LT & RT Cross Section: Date: 12/6/06 Crew: BAM - AM/H

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.5 | V. High |
| 4.5 | 1.8 | 2.5 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 8.5 | V. High |
| 0.5 | 0.11 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 5 | 0.6 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 7.9 | High |
| 90 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extreme |
| 5 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 10 | SILT W GRAVEL |
| *Stratification:* Boundary between sandy loam and gravel | | | 5 | |
| **TOTAL SCORE:** | | | 49.9 | Extreme |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM CONFLUENCE W/W. BRANCH TO GPS PT UB01



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.8 | 1.8 | 1.0 | Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: U. BACK CREEK Reach: 14 LT & RT Cross Section: Date: 12/6/06 Crew: BAM+AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 10 | Extreme |
| 3.0 | 1.0 | 3.0 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 7.8 | High |
| 0.5 | 0.17 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 10 | 1.7 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.9 | Mod. |
| 80 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extreme |
| 5 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | .5 | (MINOR) |
| **TOTAL SCORE:** | | | 48.7 | Extreme |

**Bank Erosion Hazard Index**

| Erodibility Variable | | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM UBO1 to PROPERTY BOUNDARY



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.0 | 1.0 | 1.0 | Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: W. BRANCH Reach: 15 Lt & RT Cross Section: Date: 12/6/06 Crew: BAM/AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 10 | Extreme |
| 4.3 | 1.4 | 3.1 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 8.2 | V. High |
| .5 | 0.12 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 75 | 0.9 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 7.0 | High |
| 85 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 9 | V. High |
| 10 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 44.2 | V. High |

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM CONFLUENCE W/ BACK CREEK TO WB01



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.4 | 1.2 | 1.17 | Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: W. BRANCH Reach: 16 LT & RT Cross Section: Date: 12-6-06 Crew: RAM & AMIT

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.5 | V. High |
| 2.5 | 1.0 | 2.5 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 7.5 | High |
| .5 | 0.2 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 5 | 1.0 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 7.9 | High |
| 90 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 9 | V. High |
| 16 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 5 | |
| **TOTAL SCORE:** | | | 47.9 | Extreme |

FROM UB01 TO WB02

## Bank Erosion Hazard Index

| Erodibility Variable | | Bank Erosion Potential: Very Low | Low | Moderate | High | Very High | Extreme |
|---|---|---|---|---|---|---|---|
| *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |



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## Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | |
|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | (5) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | 1.0 | 1.2 | 0.83 | V. Low |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) |
| | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | |
| | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress | | | |
| | | | | | | |

### Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

**Methods for Estimating Near-Bank Stress**

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: UT TO WB  Reach: 17 LRT  Cross Section:  Date: 12-6-06  Crew: BAM + AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 10 | Extreme |
| 3 | 0.8 | 3.8 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 6.8 | High |
| 0.7 | 0.23 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 10 | 2.3 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 7 | High |
| 85 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 10 | Extreme |
| 8 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | GRAVEL |
| *Stratification:* Boundary between sandy loam and gravel | | | 5 | |
| **TOTAL SCORE:** | | | 48.8 | Extreme |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | Value | | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | Value | | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | Value | | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | Value | | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | Index | | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

CONFLUENCE W/ W. BRANCH TO FENCE



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | |
|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme |

| | | | | | |
|---|---|---|---|---|---|
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress |
| | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress |
| | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress |
| | | | | | |
| Level III | (5) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress |
| | | .8 | .8 | 1.0 | Low |

| Dominant Near-Bank Stress |
|---|
| 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Level III | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |

| | | | |
|---|---|---|---|
| Level IV | 7 | Velocity Gradient (ft/s/ft) | Near-Bank Stress |
| | | | |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: W.B RANCH Reach: 18 LT & RT Cross Section: Date: 12-6-06 Crew: BAM & AMH

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 7.9 | High |
| 2 | 1.0 | 2.0 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 3.9 | Low |
| 1.0 | 0.5 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 10 | Extreme |
| 2 | 1.0 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 7 | High |
| 85 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 7.5 | High |
| 20 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | 0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 36.3 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| | *Bank Height/ Bankfull Height* | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| | *Root Depth/ Bank Height* | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| | *Weighted Root Density* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| | *Bank Angle* | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| | *Surface Protection* | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM WB02 TO WB03



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# Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | (5) | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.0 | 1.05 | 0.95 | V Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

## Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

### Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# BEHI Form

Stream: W. BRANCH Reach: 19 LT & RT Cross Section: Date: Crew:

| Erodibility Variable/Value | | | Index | Bank Erosion Potential |
|---|---|---|---|---|
| *Bank Height/Bankfull Height* | | | | |
| Bank Height (ft) A | Bankfull Height (ft) B | A/B | 8.9 | V. High |
| 4.0 | 1.5 | 2.7 | | |
| *Root Depth/Bank Height* | | | | |
| Root Depth (ft) C | C/A | | 6.5 | High |
| 1 | 0.25 | | | |
| *Weighted Root Density* | | | | |
| Root Density (%) D | D*(C/A) | | 9 | V. High |
| 20 | 5 | | | |
| *Bank Angle* | | | | |
| Bank Angle (degrees) | | | 5.9 | Mod. |
| 80 | | | | |
| *Surface Protection* | | | | |
| Surface Protection (%) | | | 7.5 | High |
| 20 | | | | |
| *Materials:* Upper-sandy loam. Lower-gravel with sand matrix | | | -0 | |
| *Stratification:* Boundary between sandy loam and gravel | | | 0 | |
| **TOTAL SCORE:** | | | 17.8 | High |

## Bank Erosion Hazard Index

| Erodibility Variable | | | Bank Erosion Potential | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
| *Bank Height/ Bankfull Height* | | Value | 1.0 - 1.1 | 1.11 - 1.19 | 1.2 - 1.5 | 1.6 - 2.0 | 2.1 - 2.8 | >2.8 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Root Depth/ Bank Height* | | Value | 1.0 - 0.9 | 0.89 - 0.5 | 0.49 - 0.3 | 0.29 - 0.15 | 0.14 - 0.05 | <0.05 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Weighted Root Density* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 5.0 | <5.0 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Bank Angle* | | Value | 0 - 20 | 21 - 60 | 61 - 80 | 81 - 90 | 91 - 119 | >119 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |
| *Surface Protection* | | Value | 100 - 80 | 79 - 55 | 54 - 30 | 29 - 15 | 14 - 10 | <10 |
| | | Index | 1.0 - 1.9 | 2.0 - 3.9 | 4.0 - 5.9 | 6.0 - 7.9 | 8.0 - 9.0 | 10 |

**Bank Materials**

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points)

Silt/Clay (+ 0: no adjustment)

**Stratification**

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

**Total Score**

| *Very Low* | *Low* | *Moderate* | *High* | *Very High* | *Extreme* |
|---|---|---|---|---|---|
| 5-9.5 | 10-19.5 | 20-29.5 | 30-39.5 | 40-45 | 46-50 |

FROM W303 TO END



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## Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Level I | 1 | Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High<br>Extensive deposition (continuous, cross channel). NBS = Extreme<br>Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme | | | | | | | |
| Level II | 2 | Radius of Curvature Rc (feet) | Bankfull Width $W_{bkf}$ (feet) | Ratio Rc/W | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 3 | Pool Slope $S_p$ | Average Slope S | Ratio $S_p/S$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| | 4 | Pool Slope $S_p$ | Riffle Slope $S_{rif}$ | Ratio $S_p/S_{rif}$ | Near-Bank Stress | | | | |
| | | | | | | | | | |
| Level III | 5 | Near-Bank Max Depth $d_{nb}$ (feet) | Mean Depth d (feet) | Ratio $d_{nb}/d$ | Near-Bank Stress | | | | |
| | | 1.5 | 1.6 | 0.94 | V. Low | | | | |
| | 6 | Near-Bank Max Depth $d_{nb}$ (feet) | Near-Bank Slope $S_{nb}$ | Near-Bank Shear $\tau_{nb}$ (lb/ft$^2$) | Mean Depth d (feet) | Average Slope S | Shear Stress $\tau$ (lb/ft$^2$) | Ratio $\tau_{nb}/\tau$ | Near-Bank Stress |
| | | | | | | | | | |
| Level IV | 7 | Velocity Gradient (ft/s/ft) | | Near-Bank Stress | | | | | |
| | | | | | | | | | |

| Dominant Near-Bank Stress |
|---|
| 5 |

### Converting Values to a Near-Bank Stress Rating

| Near-Bank Stress | Method Number | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Very Low** | N/A | >3.0 | < 0.20 | < 0.4 | <1.0 | <1.0 | <1.0 |
| **Low** | | 2.21 - 3.0 | 0.20 - 0.40 | 0.41 - 0.60 | 1.0 - 1.5 | 1.0 - 1.5 | 1.0 - 1.2 |
| **Moderate** | | 2.01 - 2.2 | 0.41 - 0.60 | 0.61 - 0.80 | 1.51 - 1.8 | 1.51 - 1.8 | 1.21 - 1.6 |
| **High** | See (1) Above | 1.81 - 2.0 | 0.61 - 0.80 | 0.81 - 1.0 | 1.81 - 2.5 | 1.81 - 2.5 | 1.61 - 2.0 |
| **Very High** | | 1.5 - 1.8 | 0.81 - 1.0 | 1.01 - 1.2 | 2.51 - 3.0 | 2.51- 3.0 | 2.01 - 2.3 |
| **Extreme** | | < 1.5 | > 1.0 | > 1.2 | > 3.0 | > 3.0 | > 2.3 |

**Methods for Estimating Near-Bank Stress**

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope ($S_p/S$): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope ($S_p/S_{rif}$): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth ($d_{nb}/d_{bkf}$): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress ($t_{nb}/t_{bkf}$): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**


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# APPENDIX M

## Wetland Delineation Survey

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| NCDENR D06017S | 1 |

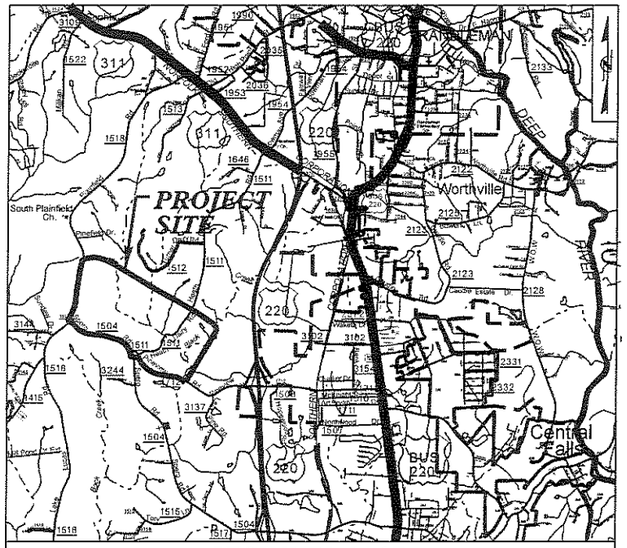
PREPARED IN THE OFFICES OF:

*AECOM USA, Inc.*
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552

# STATE OF NORTH CAROLINA
# ECOSYSTEM ENHANCEMENT PROGRAM

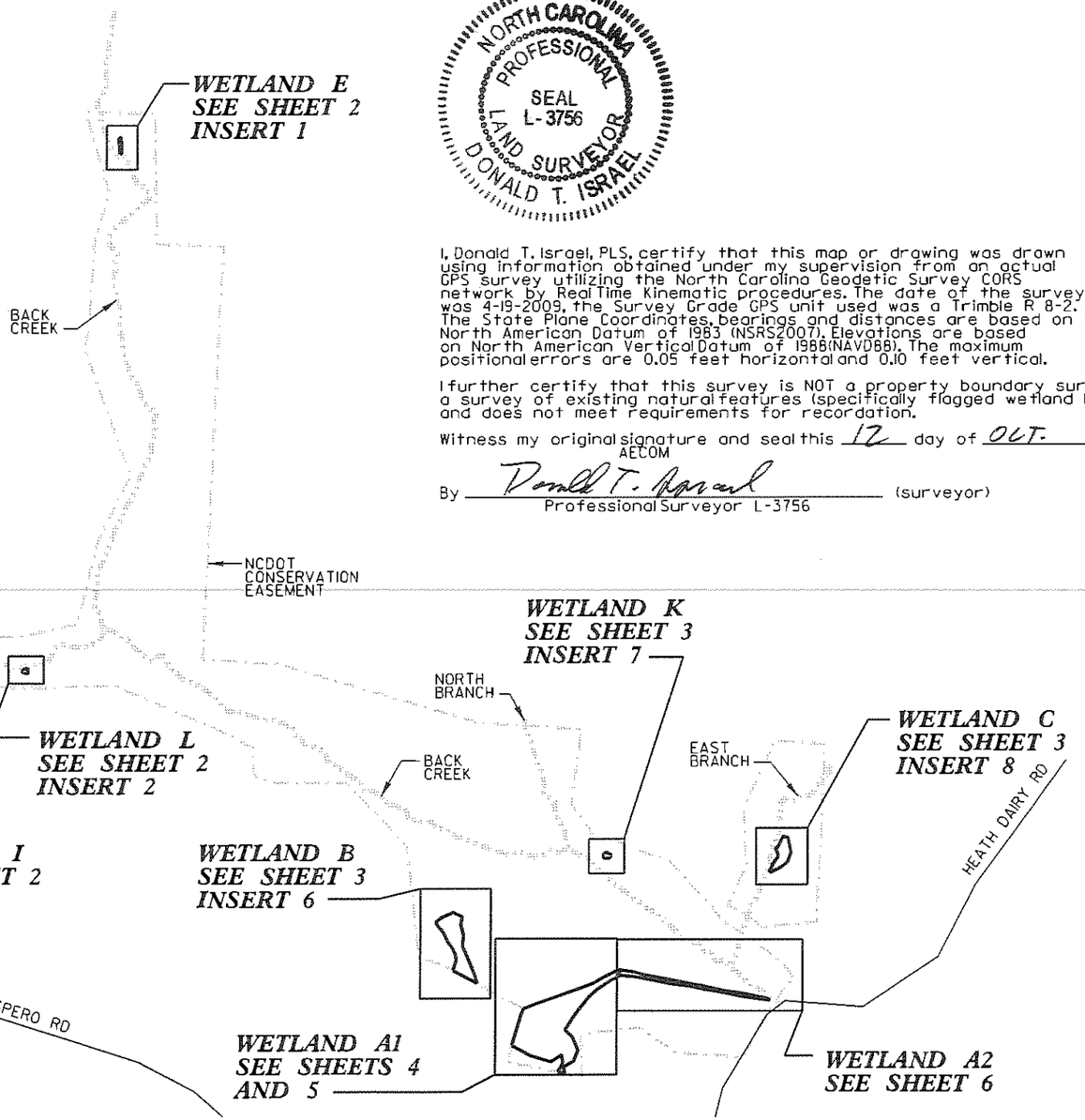
# *RANDOLPH CO.*

***LOCATION: HEATH DAIRY ROAD STREAM RESTORATION SITE***
***NW OF ASHEBORO AND SW OF RANDLEMAN***
***WORK: WETLAND SURVEY***




*VICINITY MAP*

NC GRID NAD 83




NORTH CAROLINA PROFESSIONAL SEAL L-3756 LAND SURVEYOR DONALD T. ISRAEL

I, Donald T. Israel, PLS, certify that this map or drawing was drawn using information obtained under my supervision from an actual GPS survey utilizing the North Carolina Geodetic Survey CORS network by Real Time Kinematic procedures. The date of the survey was 4-19-2009, the Survey Grade GPS unit used was a Trimble R 8-2. The State Plane Coordinates, bearings and distances are based on the North American Datum of 1983 (NSRS2007). Elevations are based on North American Vertical Datum of 1988(NAVD88). The maximum positional errors are 0.05 feet horizontal and 0.10 feet vertical.

I further certify that this survey is NOT a property boundary survey but a survey of existing natural features (specifically flagged wetland boundaries) and does not meet requirements for recordation.

Witness my original signature and seal this 12 day of OCT. 2009

AECOM
By Donald T. Israel (surveyor)
Professional Surveyor L-3756

NOTICE: Features not surveyed by AECOM of North Carolina, Inc. exist in this Wetland Survey. Surface road feature was obtained from NC Dept. of Transportation. Conservation Easements were obtained from Stantec Consulting Services (License: F-0672) and Level Cross Surveying, PLLC (License: P-0332).

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| NCDENR D06017S | 2 |

PREPARED IN THE OFFICES OF:

**AECOM USA, Inc.**

3333 Regency Parkway, Suite 120 – Cary, NC 27518

license no: F-0552

I, Donald T. Israel, PLS, certify that this map or drawing was drawn using information obtained under my supervision from an actual GPS survey utilizing the North Carolina Geodetic Survey CORS network by Real Time Kinematic procedures. The date of the survey was 4-19-2009, the Survey Grade GPS unit used was a Trimble R 8-2. The State Plane Coordinates, bearings and distances are based on the North American Datum of 1983 (NSRS2007). Elevations are based on North American Vertical Datum of 1988(NAVD88). The maximum positional errors are 0.05 feet horizontal and 0.10 feet vertical.

I further certify that this survey is NOT a property boundary survey but a survey of existing natural features (specifically flagged wetland boundaries) and does not meet requirements for recordation.

Witness my original signature and seal this 12 day of Oct. 2009

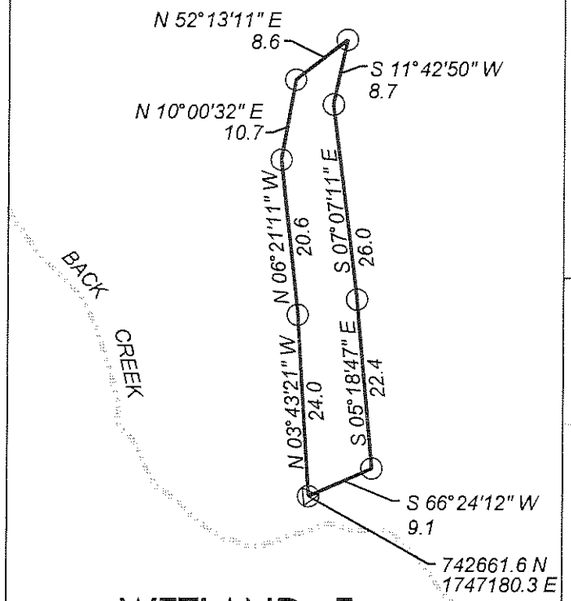
By Donald T. Israel AECOM (surveyor)

Professional Surveyor L-3756

NORTH CAROLINA PROFESSIONAL SEAL L-3756 LAND SURVEYOR DONALD T. ISRAEL

10 0 10 20

## INSERT 1




**WETLAND E**

**0.010 AC**

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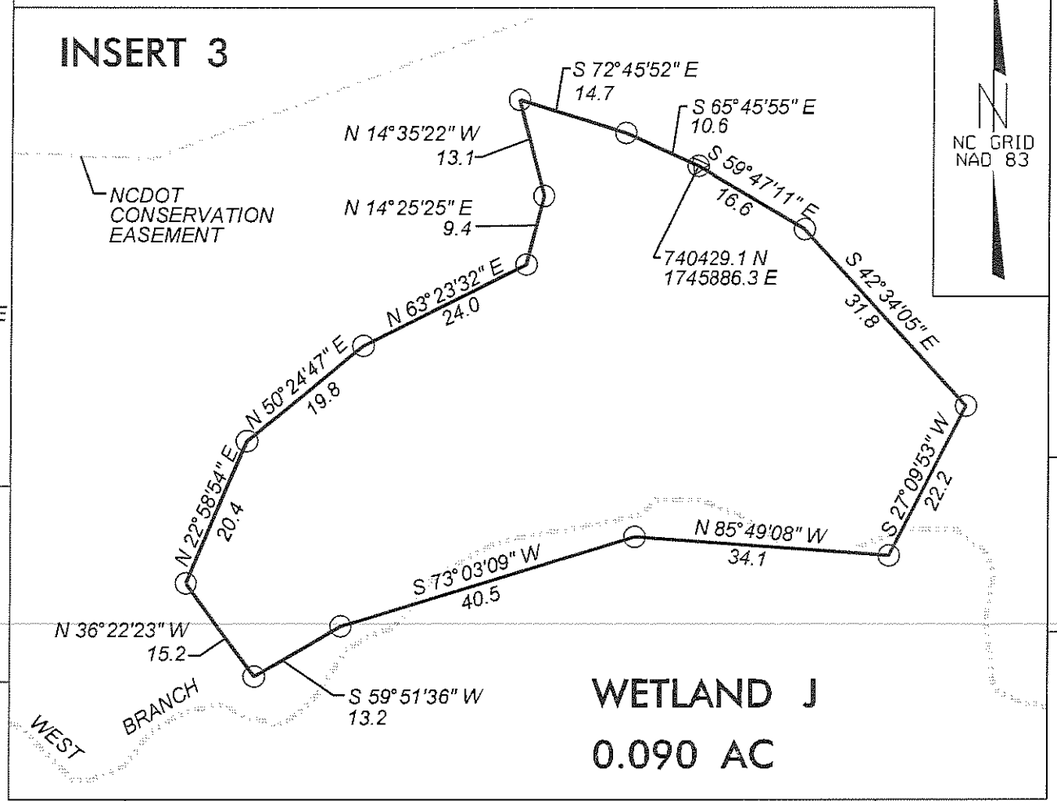
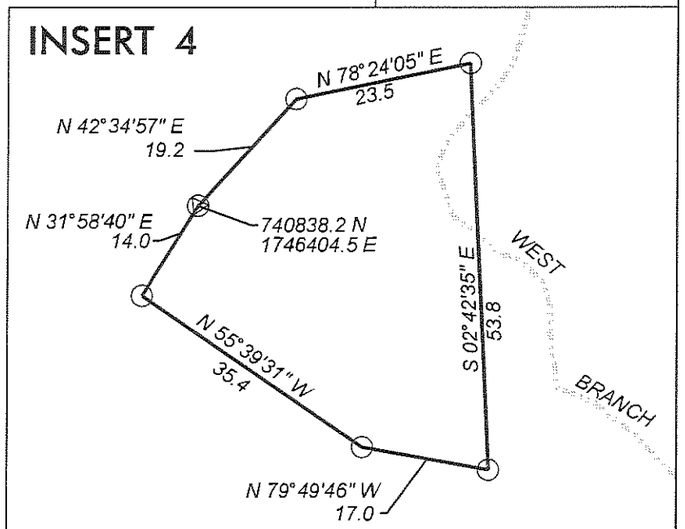



**WETLAND J**

**0.090 AC**

NC GRID NAD 83

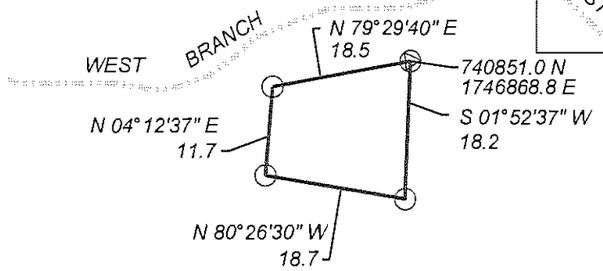
## INSERT 4




**WETLAND F**

**0.036 AC**

## INSERT 2



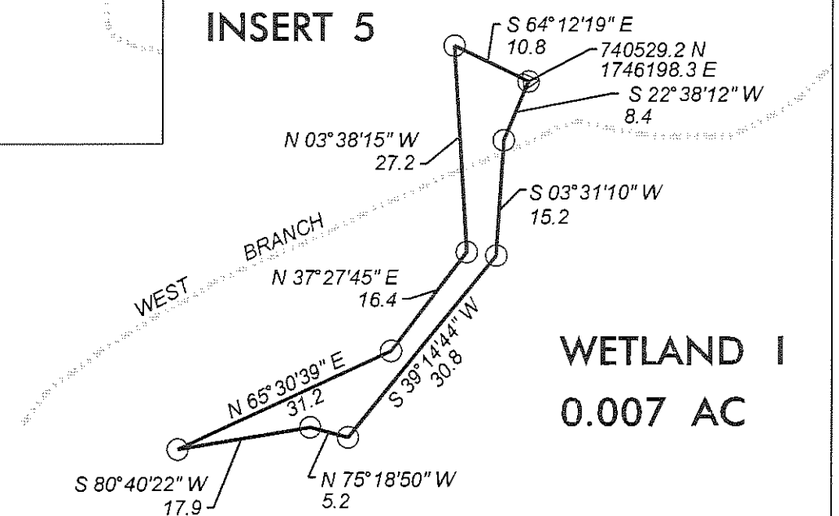

**WETLAND L**

**0.007 AC**

NOTICE: Features not surveyed by AECOM of North Carolina, Inc. exist in this Wetland Survey. Surface road feature was obtained from NC Dept. of Transportation. Conservation Easements were obtained from Stantec Consulting Services (License: F-0672) and Level Cross Surveying, PLLC (License: P-0332).

ALL DISTANCES ARE IN FEET UNLESS OTHERWISE NOTED

## INSERT 5




**WETLAND I**

**0.007 AC**

ALL DISTANCES ARE IN FEET UNLESS OTHERWISE NOTED

NC GRID
NAD 83

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| NCDENR D06017S | 3 |

PREPARED IN THE OFFICES OF:

**AECOM USA, Inc.**
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552

10 0 10 20

## WETLAND K
0.010 AC

INSERT 7

S 76°07'22" E 11.7
S 63°23'03" E 14.1
S 44°22'08" W 14.4
S 81°12'56" W 15.4
N 38°41'05" E 14.7
N 37°31'16" W 13.0

740184.0 N
1748923.7 E

## WETLAND C
0.104 AC

INSERT 8

S 79°27'58" E 18.2
S 10°58'46" E 54.7
S 20°30'53" W 32.5
S 50°32'18" W 32.9
S 63°58'45" W 44.1
N 22°12'41" E 34.9
N 34°10'04" E 31.6
N 10°57'56" W 16.7
N 29°51'01" W 10.2
N 38°50'24" E 17.7
N 25°13'04" E 33.5

EAST BRANCH

740131.9 N
1749492.8 E

## WETLAND B
0.307 AC

INSERT 6

S 65°33'40" E 36.4
S 09°33'34" W 28.9
S 14°58'30" E 39.2
S 05°06'55" W 37.2
S 23°06'02" E 26.6
S 23°34'26" E 45.3
S 21°51'53" E 32.1
S 17°15'26" E 36.1
N 62°25'32" W 97.0
N 14°57'12" E 23.8
N 09°19'50" W 19.6
N 24°14'51" W 23.8
N 37°15'20" W 27.8
N 27°47'10" W 15.7
N 22°44'52" W 20.1
N 39°53'48" W 34.9
N 29°40'56" W 11.7
N 48°31'28" E 20.1
N 65°24'19" E 50.4
N 21°44'00" E 15.2

739745.5 N
1748457.3 E

NCDOT CONSERVATION EASEMENT

I, Donald T. Israel, PLS, certify that this map or drawing was drawn using information obtained under my supervision from an actual GPS survey utilizing the North Carolina Geodetic Survey CORS network by Real Time Kinematic procedures. The date of the survey was 4-19-2009, the Survey Grade GPS unit used was a Trimble R 8-2. The State Plane Coordinates, bearings and distances are based on the North American Datum of 1983 (NSRS2007). Elevations are based on North American Vertical Datum of 1988(NAVD88). The maximum positional errors are 0.05 feet horizontal and 0.10 feet vertical.

I further certify that this survey is NOT a property boundary survey but a survey of existing natural features (specifically flagged wetland boundaries) and does not meet requirements for recordation.

Witness my original signature and seal this 17 day of OCT. 2009

AECOM
By Donald T. Israel (surveyor)
Professional Surveyor L-3756

NORTH CAROLINA PROFESSIONAL SEAL L-3756 LAND SURVEYOR DONALD T. ISRAEL

NOTICE: Features not surveyed by AECOM of North Carolina, Inc. exist in this Wetland Survey. Surface road feature was obtained from NC Dept. of Transportation. Conservation Easements were obtained from Stantec Consulting Services (License: F-0672) and LevelCross Surveying, PLLC (License: P-0332).

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| NCDENR D060175 | 4 |

PREPARED IN THE OFFICES OF:

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license no: F-0552

10 0 10 20

MATCHLINE SEE SHEET 5

S 45°15'58" E 37.3

S 22°55'38" E 48.4

S 20°42'38" W 40.4

S 59°47'20" W 42.9

S 13°37'16" E 23.5

N 75°59'00" W 26.2

N 30°06'21" E 35.8

N 09°38'25" W 28.7

S 57°39'31" W 45.4

N 73°36'55" W 74.3

N 61°26'50" W 75.4

N 16°28'21" E 103.5

N 27°26'29" E 31.4

N 68°31'36" E 45.5

N 70°30'55" E 93.3

## WETLAND A1

## 1.075 AC

*(INCLUDES AREA SHOWN ON BOTH SHEETS 4 AND 5)*

NCDOT CONSERVATION EASEMENT

NCDOT CONSERVATION EASEMENT

GRID NC NAD 83

NORTH CAROLINA PROFESSIONAL SEAL L-3756 LAND SURVEYOR DONALD T. ISRAEL

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I, Donald T. Israel, PLS, certify that this map or drawing was drawn using information obtained under my supervision from an actual GPS survey utilizing the North Carolina Geodetic Survey CORS network by Real Time Kinematic procedures. The date of the survey was 4-19-2009, the Survey Grade GPS unit used was a Trimble R 8-2. The State Plane Coordinates, bearings and distances are based on the North American Datum of 1983 (NSRS2007). Elevations are based on North American Vertical Datum of 1988(NAVD88). The maximum positional errors are 0.05 feet horizontal and 0.10 feet vertical.

I further certify that this survey is NOT a property boundary survey but a survey of existing natural features (specifically flagged wetland boundaries) and does not meet requirements for recordation.

Witness my original signature and seal this 12 day of OCT. 2009

AECOM

By Donald T. Israel (surveyor)

Professional Surveyor L-3756

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| NCDENR D06017S | 5 |

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license no: F-0552

10 0 10 20

NC NAD GRID 83

MATCHLINE SEE SHEET 4

N 70°30'55" E
93.3

N 70°34'07" E
64.1

N 70°02'56" E
61.6

N 59°31'27" E
30.9

N 61°38'22" E
32.4

N 64°47'09" E
36.5

S 18°39'40" E
21.6

S 65°07'18" W
33.0

S 57°25'57" W
30.8

S 56°57'19" W
32.7

S 48°04'23" W
40.9

S 38°59'37" W
57.0

S 34°48'23" W
41.8

S 32°15'22" W
42.2

739772.2 N
1748966.0 E

MATCHLINE SEE SHEET 6

## WETLAND A1
## 1.075 AC

*(INCLUDES AREAS SHOWN ON BOTH SHEETS 4 AND 5)*

## WETLAND A2
## 0.136 AC

*(INCLUDES AREAS SHOWN ON BOTH SHEETS 5 AND 6)*

ALL DISTANCES ARE IN FEET UNLESS OTHERWISE NOTED

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NORTH CAROLINA PROFESSIONAL SEAL L-3756 LAND SURVEYOR DONALD T. ISRAEL

I, Donald T. Israel, PLS, certify that this map or drawing was drawn using information obtained under my supervision from an actual GPS survey utilizing the North Carolina Geodetic Survey CORS network by Real Time Kinematic procedures. The date of the survey was 4-19-2009, the Survey Grade GPS unit used was a Trimble R 8-2. The State Plane Coordinates, bearings and distances are based on the North American Datum of 1983 (NSRS2007). Elevations are based on North American Vertical Datum of 1988(NAVD88). The maximum positional errors are 0.05 feet horizontal and 0.10 feet vertical.

I further certify that this survey is NOT a property boundary survey but a survey of existing natural features (specifically flagged wetland boundaries) and does not meet requirements for recordation.

Witness my original signature and seal this 12 day of Oct. 2009

AECOM

By Donald T. Israel (surveyor)

Professional Surveyor L-3756

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| NCDENR D06017S | 6 |

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license no: F-0552

10 0 10 20

NC GRID NAD 83

# WETLAND A2

## 0.136 AC

*(INCLUDES AREAS SHOWN ON BOTH SHEETS 5 AND 6)*

MATCHLINE SEE SHEET 5

S 81°21'48" E 56.1
S 75°08'04" E 34.3
S 79°04'16" E 103.2
S 79°06'10" E 67.1
N 85°38'24" W 47.9
N 80°02'31" W 39.2
N 78°46'11" W 102.8
N 83°35'45" W 54.9

MATCHLINE SEE BELOW

I, Donald T. Israel, PLS, certify that this map or drawing was drawn using information obtained under my supervision from an actual GPS survey utilizing the North Carolina Geodetic Survey CORS network by RealTime Kinematic procedures. The date of the survey was 4-19-2009, the Survey Grade GPS unit used was a Trimble R 8-2. The State Plane Coordinates, bearings and distances are based on the North American Datum of 1983 (NSRS2007). Elevations are based on North American Vertical Datum of 1988(NAVD88). The maximum positional errors are 0.05 feet horizontal and 0.10 feet vertical.

I further certify that this survey is NOT a property boundary survey but a survey of existing natural features (specifically flagged wetland boundaries) and does not meet requirements for recordation.

Witness my original signature and seal this 12 day of OCT. 2009

By AECOM Donald T. Israel Professional Surveyor L-3756 (surveyor)

NORTH CAROLINA PROFESSIONAL SEAL L-3756 LAND SURVEYOR DONALD T. ISRAEL

BACK CREEK

MATCHLINE SEE ABOVE

S 80°51'56" E 42.5
S 77°23'09" E 76.7
S 81°32'33" E 73.9
S 78°13'56" E 86.8
S 54°43'36" E 9.7
N 78°41'59" W 52.5
N 80°19'10" W 73.5
N 77°45'51" W 70.9
N 82°41'49" W 97.3


# WETLAND A2

## 0.136 AC

*(INCLUDES AREAS SHOWN ON BOTH SHEETS 5 AND 6)*


NOTICE: Features not surveyed by AECOM of North Carolina, Inc. exist in this Wetland Survey. Surface road feature was obtained from NC Dept. of Transportation. Conservation Easements were obtained from Stantec Consulting Services (License: F-0672) and Level Cross Surveying, PLLC (License: P-0332).

ALL DISTANCES ARE IN FEET UNLESS OTHERWISE NOTED

# APPENDIX N

## Soil Test Results

NCDA&CS Agronomic Division Phone: (919)733-2655 Web Site: www.ncagr.com/agronomi/ Report No: 15774

# Soil Test Report

12/4/2008

SERVING N.C. RESIDENTS FOR OVER 60 YEARS

*Grower:* **Howell, Andrew**
4141 Parklake Ave.
Raleigh, NC 27609

*Copies To:*

*Farm:* **Randolph County**

**Agronomist Comments**

I -- 11, 4

| Field Information | | Applied Lime | | | Recommendations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sample No.* | *Last Crop* | *Mo* | *Yr* | *T/A* | *Crop or Year* | *Lime* | *N* | *$P_2O_5$* | *$K_2O$* | *Mg* | *S* | *Cu* | *Zn* | *B* | *Mn* | *See Note* |
| HDR01 | | | | | 1st Crop: Hardwood,E | .4T | 0.0 | 50-70 | 60-80 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: Tree, Shade | 0 | (20 lbs 5-10-10 or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| *Soil Class* | *HM%* | *W/V* | *CEC* | *BS%* | *Ac* | *pH* | *P-I* | *K-I* | *Ca%* | *Mg%* | *Mn-I* | *Mn-AI(1)* | *Mn-AI(2)* | *Zn-I* | *Zn-AI* | *Cu-I* | *S-I* | *SS-I* | *$NO_3$-N* | *$NH_4$-N* | *Na* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.41 | 1.09 | 7.8 | 86.0 | 1.1 | 5.6 | 8 | 21 | 63.0 | 22.0 | 321 | | | 97 | 97 | 173 | 44 | | | | 0.2 |

| Field Information | | Applied Lime | | | Recommendations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sample No.* | *Last Crop* | *Mo* | *Yr* | *T/A* | *Crop or Year* | *Lime* | *N* | *$P_2O_5$* | *$K_2O$* | *Mg* | *S* | *Cu* | *Zn* | *B* | *Mn* | *See Note* |
| HDR02 | | | | | 1st Crop: Hardwood,E | .3T | 0.0 | 30-50 | 70-90 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: Tree, Shade | 0 | (20 lbs 5-10-10 or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| *Soil Class* | *HM%* | *W/V* | *CEC* | *BS%* | *Ac* | *pH* | *P-I* | *K-I* | *Ca%* | *Mg%* | *Mn-I* | *Mn-AI(1)* | *Mn-AI(2)* | *Zn-I* | *Zn-AI* | *Cu-I* | *S-I* | *SS-I* | *$NO_3$-N* | *$NH_4$-N* | *Na* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.36 | 1.03 | 7.8 | 86.0 | 1.1 | 5.8 | 19 | 16 | 65.0 | 20.0 | 494 | | | 104 | 104 | 153 | 137 | | | | 0.7 |

| Field Information | | Applied Lime | | | Recommendations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sample No.* | *Last Crop* | *Mo* | *Yr* | *T/A* | *Crop or Year* | *Lime* | *N* | *$P_2O_5$* | *$K_2O$* | *Mg* | *S* | *Cu* | *Zn* | *B* | *Mn* | *See Note* |
| HDR03 | | | | | 1st Crop: Hardwood,E | .5T | 0.0 | 0 | 20-40 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: Tree, Shade | 0 | (1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| *Soil Class* | *HM%* | *W/V* | *CEC* | *BS%* | *Ac* | *pH* | *P-I* | *K-I* | *Ca%* | *Mg%* | *Mn-I* | *Mn-AI(1)* | *Mn-AI(2)* | *Zn-I* | *Zn-AI* | *Cu-I* | *S-I* | *SS-I* | *$NO_3$-N* | *$NH_4$-N* | *Na* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.6 | 1.07 | 8.0 | 85.0 | 1.2 | 5.6 | 53 | 55 | 58.0 | 23.0 | 357 | | | 267 | 267 | 277 | 142 | | | | 0.4 |

| Field Information | | Applied Lime | | | Recommendations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sample No.* | *Last Crop* | *Mo* | *Yr* | *T/A* | *Crop or Year* | *Lime* | *N* | *$P_2O_5$* | *$K_2O$* | *Mg* | *S* | *Cu* | *Zn* | *B* | *Mn* | *See Note* |
| HDR04 | | | | | 1st Crop: Hardwood,E | 0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: Tree, Shade | 0 | (1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| *Soil Class* | *HM%* | *W/V* | *CEC* | *BS%* | *Ac* | *pH* | *P-I* | *K-I* | *Ca%* | *Mg%* | *Mn-I* | *Mn-AI(1)* | *Mn-AI(2)* | *Zn-I* | *Zn-AI* | *Cu-I* | *S-I* | *SS-I* | *$NO_3$-N* | *$NH_4$-N* | *Na* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.56 | 1.12 | 14.5 | 87.0 | 1.9 | 6.1 | 136 | 218 | 53.0 | 26.0 | 265 | | | 204 | 204 | 274 | 30 | | | | 0.1 |

| Field Information | Applied Lime | Recommendations |
|---|---|---|

| Sample No. | Last Crop | Mo | Yr | T/A | Crop or Year | | Lime | N | $P_2O_5$ | $K_2O$ | Mg | S | Cu | Zn | B | Mn | See Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR05 | | | | | 1st Crop: | Hardwood,E | .4T | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: | Tree, Shade | 0 | (1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| Soil Class | HM% | W/V | CEC | BS% | Ac | pH | P-I | K-I | Ca% | Mg% | Mn-I | Mn-AI(1) | Mn-AI(2) | Zn-I | Zn-AI | Cu-I | S-I | SS-I | $NO_3$-N | $NH_4$-N | Na |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.6 | 1.09 | 11.7 | 87.0 | 1.5 | 5.8 | 74 | 90 | 60.0 | 23.0 | 292 | | | 202 | 202 | 134 | 39 | | | | 0.1 |

| Field Information | Applied Lime | Recommendations |
|---|---|---|

| Sample No. | Last Crop | Mo | Yr | T/A | Crop or Year | | Lime | N | $P_2O_5$ | $K_2O$ | Mg | S | Cu | Zn | B | Mn | See Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR06 | | | | | 1st Crop: | Hardwood,E | .8T | 0.0 | 50-70 | 30-50 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: | Tree, Shade | 0 | (20 lbs 5-10-10 or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| Soil Class | HM% | W/V | CEC | BS% | Ac | pH | P-I | K-I | Ca% | Mg% | Mn-I | Mn-AI(1) | Mn-AI(2) | Zn-I | Zn-AI | Cu-I | S-I | SS-I | $NO_3$-N | $NH_4$-N | Na |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.36 | 1.19 | 7.7 | 78.0 | 1.7 | 5.5 | 9 | 41 | 57.0 | 19.0 | 350 | | | 70 | 70 | 113 | 54 | | | | 0.2 |

| Field Information | Applied Lime | Recommendations |
|---|---|---|

| Sample No. | Last Crop | Mo | Yr | T/A | Crop or Year | | Lime | N | $P_2O_5$ | $K_2O$ | Mg | S | Cu | Zn | B | Mn | See Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR07 | | | | | 1st Crop: | Hardwood,E | 0 | 0.0 | 0-20 | 0 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: | Tree, Shade | 0 | (20 lbs 5-10-5 or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| Soil Class | HM% | W/V | CEC | BS% | Ac | pH | P-I | K-I | Ca% | Mg% | Mn-I | Mn-AI(1) | Mn-AI(2) | Zn-I | Zn-AI | Cu-I | S-I | SS-I | $NO_3$-N | $NH_4$-N | Na |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.6 | 1.19 | 7.8 | 85.0 | 1.2 | 5.9 | 36 | 190 | 51.0 | 22.0 | 1521 | | | 81 | 81 | 130 | 91 | | | | 0.1 |

| Field Information | Applied Lime | Recommendations |
|---|---|---|

| Sample No. | Last Crop | Mo | Yr | T/A | Crop or Year | | Lime | N | $P_2O_5$ | $K_2O$ | Mg | S | Cu | Zn | B | Mn | See Note |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HDR08 | | | | | 1st Crop: | Hardwood,E | 1T | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 11 |
| | | | | | 2nd Crop: | Tree, Shade | 0 | (1.0 lbs Nitrogen or EQUIV PER 1000 SQ FT) | | | | 0 | | | | | 4 |

**Test Results**

| Soil Class | HM% | W/V | CEC | BS% | Ac | pH | P-I | K-I | Ca% | Mg% | Mn-I | Mn-AI(1) | Mn-AI(2) | Zn-I | Zn-AI | Cu-I | S-I | SS-I | $NO_3$-N | $NH_4$-N | Na |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIN | 0.71 | 1.04 | 8.6 | 81.0 | 1.6 | 5.0 | 77 | 147 | 46.0 | 27.0 | 324 | | | 147 | 147 | 83 | 215 | | | | 0.2 |

# APPENDIX O

## FEMA Floodplain Requirements Checklist

# EEP Floodplain Requirements Checklist

This form was developed by the National Flood Insurance program, NC Floodplain Mapping program and Ecosystem Enhancement Program to be filled for all EEP projects. The form is intended to summarize the floodplain requirements during the design phase of the projects. The form should be submitted to the Local Floodplain Administrator with three copies submitted to NFIP (attn. Edward Curtis), NC Floodplain Mapping Unit (attn. John Gerber) and NC Ecosystem Enhancement Program.

## Project Location

| | |
|---|---|
| Name of project: | Heath Dairy Road Stream Restoration Site |
| Name of stream or feature: | Back Creek Tributary 1 and Back Creek Tributary 1A |
| County: | Randolph |
| Name of river basin: | Yadkin |
| Is project urban or rural? | rural |
| Name of Jurisdictional municipality/county: | Randolph County |
| DFIRM panel number for entire site: | 3710774400 J, 3710774300 J |
| Consultant name: | HSMM of North Carolina, Inc. |
| Phone number: | 919-460-6895 |
| Address: | 3333 Regency Parkway, Ste 120<br>Cary, NC 27518 |

# Design Information

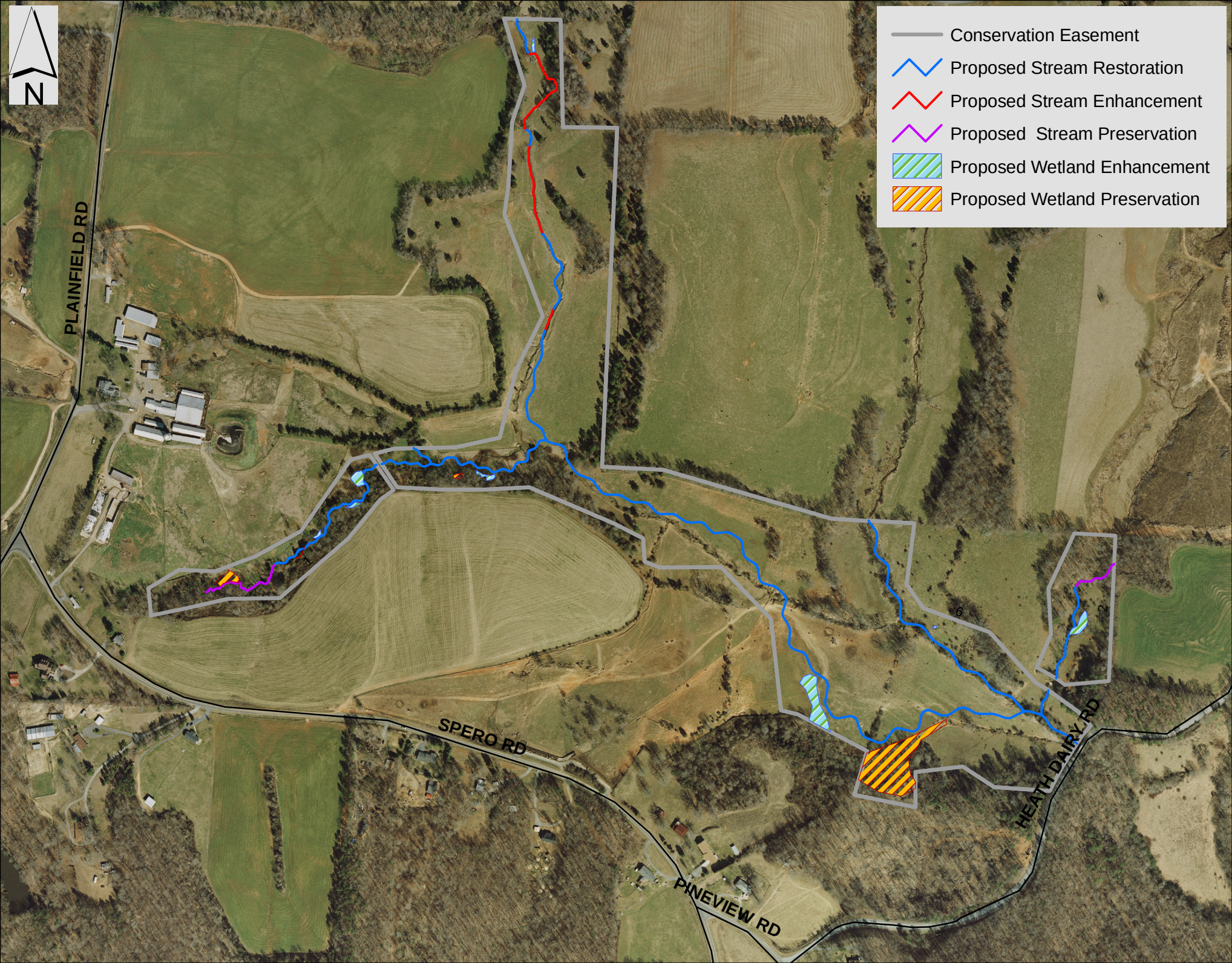
Provide a general description of project (one paragraph). Include project limits on a reference orthophotograph at a scale of 1" = 500".

*This project is located northwest of Asheboro and southwest of Randleman and is in a rural, agricultural setting. This project consists of approximately 7,780' of stream restoration, 960' of stream enhancement, 640' of stream preservation, 0.5 AC of wetland enhancement, and 1.2 AC of wetland preservation. Restoration activities will include channel relocation, grading, filling, and planting. There is an underground AT&T easement within a section of the conservation easement, but it will be undisturbed. Figure showing project limit is attached.*

Summarize stream reaches or wetland areas according to their restoration priority.

*Example*

| Reach | Length / Area | Priority |
|---|---|---|
| *Back Creek 1a* | *155'* | *Two (Restoration)* |
| *Back Creek 1b* | *470'* | *One (Enhancement)* |
| *Back Creek 1c* | *75'* | *One (Restoration)* |
| *Back Creek 1d* | *150'* | *One (Enhancement)* |
| *Back Creek 2a* | *240'* | *One (Enhancement)* |
| *Back Creek 2b* | *370'* | *One (Restoration)* |
| *Back Creek 2c* | *100'* | *One (Enhancement)* |
| *Back Creek 2d* | *520'* | *Two (Restoration)* |
| *Back Creek 3* | *1,750'* | *One (Restoration)* |
| *Back Creek 4a* | *890'* | *One (Restoration)* |
| *Back Creek 4b* | *325'* | *Two (Restoration)* |
| *Back Creek 5* | *300'* | *Two (Restoration)* |
| *West Branch 1a* | *417'* | *Preservation* |
| *West Branch 1b* | *380'* | *One (Restoration)* |
| *West Branch 2* | *553'* | *One (Restoration)* |
| *West Branch 3* | *657'* | *One (Restoration)* |
| *North Branch* | *1,167'* | *Two (Restoration)* |
| *East Branch 1a* | *219'* | *Preservation* |
| *East Branch 1b* | *537'* | *One (Restoration)* |
| *UT to West Branch* | *102'* | *One (Restoration)* |
| *Wetland A* | *1.091 AC* | *Preservation* |
| *Wetland B* | *0.285 AC* | *Enhancement* |
| *Wetland C* | *0.079 AC* | *Enhancement* |
| *Wetland D* | *0.026 AC* | *Enhancement* |
| *Wetland E* | *0.014 AC* | *Enhancement* |
| *Wetland F* | *0.063 AC* | *Enhancement* |
| *Wetland G* | *0.012 AC* | *Enhancement* |
| *Wetland H* | *0.010 AC* | *Enhancement* |
| *Wetland I* | *0.003 AC* | *Preservation* |
| *Wetland J* | *0.079 AC* | *Preservation* |
| *Wetland K* | *0.003 AC* | *Enhancement* |
| *Wetland L* | *0.017 AC* | *Preservation* |


N
Conservation Easement
Proposed Stream Restoration
Proposed Stream Enhancement
Proposed Stream Preservation
Proposed Wetland Enhancement
Proposed Wetland Preservation
PLAINFIELD RD
SPERO RD
PINEVIEW RD
HEATH DAIRY RD
1
2
6

# Floodplain Information

Is project located in a Special Flood Hazard Area (SFHA)?

☑ Yes ☐ No

If project is located in a SFHA, check how it was determined:

☐ Redelineation

☐ Detailed Study

☑ Limited Detail Study

☐ Approximate Study

☐ Don't know

List flood zone designation:

Check if applies:

☑ AE Zone

- ☐ Floodway
- ☑ Non-Encroachment
- ☐ None

☐ A Zone

- ☐ Local Setbacks Required
- ☐ No Local Setbacks Required

If local setbacks are required, list how many feet:

Does proposed channel boundary encroach outside floodway/non-encroachment/setbacks?

☑ Yes ☐ No

Land Acquisition (Check)

☐ State owned (fee simple)

☑ Conservation easment (Design Bid Build)

☐ Conservation Easement (Full Delivery Project)

Note: if the project property is state-owned, then all requirements should be addressed to the Department of Administration, State Construction Office (attn: Herbert Neily, (919) 807-4101)

Is community/county participating in the NFIP program?

☑ Yes ☐ No

Note: if community is not participating, then all requirements should be addressed to NFIP (attn: Edward Curtis, (919) 715-8000 x369)

Name of Local Floodplain Administrator: Randall Brim
Phone Number: 336-318-6551

## Floodplain Requirements

This section to be filled by designer/applicant following verification with the LFPA

☐ No Action

☐ No Rise

☐ Letter of Map Revision

☑ Conditional Letter of Map Revision

☐ Other Requirements

List other requirements:

Comments:

The channel is being moved back to its historic location and bed profile is being modified. Also, the effective study did not account for the significant flooding caused by the historical dam under the bridge at Heath Dairy Rd, which is at the downstream limit of this project. A CLOMR is to be submitted at a later date, but prior to construction.

Name: Tammie Tucker Signature: Tammie Tucker

Title: Engineer II Date: 04/09/09

# APPENDIX P

## EDR Radius Map Report

# The EDR Radius Map
## with GeoCheck®

Heath Dairy Rd.
Mitigation Site
Ash, NC 27317

Inquiry Number: 0981636.1s

May 21, 2003


Environmental Data Resources, Inc.

*The* Source For Environmental Risk Management Data

3530 Post Road
Southport, Connecticut 06890

Nationwide Customer Service

Telephone: 1-800-352-0050
Fax: 1-800-231-6802
Internet: www.edrnet.com


FORM-NEW

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| Government Records Searched/Data Currency Tracking | GR-1 |

## GEOCHECK ADDENDUM

| | |
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*Thank you for your business.*
Please contact EDR at 1-800-352-0050
with any questions or comments.


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# EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The report meets the government records search requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-00. Search distances are per ASTM standard or custom distances requested by the user.

## TARGET PROPERTY INFORMATION

### ADDRESS

MITIGATION SITE
ASH, NC 27317

### COORDINATES

| | |
|---|---|
| Latitude (North): | 35.779300 - 35° 46' 45.5" |
| Longitude (West): | 79.844700 - 79° 50' 40.9" |
| Universal Tranverse Mercator: | Zone 17 |
| UTM X (Meters): | 604418.5 |
| UTM Y (Meters): | 3959885.8 |
| Elevation: | 610 ft. above sea level |

### USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

| | |
|---|---|
| Target Property: | 2435079-G7 RANDLEMAN, NC |
| Source: | USGS 7.5 min quad index |

## TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

## DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ( "reasonably ascertainable ") government records either on the target property or within the ASTM E 1527-00 search radius around the target property for the following databases:

### FEDERAL ASTM STANDARD

| | |
|---|---|
| NPL | National Priority List |
| Proposed NPL | Proposed National Priority List Sites |
| CERCLIS | Comprehensive Environmental Response, Compensation, and Liability Information System |
| CERC-NFRAP | CERCLIS No Further Remedial Action Planned |
| CORRACTS | Corrective Action Report |
| RCRIS-TSD | Resource Conservation and Recovery Information System |
| RCRIS-LQG | Resource Conservation and Recovery Information System |
| RCRIS-SQG | Resource Conservation and Recovery Information System |
| ERNS | Emergency Response Notification System |

### STATE ASTM STANDARD

| | |
|---|---|
| SHWS | Inactive Hazardous Sites Inventory |

| | |
|---|---|
| SWF/LF | List of Solid Waste Facilities |
| LUST | Incidents Management Database |
| UST | Petroleum Underground Storage Tank Database |
| OLI | Old Landfill Inventory |
| INDIAN UST | Underground Storage Tanks on Indian Land |
| VCP | Responsible Party Voluntary Action Sites |

FEDERAL ASTM SUPPLEMENTAL

| | |
|---|---|
| CONSENT | Superfund (CERCLA) Consent Decrees |
| ROD | Records Of Decision |
| Delisted NPL | National Priority List Deletions |
| FINDS | Facility Index System/Facility Identification Initiative Program Summary Report |
| HMIRS | Hazardous Materials Information Reporting System |
| MLTS | Material Licensing Tracking System |
| MINES | Mines Master Index File |
| NPL Liens | Federal Superfund Liens |
| PADS | PCB Activity Database System |
| DOD | Department of Defense Sites |
| RAATS | RCRA Administrative Action Tracking System |
| TRIS | Toxic Chemical Release Inventory System |
| TSCA | Toxic Substances Control Act |
| SSTS | Section 7 Tracking Systems |
| FTTS | FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act) |

STATE OR LOCAL ASTM SUPPLEMENTAL

| | |
|---|---|
| NC HSDS | Hazardous Substance Disposal Site |
| AST | AST Database |
| LUST TRUST | State Trust Fund Database |
| IMD | Incident Management Database |

EDR PROPRIETARY HISTORICAL DATABASES

| | |
|---|---|
| Coal Gas | Former Manufactured Gas (Coal Gas) Sites |

BROWNFIELDS DATABASES

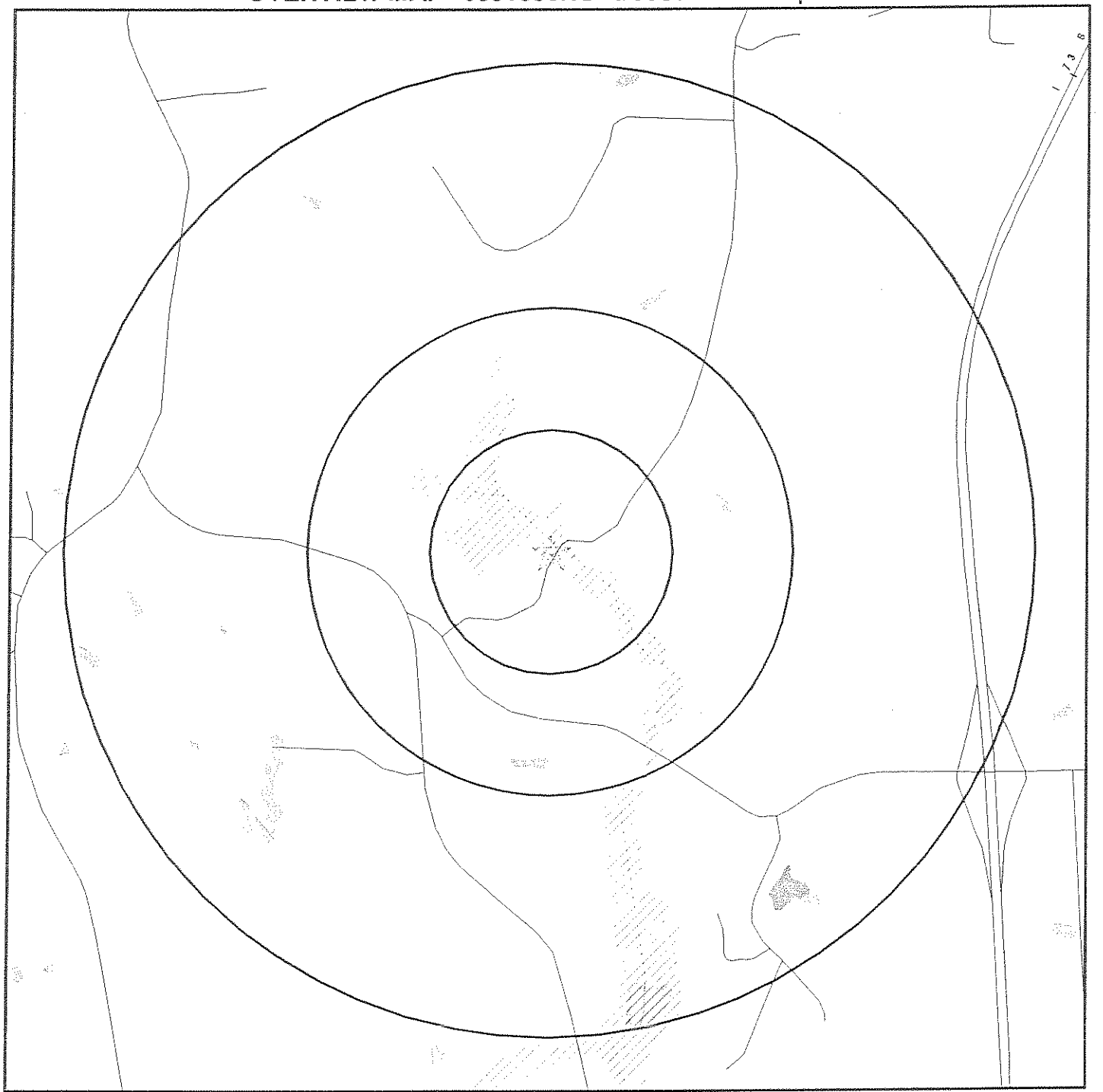
| | |
|---|---|
| Brownfields | Brownfields Projects Inventory |
| VCP | Responsible Party Voluntary Action Sites |

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were not identified.

Unmappable (orphan) sites are not considered in the foregoing analysis.

# OVERVIEW MAP - 0981636.1s - Ecoscience Corp Inc




- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- National Priority List Sites
- Landfill Sites
- Dept. Defense Sites
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Wetlands
- Hazardous Substance Disposal Sites

| | | | |
|---|---|---|---|
| TARGET PROPERTY: | Heath Dairy Rd. | CUSTOMER: | Ecoscience Corp Inc |
| ADDRESS: | Mitigation Site | CONTACT: | Corri Faquin |
| CITY/STATE/ZIP: | Ash NC 27317 | INQUIRY #: | 0981636.1s |
| LAT/LONG: | 35.7793 / 79.8447 | DATE: | May 21, 2003 6:49 pm |

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# DETAIL MAP - 0981636.1s - Ecoscience Corp Inc




- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- Sensitive Receptors
- National Priority List Sites
- Landfill Sites
- Dept. Defense Sites
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Hazardous Substance Disposal Sites

0 1/16 1/8 1/4 Miles

| | | | |
|---|---|---|---|
| TARGET PROPERTY: | Heath Dairy Rd. | CUSTOMER: | Ecoscience Corp Inc |
| ADDRESS: | Mitigation Site | CONTACT: | Corri Faquin |
| CITY/STATE/ZIP: | Ash NC 27317 | INQUIRY #: | 0981636.1s |
| LAT/LONG: | 35.7793 / 79.8447 | DATE: | May 21, 2003 6:49 pm |

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# MAP FINDINGS SUMMARY

| Database | Target Property | Search Distance (Miles) | < 1/8 | 1/8 - 1/4 | 1/4 - 1/2 | 1/2 - 1 | > 1 | Total Plotted |
|---|---|---|---|---|---|---|---|---|
| **FEDERAL ASTM STANDARD** | | | | | | | | |
| NPL | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| Proposed NPL | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| CERCLIS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| CERC-NFRAP | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| CORRACTS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| RCRIS-TSD | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| RCRIS Lg. Quan. Gen. | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| RCRIS Sm. Quan. Gen. | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| ERNS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| **STATE ASTM STANDARD** | | | | | | | | |
| State Haz. Waste | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| State Landfill | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| LUST | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| UST | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| OLI | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| INDIAN UST | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| VCP | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| **FEDERAL ASTM SUPPLEMENTAL** | | | | | | | | |
| CONSENT | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| ROD | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| Delisted NPL | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| FINDS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| HMIRS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| MLTS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| MINES | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| NPL Liens | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| PADS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| DOD | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| RAATS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| TRIS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| TSCA | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| SSTS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| FTTS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| **STATE OR LOCAL ASTM SUPPLEMENTAL** | | | | | | | | |
| NC HSDS | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| AST | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| LUST TRUST | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| IMD | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| **EDR PROPRIETARY HISTORICAL DATABASES** | | | | | | | | |
| Coal Gas | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |

# MAP FINDINGS SUMMARY

| Database | Target Property | Search Distance (Miles) | < 1/8 | 1/8 - 1/4 | 1/4 - 1/2 | 1/2 - 1 | > 1 | Total Plotted |
|---|---|---|---|---|---|---|---|---|
| **BROWNFIELDS DATABASES** | | | | | | | | |
| Brownfields | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |
| VCP | | 1.000 | 0 | 0 | 0 | 0 | NR | 0 |

NOTES:

AQUIFLOW - see EDR Physical Setting Source Addendum

TP = Target Property

NR = Not Requested at this Search Distance

Sites may be listed in more than one database

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

NO SITES FOUND

ORPHAN SUMMARY

| City | EDR ID | Site Name | Site Address | Zip | Database(s) |
|---|---|---|---|---|---|
| ASH | S105766340 | IDAETH ROWE'S RESIDENCE | BOX A-8 RT. 1 | | LUST |
| LEVEL CROSS | S103717039 | GARDNER PROPERTY (JOHN) | HWY 268 / SILOAM RD. | 27317 | IMD |
| LEVEL CROSS | S105766674 | GARDNER PROPERTY, JOHN C.W. & CARROLL F. | HWY 268 @ SILOAM RD | 27317 | LUST |
| NEW SALEM | S104914190 | OLD STORE PROPERTY | 6121-A HWY 205 | 27317 | IMD, LUST |
| NEW SALEM | S105764476 | BAUCOM'S STORE | HWY 218 / 205 | 27317 | LUST |
| NEW SALEM | U001191178 | NEW SALEM | HIGHWAY 218 | 27317 | UST |
| RANDLEMAN | U001192078 | GAMBLE SERVICE STATION | ROUTE 1 | 27317 | UST |
| RANDLEMAN | U001198205 | COLTRANE MILL | ROUTE 1 / COLTRANE MILL ROAD | 27317 | UST |
| RANDLEMAN | U001202313 | PEARLIE PUGH | RT. 1, BOX 483 | 27317 | UST |
| RANDLEMAN | 1004744700 | RAY'S FURNITURE CO INC | RT 2 BOX 256 | 27317 | RCRIS-SQG, FINDS |
| RANDLEMAN | S105485921 | MODERN GARBAGE DUMP | SR 2126, 4 MI S OF TOWN | 27317 | OLI |
| RANDLEMAN | S105485923 | RANDLEMAN DUMP | SR 2133 @ END OF RD | 27317 | OLI |
| RANDLEMAN | 1004745939 | SOPHIA BODY SHOP | HWY 311 S | 27350 | RCRIS-SQG, FINDS |
| RANDLEMAN | U003145398 | PETTY ENTERPRISES, INC. | RT. 4 BOX 86 | 27317 | IMD, LUST, UST |
| RANDLEMAN | U003369559 | LIBERTY TEXACO | 4994 HWY 49 SOUTH | 27317 | UST |
| RANDLEMAN | 1004745398 | DART CONTAINER OF NORTH CAROLINA | 220 BUSINESS & SR 1630 | 27317 | RCRIS-SQG, FINDS |
| RANDLEMAN | 1004746313 | MID-STATE PAPER BOX CO | 4139 US HWY 311 | 27317 | RCRIS-SQG, FINDS, LUST |
| SOPHIA | 1004746109 | RYDER TRUCK RENTAL | RT #3 BOX 454 | 27350 | RCRIS-SQG, FINDS |
| SOPHIA | U001198505 | NEW MARKET SCHOOL | ROUTE 1 BOX 5 | 27350 | UST |
| SOPHIA | U003146313 | SOPHIE GULF | RT 1 HWY 311 | 27350 | UST |
| SOPHIA | S105766710 | NCDOT - PARCEL 90 | ROUTE 2, BOX 243 | 27350 | LUST |
| SOPHIA | S105766513 | NCDOT - PARCEL 74A - TONY FARLOW | HWY 311 S | 27350 | LUST |
| SOPHIA | U001202957 | H & M GROCERY | 5708 HWY 311 SOUTH | 27350 | LUST, UST |

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

**Elapsed ASTM days:** Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

## FEDERAL ASTM STANDARD RECORDS

**NPL:** National Priority List
Source: EPA
Telephone: N/A
National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 01/29/03
Date Made Active at EDR: 03/04/03
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 02/04/03
Elapsed ASTM days: 28
Date of Last EDR Contact: 05/09/03

**NPL Site Boundaries**

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 3
Telephone 215-814-5418

EPA Region 4
Telephone 404-562-8033

EPA Region 6
Telephone: 214-655-6659

EPA Region 8
Telephone: 303-312-6774

**Proposed NPL:** Proposed National Priority List Sites
Source: EPA
Telephone: N/A

Date of Government Version: 01/29/03
Date Made Active at EDR: 03/04/03
Database Release Frequency: Semi-Annually

Date of Data Arrival at EDR: 02/04/03
Elapsed ASTM days: 28
Date of Last EDR Contact: 05/05/03

**CERCLIS:** Comprehensive Environmental Response, Compensation, and Liability Information System
Source: EPA
Telephone: 703-413-0223
CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 03/19/03
Date Made Active at EDR: 04/08/03
Database Release Frequency: Quarterly

Date of Data Arrival at EDR: 03/24/03
Elapsed ASTM days: 15
Date of Last EDR Contact: 03/24/03

**CERCLIS-NFRAP:** CERCLIS No Further Remedial Action Planned
Source: EPA
Telephone: 703-413-0223
As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

Date of Government Version: 03/19/03
Date Made Active at EDR: 04/08/03
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 03/24/03
Elapsed ASTM days: 15
Date of Last EDR Contact: 03/24/03

**CORRACTS:** Corrective Action Report
Source: EPA
Telephone: 800-424-9346
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 03/31/03
Date Made Active at EDR: 05/08/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 04/07/03
Elapsed ASTM days: 31
Date of Last EDR Contact: 03/10/03

**RCRIS:** Resource Conservation and Recovery Information System
Source: EPA/NTIS
Telephone: 800-424-9346
Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA).

Date of Government Version: 09/09/02
Date Made Active at EDR: 10/28/02
Database Release Frequency: Varies
Date of Data Arrival at EDR: 09/24/02
Elapsed ASTM days: 34
Date of Last EDR Contact: 04/18/03

**ERNS:** Emergency Response Notification System
Source: National Response Center, United States Coast Guard
Telephone: 202-260-2342
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 12/31/01
Date Made Active at EDR: 07/15/02
Database Release Frequency: Annually
Date of Data Arrival at EDR: 07/02/02
Elapsed ASTM days: 13
Date of Last EDR Contact: 04/28/03

## FEDERAL ASTM SUPPLEMENTAL RECORDS

**BRS:** Biennial Reporting System
Source: EPA/NTIS
Telephone: 800-424-9346
The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/99
Database Release Frequency: Biennially
Date of Last EDR Contact: 03/17/03
Date of Next Scheduled EDR Contact: 06/16/03

**CONSENT:** Superfund (CERCLA) Consent Decrees
Source: EPA Regional Offices
Telephone: Varies
Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: N/A
Database Release Frequency: Varies
Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

**ROD:** Records Of Decision
Source: EPA
Telephone: 703-416-0223
Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 01/09/03
Database Release Frequency: Annually

Date of Last EDR Contact: 04/07/03
Date of Next Scheduled EDR Contact: 07/07/03

**DELISTED NPL:** National Priority List Deletions
Source: EPA
Telephone: N/A
The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 01/29/03
Database Release Frequency: Quarterly

Date of Last EDR Contact: 05/05/03
Date of Next Scheduled EDR Contact: 08/04/03

**FINDS:** Facility Index System/Facility Identification Initiative Program Summary Report
Source: EPA
Telephone: N/A
Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 01/14/03
Database Release Frequency: Quarterly

Date of Last EDR Contact: 04/07/03
Date of Next Scheduled EDR Contact: 07/07/03

**HMIRS:** Hazardous Materials Information Reporting System
Source: U.S. Department of Transportation
Telephone: 202-366-4555
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 11/30/02
Database Release Frequency: Annually

Date of Last EDR Contact: 04/25/03
Date of Next Scheduled EDR Contact: 07/21/03

**MLTS:** Material Licensing Tracking System
Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 01/16/03
Database Release Frequency: Quarterly

Date of Last EDR Contact: 04/07/03
Date of Next Scheduled EDR Contact: 07/07/03

**MINES:** Mines Master Index File
Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959

Date of Government Version: 03/11/03
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 03/31/03
Date of Next Scheduled EDR Contact: 06/30/03

**NPL LIENS:** Federal Superfund Liens
Source: EPA
Telephone: 205-564-4267
Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/91
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 02/27/03
Date of Next Scheduled EDR Contact: 05/26/03

**PADS:** PCB Activity Database System
Source: EPA
Telephone: 202-564-3887
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 12/12/02
Database Release Frequency: Annually

Date of Last EDR Contact: 05/12/03
Date of Next Scheduled EDR Contact: 08/11/03

**DOD:** Department of Defense Sites
Source: USGS
Telephone: 703-648-5920
This data set consists of federally owned or administered lands, administered by the Department of Defense, that have any area equal to or greater than 640 acres of the United States, Puerto Rico, and the U.S. Virgin Islands.

Date of Government Version: 10/01/02
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 05/12/03
Date of Next Scheduled EDR Contact: 08/11/03

**RAATS:** RCRA Administrative Action Tracking System
Source: EPA
Telephone: 202-564-4104
RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95
Database Release Frequency: No Update Planned

Date of Last EDR Contact: 03/10/03
Date of Next Scheduled EDR Contact: 06/09/03

**TRIS:** Toxic Chemical Release Inventory System
Source: EPA
Telephone: 202-260-1531
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/00
Database Release Frequency: Annually

Date of Last EDR Contact: 03/25/03
Date of Next Scheduled EDR Contact: 06/23/03

**TSCA:** Toxic Substances Control Act
Source: EPA
Telephone: 202-260-5521
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/98
Database Release Frequency: Every 4 Years

Date of Last EDR Contact: 03/06/03
Date of Next Scheduled EDR Contact: 06/09/03

**FTTS INSP:** FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA
Telephone: 202-564-2501

Date of Government Version: 04/15/03
Database Release Frequency: Quarterly

Date of Last EDR Contact: 06/24/03
Date of Next Scheduled EDR Contact: 06/23/03

**SSTS:** Section 7 Tracking Systems
Source: EPA
Telephone: 202-564-5008
Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/00
Database Release Frequency: Annually
Date of Last EDR Contact: 04/23/03
Date of Next Scheduled EDR Contact: 07/21/03

**FTTS:** FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-564-2501
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/15/03
Database Release Frequency: Quarterly
Date of Last EDR Contact: 03/24/03
Date of Next Scheduled EDR Contact: 06/23/03

## STATE OF NORTH CAROLINA ASTM STANDARD RECORDS

**SHWS:** Inactive Hazardous Sites Inventory
Source: Department of Environment, Health and Natural Resources
Telephone: 919-733-2801
State Hazardous Waste Sites. State hazardous waste site records are the states' equivalent to CERCLIS. These sites may or may not already be listed on the federal CERCLIS list. Priority sites planned for cleanup using state funds (state equivalent of Superfund) are identified along with sites where cleanup will be paid for by potentially responsible parties. Available information varies by state.

Date of Government Version: 04/08/03
Date Made Active at EDR: 05/08/03
Database Release Frequency: Annually
Date of Data Arrival at EDR: 04/21/03
Elapsed ASTM days: 17
Date of Last EDR Contact: 04/15/03

**SWF/LF:** List of Solid Waste Facilities
Source: Department of Environment and Natural Resources
Telephone: 919-733-0692
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 04/29/03
Date Made Active at EDR: 05/08/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 04/29/03
Elapsed ASTM days: 9
Date of Last EDR Contact: 04/28/03

**LUST:** Incidents Management Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1315
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 03/07/03
Date Made Active at EDR: 04/16/03
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 03/10/03
Elapsed ASTM days: 37
Date of Last EDR Contact: 03/10/03

**UST:** Petroleum Underground Storage Tank Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1308
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 11/08/02
Date Made Active at EDR: 12/09/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 11/13/02
Elapsed ASTM days: 26
Date of Last EDR Contact: 03/13/03

**OLI:** Old Landfill Inventory
Source: Department of Environment & Natural Resources
Telephone: 919-733-4996

Date of Government Version: 04/08/03
Date Made Active at EDR: 05/21/03
Database Release Frequency: Varies
Date of Data Arrival at EDR: 04/28/03
Elapsed ASTM days: 23
Date of Last EDR Contact: 04/28/03

**VCP:** Responsible Party Voluntary Action Sites
Source: Department of Environment and Natural Resources
Telephone: 919-733-4996

Date of Government Version: 02/04/03
Date Made Active at EDR: 02/28/03
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 02/10/03
Elapsed ASTM days: 18
Date of Last EDR Contact: 04/15/03

**INDIAN UST:** Underground Storage Tanks on Indian Land
Source: EPA Region 4
Telephone: 404-562-9424

Date of Government Version: N/A
Date Made Active at EDR: N/A
Database Release Frequency: Varies
Date of Data Arrival at EDR: N/A
Elapsed ASTM days: 0
Date of Last EDR Contact: N/A

## STATE OF NORTH CAROLINA ASTM SUPPLEMENTAL RECORDS

**HSDS:** Hazardous Substance Disposal Site
Source: North Carolina Center for Geographic Information and Analysis
Telephone: 919-733-2090
Locations of uncontrolled and unregulated hazardous waste sites. The file includes sites on the National Priority List as well as those on the state priority list.

Date of Government Version: 06/21/95
Database Release Frequency: Biennially
Date of Last EDR Contact: 03/06/03
Date of Next Scheduled EDR Contact: 06/02/03

**AST:** AST Database
Source: Department of Environment and Natural Resources
Telephone: 919-715-6170
Facilities with aboveground storage tanks that have a capacity greater than 21,000 gallons.

Date of Government Version: 01/01/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 04/21/03
Date of Next Scheduled EDR Contact: 07/21/03

**LUST TRUST:** State Trust Fund Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1315
This database contains information about claims against the State Trust Funds for reimbursements for expenses incurred while remediating Leaking USTs.

Date of Government Version: 02/07/03
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 05/12/03
Date of Next Scheduled EDR Contact: 08/11/03

**IMD:** Incident Management Database
Source: Department of Environment and Natural Resources
Telephone: 919-733-1315
Groundwater and/or soil contamination incidents

# GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Date of Government Version: 04/24/03
Database Release Frequency: Quarterly

Date of Last EDR Contact: 04/28/03
Date of Next Scheduled EDR Contact: 07/28/03

## EDR PROPRIETARY HISTORICAL DATABASES

**Former Manufactured Gas (Coal Gas) Sites:** The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

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The information contained in this report has predominantly been obtained from publicly available sources produced by entities other than Real Property Scan. While reasonable steps have been taken to insure the accuracy of this report, Real Property Scan does not guarantee the accuracy of this report. Any liability on the part of Real Property Scan is strictly limited to a refund of the amount paid. No claim is made for the actual existence of toxins at any site. This report does not constitute a legal opinion.

## STATE OF NORTH CAROLINA BROWNFIELDS DATABASES RECORDS

**Brownfields:** Brownfields Projects Inventory
Source: Department of Environment and Natural Resources
Telephone: 919-733-4996
A brownfield site is an abandoned, idled, or underused property where the threat of environmental contamination has hindered its redevelopment. All of the sites in the inventory are working toward a brownfield agreement for cleanup and liabitliy control.

Date of Government Version: 09/30/02
Database Release Frequency: Varies

Date of Last EDR Contact: 05/06/03
Date of Next Scheduled EDR Contact: 08/04/03

**VCP:** Responsible Party Voluntary Action Sites
Source: Department of Environment and Natural Resources
Telephone: 919-733-4996

Date of Government Version: 02/04/03
Database Release Frequency: Semi-Annually

Date of Last EDR Contact: 04/15/03
Date of Next Scheduled EDR Contact: 07/14/03

## OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

**Oil/Gas Pipelines:** This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines.

**Electric Power Transmission Line Data**
Source: PennWell Corporation
Telephone: (800) 823-6277
This map includes information copyrighted by PennWell Corporation. This information is provided on a best effort basis and PennWell Corporation does not guarantee its accuracy nor warrant its fitness for any particular purpose. Such information has been reprinted with the permission of PennWell.

**Sensitive Receptors:** There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

**AHA Hospitals:**
Source: American Hospital Association, Inc.
Telephone: 312-280-5991
The database includes a listing of hospitals based on the American Hospital Association's annual survey of hospitals.

**Medical Centers: Provider of Services Listing**
Source: Centers for Medicare & Medicaid Services
Telephone: 410-786-3000
A listing of hospitals with Medicare provider number, produced by Centers of Medicare & Medicaid Services, a federal agency within the U.S. Department of Health and Human Services.

**Nursing Homes**
Source: National Institutes of Health
Telephone: 301-594-6248
Information on Medicare and Medicaid certified nursing homes in the United States.

**Public Schools**
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on elementary and secondary public education in the United States. It is a comprehensive, annual, national statistical database of all public elementary and secondary schools and school districts, which contains data that are comparable across all states.

**Private Schools**
Source: National Center for Education Statistics
Telephone: 202-502-7300
The National Center for Education Statistics' primary database on private school locations in the United States.

**Daycare Centers: Child Care Facility List**
Source: Department of Health & Human Services
Telephone: 919-662-4499

**Flood Zone Data:** This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

**NWI:** National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

STREET AND ADDRESS INFORMATION

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# GEOCHECK® - PHYSICAL SETTING SOURCE ADDENDUM

**TARGET PROPERTY ADDRESS**

HEATH DAIRY RD.
MITIGATION SITE
ASH, NC 27317

**TARGET PROPERTY COORDINATES**

| | |
|---|---|
| Latitude (North): | 35.779301 - 35° 46' 45.5" |
| Longitude (West): | 79.844704 - 79° 50' 40.9" |
| Universal Tranverse Mercator: | Zone 17 |
| UTM X (Meters): | 604418.5 |
| UTM Y (Meters): | 3959885.8 |
| Elevation: | 610 ft. above sea level |

EDR's GeoCheck Physical Setting Source Addendum has been developed to assist the environmental professional with the collection of physical setting source information in accordance with ASTM 1527-00, Section 7.2.3. Section 7.2.3 requires that a current USGS 7.5 Minute Topographic Map (or equivalent, such as the USGS Digital Elevation Model) be reviewed. It also requires that one or more additional physical setting sources be sought when (1) conditions have been identified in which hazardous substances or petroleum products are likely to migrate to or from the property, and (2) more information than is provided in the current USGS 7.5 Minute Topographic Map (or equivalent) is generally obtained, pursuant to local good commercial or customary practice, to assess the impact of migration of recognized environmental conditions in connection with the property. Such additional physical setting sources generally include information about the topographic, hydrologic, hydrogeologic, and geologic characteristics of a site, and wells in the area.

Assessment of the impact of contaminant migration generally has two principle investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata. EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

## GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

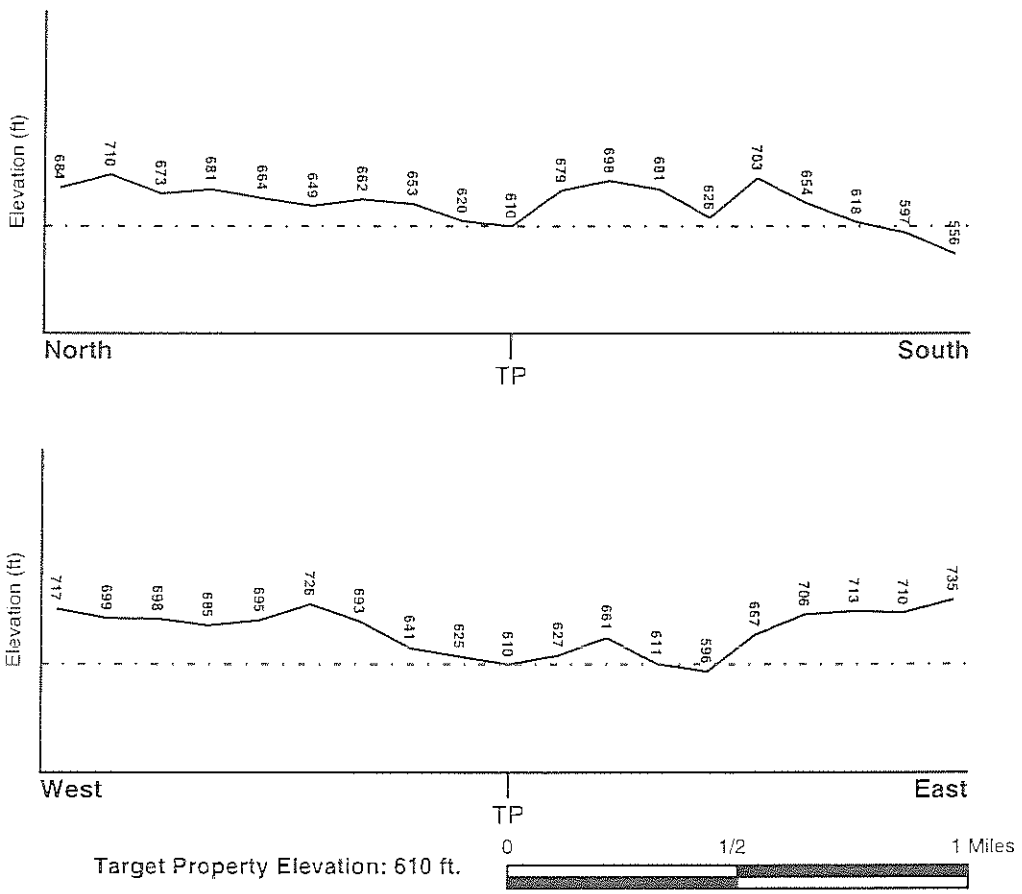
## TOPOGRAPHIC INFORMATION

Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

### TARGET PROPERTY TOPOGRAPHY

| | |
|---|---|
| USGS Topographic Map: | 2435079-G7 RANDLEMAN, NC |
| General Topographic Gradient: | General North |
| Source: | USGS 7.5 min quad index |

### SURROUNDING TOPOGRAPHY: ELEVATION PROFILES




Target Property Elevation: 610 ft.

Source: Topography has been determined from the USGS Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

## HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

### FEMA FLOOD ZONE

| Target Property County | FEMA Flood Electronic Data |
|---|---|
| RANDOLPH, NC | YES - refer to the Overview Map and Detail Map |

Flood Plain Panel at Target Property: 3701950200B

Additional Panels in search area: 3701960003B

### NATIONAL WETLAND INVENTORY

| NWI Quad at Target Property | NWI Electronic Data Coverage |
|---|---|
| RANDLEMAN | YES - refer to the Overview Map and Detail Map |

## HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

## AQUIFLOW®

Search Radius: 1.000 Mile.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

| MAP ID | LOCATION FROM TP | GENERAL DIRECTION GROUNDWATER FLOW |
|---|---|---|
| Not Reported | | |

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

## GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

## GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

### ROCK STRATIGRAPHIC UNIT

### GEOLOGIC AGE IDENTIFICATION

| | | | |
|---|---|---|---|
| Era: | Paleozoic | Category: | Volcanic Rocks |
| System: | Cambrian | | |
| Series: | Cambrian volcanic rocks | | |
| Code: | Cv *(decoded above as Era, System & Series)* | | |

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

### DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps. The following information is based on Soil Conservation Service STATSGO data.

| | |
|---|---|
| Soil Component Name: | HERNDON |
| Soil Surface Texture: | silt loam |
| Hydrologic Group: | Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures. |
| Soil Drainage Class: | Well drained. Soils have intermediate water holding capacity. Depth to water table is more than 6 feet. |

Hydric Status: Soil does not meet the requirements for a hydric soil.

Corrosion Potential - Uncoated Steel: HIGH

Depth to Bedrock Min: > 60 inches

Depth to Bedrock Max: > 60 inches

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

| Soil Layer Information | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Boundary | | | Classification | | | |
| Layer | Upper | Lower | Soil Texture Class | AASHTO Group | Unified Soil | Permeability Rate (in/hr) | Soil Reaction (pH) |
| 1 | 0 inches | 9 inches | silt loam | Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils. | FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt. | Max: 2.00<br>Min: 0.60 | Max: 6.50<br>Min: 4.50 |
| 2 | 9 inches | 48 inches | silty clay loam | Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils. | FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt. | Max: 2.00<br>Min: 0.60 | Max: 5.50<br>Min: 3.60 |
| 3 | 48 inches | 68 inches | silt loam | Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils. | FINE-GRAINED SOILS, Silts and Clays (liquid limit 50% or more), Elastic silt. | Max: 2.00<br>Min: 0.60 | Max: 5.50<br>Min: 3.60 |

OTHER SOIL TYPES IN AREA

Based on Soil Conservation Service STATSGO data, the following additional subordinant soil types may appear within the general area of target property.

Soil Surface Textures: sandy loam
stony - silt loam
gravelly - silt loam
clay loam
channery - silt loam
loam

Surficial Soil Types: sandy loam
stony - silt loam
gravelly - silt loam
clay loam
channery - silt loam
loam

Shallow Soil Types: silty clay loam
sandy clay
silt loam
loam
clay loam
very channery - silt loam

Deeper Soil Types: silty clay loam
weathered bedrock
unweathered bedrock
sandy clay loam
clay

# GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

## ADDITIONAL ENVIRONMENTAL RECORD SOURCES

According to ASTM E 1527-00, Section 7.2.2, "one or more additional state or local sources of environmental records may be checked, in the discretion of the environmental professional, to enhance and supplement federal and state sources... Factors to consider in determining which local or additional state records, if any, should be checked include (1) whether they are reasonably ascertainable, (2) whether they are sufficiently useful, accurate, and complete in light of the objective of the records review (see 7.1.1), and (3) whether they are obtained, pursuant to local, good commercial or customary practice." One of the record sources listed in Section 7.2.2 is water well information. Water well information can be used to assist the environmental professional in assessing sources that may impact groundwater flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

## WELL SEARCH DISTANCE INFORMATION

| DATABASE | SEARCH DISTANCE (miles) |
|---|---|
| Federal USGS | 1.000 |
| Federal FRDS PWS | Nearest PWS within 1 mile |
| State Database | 1.000 |

## FEDERAL USGS WELL INFORMATION

| MAP ID | WELL ID | LOCATION FROM TP |
|---|---|---|
| 1 | USGS0811207 | 1/2 - 1 Mile SW |
| 2 | USGS0811265 | 1/2 - 1 Mile SSE |

## FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

| MAP ID | WELL ID | LOCATION FROM TP |
|---|---|---|
| No PWS System Found | | |

Note: PWS System location is not always the same as well location.

## STATE DATABASE WELL INFORMATION

| MAP ID | WELL ID | LOCATION FROM TP |
|---|---|---|
| 3 | NCWS004762 | 1/2 - 1 Mile South |

# PHYSICAL SETTING SOURCE MAP - 0981636.1s




0 1/4 1/2 1 Miles

- County Boundary
- Major Roads
- Contour Lines
- Earthquake epicenter, Richter 5 or greater
- Water Wells
- Public Water Supply Wells
- Cluster of Multiple Icons
- Groundwater Flow Direction
- GI Indeterminate Groundwater Flow at Location
- GV Groundwater Flow Varies at Location
- Wildlife Areas
- Natural Areas
- Rare & Endangered Species

| | | | |
|---|---|---|---|
| TARGET PROPERTY: | Heath Dairy Rd. | CUSTOMER: | Ecoscience Corp Inc |
| ADDRESS: | Mitigation Site | CONTACT: | Corri Faquin |
| CITY/STATE/ZIP: | Ash NC 27317 | INQUIRY #: | 0981636.1s |
| LAT/LONG: | 35.7793 / 79.8447 | DATE: | May 21, 2003 6:49 pm |

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# GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID
Direction
Distance
Elevation

| | Database | EDR ID Number |
|---|---|---|
| 1<br>SW<br>1/2 - 1 Mile<br>Higher | FED USGS | USGS0811207 |

| | | | |
|---|---|---|---|
| Agency: | USGS | Site ID: | 354624079510301 |
| Site Name: | RA-050 WILLARD W COX | | |
| Dec. Latitude: | 35.77347 | | |
| Dec. Longitude: | -79.85059 | | |
| Coord Sys: | NAD83 | | |
| State: | NC | | |
| County: | Randolph County | | |
| Altitude: | Not Reported | | |
| Hydrologic code: | Not Reported | | |
| Topographic: | Hillside (slope) | | |
| Site Type: | Ground-water other than Spring | | |
| Const Date: | Not Reported | Inven Date: | Not Reported |
| Well Type: | Single well, other than collector or Ranney type | | |
| Primary Aquifer: | 370FCMV | | |
| Aquifer type: | Not Reported | Well depth: | 91.0 |
| Hole depth: | Not Reported | Source: | S |
| Project no: | Not Reported | | |

---

| | Database | EDR ID Number |
|---|---|---|
| 2<br>SSE<br>1/2 - 1 Mile<br>Higher | FED USGS | USGS0811265 |

| | | | |
|---|---|---|---|
| Agency: | USGS | Site ID: | 354620079502301 |
| Site Name: | RA-051 WILLIAM J HYLTON | | |
| Dec. Latitude: | 35.77236 | | |
| Dec. Longitude: | -79.83948 | | |
| Coord Sys: | NAD83 | | |
| State: | NC | | |
| County: | Randolph County | | |
| Altitude: | Not Reported | | |
| Hydrologic code: | Not Reported | | |
| Topographic: | Hilltop | | |
| Site Type: | Ground-water other than Spring | | |
| Const Date: | Not Reported | Inven Date: | Not Reported |
| Well Type: | Single well, other than collector or Ranney type | | |
| Primary Aquifer: | 370FCMV | | |
| Aquifer type: | Not Reported | Well depth: | 87.0 |
| Hole depth: | Not Reported | Source: | S |
| Project no: | Not Reported | | |

---

| | Database | EDR ID Number |
|---|---|---|
| 3<br>South<br>1/2 - 1 Mile<br>Higher | NC WELLS | NCWS004762 |

| | | | |
|---|---|---|---|
| Site Name: | WELL #1 | | |
| PWS ID: | 0276469 | Source code: | W01 |
| City: | RANDLEMAN | | |
| County: | Randolph | | |
| Latitude: | 354600.342 | Longitude: | 795044.979 |
| Availability: | Permanent | | |
| Type: | Ground | Depth: | 0 |
| Owner: | FRIENDSHIP BAPTIST CHURCH | | |

# GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS
## RADON

AREA RADON INFORMATION

State Database: NC Radon

Radon Test Results

| County | Result Type | Total Sites | Avg pCi/L | Range pCi/L |
|---|---|---|---|---|
| RANDOLPH | Statistical | 8 | 0.44 | 0.00-1.20 |
| RANDOLPH | Non-Statistical | 50 | 1.62 | 0.00-8.00 |

Federal EPA Radon Zone for RANDOLPH County: 3

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

---

Federal Area Radon Information for Zip Code: 27317

Number of sites tested: 1

| Area | Average Activity | % <4 pCi/L | % 4-20 pCi/L | % >20 pCi/L |
|---|---|---|---|---|
| Living Area - 1st Floor | 0.700 pCi/L | 100% | 0% | 0% |
| Living Area - 2nd Floor | Not Reported | Not Reported | Not Reported | Not Reported |
| Basement | 0.400 pCi/L | 100% | 0% | 0% |

# PHYSICAL SETTING SOURCE RECORDS SEARCHED

## HYDROLOGIC INFORMATION

**Flood Zone Data:** This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

**NWI:** National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

## HYDROGEOLOGIC INFORMATION

**AQUIFLOW$^R$ Information System**

Source: EDR proprietary database of groundwater flow information

EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

## GEOLOGIC INFORMATION

**Geologic Age and Rock Stratigraphic Unit**

Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

**STATSGO:** State Soil Geographic Database

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the national Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

## ADDITIONAL ENVIRONMENTAL RECORD SOURCES

### FEDERAL WATER WELLS

**PWS:** Public Water Systems

Source: EPA/Office of Drinking Water

Telephone: 202-564-3750

Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

**PWS ENF:** Public Water Systems Violation and Enforcement Data

Source: EPA/Office of Drinking Water

Telephone: 202-564-3750

Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

**USGS Water Wells:** USGS National Water Inventory System (NWIS)

This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on wells, springs, and other sources of groundwater.

# PHYSICAL SETTING SOURCE RECORDS SEARCHED

## STATE RECORDS

**North Carolina Wildlife Resources/Game Lands**
Source: Center for Geographic Information and Analysis
Telephone: 919-733-2090
All publicly owned game lands managed by the North Carolina Wildlife Resources Commission and as listed in Hunting and Fishing Maps for North Carolina Game Lands, 1989-90.

**North Carolina Rare/Endangered Species and Natural Areas**
Source: Natural Heritage Occurrence Sites Center for Geographic Information and Analysis
Telephone: 919-733-2090

**North Carolina Public Water Supply Wells**
Source: Department of Environmental Health
Telephone: 919-715-3243

## RADON

**State Database: NC Radon**
Source: Department of Environment & Natural Resources
Telephone: 919-733-4984
Radon Statistical and Non Statiscal Data

**Area Radon Information**
Source: USGS
Telephone: 703-356-4020
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

**EPA Radon Zones**
Source: EPA
Telephone: 703-356-4020
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

## OTHER

**Airport Landing Facilities:** Private and public use landing facilities
Source: Federal Aviation Administration, 800-457-6656

**Epicenters:** World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

# APPENDIX Q

## Preliminary Plans

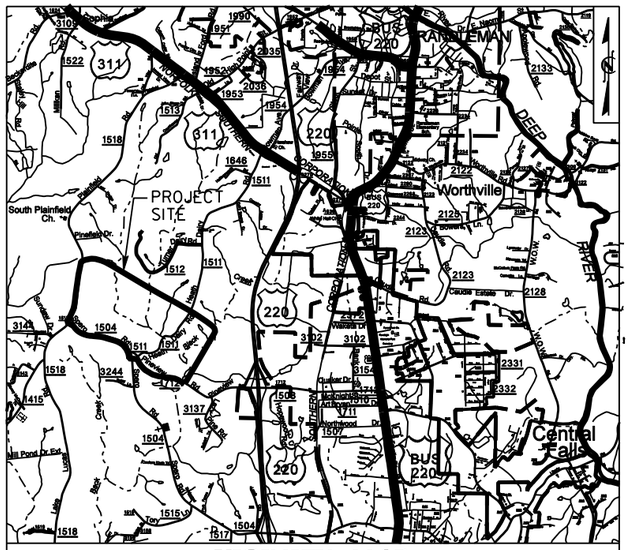
| PROJECT REFERENCE NO. | SHEET NO. | TOTAL SHEETS |
|---|---|---|
| NCDENR D06017S | 1 | XX |

# STATE OF NORTH CAROLINA
# ECOSYSTEM ENHANCEMENT PROGRAM

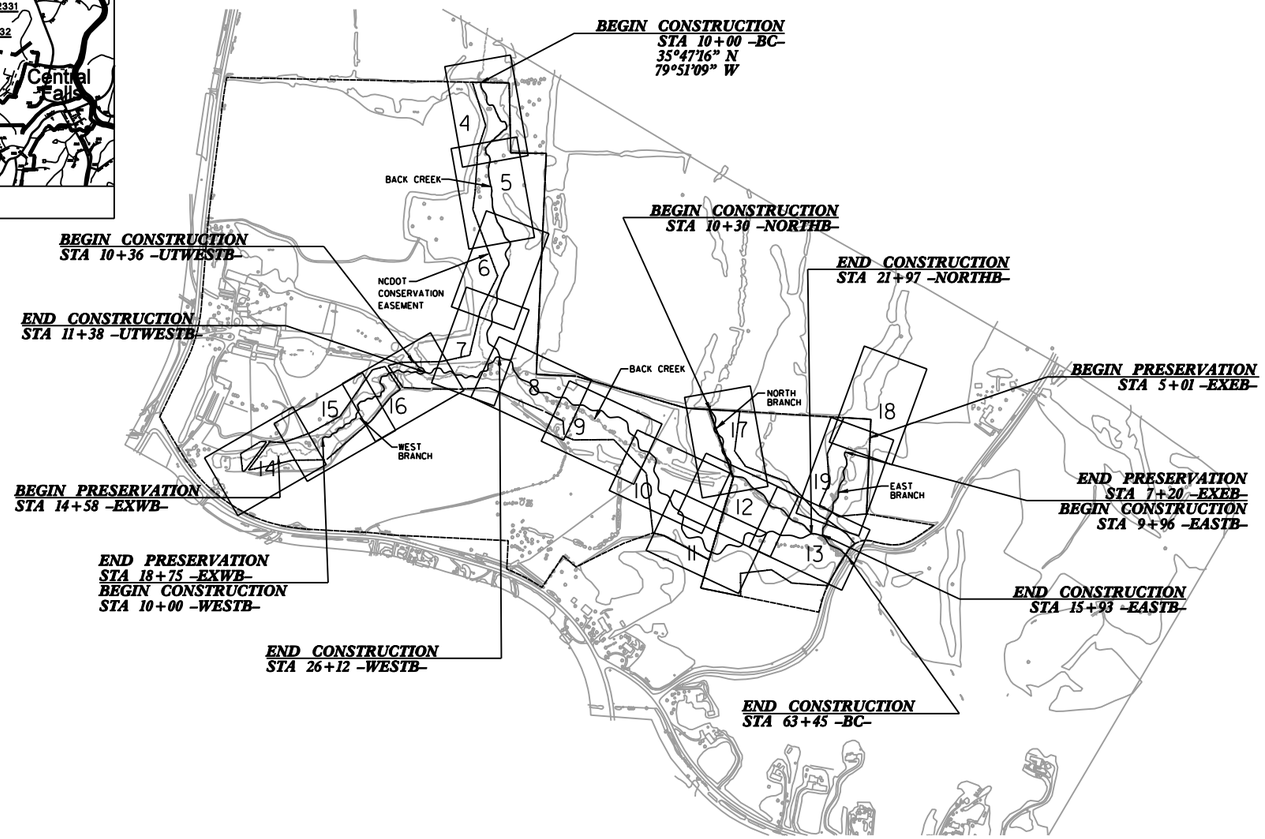
## RANDOLPH CO.

***LOCATION: HEATH DAIRY ROAD STREAM RESTORATION SITE NW OF ASHEBORO AND SW OF RANDLEMAN***

***TYPE OF WORK: STREAM RESTORATION, GRADING, SEEDING, PLANTING, AND FENCING***




***VICINITY MAP***




***SHEET INDEX***


| | |
|---|---|
| 1 | TITLE SHEET |
| 2 | SITE PLAN |
| 3 | TYPICAL SECTIONS |
| 3A – 3E | DETAILS |
| 4 – 19 | PLAN SHEETS |
| 20 – 29 | PROFILE SHEETS |
| PP1 – PP3 | PLANTING PLAN |
| X1 – X36 | CROSS SECTION SHEETS |


***GRAPHIC SCALES***

20′ 10′ 0′ 20′ 40′
PLANS

20′ 10′ 0′ 20′ 40′
PROFILE (HORIZONTAL)

2′ 1′ 0′ 2′ 4′
PROFILE (VERTICAL)

***PROJECT UNITS***

STREAM PRESERVATION: 636 LF
STREAM ENHANCEMENT: 960 LF
STREAM RESTORATION: 7781 LF
WETLAND PRESERVATION: 1.18 AC
WETLAND ENHANCEMENT: 0.60 AC

| STREAM DESIGN ENGINEER (Wolf Creek Engineering) | WETLAND /STORMWATER DESIGN ENGINEER (WAZ Engineering) |
|---|---|
| PRELIMINARY PLANS DO NOT USE FOR CONSTRUCTION | |


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F–0552*

TAMMIE TUCKER, EI
HSMM PROJECT CONTACT


***DRAFT***

SUBMITTED TO NCEEP ON JULY 23, 2009

***HEATH DAIRY ROAD STREAM RESTORATION SITE***

200' 0' 200' 400'
100'

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 2 |

| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |
|---|---|

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ON BEHALF OF:

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*license no: F-0552*


WETLAND E (ENHANCEMENT)
BACK CREEK
AT&T EASEMENT
INGRESS/EGRESS EASEMENT
NCDOT CONSERVATION EASEMENT, TYP.
EAST BRANCH
NORTH BRANCH
WETLAND C (ENHANCEMENT)
WETLAND K (ENHANCEMENT)
INGRESS/EGRESS EASEMENT
BACK CREEK
WETLAND A-2 (ENHANCEMENT)
WETLAND A-1 (PRESERVATION)
WETLAND B (ENHANCEMENT)
WETLAND F (ENHANCEMENT)
UT TO WEST BRANCH
WEST BRANCH
WETLAND L (PRESERVATION)
WETLAND I (PRESERVATION)
WETLAND J (PRESERVATION)
PROPERTY BOUNDARY, TYP.
PLAINFIELD RD.
SPERO RD.
PINEVIEW RD.
HEATH DAIRY RD.

SITE PLAN

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 3 |

STREAM DESIGN ENGINEER

WETLAND / STORMWATER DESIGN ENGINEER

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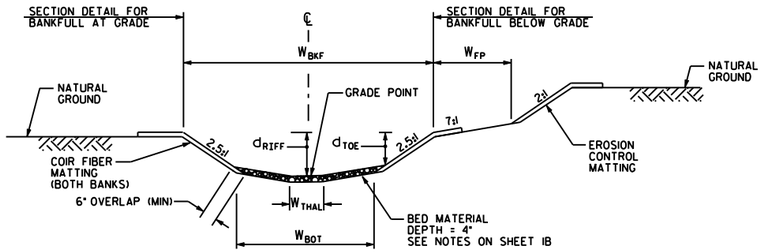
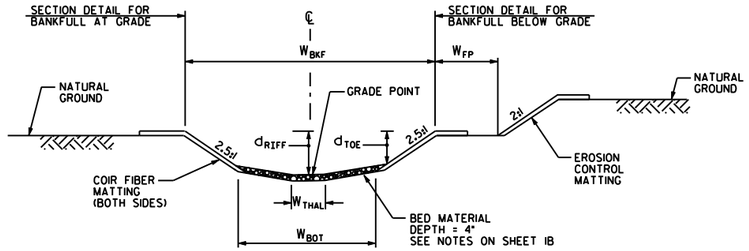
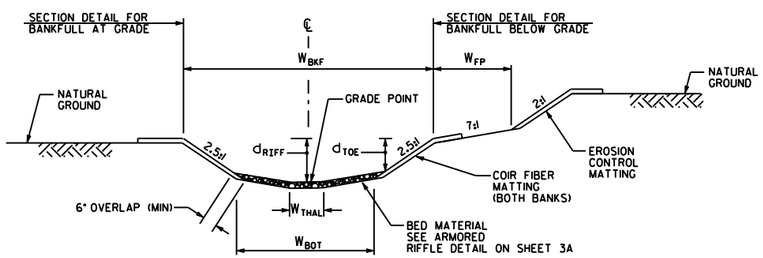


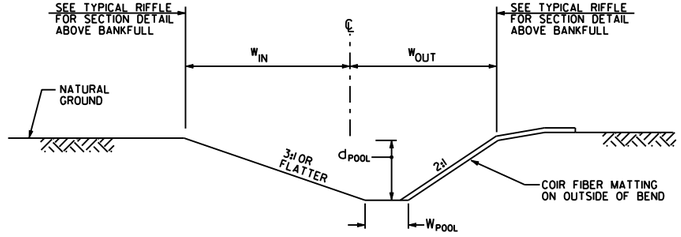

SECTION 1
TYPICAL RIFFLE
NOT TO SCALE




SECTION 3
TYPICAL RIFFLE
NOT TO SCALE




SECTION 2
TYPICAL RIFFLE (ARMORED)
NOT TO SCALE




TYPICAL POOL SECTION
NOT TO SCALE

TABLE 1: SECTION DIMENSIONS

| | | | RIFFLE DIMENSIONS | | | | | | POOL DIMENSIONS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REACH | SECTION | STATION | $W_{THAL}$(ft) | $W_{BOT}$(ft) | $W_{BKF}$(ft) | $W_{FP}$(ft) | $d_{RIFF}$(ft) | $d_{TOE}$(ft) | $W_{POOL}$(ft) | $W_{IN}$(ft) | $W_{OUT}$(ft) | $d_{POOL}$(ft) |
| BACK CREEK 1 | 1 | STA 10+00 TO STA 18+50 | 4 | 10 | 16.5 | 7 | 1.5 | 1.2 | 4 | 9.9 | 8.25 | 2.25 |
| BACK CREEK 2 | 1 | STA 18+50 TO STA 30+80 | 4 | 10 | 16.6 | 8 | 1.6 | 1.3 | 4 | 10 | 8.3 | 2.4 |
| BACK CREEK 3 | 1 | STA 30+80 TO STA 48+30 | 5 | 10.5 | 17.5 | 8 | 1.7 | 1.4 | 5 | 10.5 | 8.75 | 2.55 |
| BACK CREEK 4A | 3 | STA 48+30 TO STA 57+20 | 4 | 8 | 16.5 | 8 | 2 | 1.7 | 4 | 10.75 | 8.25 | 3 |
| BACK CREEK 4B | 2 | STA 57+20 TO STA 60+45 | 5 | 10.5 | 17.5 | 9 | 1.7 | 1.4 | 5 | 10.5 | 8.75 | 2.55 |
| BACK CREEK 5 | 2 | STA 60+45 TO STA 63+45 | 6 | 13.5 | 22.5 | 11 | 2.2 | 1.8 | 6 | 13.5 | 11.25 | 3.3 |
| WEST BRANCH 1A | 1 | STA 10+00 TO STA 12+00 | 2 | 3.8 | 5.8 | 4 | 0.55 | 0.4 | 2 | 3.5 | 2.9 | 0.825 |
| WEST BRANCH 1B | 2 | STA 12+00 TO STA 13+80 | 2 | 3.8 | 5.8 | 4 | 0.55 | 0.4 | 2 | 3.5 | 2.9 | 0.825 |
| WEST BRANCH 2A | 1 | STA 13+80 TO STA 18+00 | 2 | 3.95 | 6.2 | 4 | 0.6 | 0.45 | 2 | 3.7 | 3.1 | 0.9 |
| WEST BRANCH 2B | 2 | STA 18+00 TO STA 19+55 | 2 | 3.95 | 6.2 | 4 | 0.6 | 0.45 | 2 | 3.7 | 3.1 | 0.9 |
| WEST BRANCH 3A | 2 | STA 19+55 TO STA 20+00 | 2 | 5.2 | 8.2 | 4 | 0.8 | 0.6 | 2 | 4.9 | 4.1 | 1.2 |
| WEST BRANCH 3B | 1 | STA 20+00 TO STA 25+30 | 2 | 5.2 | 8.2 | 4 | 0.8 | 0.6 | 2 | 4.9 | 4.1 | 1.2 |
| WEST BRANCH 3C | 2 | STA 25+30 TO STA 26+17 | 2 | 5.2 | 8.2 | 4 | 0.8 | 0.6 | 2 | 4.9 | 4.1 | 1.2 |
| UT TO WEST BRANCH | 2 | STA 10+36 TO STA 11+38 | 2 | 4 | 6 | 4 | 0.6 | 0.4 | 2 | 3.6 | 3 | 0.9 |
| NORTH BRANCH 1A | 1 | STA 10+30 TO STA 18+89 | 4 | 11 | 17 | 8 | 1.7 | 1.2 | 4 | 10.2 | 8.5 | 2.55 |
| NORTH BRANCH 1B | 2 | STA 18+89 TO STA 21+97 | 4 | 11 | 17 | 8 | 1.7 | 1.2 | 4 | 10.2 | 8.5 | 2.55 |
| EAST BRANCH 1A | 2 | STA 9+96 TO STA 10+77 | 2 | 6.5 | 10 | 5 | 1 | 0.7 | 2 | 6 | 5 | 1.5 |
| EAST BRANCH 1B | 1 | STA 10+77 TO STA 14+39 | 2 | 6.5 | 10 | 5 | 1 | 0.7 | 2 | 6 | 5 | 1.5 |
| EAST BRANCH 1C | 2 | STA 14+39 TO STA 15+93 | 2 | 6.5 | 10 | 5 | 1 | 0.7 | 2 | 6 | 5 | 1.5 |

TYPICAL SECTIONS

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 3A |

STREAM DESIGN ENGINEER

WETLAND / STORMWATER DESIGN ENGINEER

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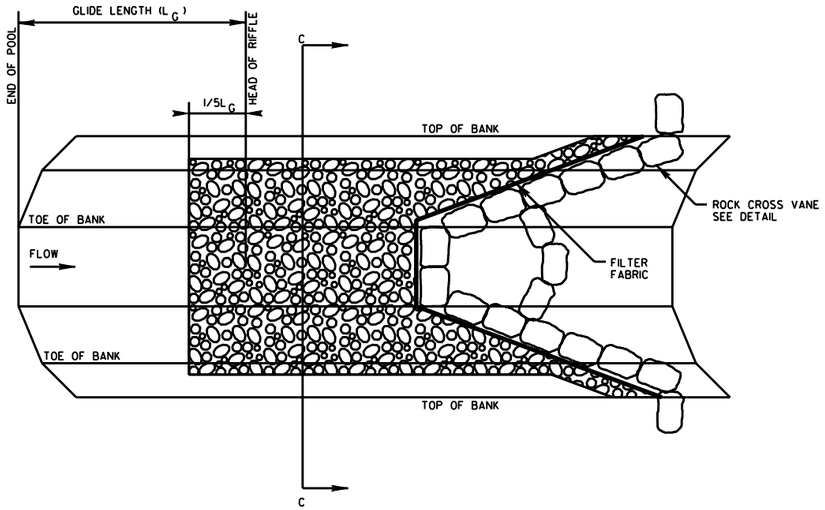
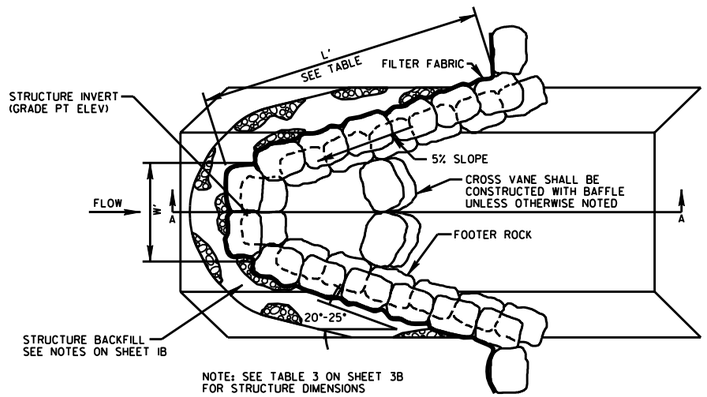
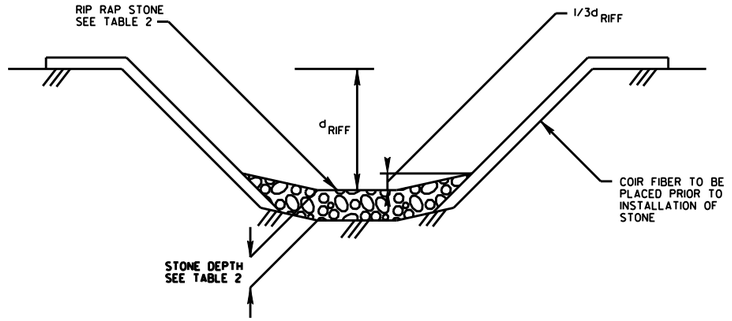



ARMORED RIFFLE DETAIL
NOT TO SCALE

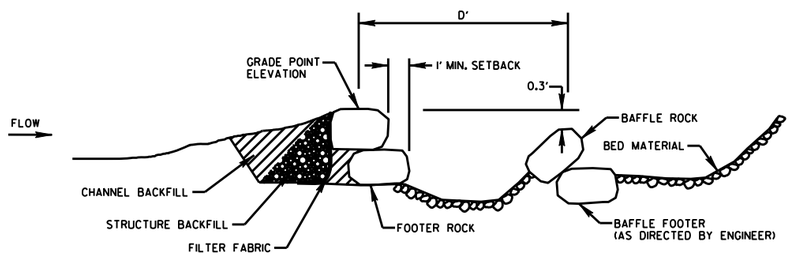



NOTE: SEE TABLE 3 ON SHEET 3B FOR STRUCTURE DIMENSIONS

ROCK CROSS VANE - PLAN
NOT TO SCALE




SECTION C-C
NOT TO SCALE




SECTION A-A
NOT TO SCALE

| TABLE 2: ARMORED RIFFLE | | | |
|---|---|---|---|
| Reach | Station | Stone Size | Depth |
| Back Creek | 57+75 TO 63+40 | 12 IN | 12 IN |
| East Branch | 10+00 TO 11+00 | 12 IN | 12 IN |
| | 14+90 TO 16+00 | 12 IN | 12 IN |
| West Branch | 11+90 TO 13+90 | 12 IN | 12 IN |
| | 18+10 TO 19+90 | 12 IN | 12 IN |
| | 25+50 TO 26+15 | 12 IN | 12 IN |
| North Branch | 19+75 TO 21+75 | 12 IN | 12 IN |

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 3B |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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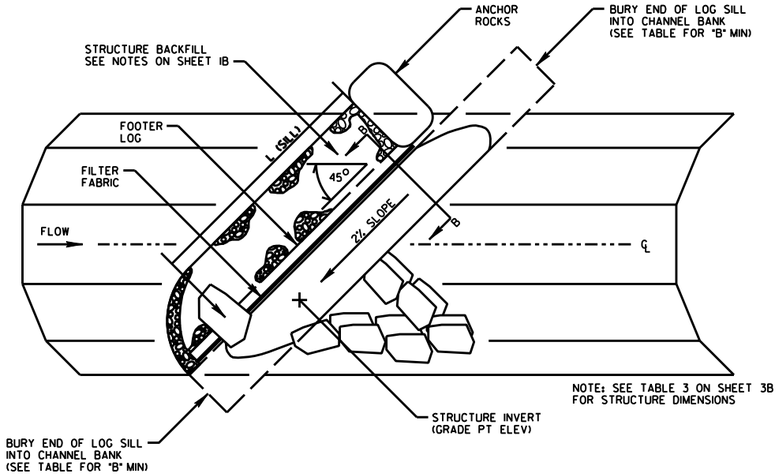
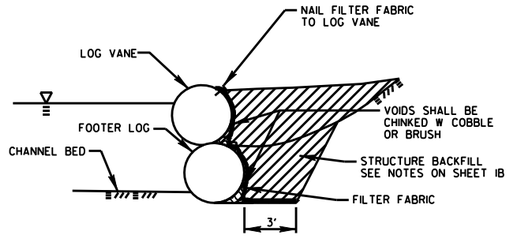
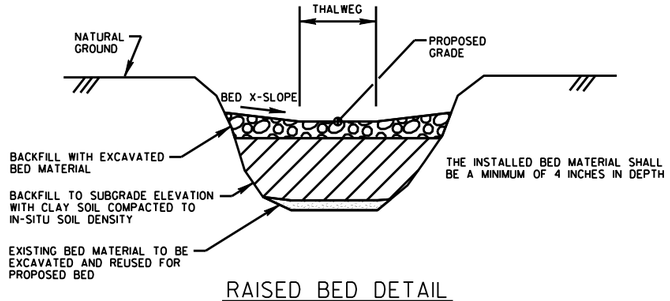



LOG SILL PLAN VIEW
NOT TO SCALE




SECTION B-B
NOT TO SCALE




RAISED BED DETAIL
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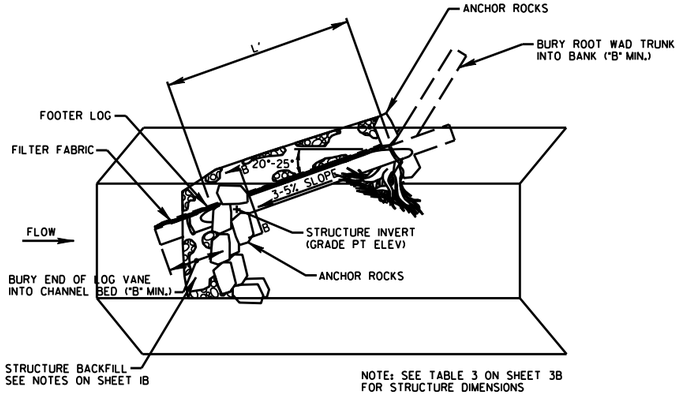


ROOT WAD - LOG VANE
NOT TO SCALE

TABLE 3: STRUCTURE DIMENSIONS

| Stream Reach | Structures | | | | | Boulders | | |
|---|---|---|---|---|---|---|---|---|
| | L (ft) | W (ft) | D (ft) | B(min) (ft) | L(sill) (ft) | Length (ft) | Width (ft) | Depth (ft) |
| Back Creek 1 | 16.5 | 5 | 8 | 7 | 15 | 2.5 | 1.5 | 1 |
| Back Creek 2 | 16.5 | 5 | 8 | 7 | 15 | 2.5 | 1.5 | 1 |
| Back Creek 3 | 17.5 | 5.3 | 8 | 8 | 16 | 2.5 | 1.5 | 1 |
| Back Creek 4A | 16.5 | 4 | 8 | 7 | 12 | 3 | 2 | 1.5 |
| Back Creek 4B | 17.5 | 5.3 | 8 | 8 | 16 | 3 | 2 | 1.5 |
| Back Creek 5 | 22.5 | 6.8 | 10 | 10 | 20 | 3 | 2 | 1.5 |
| West Branch 1A | 6 | 2 | 2.5 | 4 | 6 | 2.5 | 1.5 | 1 |
| West Branch 1B | 6 | 2 | 2.5 | 4 | 6 | 2.5 | 1.5 | 1 |
| West Branch 2A | 6 | 2 | 2.5 | 4 | 6 | 2.5 | 1.5 | 1 |
| West Branch 2B | 6 | 2 | 2.5 | 4 | 6 | 2.5 | 1.5 | 1 |
| West Branch 3A | 8 | 2.5 | 3.5 | 5 | 8 | 2.5 | 1.5 | 1 |
| West Branch 3B | 8 | 2.5 | 3.5 | 5 | 8 | 2.5 | 1.5 | 1 |
| West Branch 3C | 8 | 2.5 | 3.5 | 5 | 8 | 2.5 | 1.5 | 1 |
| UT to West Branch | 6 | 2 | 2.5 | 4 | 6 | 2.5 | 1.5 | 1 |
| North Branch 1A | 17 | 5.5 | 8 | 8 | 17 | 3 | 2 | 1.5 |
| North Branch 1B | 17 | 5.5 | 8 | 8 | 17 | 3 | 2 | 1.5 |
| East Branch 1A | 10 | 3.3 | 4.5 | 5 | 10 | 2.5 | 1.5 | 1 |
| East Branch 1B | 10 | 3.3 | 4.5 | 5 | 10 | 2.5 | 1.5 | 1 |
| East Branch 1C | 10 | 3.3 | 4.5 | 5 | 10 | 2.5 | 1.5 | 1 |

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017.S | 3C |

STREAM DESIGN ENGINEER

WETLAND / STORMWATER DESIGN ENGINEER

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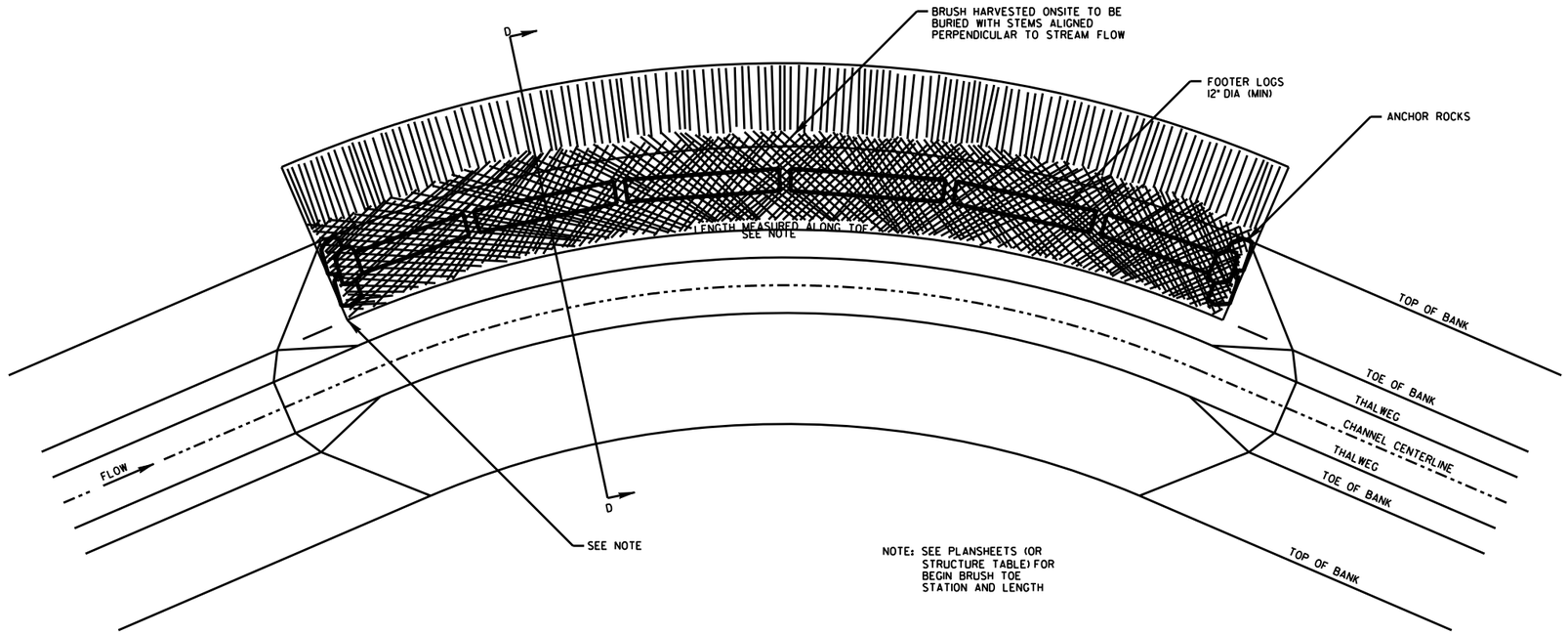
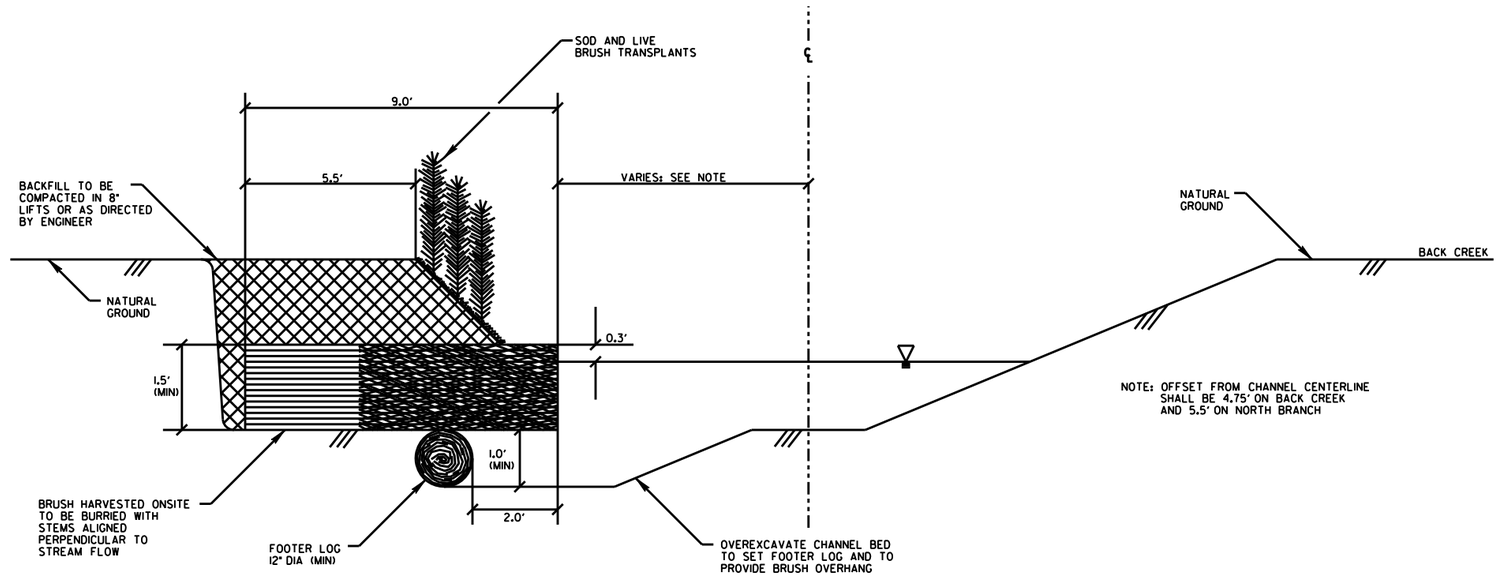



NOTE: SEE PLANSHEETS (OR STRUCTURE TABLE) FOR BEGIN BRUSH TOE STATION AND LENGTH

BRUSH TOE PLAN VIEW
NOT TO SCALE




SECTION D-D
NOT TO SCALE

IN-STREAM STRUCTURE DETAILS

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 3D |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION

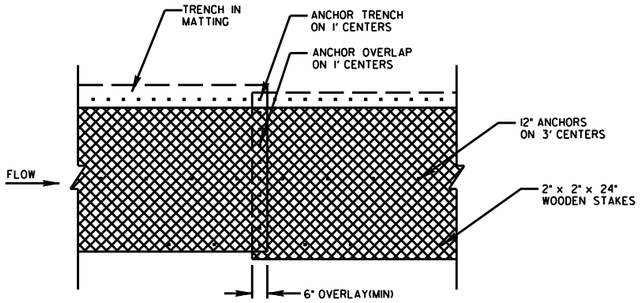

PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

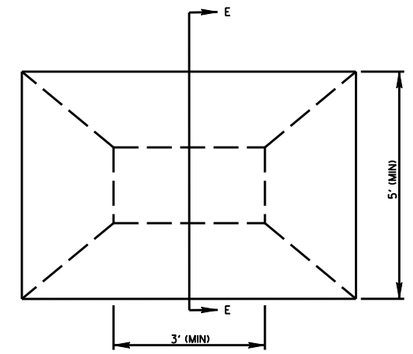
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

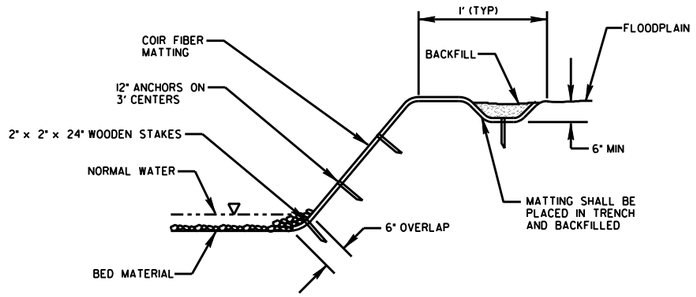
*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*

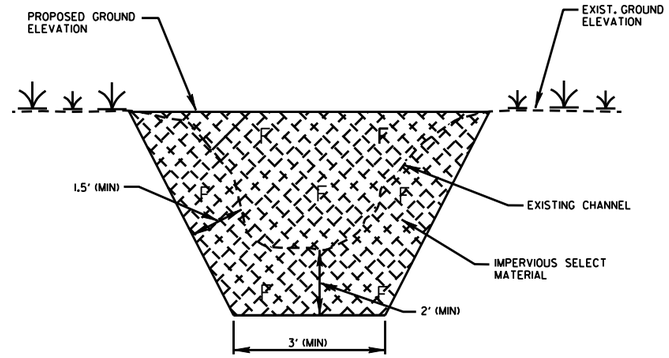

COIR FIBER MATTING DETAIL
NOT TO SCALE



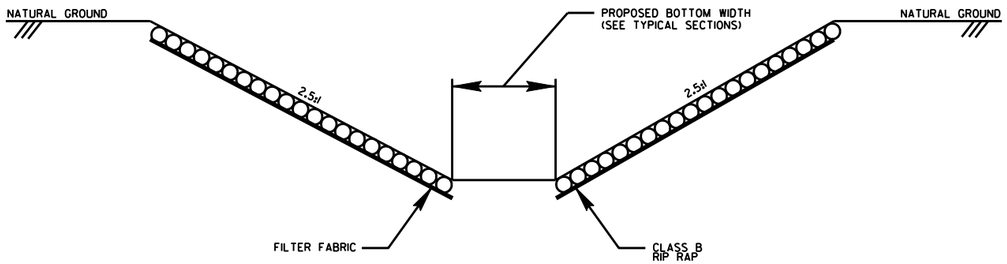

IMPERVIOUS CLAY PLUG - PLAN
NOT TO SCALE



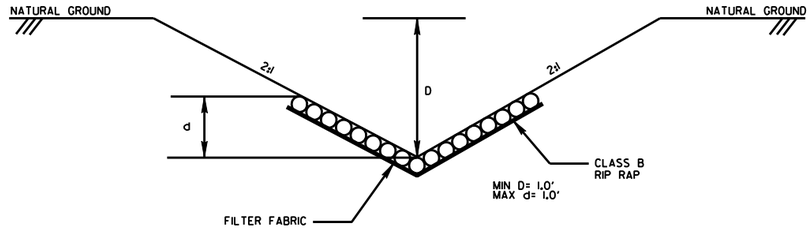

COIR FIBER MATTING SECTION
NOT TO SCALE




IMPERVIOUS CLAY PLUG - SECTION E-E
NOT TO SCALE




RIP RAP BANK PROTECTION
NOT TO SCALE




STANDARD 'V' DITCH
NOT TO SCALE

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 3E |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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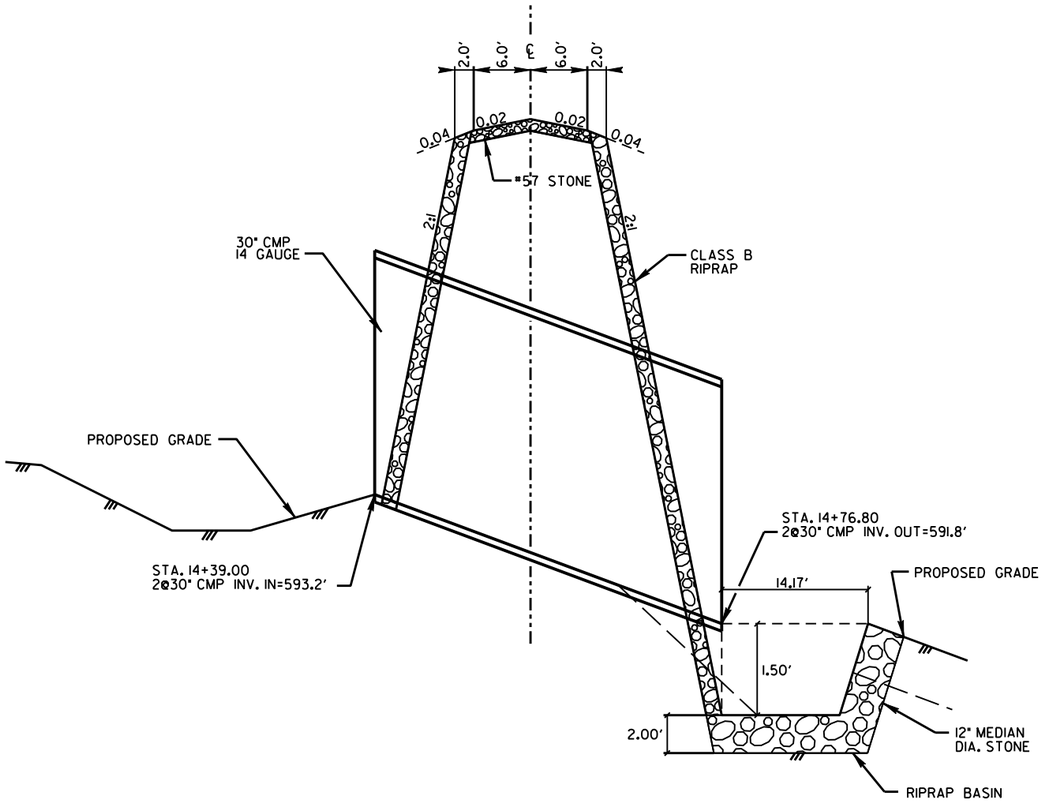
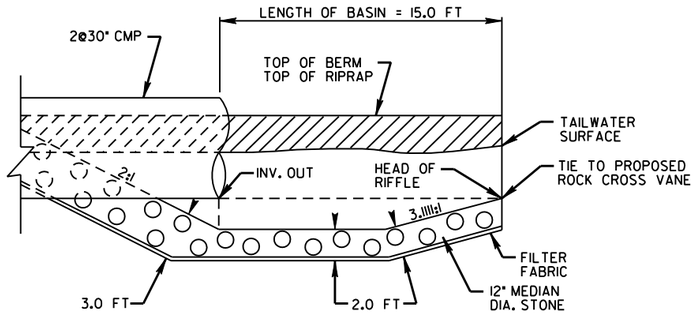
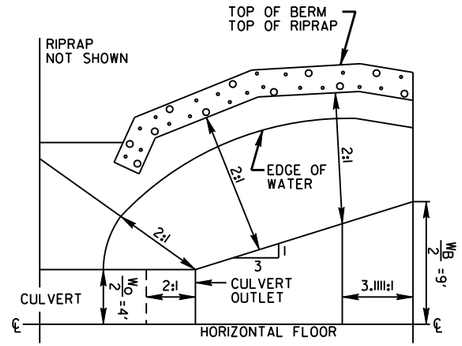


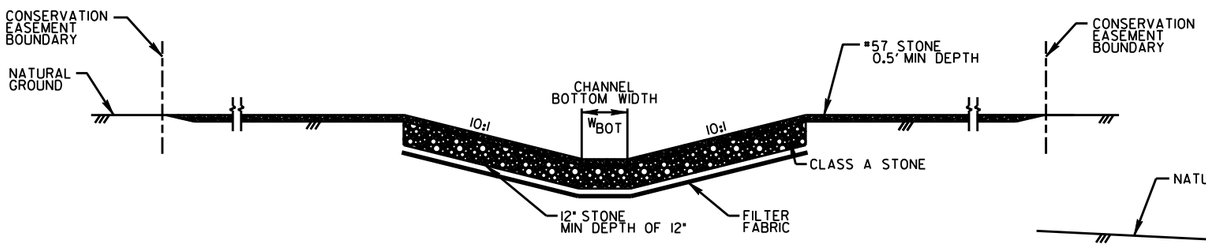

PERMANENT STREAM CROSSING (PIPED) PROFILE VIEW
NOT TO SCALE



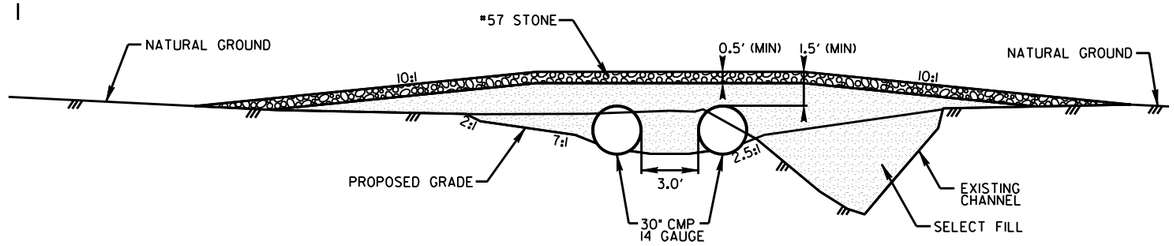

PROFILE OF RIPRAP BASIN
NOT TO SCALE




HALF PLAN OF RIPRAP BASIN
NOT TO SCALE




PERMANENT STREAM CROSSING (FORD)
NOT TO SCALE




PERMANENT STREAM CROSSING (PIPED) SECTION VIEW
NOT TO SCALE

PERMANENT STREAM CROSSING DETAILS

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 4 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552


20' 0' 20' 40'
10'

CE
PROPOSED FENCE (TYP.)
CENTER OF RADIUS CUR=BC-2, R=65
CENTER OF RADIUS CUR=BC-4, R=38
LOG VANE STA=10+12 ELEV=615.67
LOG SILL STA=10+42 ELEV=615.53
LOG VANE STA=10+81 ELEV=615.34
LOG VANE STA=11+25 ELEV=615.13
LOG VANE STA=11+54 ELEV=614.99
LOG VANE STA=13+34 ELEV=614.14
ROOTWADS (3) STA=13+50
LOG VANE STA=12+95 ELEV=614.32
LOG VANE STA=12+09 ELEV=614.73
LOG VANE STA=11+88 ELEV=614.83
10+00
11+00
12+00
13+00
14+00
15+00
16+00
CLASS B RIPRAP BANK PROTECTION SEE DETAIL SHEET 3D
STA 10+00 -BC- BEGIN RESTORATION
STA 11+55 -BC- END RESTORATION BEGIN ENHANCEMENT
NCDOT CONSERVATION EASEMENT
CUT BANKFULL BENCH ON 7:1 SLOPE (TYP.)
SPOIL PILE/ BED MATERIAL
BEDROCK (IN BANK)
STA 16+25 -BC- END ENHANCEMENT BEGIN RESTORATION
MATCHLINE SHEET 5
STA 16+50 -BC-
WETLAND E
BACK CREEK
36" POPLAR
24" CEDAR
24" CEDAR
9" HICKORY
10" HICKORY
16" HICKORY
10" CEDAR
10" IRONWOOD
18" WALNUT
8" IRONWOOD
24" ELM
LOG VANE STA=15+70 ELEV=612.92
ROCK CROSS VANE STA=16+20 ELEV=612.64
RIDGE PROPERTY LINE
CENTER OF RADIUS CUR=BC-3, R=57

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 5 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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ON BEHALF OF:
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*license no: F-0552*


20' 0' 20' 40'
10'

MATCHLINE SHEET 4 STA 16+50 -BC-

MATCHLINE SHEET 6 STA 22+00 -BC-

CENTER OF RADIUS CUR=BC-13, R=35

CENTER OF RADIUS CUR=BC-20, R=55

+ 17+00

18+00

19+00

20+00

21+00

22+00

LOG VANE STA=17+73 ELEV=611.78

LOG VANE STA=18+27 ELEV=611.47

LOG VANE STA=18+60 ELEV=611.29

LOG VANE STA=18+83 ELEV=611.16

LOG VANE STA=19+16 ELEV=610.97

LOG VANE STA=19+72 ELEV=610.66

LOG VANE STA=20+20 ELEV=610.39

STA 20+90 -BC-
END ENHANCEMENT
BEGIN RESTORATION

BACK CREEK

BEDROCK

12" IRONWOOD

28" WALNUT

STA 17+00 -BC-
END RESTORATION
BEGIN ENHANCEMENT

CREST STAGE GAUGE

CUT BANKFULL BENCH ON 7:1 SLOPE (TYP.)

'V' DITCH W/ CLASS B RIPRAP SEE DETAIL SHEET 3D

LOG VANE STA=20+73 ELEV=610.09

LOG VANE STA=21+36 ELEV=609.74

LOG VANE STA=21+84 ELEV=609.47

CENTER OF RADIUS CUR=BC-19, R=40

CENTER OF RADIUS CUR=BC-12, R=40

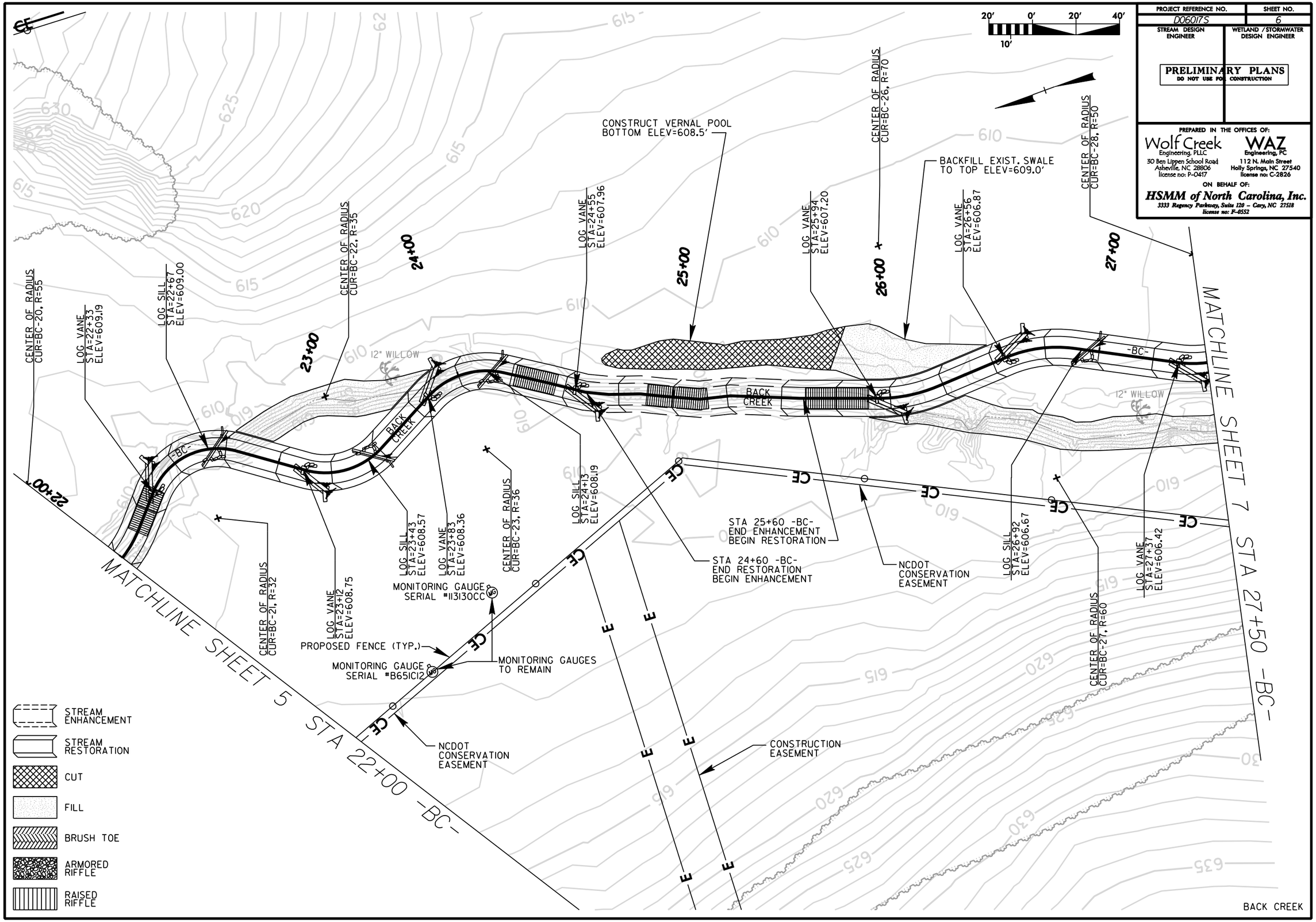
CE

PROPOSED FENCE (TYP.)

NCDOT CONSERVATION EASEMENT

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

BACK CREEK



PROJECT REFERENCE NO.
D06017S
SHEET NO.
6
STREAM DESIGN ENGINEER
WETLAND / STORMWATER DESIGN ENGINEER
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION
PREPARED IN THE OFFICES OF:
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license no: P-0417
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826
ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552
20' 0' 20' 40'
10'
CONSTRUCT VERNAL POOL
BOTTOM ELEV=608.5'
BACKFILL EXIST. SWALE
TO TOP ELEV=609.0'
CENTER OF RADIUS
CUR=BC-20, R=55
LOG VANE
STA=22+33
ELEV=609.19
LOG SILL
STA=22+67
ELEV=609.00
CENTER OF RADIUS
CUR=BC-22, R=35
LOG VANE
STA=24+55
ELEV=607.96
LOG VANE
STA=25+94
ELEV=607.20
CENTER OF RADIUS
CUR=BC-26, R=70
LOG VANE
STA=26+56
ELEV=606.87
CENTER OF RADIUS
CUR=BC-28, R=50
22+00
23+00
24+00
25+00
26+00
27+00
12" WILLOW
BACK CREEK
-BC-
CENTER OF RADIUS
CUR=BC-21, R=32
LOG VANE
STA=23+12
ELEV=608.75
LOG SILL
STA=23+43
ELEV=608.57
LOG VANE
STA=23+83
ELEV=608.36
CENTER OF RADIUS
CUR=BC-23, R=36
LOG SILL
STA=24+13
ELEV=608.19
STA 25+60 -BC-
END ENHANCEMENT
BEGIN RESTORATION
STA 24+60 -BC-
END RESTORATION
BEGIN ENHANCEMENT
NCDOT
CONSERVATION
EASEMENT
LOG SILL
STA=26+92
ELEV=606.67
CENTER OF RADIUS
CUR=BC-27, R=60
LOG VANE
STA=27+37
ELEV=606.42
MONITORING GAUGE
SERIAL #11313OCC
PROPOSED FENCE (TYP.)
MONITORING GAUGE
SERIAL #B651C12
MONITORING GAUGES
TO REMAIN
NCDOT
CONSERVATION
EASEMENT
CONSTRUCTION
EASEMENT
MATCHLINE SHEET 5 STA 22+00 -BC-
MATCHLINE SHEET 7 STA 27+50 -BC-
STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE
BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 7 |
| STREAM DESIGN ENGINEER | WETLAND /STORMWATER DESIGN ENGINEER |

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ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552


20' 0' 20' 40'
10'

MATCHLINE SHEET 8 STA 31+00 -BC-

MATCHLINE SHEET 6 STA 27+50 -BC-

MATCHLINE SHEET 16 STA 21+50 -WESTB-

CENTER OF RADIUS CUR=BC-28, R=50
LOG VANE STA=27+95 ELEV=606.11
LOG SILL STA=28+29 ELEV=605.92
LOG VANE STA=28+70 ELEV=605.70
LOG SILL STA=29+00 ELEV=605.53
CENTER OF RADIUS CUR=BC-30, R=55
LOG VANE STA=29+46 ELEV=605.28
CENTER OF RADIUS CUR=BC-31, R=35
LOG SILL STA=29+74 ELEV=605.13
LOG VANE STA=30+16 ELEV=604.90
LOG SILL STA=30+41 ELEV=604.76
LOG VANE STA=30+78 ELEV=604.56
CENTER OF RADIUS CUR=BC-32, R=45
ROCK CROSS VANE STA=25+80 ELEV=605.43
CENTER OF RADIUS CUR=WESTB-48, R=27.5
LOG SILL STA=24+82 ELEV=607.32
CENTER OF RADIUS CUR=WESTB-46, R=15
LOG SILL STA=24+40 ELEV=607.77
CENTER OF RADIUS CUR=WESTB-44, R=15
ROCK CROSS VANE STA=23+39 ELEV=608.85
CENTER OF RADIUS CUR=WESTB-42, R=17.5
CENTER OF RADIUS CUR=WESTB-49, R=17
ROCK CROSS VANE STA=26+43 ELEV=608.44
CENTER OF RADIUS CUR=WESTB-47, R=17.5
ROCK CROSS VANE STA=25+08 ELEV=607.04
ROCK CROSS VANE STA=24+66 ELEV=607.49
CENTER OF RADIUS CUR=WESTB-45, R=24.5
ROCK CROSS VANE STA=24+22 ELEV=607.96
LOG SILL STA=23+94 ELEV=608.26
ROCK CROSS VANE STA=23+78 ELEV=608.43
LOG SILL STA=23+55 ELEV=608.68
CENTER OF RADIUS CUR=WESTB-43, R=25
LOG SILL STA=23+13 ELEV=609.13
ROCK CROSS VANE STA=22+99 ELEV=609.28
CENTER OF RADIUS CUR=WESTB-41, R=17
LOG SILL STA=22+77 ELEV=609.52
LOG SILL STA=22+40 ELEV=609.92
ROCK CROSS VANE STA=22+64 ELEV=609.66
CENTER OF RADIUS CUR=WESTB-40, R=24.5
ROCK CROSS VANE STA=22+25 ELEV=610.08
ROCK CROSS VANE STA=21+85 ELEV=610.51
CENTER OF RADIUS CUR=WESTB-39, R=17
LOG SILL STA=21+60 ELEV=610.78
LOG SILL STA=22+00 ELEV=610.35
CENTER OF RADIUS CUR=WESTB-38, R=15
CENTER OF RADIUS CUR=BC-29, R=70

30" WALNUT
8" POPLAR
2" UNKNOWN
40" SWEETGUM
8" WALNUT
24" CEDAR
10" WALNUT
18" WALNUT
4-12" IRONWOOD
18" WILLOW

EXIST. FENCE WITHIN CONSERVATION EASEMENT TO BE REMOVED (TYP.)
EXIST. PIPE TO BE REMOVED
PROPOSED FENCE (TYP.)
NCDOT CONSERVATION EASEMENT

BACK CREEK
WEST BRANCH
WETLAND L

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 8 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*


20' 0' 20' 40'
10'

MATCHLINE SHEET 7 STA 31+00 -BC-

MATCHLINE SHEET 9 STA 37+00 -BC-

-BC-

31+00

32+00

33+00

34+00

35+00

36+00

37+00

CENTER OF RADIUS CUR=BC-33, R=35

LOG SILL STA=31+02 ELEV=604.42

LOG VANE STA=31+47 ELEV=604.14

LOG SILL STA=31+77 ELEV=603.96

LOG VANE STA=32+08 ELEV=603.77

CENTER OF RADIUS CUR=BC-35, R=47

LOG VANE STA=32+76 ELEV=603.35

CENTER OF RADIUS CUR=BC-36, R=57

LOG VANE STA=33+51 ELEV=602.90

CENTER OF RADIUS CUR=BC-38, R=47.5

LOG VANE STA=34+98 ELEV=602.00

LOG VANE STA=35+61 ELEV=601.61

CENTER OF RADIUS CUR=BC-40, R=55

LOG VANE STA=36+21 ELEV=601.25

LOG SILL STA=36+47 ELEV=601.09

LOG VANE STA=36+88 ELEV=600.84

CENTER OF RADIUS CUR=BC-34, R=30

CENTER OF RADIUS CUR=BC-37, R=47

LOG SILL STA=33+81 ELEV=602.71

LOG VANE STA=34+18 ELEV=602.49

LOG SILL STA=34+54 ELEV=602.27

CENTER OF RADIUS CUR=BC-39, R=55

CENTER OF RADIUS CUR=BC-41, R=35

EXIST. FENCE WITHIN CONSERVATION EASEMENT TO BE REMOVED (TYP.)

NCDOT CONSERVATION EASEMENT

PROPOSED FENCE (TYP.)

CE

BACK CREEK

18' POPLAR

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 9 |
| STREAM DESIGN ENGINEER | WETLAND /STORMWATER DESIGN ENGINEER |

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*license no: F-0552*

20' 0' 20' 40'
10'

MATCHLINE SHEET 8 STA 37+00 -BC-

37+00

CENTER OF RADIUS CUR=BC-42, R=35

LOG SILL STA=37+12 ELEV=600.69

LOG VANE STA=37+60 ELEV=600.40

LOG SILL STA=37+84 ELEV=600.25

38+00

LOG VANE STA=38+20 ELEV=600.03

CENTER OF RADIUS CUR=BC-44, R=50

LOG VANE STA=38+89 ELEV=599.61

39+00

LOG SILL STA=39+14 ELEV=599.46

LOG VANE STA=39+54 ELEV=599.21

CENTER OF RADIUS CUR=BC-46, R=34.5

40+00

LOG SILL STA=39+80 ELEV=599.06

41+00

LOG SILL STA=41+77 ELEV=597.80

CENTER OF RADIUS CUR=BC-49, R=34.5

42+00

LOG VANE STA=42+16 ELEV=597.55

43+00

CENTER OF RADIUS CUR=BC-51, R=32

MATCHLINE SHEET 10 STA 43+50 -BC-

-BC-

BACK CREEK

'V' DITCH W/ CLASS B RIPRAP SEE DETAIL SHEET 3D

CENTER OF RADIUS CUR=BC-43, R=35

CENTER OF RADIUS CUR=BC-45, R=34.5

LOG VANE STA=40+21 ELEV=598.80

CENTER OF RADIUS CUR=BC-47, R=42

LOG VANE STA=40+83 ELEV=598.41

CENTER OF RADIUS CUR=BC-48, R=34

LOG SILL STA=41+09 ELEV=598.24

LOG VANE STA=41+52 ELEV=597.96

NCDOT CONSERVATION EASEMENT

CE

PROPOSED FENCE (TYP.)

CENTER OF RADIUS CUR=BC-50, R=42

LOG SILL STA=42+46 ELEV=597.36

LOG VANE STA=42+87 ELEV=597.09

LOG VANE STA=43+17 ELEV=596.90

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 10 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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license no: C-2826

ON BEHALF OF:

HSMM of North Carolina, Inc.
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license no: F-0552


20' 0' 20' 40'
10'

MATCHLINE SHEET 9 STA 43+50 -BC-

EXIST. FENCE WITHIN CONSERVATION EASEMENT TO BE REMOVED (TYP.)

LOG VANE STA=43+57 ELEV=596.64

44+00

LOG VANE STA=44+19 ELEV=596.24

LOG SILL STA=44+50 ELEV=596.04

IMPERVIOUS CLAY PLUG TOP ELEV=600.0' SEE DETAIL SHEET 3D

MATCHLINE SHEET 17

-BC-

SECTION X-X

4:1

45+00

CENTER OF RADIUS CUR=BC-54, R=35

CENTER OF RADIUS CUR=BC-52, R=55

CENTER OF RADIUS CUR=BC-53, R=35

LOG VANE STA=44+98 ELEV=595.73

LOG VANE STA=45+65 ELEV=595.30

CENTER OF RADIUS CUR=BC-56, R=35

BACKFILL NOT REQUIRED AREA AVAILABLE FOR WASTING SPOIL MATERIAL

16'

BANKFULL

4:1 7:1 7:1 4:1

1.0'

SECTION X-X

EXCAVATE EXIST. BERM 16' OUTSIDE OF FLOODPLAIN BENCH TO AN ELEVATION OF 1' ABOVE THE BANKFULL ELEVATION - SEE SECTION X-X

LOG SILL STA=45+23 ELEV=595.57

NCDOT CONSERVATION EASEMENT

46+00

47+00

BACK CREEK

CE

CENTER OF RADIUS CUR=BC-58, R=60

48+00

BRUSH TOE (45') STA=48+68

CENTER OF RADIUS CUR=BC-55, R=50

LOG VANE STA=46+35 ELEV=594.85

LOG SILL STA=46+72 ELEV=594.61

LOG VANE STA=47+13 ELEV=594.34

LOG SILL STA=47+42 ELEV=594.16

49+00

-BC-

CENTER OF RADIUS CUR=BC-57, R=35

LOG VANE STA=47+89 ELEV=593.85

EXISTING WETLAND B

WLB

MONITORING GAUGE SERIAL #1313CD6 (MG) (PREVIOUSLY #EBDC711)

MATCHLINE SHEET 11 STA 49+00 -BC-

MATCHLINE SHEET 12

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

PROPOSED FENCE (TYP.)

BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017.S | 11 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552


20' 0' 20' 40'
10'

MATCHLINE SHEET 10 STA 49+00 -BC-

MATCHLINE SHEET 12 STA 55+50 -BC-

CONSTRUCT FLOODPLAIN BENCH AT WIDTH OF 16' FROM STA 50+40 TO STA 52+30 WITH 20' TRANSITION TO TYPICAL FLOODPLAIN WIDTH

RIDGE/SHACKLEFORD PROPERTY LINE

CENTER OF RADIUS CUR=BC-59, R=44.5

LOG SILL STA=49+12 ELEV=593.53

BRUSH TOE (30') STA=49+68

LOG SILL STA=49+98 ELEV=593.36

CENTER OF RADIUS CUR=BC-60, R=47

CENTER OF RADIUS CUR=BC-61, R=32.5

BRUSH TOE (35') STA=51+27

LOG SILL STA=51+62 ELEV=593.02

CENTER OF RADIUS CUR=BC-63, R=45

CENTER OF RADIUS CUR=BC-64, R=34.5

CENTER OF RADIUS CUR=BC-66, R=32.5

BRUSH TOE (30') STA=53+92

LOG SILL STA=55+18 ELEV=591.99

LOG VANE STA=54+69 ELEV=592.16

LOG SILL STA=54+22 ELEV=592.32

BRUSH TOE (35') STA=54+85

CENTER OF RADIUS CUR=BC-65, R=32

LOG SILL STA=53+39 ELEV=592.60

MONITORING GAUGE SERIAL #EBD6633

EXISTING WETLAND A-1

EXISTING WETLAND B

BACK CREEK

WLB

24" CEDAR

PROPOSED FENCE (TYP.)

RIDGE PROPERTY LINE

SHACKLEFORD PROPERTY LINE

PROPOSED BOLLARD (TYP.)

BRUSH TOE (30') STA=50+41

LOG SILL STA=50+70 ELEV=593.21

CENTER OF RADIUS CUR=BC-62, R=32

BRUSH TOE (30') STA=52+18

LOG SILL STA=52+48 ELEV=592.85

BRUSH TOE (35') STA=53+04

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017.S | 12 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
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20' 0' 20' 40'
10'

MATCHLINE SHEET 17 -NORTHB- STA 16+00

MATCHLINE SHEET 10

MATCHLINE SHEET 13 -NORTHB- STA 19+75

MATCHLINE SHEET 13 -BC- STA 57+75

MATCHLINE SHEET 11 STA 55+50 -BC-

WETLAND K

RIDGE/SHACKLEFORD PROPERTY LINE

-NORTHB-

-BC-

NORTH BRANCH

BACK CREEK

16+00 17+00 18+00 19+00

CENTER OF RADIUS CUR=NORTHB-8, R=50

LOG VANE STA=16+58 ELEV=592.47

BRUSH TOE (25') STA=16+75

CREST STAGE GAUGE

LOG VANE STA=17+52 ELEV=592.14

BRUSH TOE (25') STA=17+68

CENTER OF RADIUS CUR=NORTHB-10, R=75

LOG VANE STA=18+36 ELEV=591.84

BRUSH TOE (30') STA=18+53

ROCK CROSS VANE STA=19+16 ELEV=591.32

CENTER OF RADIUS CUR=NORTHB-12, R=70

CENTER OF RADIUS CUR=NORTHB-11, R=50

2-24" ASH

18" UNKNOWN

30" SYCAMORE

12" WALNUT

36" ASH

2-30" SYCAMORE

56+00 57+00

BRUSH TOE (35') STA=55+77

LOG SILL STA=56+11 ELEV=591.72

BRUSH TOE (35') STA=56+66

CENTER OF RADIUS CUR=BC-68, R=50

LOG SILL STA=57+02 ELEV=591.45

ROCK CROSS VANE STA=57+40 ELEV=591.20

CENTER OF RADIUS CUR=NORTHB-12, R=70

LOG VANE STA=55+63 ELEV=591.86

WETLAND A-2

WETLAND A-1

CENTER OF RADIUS CUR=BC-70, R=45

CENTER OF RADIUS CUR=BC-67, R=30

595 600 605

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 13 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552


20' 0' 20' 40'
10'

MATCHLINE SHEET 19 STA 14+75 -EASTB-

MATCHLINE SHEET 12 STA 19+75 -NORTHB-

MATCHLINE SHEET 12 STA 57+75 -BC-

CENTER OF RADIUS CUR=NORTHB-13, R=80

RIPRAP BASIN SEE DETAIL SHEET 3E

ROCK CROSS VANE STA=14+88 ELEV=591.46

CENTER OF RADIUS CUR=EASTB-12, R=25

CENTER OF RADIUS CUR=EASTB-11, R=25

ROCK CROSS VANE STA=15+09 ELEV=590.67

ROCK CROSS VANE STA=15+40 ELEV=589.49

CENTER OF RADIUS CUR=EASTB-13, R=25

CONSTRUCTION EASEMENT

PROPOSED BOLLARD (TYP.)

ROCK CROSS VANE STA=20+06 ELEV=590.22

ROCK CROSS VANE STA=20+98 ELEV=589.10

ROCK CROSS VANE STA=21+69 ELEV=588.24

CENTER OF RADIUS CUR=BC-76, R=50

CENTER OF RADIUS CUR=BC-73, R=50

CENTER OF RADIUS CUR=NORTHB-14, R=60

ROCK CROSS VANE STA=58+19 ELEV=590.40

CENTER OF RADIUS CUR=BC-71, R=65

ROCK CROSS VANE STA=58+88 ELEV=589.70

ROCK CROSS VANE STA=59+50 ELEV=589.07

ROCK CROSS VANE STA=60+19 ELEV=588.37

ROCK CROSS VANE STA=61+07 ELEV=587.48

CENTER OF RADIUS CUR=BC-74, R=60

CENTER OF RADIUS CUR=BC-75, R=55

ROCK CROSS VANE STA=61+79 ELEV=586.75

ROCK CROSS VANE STA=62+59 ELEV=585.94

CENTER OF RADIUS CUR=BC-77, R=75

CENTER OF RADIUS CUR=BC-70, R=45

CENTER OF RADIUS CUR=BC-72, R=90

WETLAND A-2

CREST STAGE GAUGE

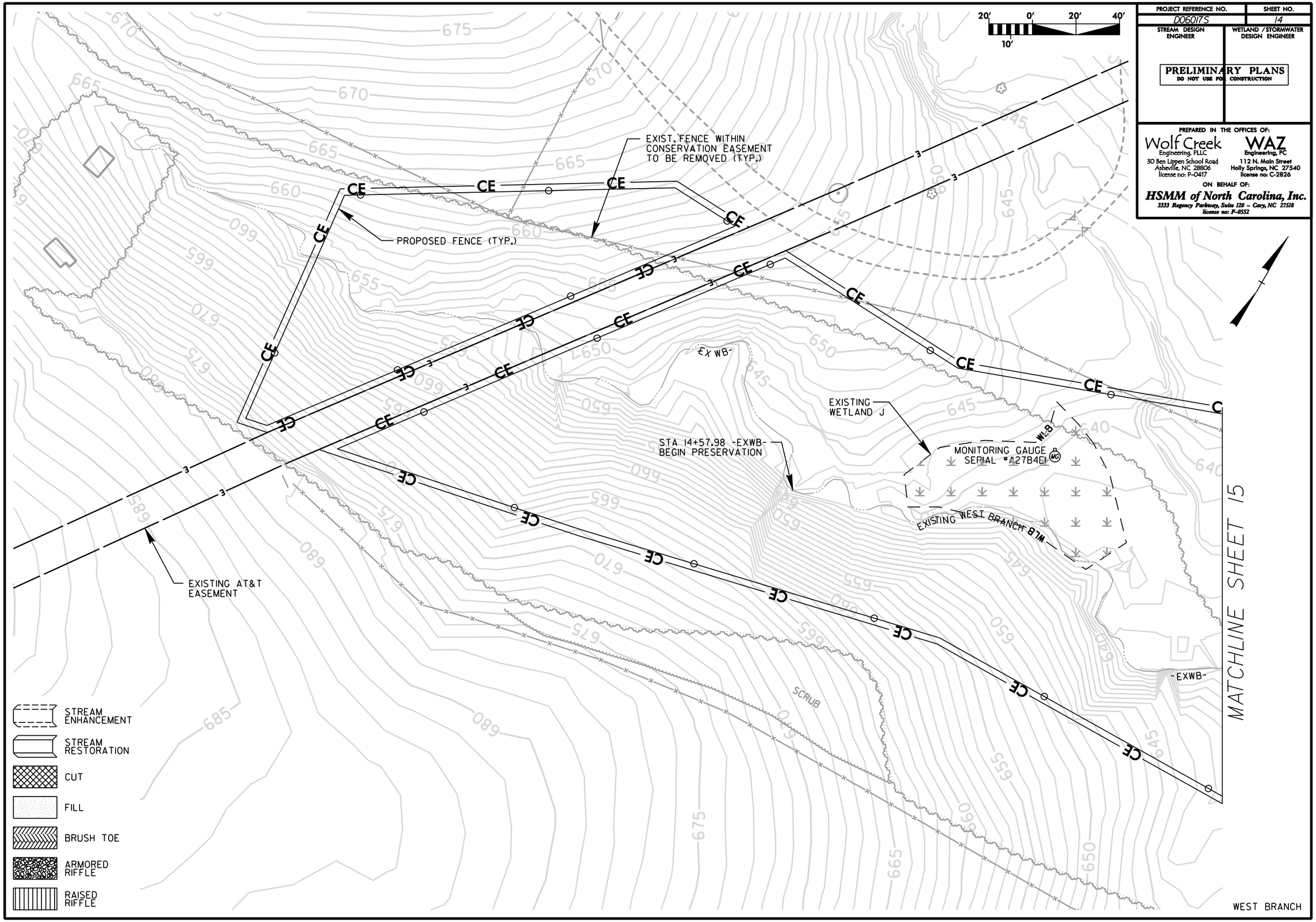
NORTH BRANCH

BACK CREEK

EAST BRANCH

12" WALNUT
24" ASH
15" ASH
20" ASH
36" ASH
24" SYCAMORE
30" SYCAMORE
24" WALNUT
18" ASH
36" UNKNOWN
16" ASH

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE



PROJECT REFERENCE NO.
D06017S
SHEET NO.
14
STREAM DESIGN ENGINEER
WETLAND / STORMWATER DESIGN ENGINEER
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION
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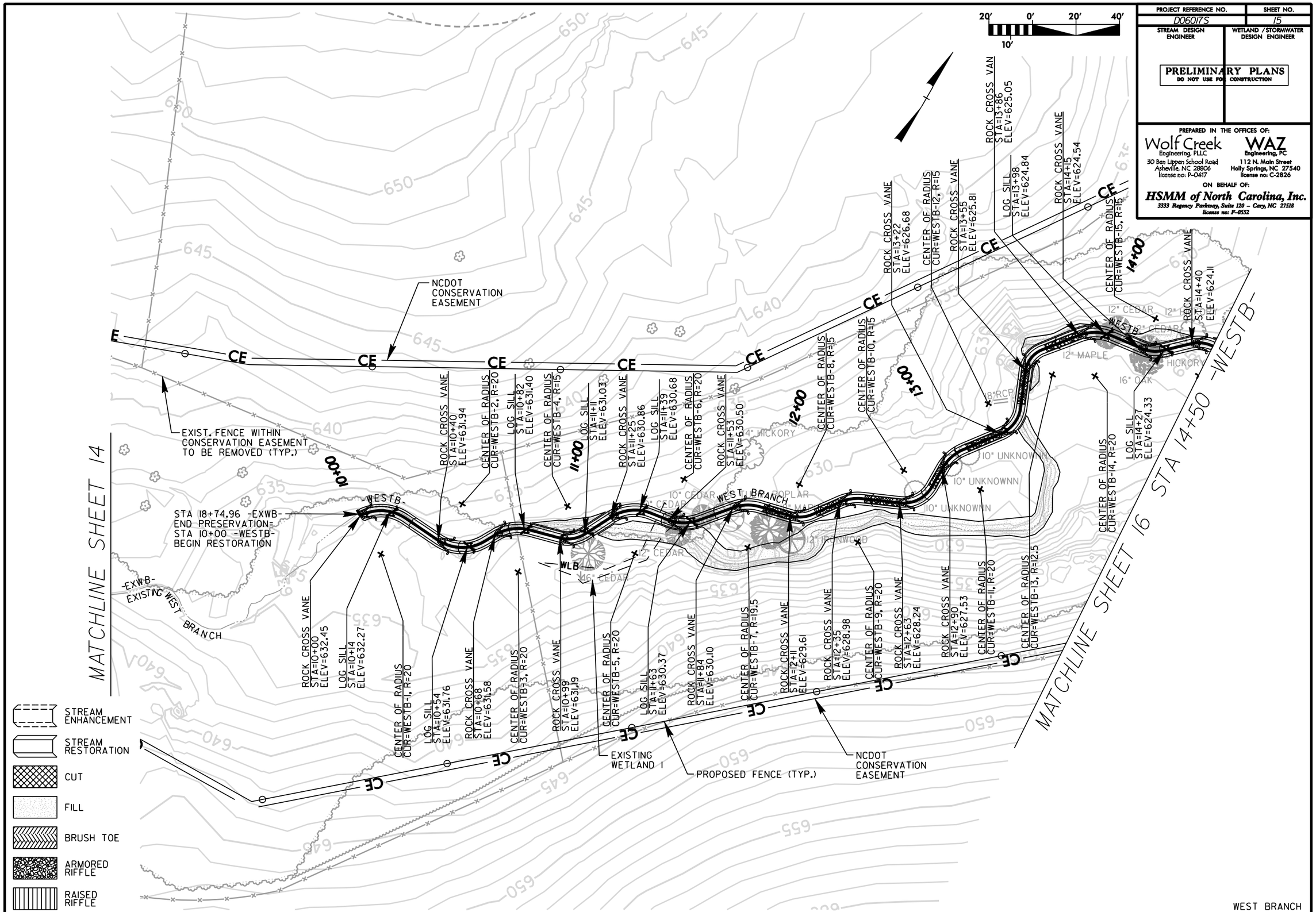
license no: P-0417
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826
ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552
20' 0' 20' 40'
10'
EXIST. FENCE WITHIN CONSERVATION EASEMENT TO BE REMOVED (TYP.)
PROPOSED FENCE (TYP.)
CE
EXISTING WETLAND J
STA 14+57.98 -EXWB- BEGIN PRESERVATION
MONITORING GAUGE SERIAL #A27B4EI
EXISTING WEST BRANCH
EXISTING AT&T EASEMENT
EXWB
SCRUB
MATCHLINE SHEET 15
WEST BRANCH
STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE



PROJECT REFERENCE NO.
D06017S
SHEET NO.
15
STREAM DESIGN ENGINEER
WETLAND / STORMWATER DESIGN ENGINEER
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION
PREPARED IN THE OFFICES OF:
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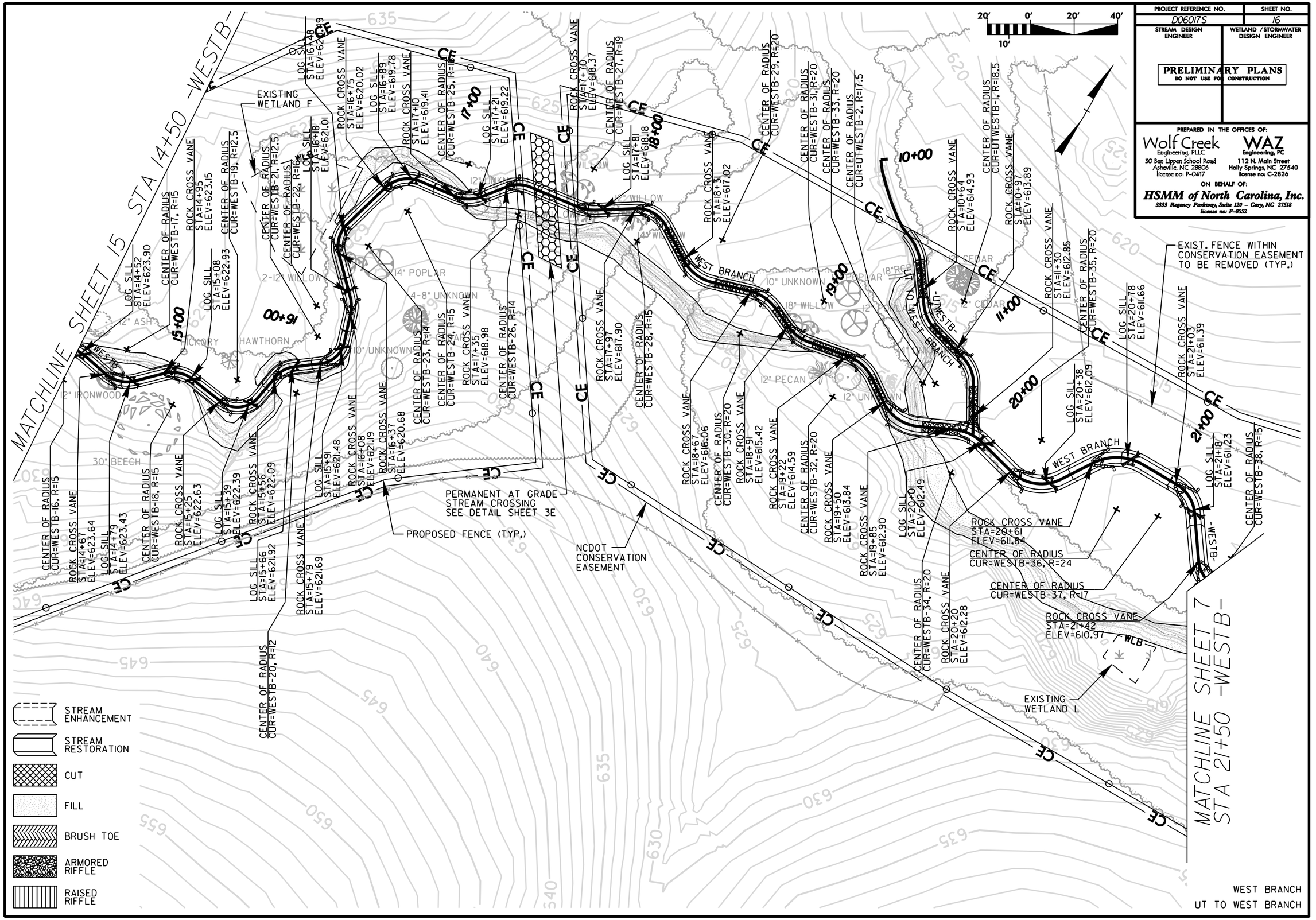
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826
ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552
20' 0' 20' 40'
10'
MATCHLINE SHEET 14
MATCHLINE SHEET 16
STA 14+50 -WESTB-
NCDOT CONSERVATION EASEMENT
EXIST. FENCE WITHIN CONSERVATION EASEMENT TO BE REMOVED (TYP.)
STA 18+74.96 -EXWB- END PRESERVATION= STA 10+00 -WESTB- BEGIN RESTORATION
-EXWB- EXISTING WEST BRANCH
WEST BRANCH
EXISTING WETLAND 1
PROPOSED FENCE (TYP.)
NCDOT CONSERVATION EASEMENT
10+00
11+00
12+00
13+00
14+00
ROCK CROSS VANE STA=10+00 ELEV=632.45
LOG SILL STA=10+14 ELEV=632.27
CENTER OF RADIUS CUR=WESTB-1, R=20
LOG SILL STA=10+54 ELEV=631.76
ROCK CROSS VANE STA=10+68 ELEV=631.58
CENTER OF RADIUS CUR=WESTB-3, R=20
ROCK CROSS VANE STA=10+99 ELEV=631.19
CENTER OF RADIUS CUR=WESTB-5, R=20
LOG SILL STA=11+63 ELEV=630.37
ROCK CROSS VANE STA=11+84 ELEV=630.10
CENTER OF RADIUS CUR=WESTB-7, R=19.5
ROCK CROSS VANE STA=12+11 ELEV=629.61
ROCK CROSS VANE STA=12+35 ELEV=628.98
CENTER OF RADIUS CUR=WESTB-9, R=20
ROCK CROSS VANE STA=12+63 ELEV=628.24
ROCK CROSS VANE STA=12+90 ELEV=627.53
CENTER OF RADIUS CUR=WESTB-11, R=20
CENTER OF RADIUS CUR=WESTB-13, R=12.5
ROCK CROSS VANE STA=10+40 ELEV=631.94
CENTER OF RADIUS CUR=WESTB-2, R=20
LOG SILL STA=10+82 ELEV=631.40
CENTER OF RADIUS CUR=WESTB-4, R=15
LOG SILL STA=11+11 ELEV=631.03
ROCK CROSS VANE STA=11+25 ELEV=630.86
LOG SILL STA=11+39 ELEV=630.68
CENTER OF RADIUS CUR=WESTB-6, R=20
ROCK CROSS VANE STA=11+53 ELEV=630.50
CENTER OF RADIUS CUR=WESTB-8, R=15
CENTER OF RADIUS CUR=WESTB-10, R=15
ROCK CROSS VANE STA=13+22 ELEV=626.68
CENTER OF RADIUS CUR=WESTB-12, R=15
ROCK CROSS VANE STA=13+55 ELEV=625.81
ROCK CROSS VAN STA=13+86 ELEV=625.05
LOG SILL STA=13+98 ELEV=624.84
ROCK CROSS VANE STA=14+15 ELEV=624.54
CENTER OF RADIUS CUR=WESTB-15, R=15
ROCK CROSS VANE STA=14+40 ELEV=624.11
LOG SILL STA=14+27 ELEV=624.33
CENTER OF RADIUS CUR=WESTB-14, R=20
CE
WLB
10" CEDAR
12" CEDAR
16" CEDAR
12" MAPLE
16" OAK
12" IRONWOOD
10" UNKNOWNN
8" RCP
4" HICKORY
STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE


MATCHLINE SHEET 15 STA 14+50 -WESTB-
MATCHLINE SHEET 7 STA 21+50 -WESTB-
PROJECT REFERENCE NO.
D06017S
SHEET NO.
16
STREAM DESIGN ENGINEER
WETLAND /STORMWATER DESIGN ENGINEER
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION
PREPARED IN THE OFFICES OF:
Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826
ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552
20' 0' 20' 40'
10'
EXISTING WETLAND F
EXISTING WETLAND L
WEST BRANCH
UT TO WEST BRANCH
PERMANENT AT GRADE STREAM CROSSING SEE DETAIL SHEET 3E
PROPOSED FENCE (TYP.)
NCDOT CONSERVATION EASEMENT
EXIST. FENCE WITHIN CONSERVATION EASEMENT TO BE REMOVED (TYP.)
CE
WLB
STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE
WEST BRANCH
UT TO WEST BRANCH

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 17 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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ON BEHALF OF:

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*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*


20' 0' 20' 40'
10'

SHACKLEFORD PROPERTY LINE

NCDOT CONSERVATION EASEMENT

CE

PROPOSED BOLLARD (TYP.)

MATCHLINE SHEET 12

STA 16+00 -NORTHB-

CENTER OF RADIUS CUR=NORTHB-1, R=22.5

LOG VANE STA=10+74 ELEV=594.55

BRUSH TOE (25') STA=10+90

10+00

LOG VANE STA=11+55 ELEV=594.26

CENTER OF RADIUS CUR=NORTHB-3, R=37.5

11+00

LOG VANE STA=12+37 ELEV=593.97

BRUSH TOE (25') STA=12+54

12+00

CENTER OF RADIUS CUR=NORTHB-5, R=40

13+00

14+00

BRUSH TOE (25') STA=14+24

CENTER OF RADIUS CUR=NORTHB-7, R=32

15+00

BRUSH TOE (25') STA=15+96

16+00

LOG VANE STA=15+81 ELEV=592.75

CENTER OF RADIUS CUR=NORTHB-8, R=50

-NORTHB-

NORTH BRANCH

STA. 10+30 -NORTHB- BEGIN RESTORATION

CENTER OF RADIUS CUR=NORTHB-2, R=50

BRUSH TOE (25') STA=11+71

CENTER OF RADIUS CUR=NORTHB-4, R=40

LOG VANE STA=13+22 ELEV=593.67

BRUSH TOE (20') STA=13+42

LOG VANE STA=14+08 ELEV=593.36

CENTER OF RADIUS CUR=NORTHB-6, R=50

LOG VANE STA=14+89 ELEV=593.07

BRUSH TOE (25') STA=15+06

RIDGE/SHACKLEFORD PROPERTY LINE

BACKFILL NOT REQUIRED AREA AVAILABLE FOR WASTING SPOIL MATERIAL

MATCHLINE SHEET 10

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE

NORTH BRANCH

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017.S | 18 |

| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |
|---|---|
| | |

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license no: C-2826

ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*


20' 0' 20' 40'
10'

STA 5+00.69 -EXEB-
BEGIN PRESERVATION

NCDOT CONSERVATION EASEMENT

-EXEB-

EXISTING EAST BRANCH

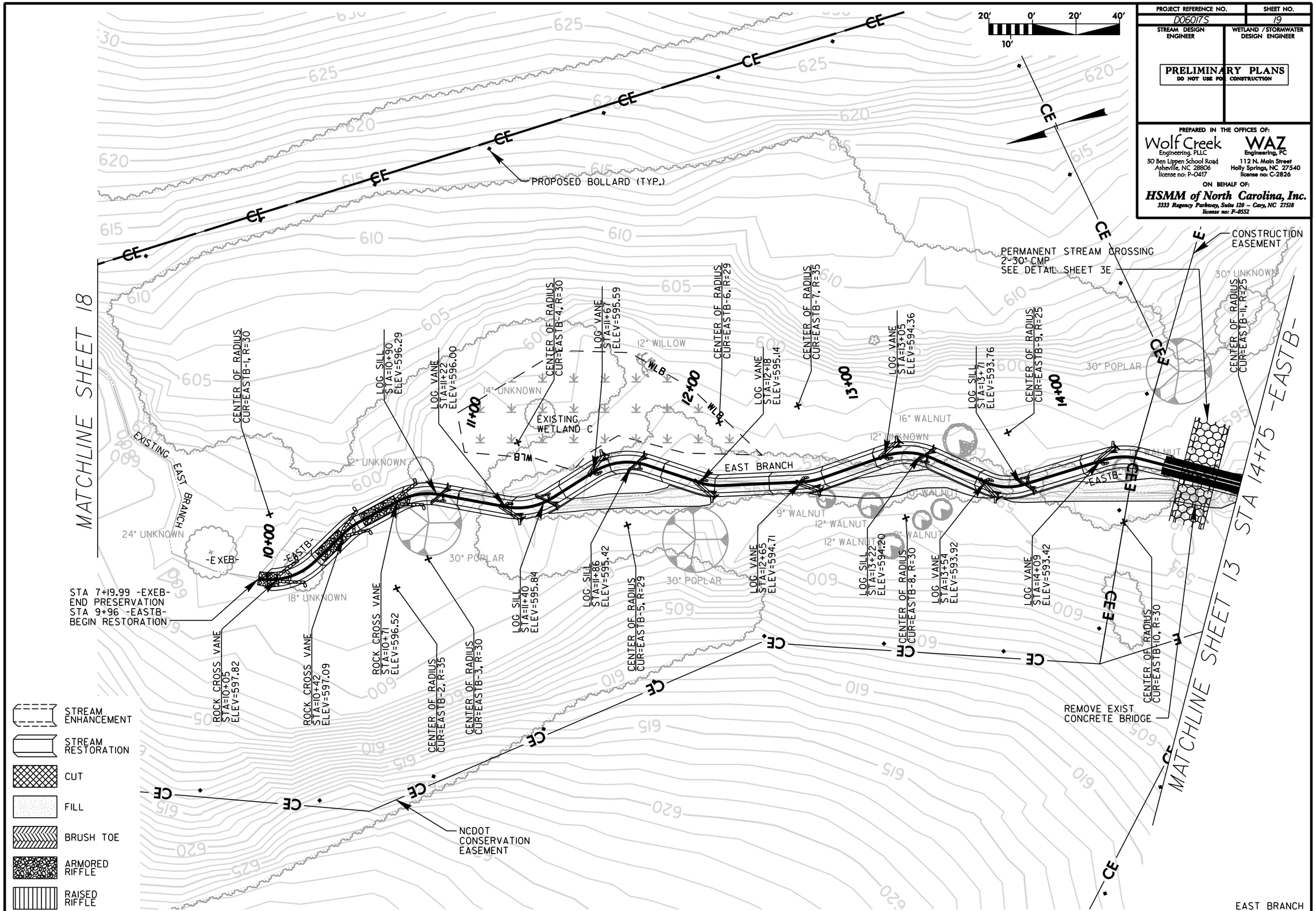
PROPOSED BOLLARD (TYP.)

CE

MATCHLINE SHEET 19

EAST BRANCH

STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE



PROJECT REFERENCE NO.
D06017S
SHEET NO.
19
STREAM DESIGN ENGINEER
WETLAND / STORMWATER DESIGN ENGINEER
PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION
PREPARED IN THE OFFICES OF:
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30 Ben Lippen School Road
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license no: P-0417
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826
ON BEHALF OF:
HSMM of North Carolina, Inc.
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552
20' 0' 20' 40'
10'
MATCHLINE SHEET 18
MATCHLINE SHEET 13
STA 14+75 -EASTB-
PROPOSED BOLLARD (TYP.)
CONSTRUCTION EASEMENT
PERMANENT STREAM CROSSING
2-30" CMP
SEE DETAIL SHEET 3E
EXISTING EAST BRANCH
EXISTING WETLAND C
EAST BRANCH
-EXEB-
-EASTB-
STA 7+19.99 -EXEB-
END PRESERVATION
STA 9+96 -EASTB-
BEGIN RESTORATION
ROCK CROSS VANE STA=10+05 ELEV=597.82
ROCK CROSS VANE STA=10+42 ELEV=597.09
ROCK CROSS VANE STA=10+71 ELEV=596.52
CENTER OF RADIUS CUR=EASTB-2, R=35
CENTER OF RADIUS CUR=EASTB-3, R=30
LOG SILL STA=11+40 ELEV=595.84
LOG SILL STA=11+86 ELEV=595.42
CENTER OF RADIUS CUR=EASTB-5, R=29
LOG VANE STA=12+65 ELEV=594.71
LOG SILL STA=13+22 ELEV=594.20
CENTER OF RADIUS CUR=EASTB-8, R=30
LOG VANE STA=13+54 ELEV=593.92
LOG VANE STA=14+09 ELEV=593.42
CENTER OF RADIUS CUR=EASTB-10, R=30
CENTER OF RADIUS CUR=EASTB-11, R=25
CENTER OF RADIUS CUR=EASTB-1, R=30
LOG SILL STA=10+90 ELEV=596.29
LOG VANE STA=11+22 ELEV=596.00
CENTER OF RADIUS CUR=EASTB-4, R=30
LOG VANE STA=11+67 ELEV=595.59
CENTER OF RADIUS CUR=EASTB-6, R=29
LOG VANE STA=12+18 ELEV=595.14
CENTER OF RADIUS CUR=EASTB-7, R=35
LOG VANE STA=13+05 ELEV=594.36
LOG SILL STA=13+71 ELEV=593.76
CENTER OF RADIUS CUR=EASTB-9, R=25
REMOVE EXIST CONCRETE BRIDGE
NCDOT CONSERVATION EASEMENT
24" UNKNOWN
18" UNKNOWN
12" UNKNOWN
14" UNKNOWN
12" WILLOW
30" POPLAR
30" UNKNOWN
16" WALNUT
12" WALNUT
10" WALNUT
9" WALNUT
10+00
11+00
12+00
13+00
14+00
STREAM ENHANCEMENT
STREAM RESTORATION
CUT
FILL
BRUSH TOE
ARMORED RIFFLE
RAISED RIFFLE
EAST BRANCH

# BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 20 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

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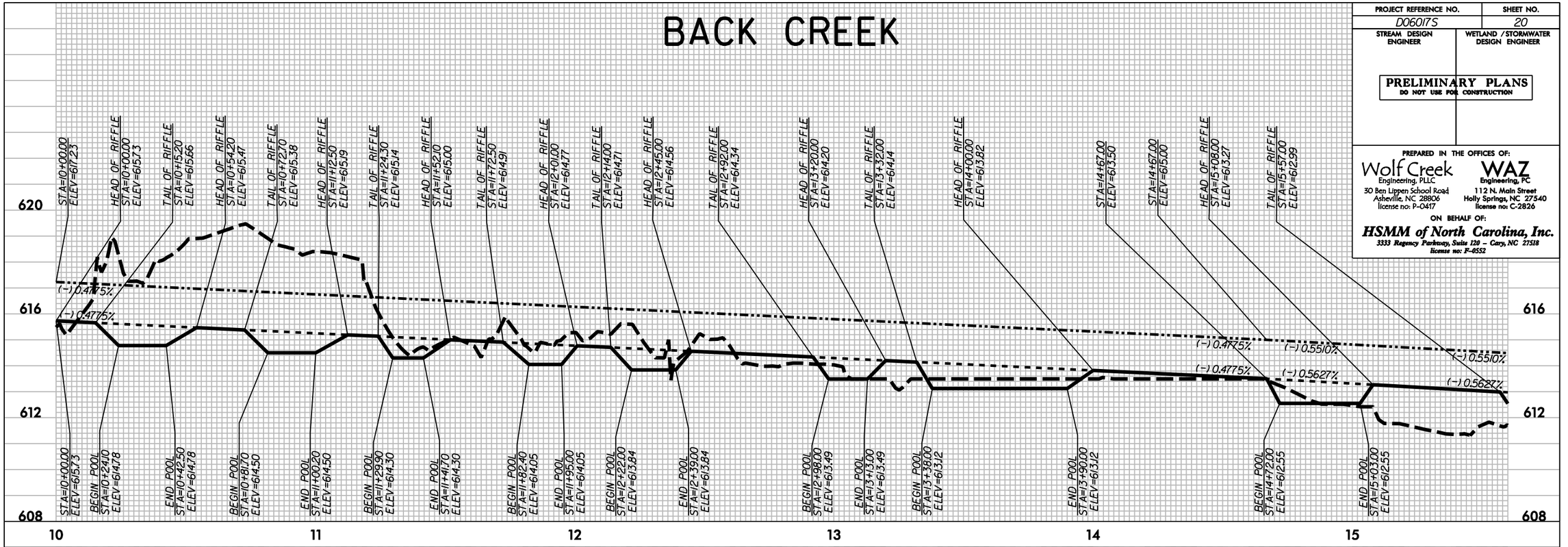
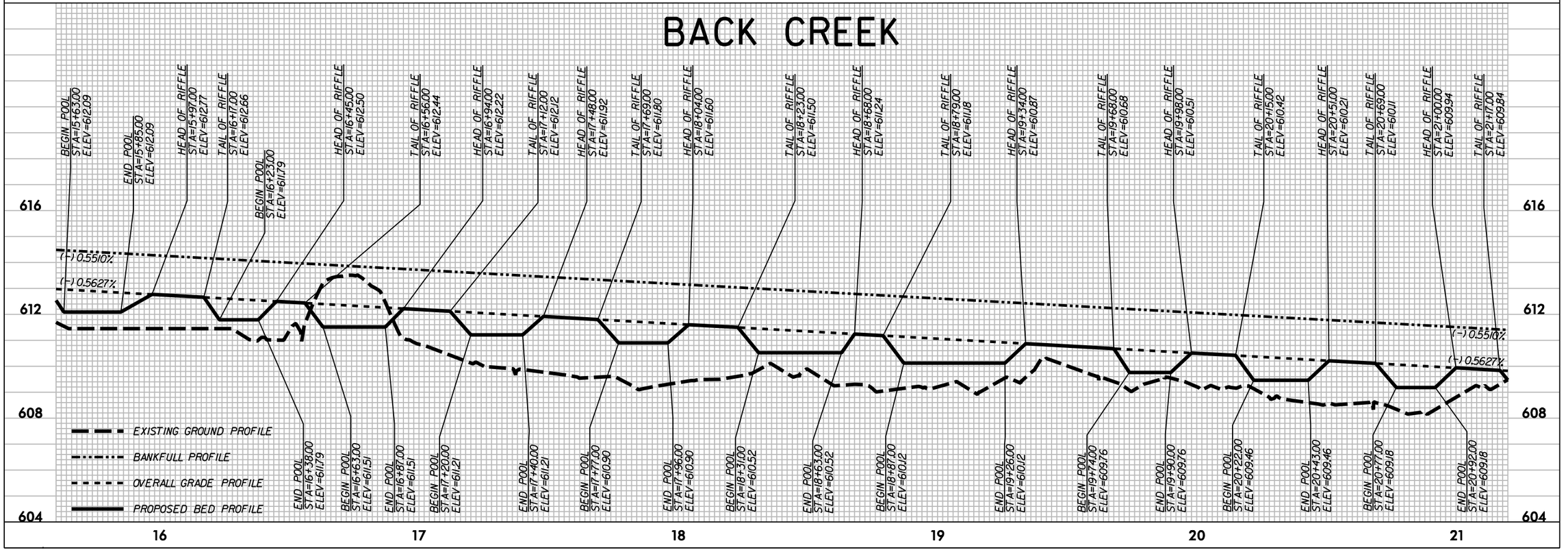
*license no: F-0552*

# BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 21 |

STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION

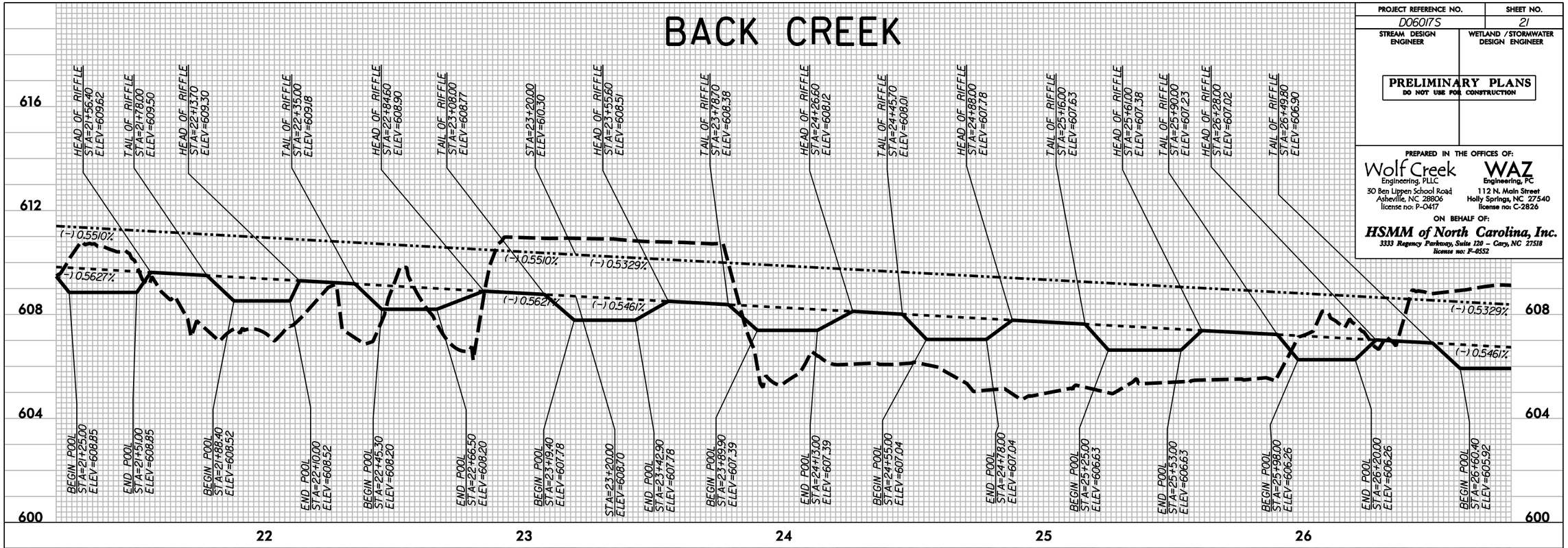
PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

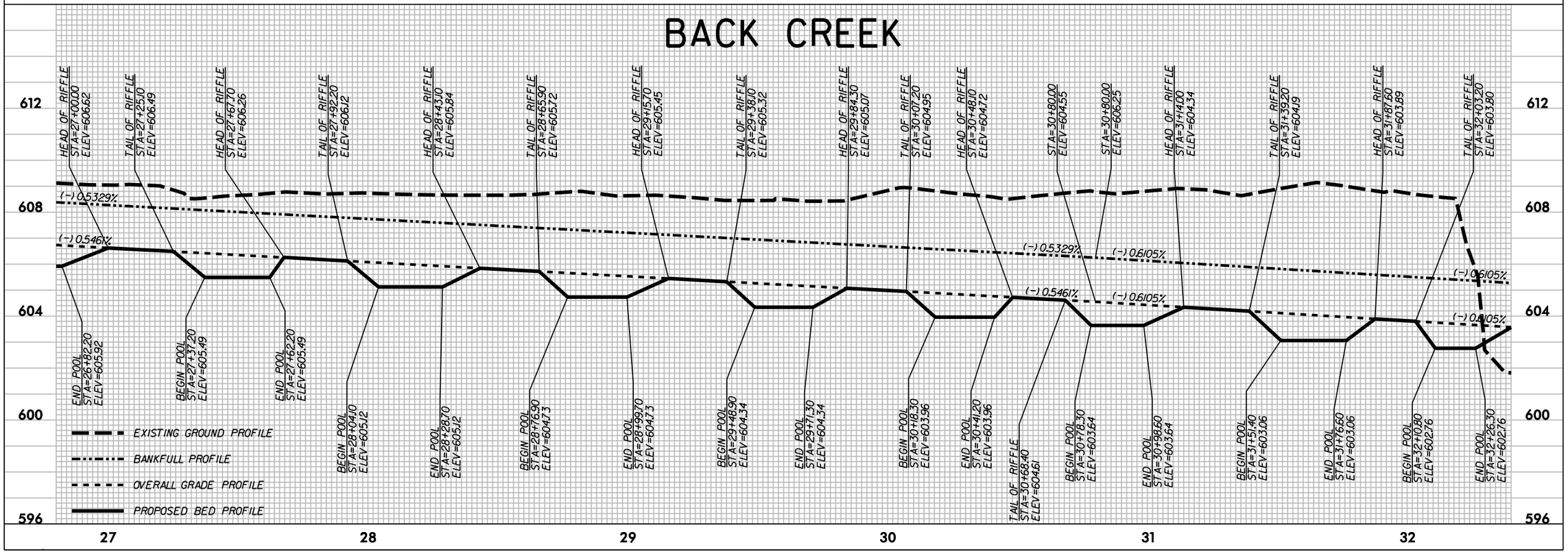
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

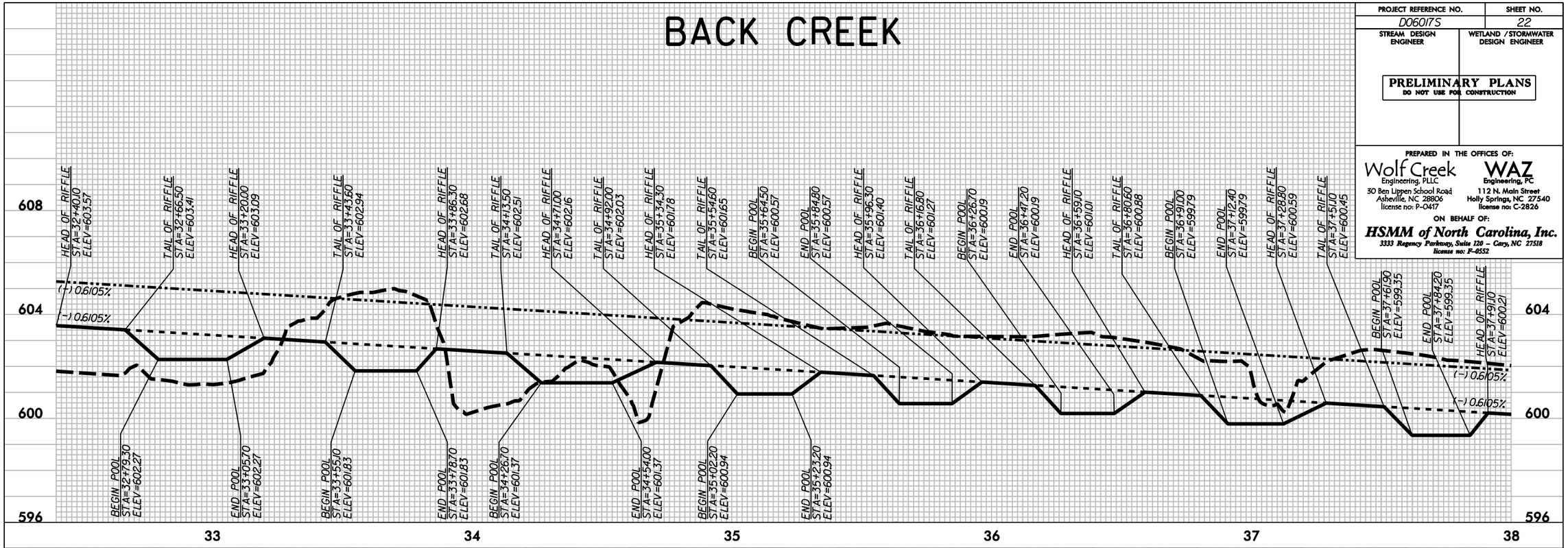
**HSMM of North Carolina, Inc.**
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552




# BACK CREEK



# BACK CREEK




| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 22 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION

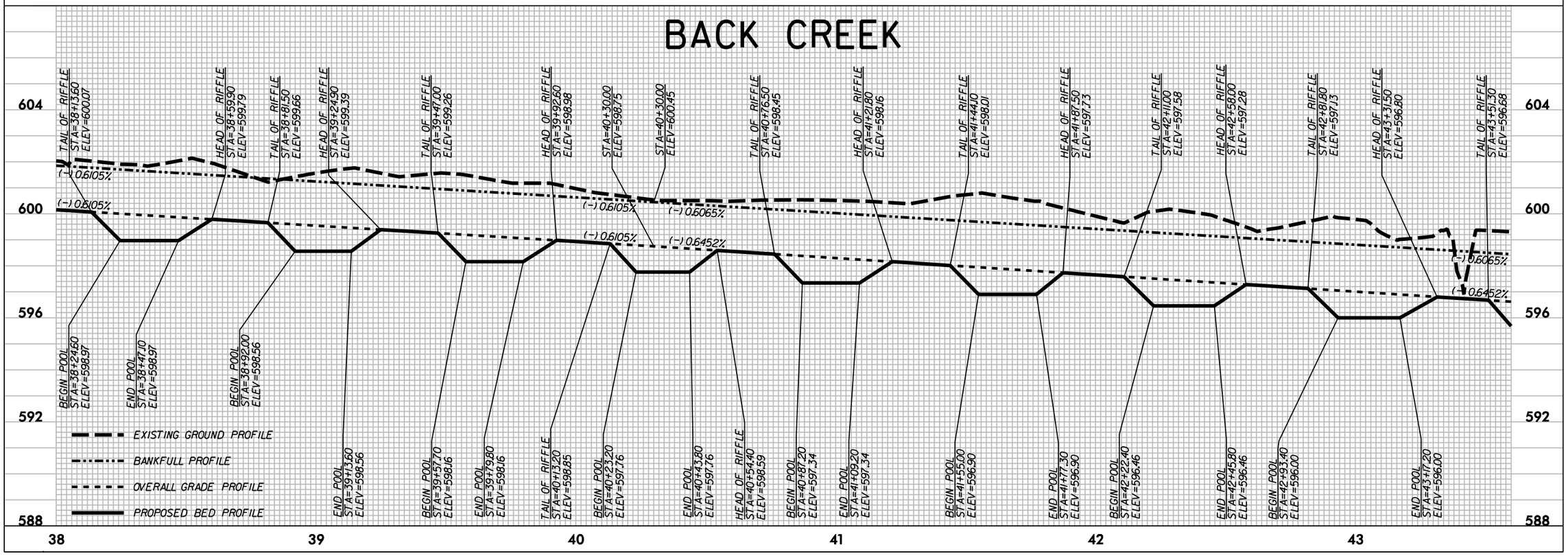

PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

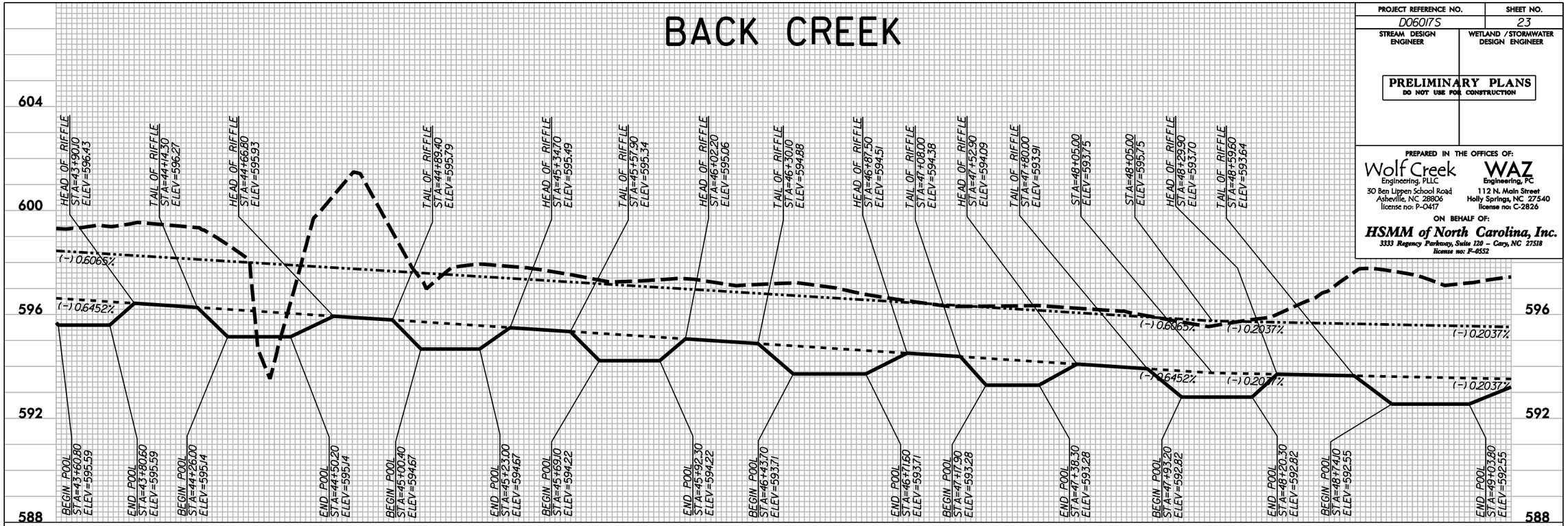
WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:
**HSMM of North Carolina, Inc.**
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552


# BACK CREEK



# BACK CREEK




| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 23 |

STREAM DESIGN ENGINEER

WETLAND / STORMWATER DESIGN ENGINEER

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION

PREPARED IN THE OFFICES OF:

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30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

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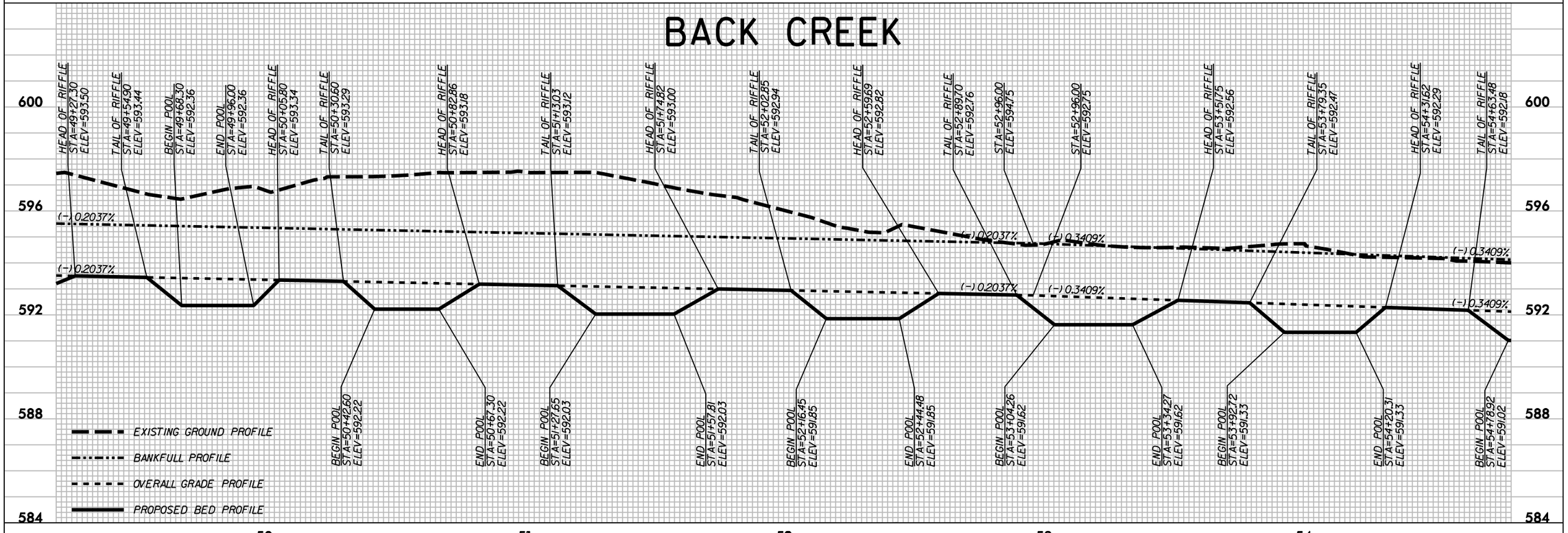
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

***HSMM of North Carolina, Inc.***
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*

# BACK CREEK



# BACK CREEK

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 24 |
| STREAM DESIGN ENGINEER | WETLAND /STORMWATER DESIGN ENGINEER |

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

*HSMM of North Carolina, Inc.*
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552


STA=55+16.00 ELEV=592.00
STA=55+16.00 ELEV=594.00
HEAD OF RIFFLE STA=55+27.03 ELEV=591.97
TAIL OF RIFFLE STA=55+58.15 ELEV=591.88
HEAD OF RIFFLE STA=56+22.16 ELEV=591.69
TAIL OF RIFFLE STA=56+51.82 ELEV=591.60
HEAD OF RIFFLE STA=57+10.17 ELEV=591.43
STA=57+20.00 ELEV=593.10
TAIL OF RIFFLE STA=57+36.96 ELEV=591.23
HEAD OF RIFFLE STA=57+92.83 ELEV=590.66
TAIL OF RIFFLE STA=58+13.92 ELEV=590.45
HEAD OF RIFFLE STA=58+58.15 ELEV=590.00
TAIL OF RIFFLE STA=58+81.20 ELEV=589.77
HEAD OF RIFFLE STA=59+24.31 ELEV=589.33
TAIL OF RIFFLE STA=59+47.79 ELEV=589.09
HEAD OF RIFFLE STA=59+97.08 ELEV=588.59
TAIL OF RIFFLE STA=60+23.38 ELEV=588.33

(–) 0.3409%
(–) 0.4412%
(–) 0.2941%
(–) 0.9328%
(–) 1.0128%

END POOL STA=55+10.77 ELEV=591.02
BEGIN POOL STA=55+73.24 ELEV=590.74
END POOL STA=56+04.37 ELEV=590.74
BEGIN POOL STA=56+66.20 ELEV=590.47
END POOL STA=56+95.87 ELEV=590.47
STA=57+20.00 ELEV=591.40
BEGIN POOL STA=57+49.95 ELEV=589.98
END POOL STA=57+76.74 ELEV=589.98
BEGIN POOL STA=58+24.15 ELEV=589.28
END POOL STA=58+45.24 ELEV=589.28
BEGIN POOL STA=58+92.37 ELEV=588.57
END POOL STA=59+15.41 ELEV=588.57
BEGIN POOL STA=59+59.18 ELEV=587.89
END POOL STA=59+82.67 ELEV=587.89
BEGIN POOL STA=60+36.13 ELEV=587.08

55 56 57 58 59 60

592 588 584


BACK CREEK


HEAD OF RIFFLE STA=60+77.22 ELEV=587.78
TAIL OF RIFFLE STA=61+02.68 ELEV=587.52
HEAD OF RIFFLE STA=61+54.36 ELEV=587.00
TAIL OF RIFFLE STA=61+73.96 ELEV=586.80
HEAD OF RIFFLE STA=62+21.67 ELEV=586.32
TAIL OF RIFFLE STA=62+46.83 ELEV=586.06
HEAD OF RIFFLE STA=63+01.00 ELEV=585.52
STA=63+45.00 ELEV=587.27

(–) 0.9328%
(–) 1.0128%

END POOL STA=60+62.43 ELEV=587.08
BEGIN POOL STA=61+15.03 ELEV=586.04
END POOL STA=61+40.50 ELEV=586.04
BEGIN POOL STA=61+83.41 ELEV=585.41
END POOL STA=62+03.07 ELEV=585.41
BEGIN POOL STA=62+59.03 ELEV=584.59
END POOL STA=62+84.19 ELEV=584.59
TAIL OF RIFFLE STA=63+45.00 ELEV=585.07
STA=63+45.00 ELEV=585.07

EXISTING GROUND PROFILE
BANKFULL PROFILE
OVERALL GRADE PROFILE
PROPOSED BED PROFILE

61 62 63

592 588 584 580 576

# WEST BRANCH

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 25 |

STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
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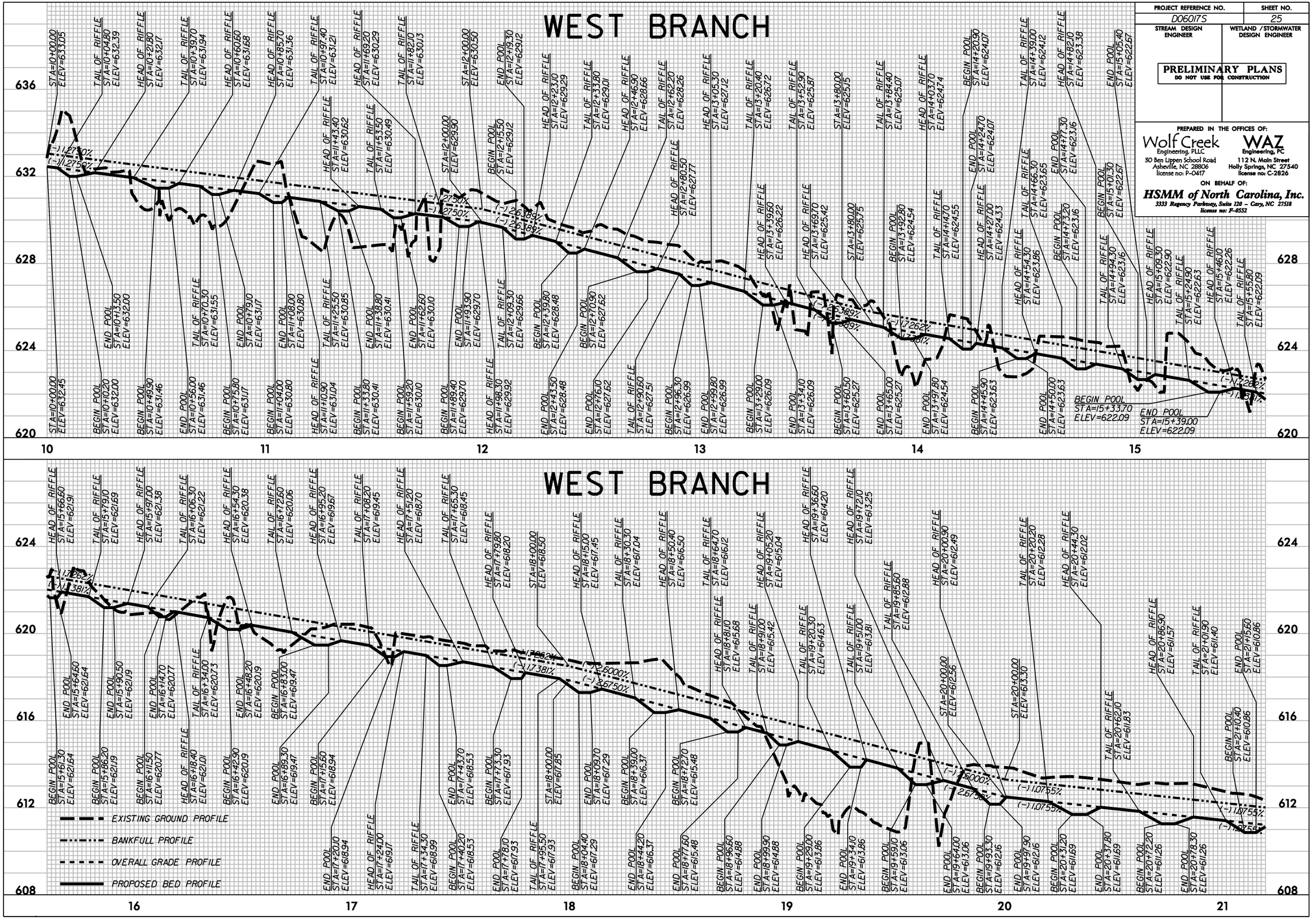
ON BEHALF OF:

*HSMM of North Carolina, Inc.*
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552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TAIL OF RIFFLE STA=10+04.80 ELEV=632.39
HEAD OF RIFFLE STA=10+21.80 ELEV=632.17
TAIL OF RIFFLE STA=10+39.70 ELEV=631.94
HEAD OF RIFFLE STA=10+60.60 ELEV=631.68
HEAD OF RIFFLE STA=10+85.70 ELEV=631.36
TAIL OF RIFFLE STA=10+97.40 ELEV=631.21
HEAD OF RIFFLE STA=11+69.20 ELEV=630.29
TAIL OF RIFFLE STA=11+82.10 ELEV=630.13
STA=12+00.00 ELEV=629.90
END POOL STA=12+19.30 ELEV=629.12
BEGIN POOL STA=12+15.50 ELEV=629.12
HEAD OF RIFFLE STA=12+23.10 ELEV=629.29
TAIL OF RIFFLE STA=12+33.80 ELEV=629.01
HEAD OF RIFFLE STA=12+46.90 ELEV=628.66
TAIL OF RIFFLE STA=12+62.20 ELEV=628.26
HEAD OF RIFFLE STA=12+80.50 ELEV=627.77
HEAD OF RIFFLE STA=13+05.30 ELEV=627.12
TAIL OF RIFFLE STA=13+20.40 ELEV=626.72
HEAD OF RIFFLE STA=13+39.60 ELEV=626.22
TAIL OF RIFFLE STA=13+52.90 ELEV=625.87
HEAD OF RIFFLE STA=13+69.70 ELEV=625.42
STA=13+80.00 ELEV=625.15
TAIL OF RIFFLE STA=13+84.40 ELEV=625.07
HEAD OF RIFFLE STA=14+03.70 ELEV=624.74
BEGIN POOL STA=14+20.90 ELEV=624.07
END POOL STA=14+24.70 ELEV=624.07
TAIL OF RIFFLE STA=14+39.00 ELEV=624.12
HEAD OF RIFFLE STA=14+82.10 ELEV=623.38
END POOL STA=15+05.40 ELEV=622.67
STA=10+00.00 ELEV=632.45
BEGIN POOL STA=10+10.20 ELEV=632.00
END POOL STA=10+13.50 ELEV=632.00
TAIL OF RIFFLE STA=10+70.30 ELEV=631.55
END POOL STA=10+79.10 ELEV=631.17
BEGIN POOL STA=10+75.80 ELEV=631.17
END POOL STA=10+56.00 ELEV=631.46
BEGIN POOL STA=10+49.90 ELEV=631.46
BEGIN POOL STA=11+04.00 ELEV=630.80
END POOL STA=11+08.00 ELEV=630.80
HEAD OF RIFFLE STA=11+10.90 ELEV=631.04
TAIL OF RIFFLE STA=11+25.50 ELEV=630.85
BEGIN POOL STA=11+33.80 ELEV=630.41
END POOL STA=11+38.80 ELEV=630.41
BEGIN POOL STA=11+59.20 ELEV=630.10
END POOL STA=11+62.60 ELEV=630.10
BEGIN POOL STA=11+89.40 ELEV=629.70
END POOL STA=11+93.90 ELEV=629.70
HEAD OF RIFFLE STA=11+98.30 ELEV=629.92
TAIL OF RIFFLE STA=12+09.30 ELEV=629.66
BEGIN POOL STA=12+39.80 ELEV=628.48
END POOL STA=12+43.50 ELEV=628.48
BEGIN POOL STA=12+70.90 ELEV=627.62
END POOL STA=12+76.10 ELEV=627.62
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BEGIN POOL STA=12+96.30 ELEV=626.99
END POOL STA=12+99.80 ELEV=626.99
BEGIN POOL STA=13+29.00 ELEV=626.09
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END POOL STA=13+65.00 ELEV=625.27
BEGIN POOL STA=13+92.80 ELEV=624.54
END POOL STA=13+97.80 ELEV=624.54
TAIL OF RIFFLE STA=14+03.70 ELEV=624.55
HEAD OF RIFFLE STA=14+27.00 ELEV=624.33
BEGIN POOL STA=14+24.70 ELEV=624.07
HEAD OF RIFFLE STA=14+54.30 ELEV=623.86
TAIL OF RIFFLE STA=14+66.30 ELEV=623.65
END POOL STA=14+50.00 ELEV=623.63
BEGIN POOL STA=14+45.90 ELEV=623.63
BEGIN POOL STA=14+73.20 ELEV=623.16
END POOL STA=14+77.30 ELEV=623.16
TAIL OF RIFFLE STA=14+94.30 ELEV=623.16
HEAD OF RIFFLE STA=15+09.30 ELEV=622.90
TAIL OF RIFFLE STA=15+24.90 ELEV=622.63
HEAD OF RIFFLE STA=15+46.10 ELEV=622.26
TAIL OF RIFFLE STA=15+55.80 ELEV=622.09
BEGIN POOL STA=15+33.70 ELEV=622.09
END POOL STA=15+39.00 ELEV=622.09
(-)1.275%
(-)1.275%
(-)1.275%

# WEST BRANCH

HEAD OF RIFFLE STA=21+21.20 ELEV=611.20
TAIL OF RIFFLE STA=21+40.00 ELEV=610.99
HEAD OF RIFFLE STA=21+64.20 ELEV=610.73
TAIL OF RIFFLE STA=21+82.90 ELEV=610.53
HEAD OF RIFFLE STA=22+05.90 ELEV=610.29
HEAD OF RIFFLE STA=22+48.20 ELEV=609.83
HEAD OF RIFFLE STA=22+79.80 ELEV=609.49
TAIL OF RIFFLE STA=22+97.40 ELEV=609.30
HEAD OF RIFFLE STA=23+19.60 ELEV=609.06
HEAD OF RIFFLE STA=23+60.60 ELEV=608.62
TAIL OF RIFFLE STA=23+78.10 ELEV=608.43
HEAD OF RIFFLE STA=24+00.80 ELEV=608.19
TAIL OF RIFFLE STA=24+21.00 ELEV=607.97
HEAD OF RIFFLE STA=24+46.90 ELEV=607.69
TAIL OF RIFFLE STA=24+65.50 ELEV=607.49
HEAD OF RIFFLE STA=24+89.10 ELEV=607.24
TAIL OF RIFFLE STA=25+07.00 ELEV=607.05
TAIL OF RIFFLE STA=25+43.70 ELEV=606.42
HEAD OF RIFFLE STA=25+64.30 ELEV=605.86
TAIL OF RIFFLE STA=25+79.40 ELEV=605.44
HEAD OF RIFFLE STA=26+00.00 ELEV=604.90
STA=25+30.00 ELEV=606.80
STA=25+30.00 ELEV=607.60
STA=26+12.00 ELEV=605.35
STA=26+12.00 ELEV=604.55
(-) 1.07552%
(-) 1.07552%
(-) 1.07552%
(-) 2.74391%
(-) 2.74391%
(-) 2.74391%
(-) 2.74391%
BEGIN POOL STA=21+50.60 ELEV=610.41
END POOL STA=21+57.00 ELEV=610.41
BEGIN POOL STA=21+93.60 ELEV=609.95
END POOL STA=21+99.90 ELEV=609.95
TAIL OF RIFFLE STA=22+23.70 ELEV=610.09
BEGIN POOL STA=22+33.80 ELEV=609.52
END POOL STA=22+39.90 ELEV=609.52
TAIL OF RIFFLE STA=22+62.90 ELEV=609.67
BEGIN POOL STA=22+71.30 ELEV=609.13
END POOL STA=22+76.30 ELEV=609.13
BEGIN POOL STA=23+07.40 ELEV=608.73
END POOL STA=23+13.40 ELEV=608.73
TAIL OF RIFFLE STA=23+38.00 ELEV=608.86
BEGIN POOL STA=23+48.50 ELEV=608.28
END POOL STA=23+54.80 ELEV=608.28
BEGIN POOL STA=23+88.10 ELEV=607.86
END POOL STA=23+94.00 ELEV=607.86
BEGIN POOL STA=24+32.60 ELEV=607.37
END POOL STA=24+39.50 ELEV=607.37
BEGIN POOL STA=24+76.00 ELEV=606.91
END POOL STA=24+82.30 ELEV=606.91
BEGIN POOL STA=25+17.10 ELEV=606.47
END POOL STA=25+23.20 ELEV=606.47
HEAD OF RIFFLE STA=25+28.60 ELEV=606.81
BEGIN POOL STA=25+52.30 ELEV=605.65
END POOL STA=25+57.40 ELEV=605.65
BEGIN POOL STA=25+88.00 ELEV=604.64
END POOL STA=25+94.00 ELEV=604.64
TAIL OF RIFFLE STA=26+12.00 ELEV=604.55

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 26 |

STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION

PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

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112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

**HSMM of North Carolina, Inc.**
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552

# UT to WEST BRANCH

STA=10+36.00 ELEV=615.50
STA=10+36.00 ELEV=616.10
STA=10+46.00 ELEV=616.10
STA=10+46.00 ELEV=615.50
BEGIN POOL STA=10+68.00 ELEV=614.22
HEAD OF RIFFLE STA=10+81.00 ELEV=614.39
TAIL OF RIFFLE STA=10+97.00 ELEV=613.89
BEGIN POOL STA=11+01.00 ELEV=613.12
TAIL OF RIFFLE STA=11+30.00 ELEV=612.85
STA=11+38.00 ELEV=613.20
STA=11+38.00 ELEV=612.60
0.0000%
0.0000%
(-) 3.15229%
(-) 3.15229%
(-) 3.15229%
(-) 3.15229%
BEGIN POOL STA=10+40.00 ELEV=615.17
END POOL STA=10+47.00 ELEV=615.17
HEAD OF RIFFLE STA=10+51.00 ELEV=615.34
TAIL OF RIFFLE STA=10+64.00 ELEV=614.93
END POOL STA=10+77.00 ELEV=614.22
END POOL STA=11+12.00 ELEV=613.12
HEAD OF RIFFLE STA=11+16.00 ELEV=613.29
BEGIN POOL STA=11+34.00 ELEV=612.16

EXISTING GROUND PROFILE
BANKFULL PROFILE
OVERALL GRADE PROFILE
PROPOSED BED PROFILE

# NORTH BRANCH

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 27 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*

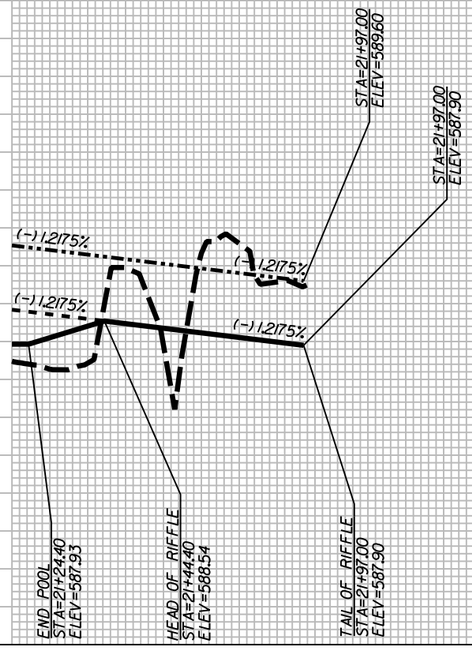

STA=10+10.00 ELEV=594.78
STA=10+10.00 ELEV=596.48
HEAD OF RIFFLE STA=10+38.70 ELEV=594.68
TAIL OF RIFFLE STA=10+66.50 ELEV=594.58
HEAD OF RIFFLE STA=11+22.00 ELEV=594.38
TAIL OF RIFFLE STA=11+48.70 ELEV=594.29
HEAD OF RIFFLE STA=12+03.20 ELEV=594.09
TAIL OF RIFFLE STA=12+30.60 ELEV=593.99
HEAD OF RIFFLE STA=12+87.70 ELEV=593.79
TAIL OF RIFFLE STA=13+13.80 ELEV=593.70
HEAD OF RIFFLE STA=13+68.30 ELEV=593.50
TAIL OF RIFFLE STA=13+97.80 ELEV=593.40
HEAD OF RIFFLE STA=14+53.90 ELEV=593.20
TAIL OF RIFFLE STA=14+83.60 ELEV=593.09
HEAD OF RIFFLE STA=15+45.70 ELEV=592.87
(-) 0.3561%
BEGIN POOL STA=10+80.80 ELEV=593.58
END POOL STA=11+08.60 ELEV=593.58
BEGIN POOL STA=11+62.50 ELEV=593.29
END POOL STA=11+89.20 ELEV=593.29
BEGIN POOL STA=12+44.70 ELEV=593.00
END POOL STA=12+72.10 ELEV=593.00
BEGIN POOL STA=13+27.30 ELEV=592.71
END POOL STA=13+53.40 ELEV=592.71
BEGIN POOL STA=14+13.10 ELEV=592.39
END POOL STA=14+42.60 ELEV=592.39
BEGIN POOL STA=14+98.90 ELEV=592.08
END POOL STA=15+28.50 ELEV=592.08
(-) 0.3561%

# NORTH BRANCH

TAIL OF RIFFLE STA=15+73.40 ELEV=592.77
HEAD OF RIFFLE STA=16+26.70 ELEV=592.58
TAIL OF RIFFLE STA=16+53.40 ELEV=592.49
HEAD OF RIFFLE STA=17+99.40 ELEV=591.97
STA=18+89.00 ELEV=593.35
HEAD OF RIFFLE STA=19+66.00 ELEV=590.71
TAIL OF RIFFLE STA=20+04.90 ELEV=590.24
HEAD OF RIFFLE STA=20+59.20 ELEV=589.58
TAIL OF RIFFLE STA=20+92.50 ELEV=589.17
(-) 0.3561%
(-) 1.2175%
BEGIN POOL STA=15+87.70 ELEV=591.77
END POOL STA=16+15.30 ELEV=591.77
BEGIN POOL STA=16+67.20 ELEV=591.49
END POOL STA=16+94.00 ELEV=591.49
HEAD OF RIFFLE STA=17+12.70 ELEV=592.28
TAIL OF RIFFLE STA=17+42.20 ELEV=592.17
BEGIN POOL STA=17+57.30 ELEV=591.96
END POOL STA=17+86.80 ELEV=591.96
TAIL OF RIFFLE STA=18+28.50 ELEV=591.87
BEGIN POOL STA=18+43.60 ELEV=590.86
END POOL STA=18+72.10 ELEV=590.86
HEAD OF RIFFLE STA=18+78.60 ELEV=591.69
STA=18+89.00 ELEV=591.65
TAIL OF RIFFLE STA=19+15.80 ELEV=591.32
BEGIN POOL STA=19+37.00 ELEV=590.06
END POOL STA=19+49.70 ELEV=590.06
BEGIN POOL STA=20+27.10 ELEV=588.96
END POOL STA=20+40.40 ELEV=588.96
BEGIN POOL STA=21+11.40 ELEV=587.93
(-) 1.2175%

EXISTING GROUND PROFILE
BANKFULL PROFILE
OVERALL GRADE PROFILE
PROPOSED BED PROFILE

# NORTH BRANCH




| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 28 |

STREAM DESIGN ENGINEER

WETLAND / STORMWATER DESIGN ENGINEER

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*

# EAST BRANCH

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | 29 |
| STREAM DESIGN ENGINEER | WETLAND / STORMWATER DESIGN ENGINEER |

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

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30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:
**HSMM of North Carolina, Inc.**
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552


HEAD OF RIFFLE STA=9+96.00 ELEV=589.47
STA=9+96.00 ELEV=589.47
HEAD OF RIFFLE STA=10+27.20 ELEV=597.38
TAIL OF RIFFLE STA=10+39.50 ELEV=597.14
HEAD OF RIFFLE STA=10+53.00 ELEV=596.87
TAIL OF RIFFLE STA=10+70.40 ELEV=596.53
STA=10+77.00 ELEV=589.47
HEAD OF RIFFLE STA=10+95.30 ELEV=596.24
TAIL OF RIFFLE STA=11+18.60 ELEV=596.03
HEAD OF RIFFLE STA=11+45.30 ELEV=595.80
TAIL OF RIFFLE STA=11+66.40 ELEV=595.61
HEAD OF RIFFLE STA=11+97.30 ELEV=595.34
TAIL OF RIFFLE STA=12+13.10 ELEV=595.20
HEAD OF RIFFLE STA=12+36.30 ELEV=594.99
TAIL OF RIFFLE STA=12+56.80 ELEV=594.81
TAIL OF RIFFLE STA=13+01.40 ELEV=594.42
BEGIN POOL STA=13+14.60 ELEV=593.73
TAIL OF RIFFLE STA=13+50.60 ELEV=593.98
BEGIN POOL STA=13+61.80 ELEV=593.32
HEAD OF RIFFLE STA=13+79.40 ELEV=593.73
TAIL OF RIFFLE STA=14+03.80 ELEV=593.51
STA=14+39.00 ELEV=589.47
STA=14+39.00 ELEV=589.47
HEAD OF RIFFLE STA=14+39.00 ELEV=593.20
TAIL OF RIFFLE STA=14+64.70 ELEV=592.24
HEAD OF RIFFLE STA=14+89.50 ELEV=591.32
(-) 1.9753%
(-) 1.9753%
(-) 1.9753%
(-) 0.8840%
(-) 0.8840%
(-) 0.8840%
(-) 3.7208%
(-) 3.7208%
(-) 3.7208%
HEAD OF RIFFLE STA=9+96.00 ELEV=598.00
TAIL OF RIFFLE STA=10+05.30 ELEV=597.82
BEGIN POOL STA=10+11.40 ELEV=597.12
END POOL STA=10+15.00 ELEV=597.12
BEGIN POOL STA=10+46.40 ELEV=596.42
END POOL STA=10+50.60 ELEV=596.42
STA=10+77.00 ELEV=589.47
BEGIN POOL STA=10+80.30 ELEV=595.82
END POOL STA=10+86.20 ELEV=595.82
BEGIN POOL STA=11+31.90 ELEV=595.34
BEGIN POOL STA=11+78.30 ELEV=594.94
END POOL STA=11+39.80 ELEV=595.34
END POOL STA=11+85.50 ELEV=594.94
BEGIN POOL STA=12+22.00 ELEV=594.57
END POOL STA=12+27.40 ELEV=594.57
BEGIN POOL STA=12+88.50 ELEV=594.15
END POOL STA=12+75.50 ELEV=594.15
HEAD OF RIFFLE STA=12+78.30 ELEV=594.62
END POOL STA=13+22.40 ELEV=593.73
HEAD OF RIFFLE STA=13+31.00 ELEV=594.15
END POOL STA=13+68.50 ELEV=593.32
BEGIN POOL STA=14+17.60 ELEV=592.82
END POOL STA=14+25.90 ELEV=592.82
BEGIN POOL STA=14+79.40 ELEV=590.87
END POOL STA=14+88.10 ELEV=590.87
TAIL OF RIFFLE STA=15+05.90 ELEV=590.71
BEGIN POOL STA=15+15.30 ELEV=589.65
END POOL STA=15+20.90 ELEV=589.65
HEAD OF RIFFLE STA=15+23.80 ELEV=590.04
TAIL OF RIFFLE STA=15+39.20 ELEV=589.47

600 596 592 588 584

10 11 12 13 14 15

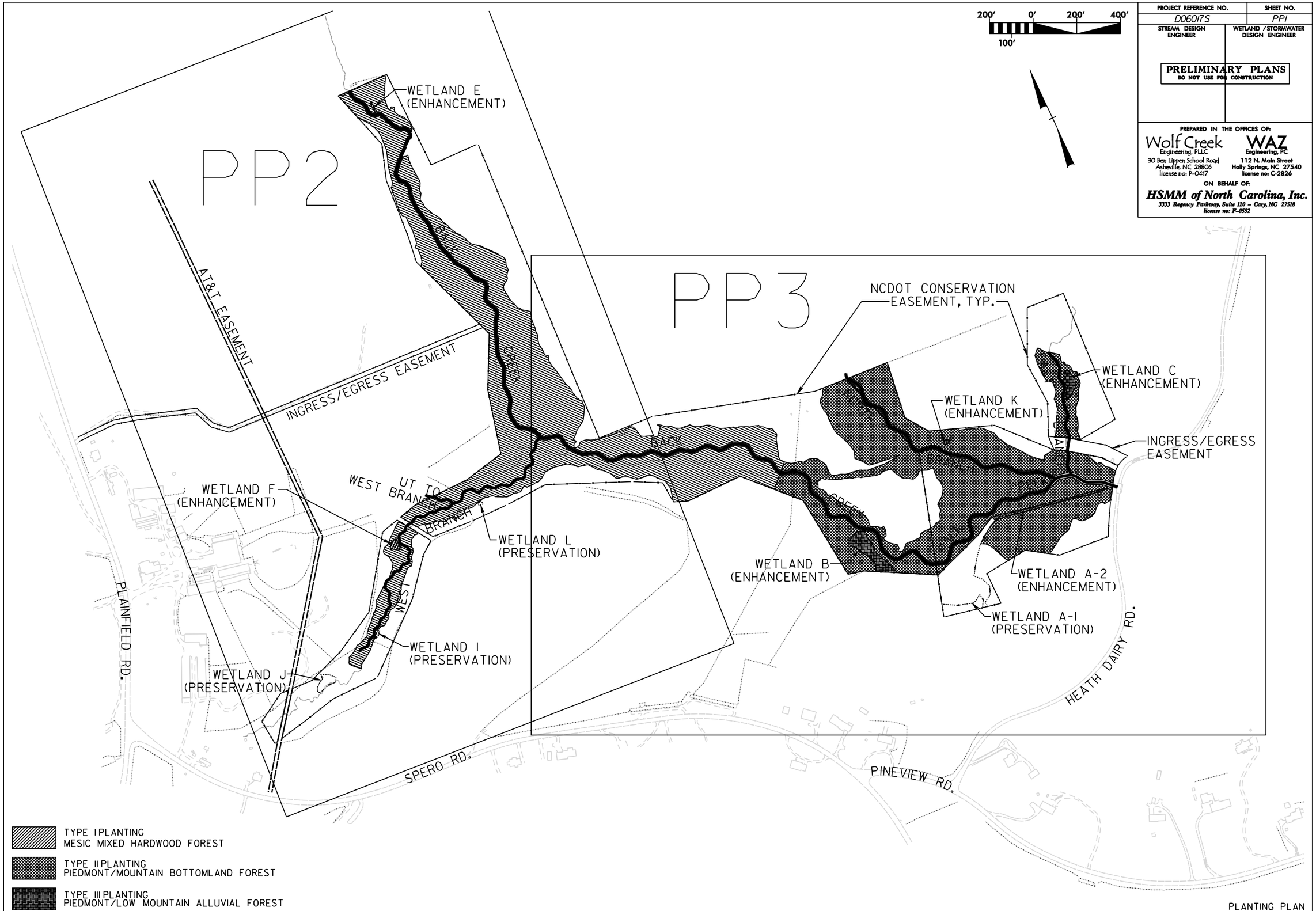

# EAST BRANCH


HEAD OF RIFFLE STA=15+57.00 ELEV=588.84
STA=15+93.00 ELEV=588.47
TAIL OF RIFFLE STA=15+93.00 ELEV=587.47
(-) 3.7208%
(-) 3.7208%
(-) 3.7208%
(-) 3.7208%
BEGIN POOL STA=15+48.00 ELEV=588.42
END POOL STA=15+54.00 ELEV=588.42
STA=15+93.00 ELEV=587.47

592 588 584 580 576

16

EXISTING GROUND PROFILE
BANKFULL PROFILE
OVERALL GRADE PROFILE
PROPOSED BED PROFILE




| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | PP1 |
| STREAM DESIGN ENGINEER | WETLAND /STORMWATER DESIGN ENGINEER |

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION

PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

**HSMM of North Carolina, Inc.**
3333 Regency Parkway, Suite 120 – Cary, NC 27518
license no: F-0552

PLANTING PLAN

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | PP2 |

STREAM DESIGN ENGINEER

WETLAND / STORMWATER DESIGN ENGINEER

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*


100' 0' 100' 200'

50'

WETLAND E
(ENHANCEMENT)

BACK CREEK

WETLAND L
(PRESERVATION)

INGRESS/EGRESS EASEMENT

WEST BRANCH UT TO

WEST

WETLAND F
(ENHANCEMENT)

WETLAND I
(PRESERVATION)

AT&T EASEMENT

WETLAND J
(PRESERVATION)

TYPE I PLANTING
MESIC MIXED HARDWOOD FOREST

TYPE II PLANTING
PIEDMONT/MOUNTAIN BOTTOMLAND FOREST

TYPE III PLANTING
PIEDMONT/LOW MOUNTAIN ALLUVIAL FOREST

PLANTING PLAN

| PROJECT REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | PP3 |

STREAM DESIGN ENGINEER

WETLAND / STORMWATER DESIGN ENGINEER

**PRELIMINARY PLANS**
DO NOT USE FOR CONSTRUCTION


PREPARED IN THE OFFICES OF:

Wolf Creek Engineering, PLLC
30 Ben Lippen School Road
Asheville, NC 28806
license no: P-0417

WAZ Engineering, PC
112 N. Main Street
Holly Springs, NC 27540
license no: C-2826

ON BEHALF OF:

*HSMM of North Carolina, Inc.*
*3333 Regency Parkway, Suite 120 – Cary, NC 27518*
*license no: F-0552*


100' 0' 100' 200'
50'

NCDOT CONSERVATION EASEMENT, TYP.

WETLAND C (ENHANCEMENT)

WETLAND K (ENHANCEMENT)

INGRESS/EGRESS EASEMENT

BACK BRANCH CREEK

WETLAND B (ENHANCEMENT)

WETLAND A-2 (ENHANCEMENT)

WETLAND A-1 (PRESERVATION)

HEATH DAIRY RD.

TYPE I PLANTING
MESIC MIXED HARDWOOD FOREST

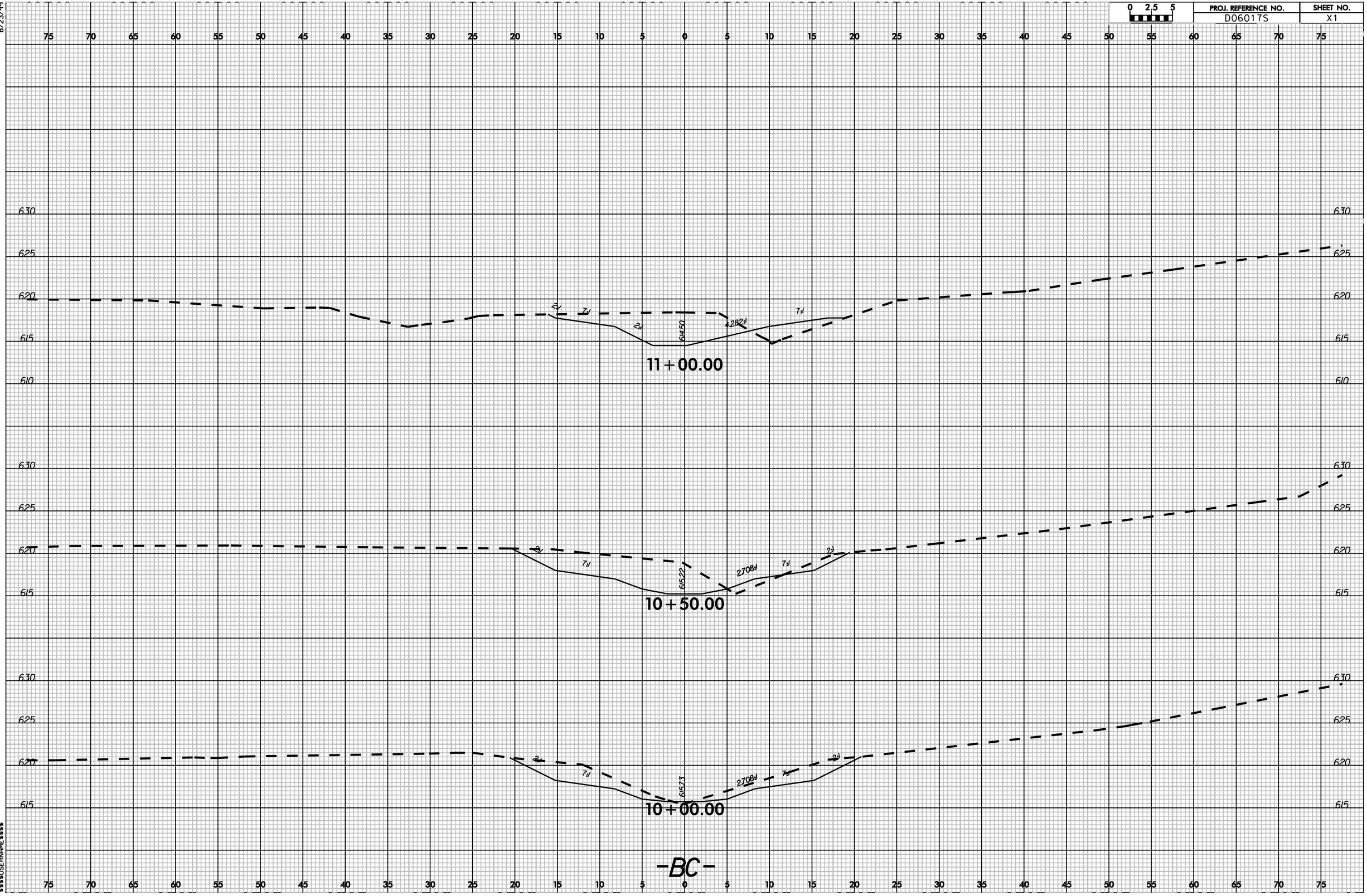
TYPE II PLANTING
PIEDMONT/MOUNTAIN BOTTOMLAND FOREST

TYPE III PLANTING
PIEDMONT/LOW MOUNTAIN ALLUVIAL FOREST

PLANTING PLAN

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X1 |




$$$$$$$SYSTIME$$$$$$
$$$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X2 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

630 625 620 615 610

7.1% 614.54 2.1% 7.1%

12 + 50.00

630 625 620 615 610

7.1% 614.65

12 + 00.00

635 630 625 620 615 610

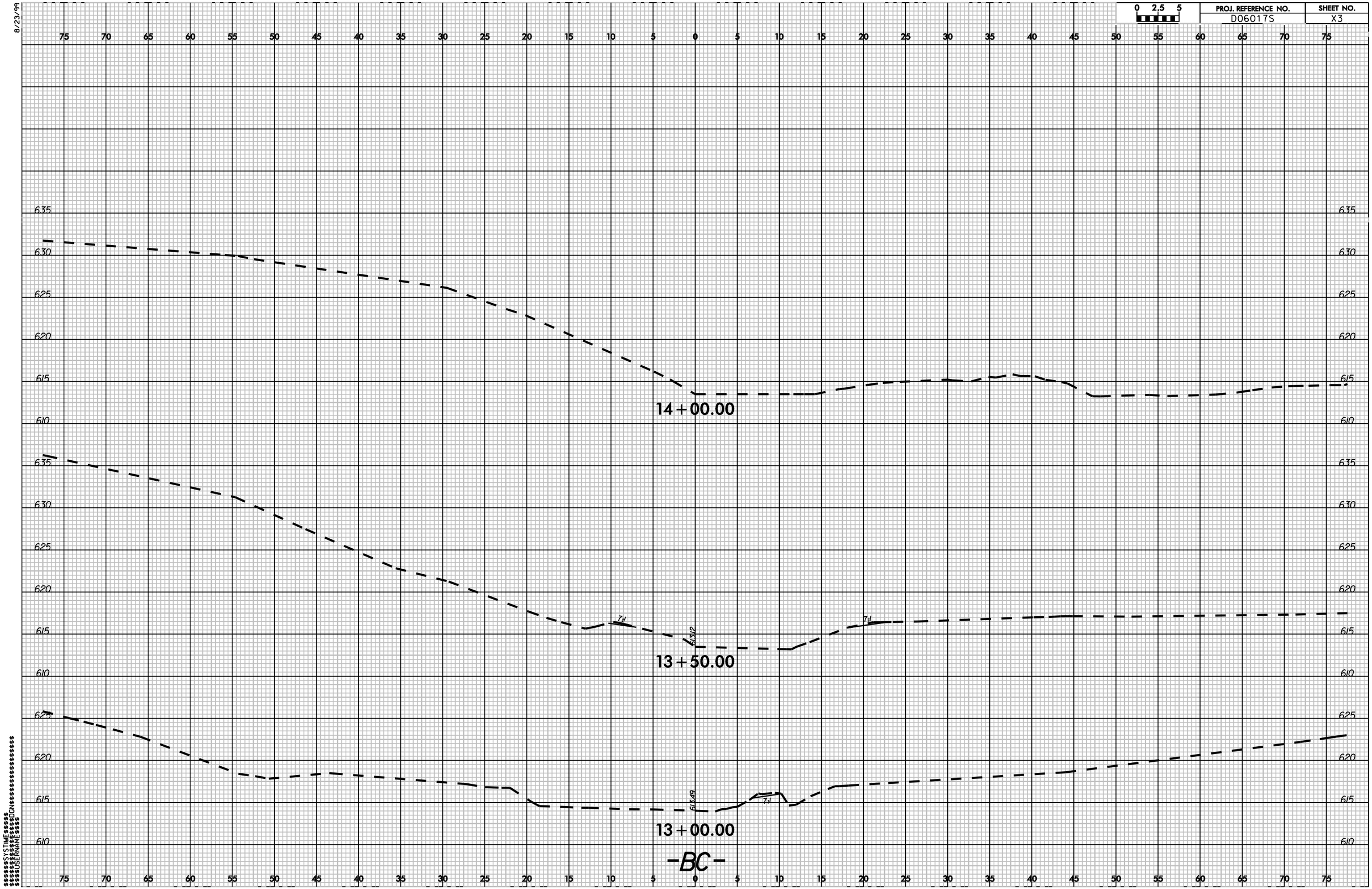
8.2% 7.1% 614.86 2.70% 7.1% 8.2%

11 + 50.00

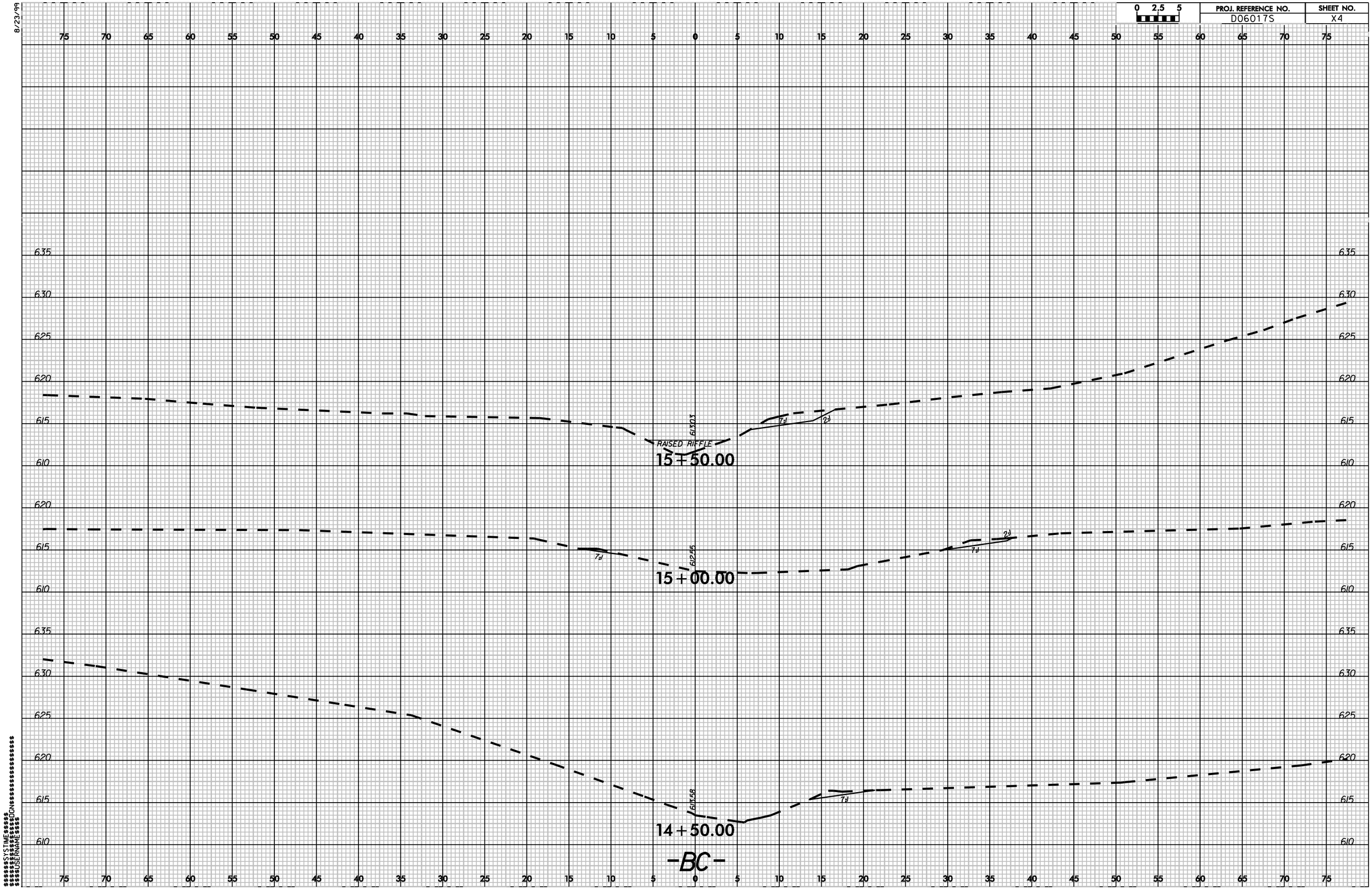
-BC-

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

$$$$$$$SYSTIME$$$$$$
$$$$$$$



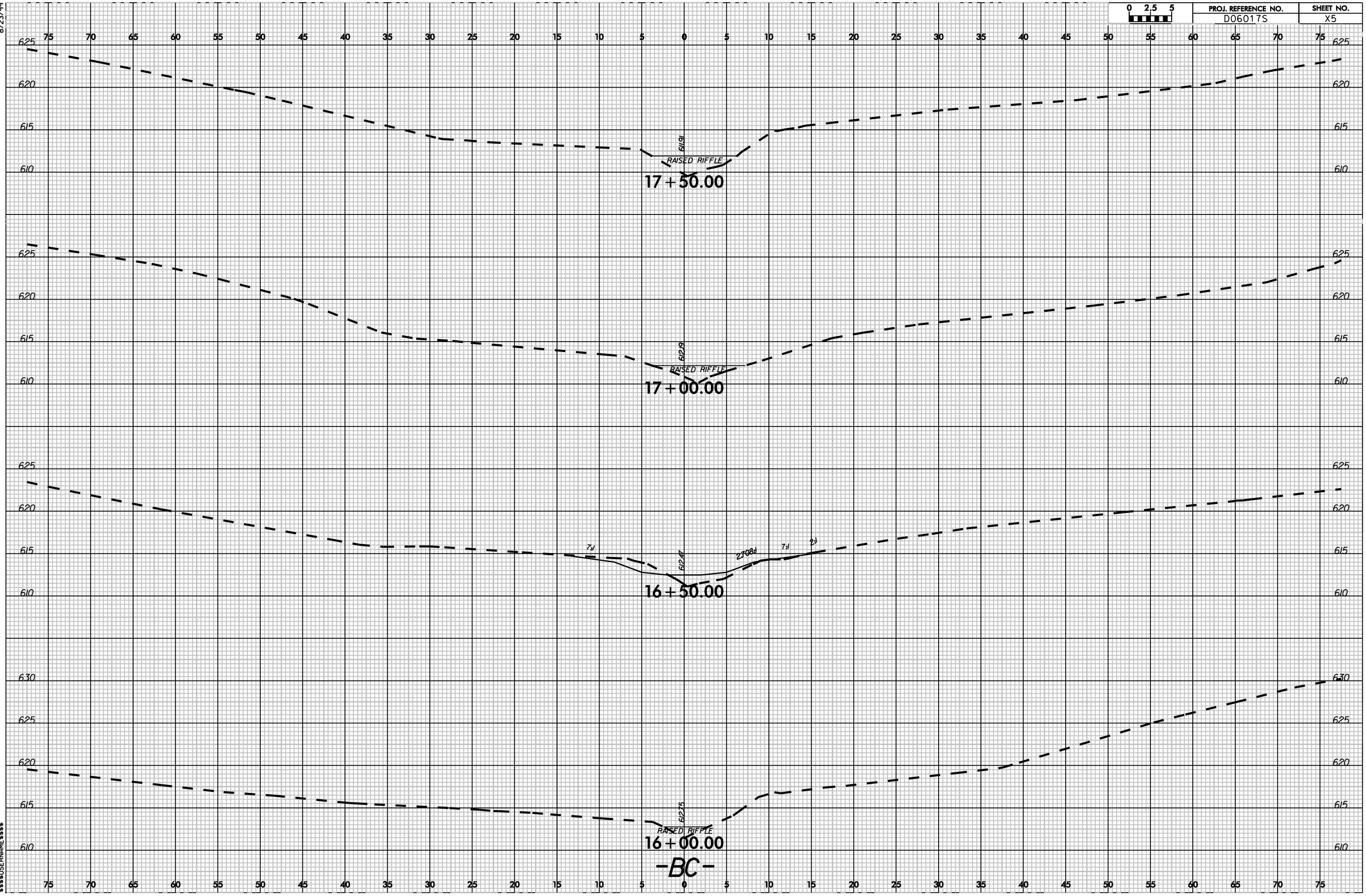
8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X3
14+00.00
13+50.00
13+00.00
7:1
613.12
613.49
-BC-
$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$



0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X4
8/23/99
RAISED RIFFLE
15+50.00
15+00.00
14+50.00
-BC-

8/23/99

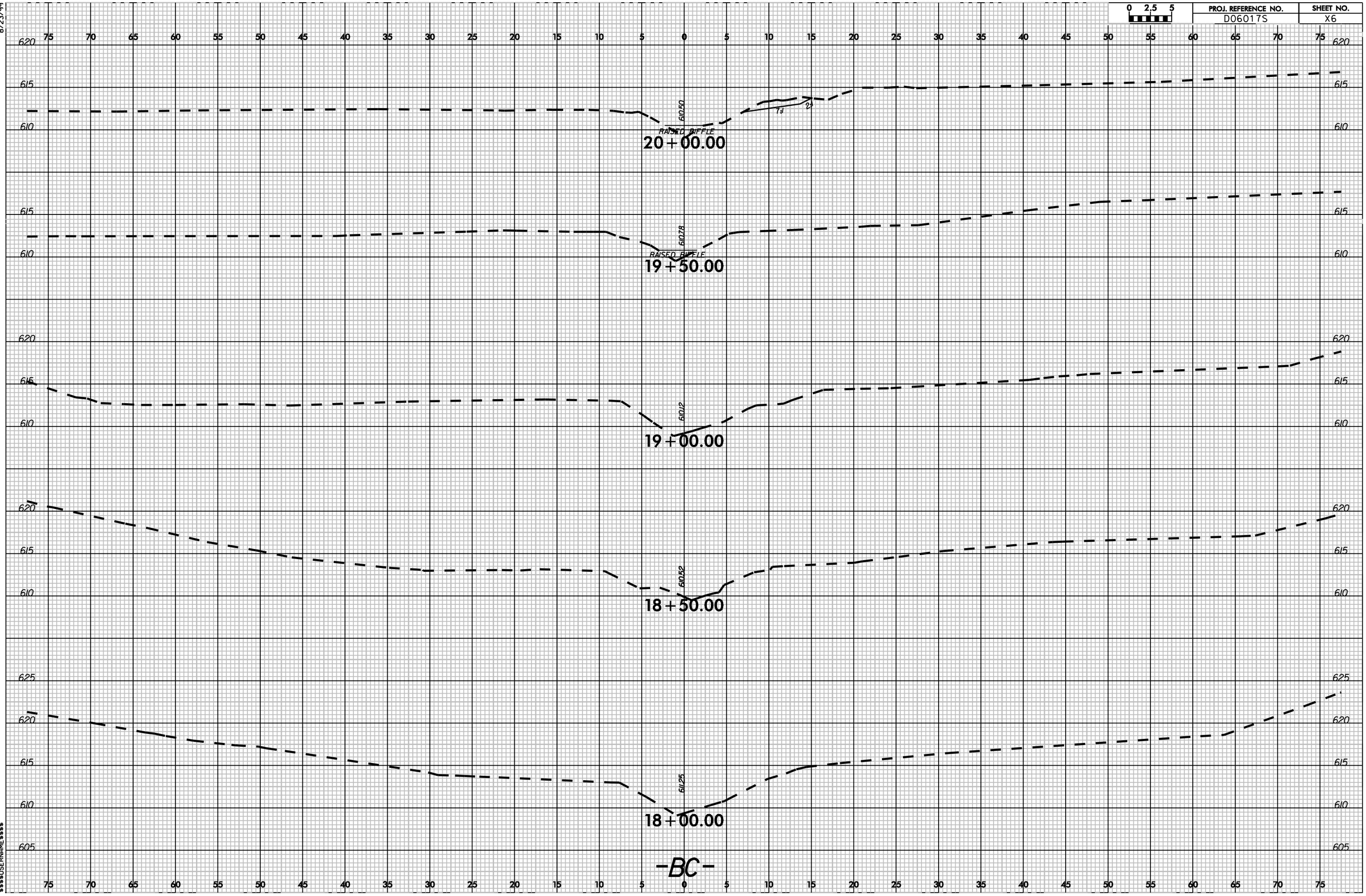
| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X5 |



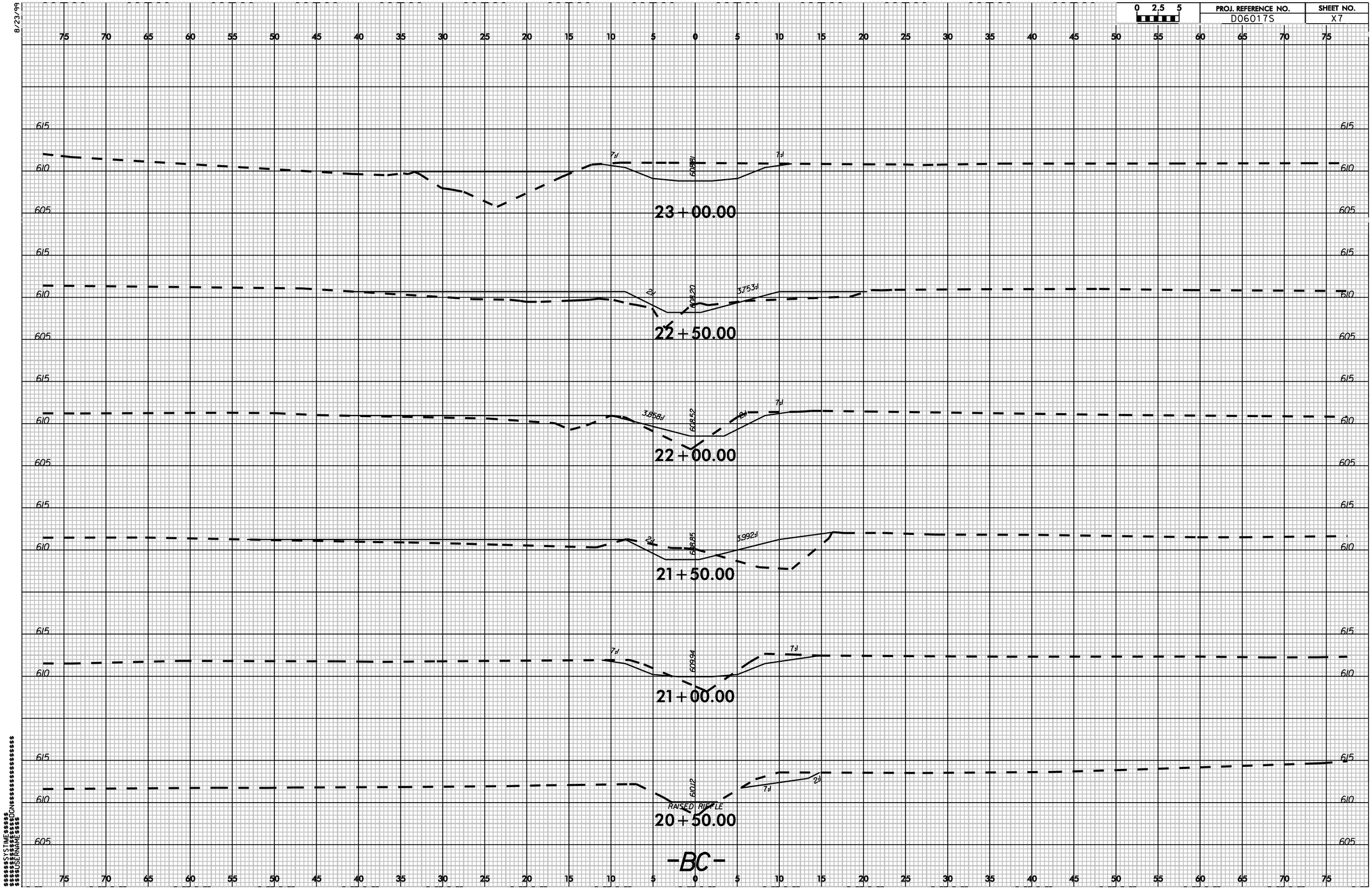

$$$$$$$SYSTIME$$$$$$
$$$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$

8/23/99

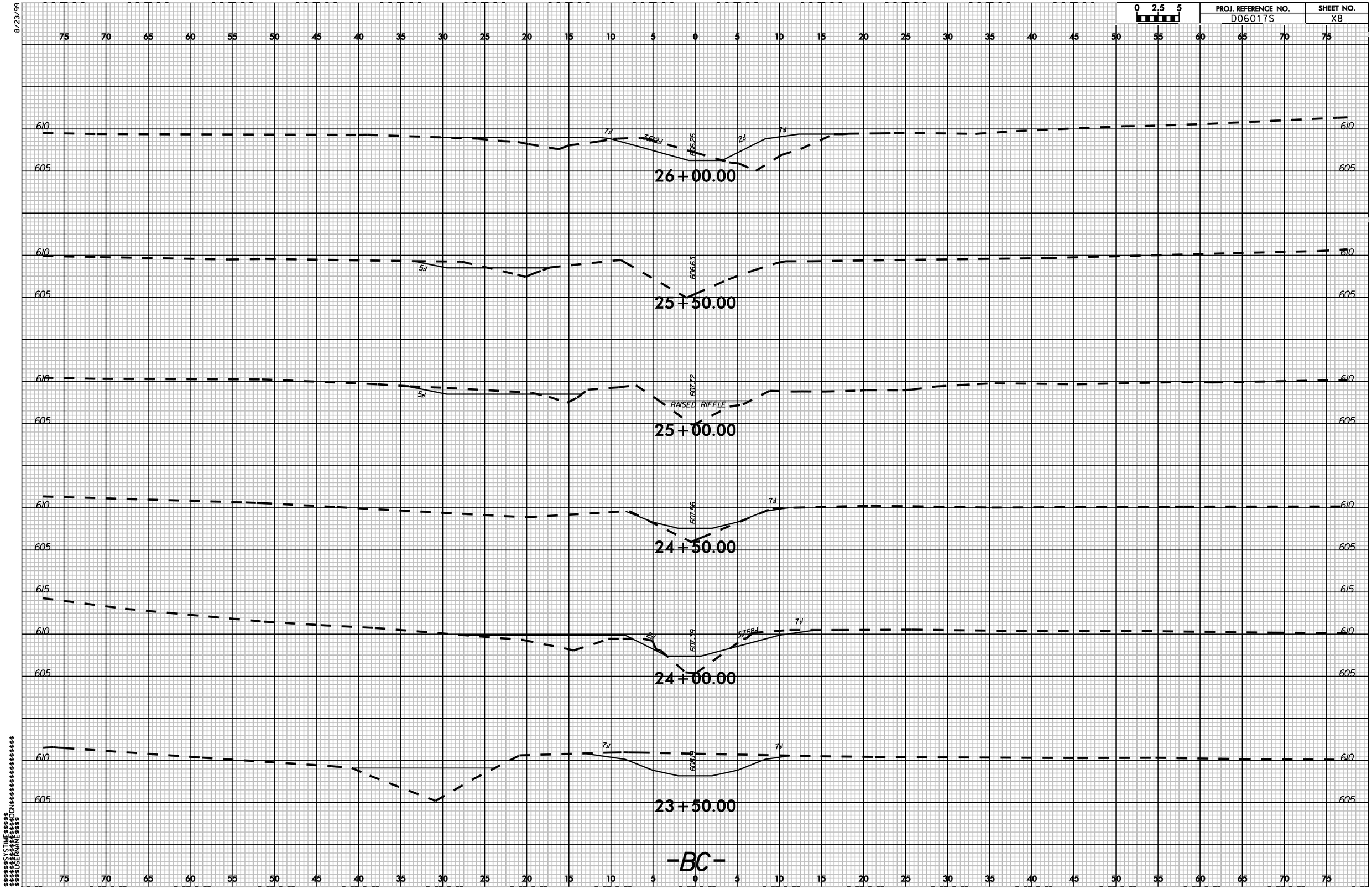
| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X6 |



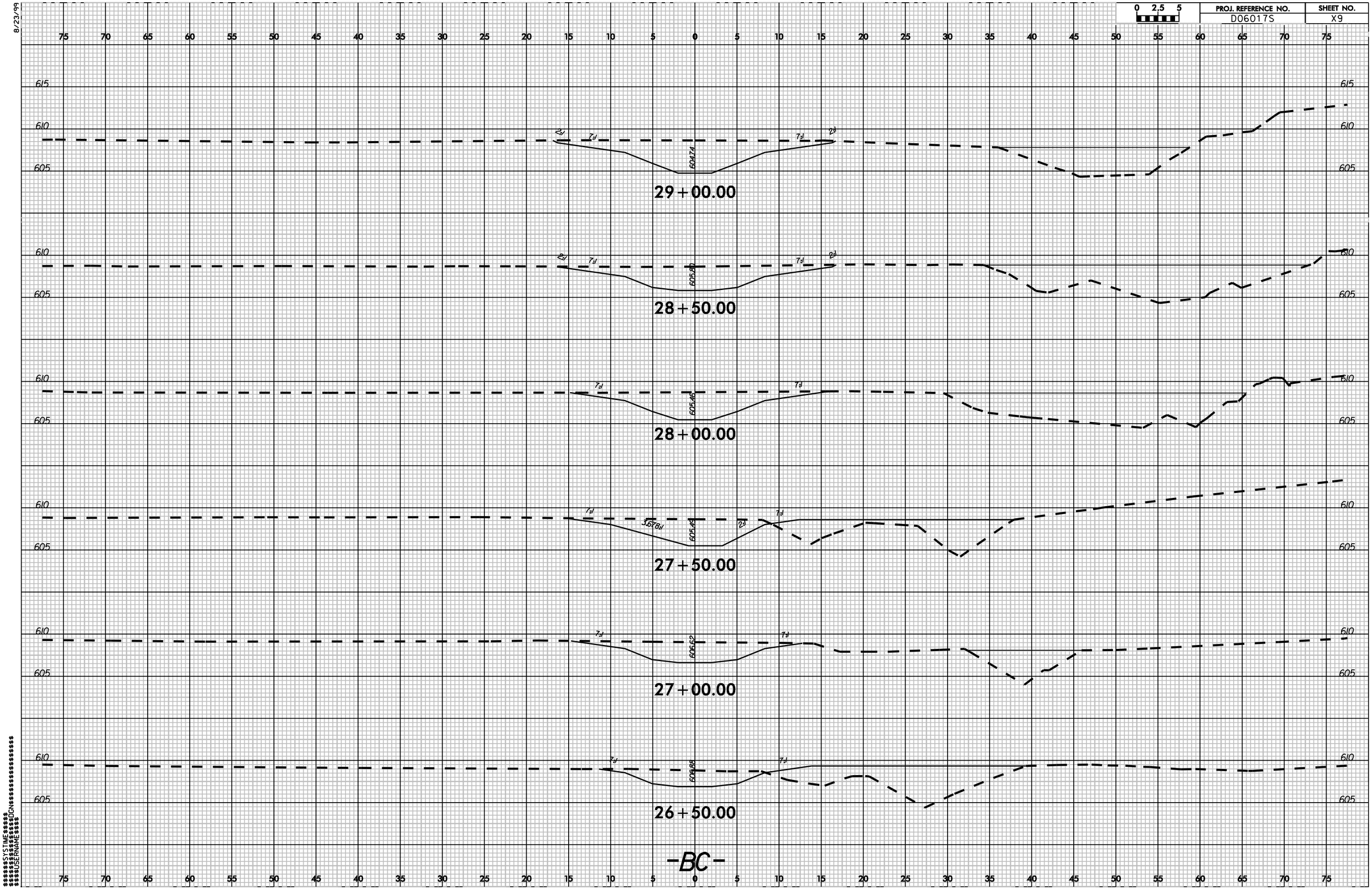

$$$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$



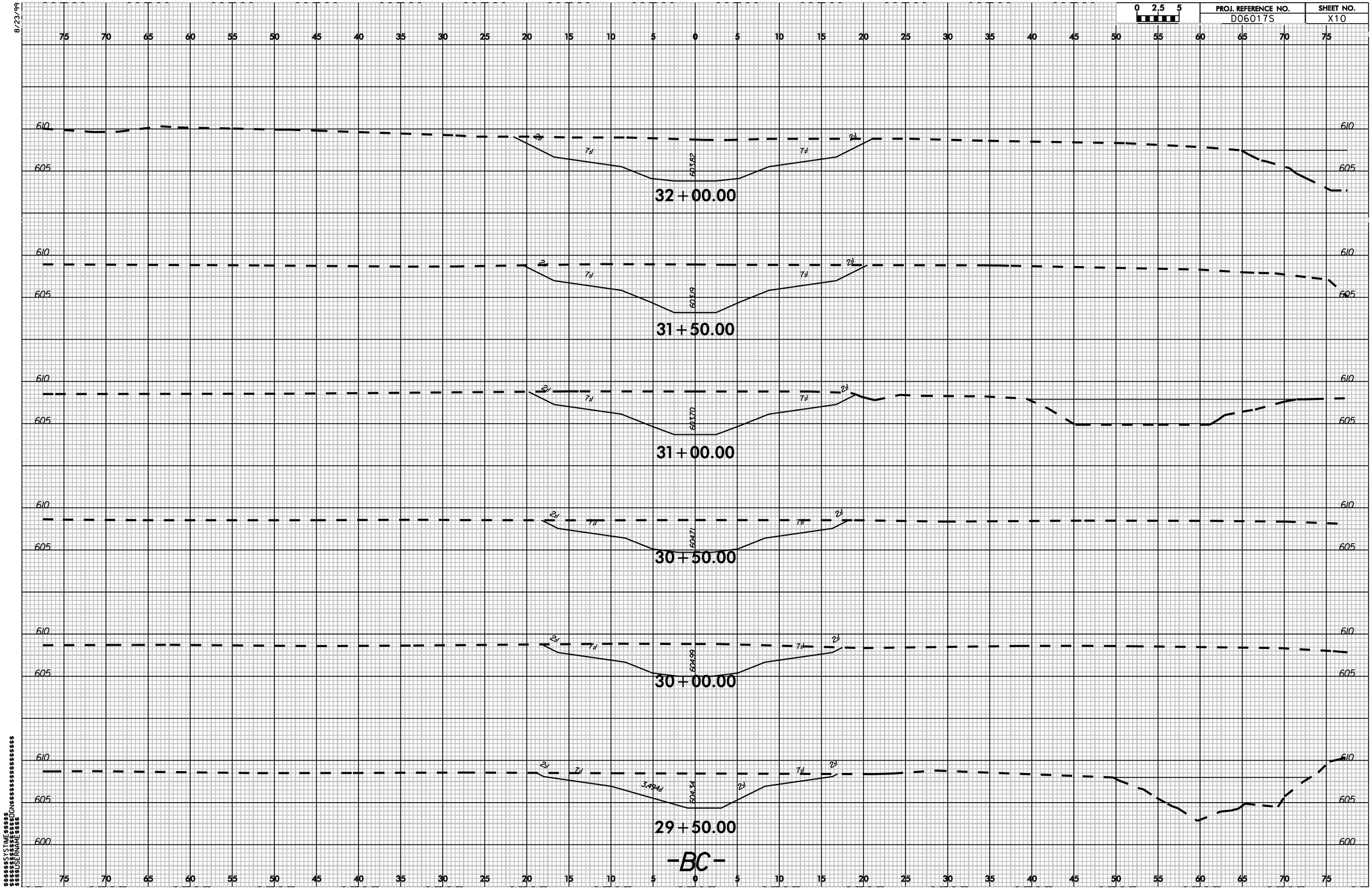
8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X7
23+00.00
22+50.00
22+00.00
21+50.00
21+00.00
20+50.00
RAISED RIFFLE
-BC-



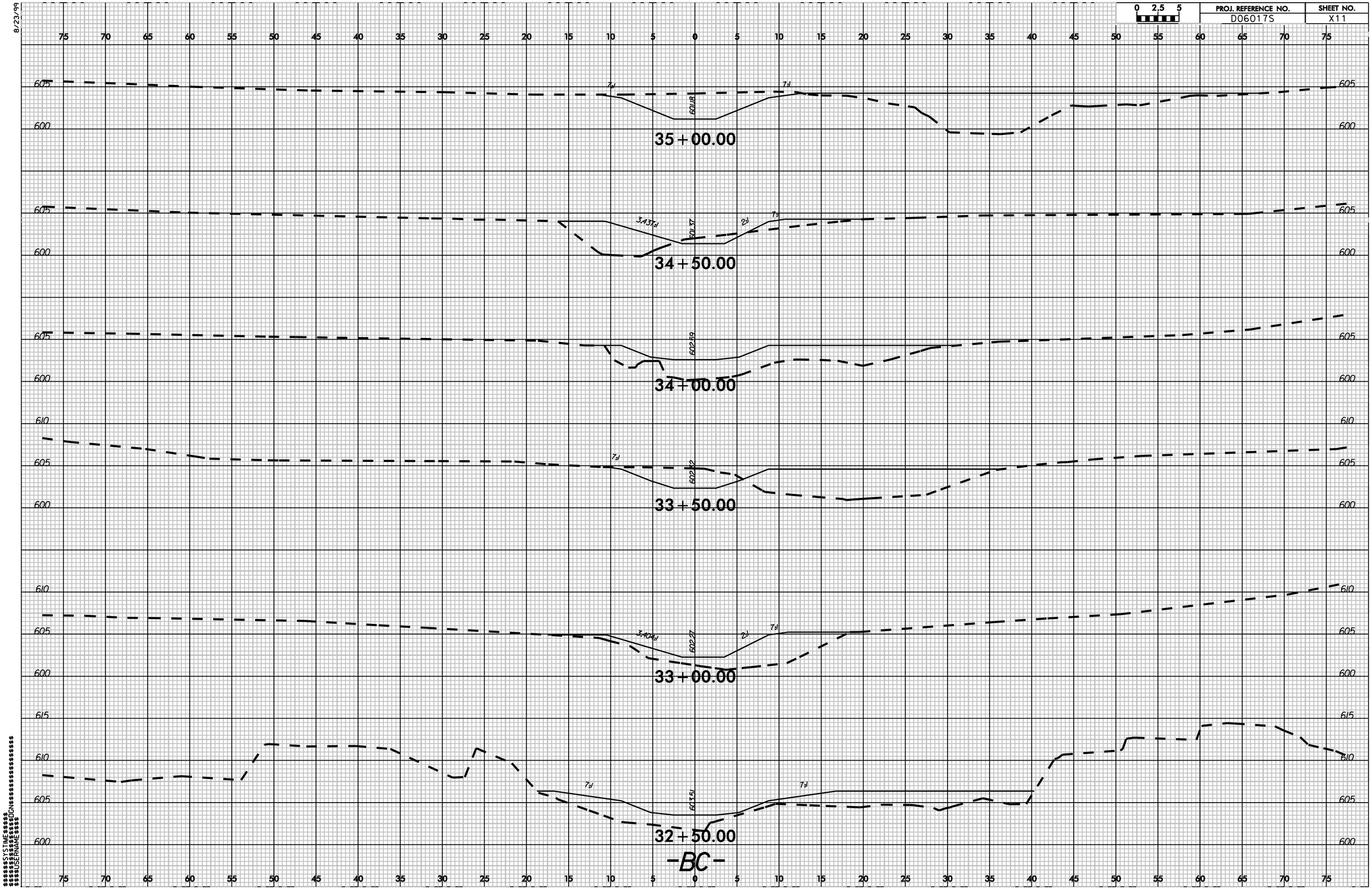
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X8
8/23/99
26+00.00
25+50.00
25+00.00
RAISED RIFFLE
24+50.00
24+00.00
23+50.00
-BC-



8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X9
29+00.00
28+50.00
28+00.00
27+50.00
27+00.00
26+50.00
-BC-



8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X10
32+00.00
603.82
31+50.00
603.19
31+00.00
603.70
30+50.00
604.71
30+00.00
604.99
29+50.00
604.34
3.494:1
-BC-
$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$



8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X11
35+00.00
34+50.00
34+00.00
33+50.00
33+00.00
32+50.00
-BC-

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X12 |

38+00.00

37+50.00

37+00.00

36+50.00

36+00.00

35+50.00

-BC-

$$$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X13 |

41+50.00

41+00.00

40+50.00

40+00.00

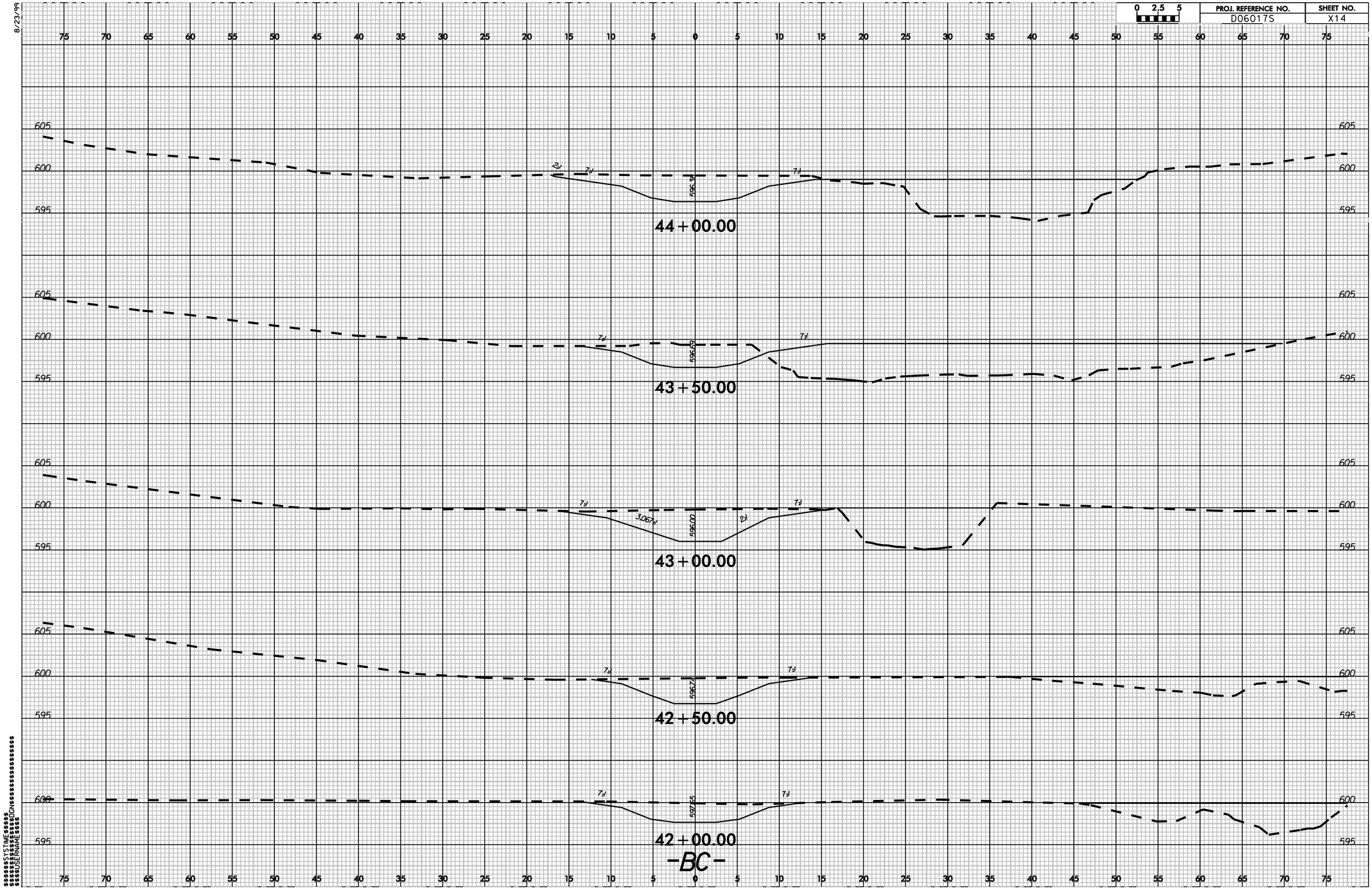
39+50.00

39+00.00

38+50.00

-BC-

$$$$$$$SYSTIME$$$$$$
$$$$$$$



0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X14
8/23/99
44+00.00
43+50.00
43+00.00
42+50.00
42+00.00
-BC-

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X15 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

600 595

7:1 5933' 7:1

47+50.00

600 595

7:1 5943' 7:1

47+00.00

595 590

7:1 2782' 5937' 2:1 7:1

46+50.00

600 595

7:1 5947' 7:1

46+00.00

600 595

7:1 5923' 7:1

45+50.00

600 595

7:1 5947'

45+00.00

600 595 590

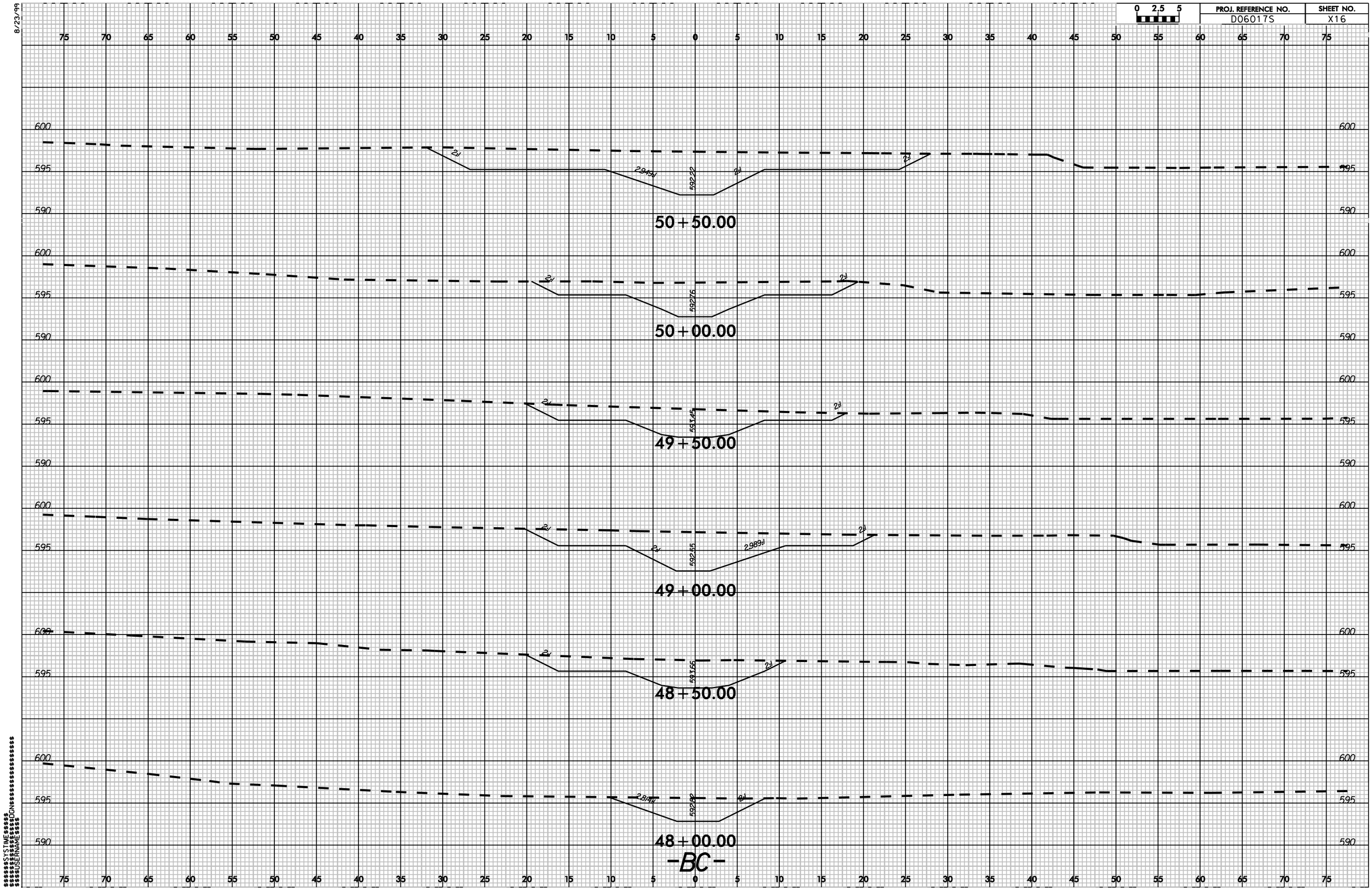
7:1 2:1 5954' 3,158' 7:1

44+50.00

-BC-

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

$$$$$$$SYSTIME$$$$$$
$$$$$$$



0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X16
8/23/99
50+50.00
50+00.00
49+50.00
49+00.00
48+50.00
48+00.00
-BC-

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X17 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

595
590

2:1 2:1 591.31 2.88% 2:1

**54+00.00**

595
590

2:1 592.47 2:1

**53+50.00**

595
590

2:1 591.94 2:1

**53+00.00**

595
590

2:1 592.21 2:1

**52+50.00**

595
590

2:1 592.95 2:1

**52+00.00**

600
595
590

2:1 2:1 592.05 2.97% 2:1

**51+50.00**

600
595
590

2:1 591.75 2:1

**51+00.00**

**-BC-**

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

$$$$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
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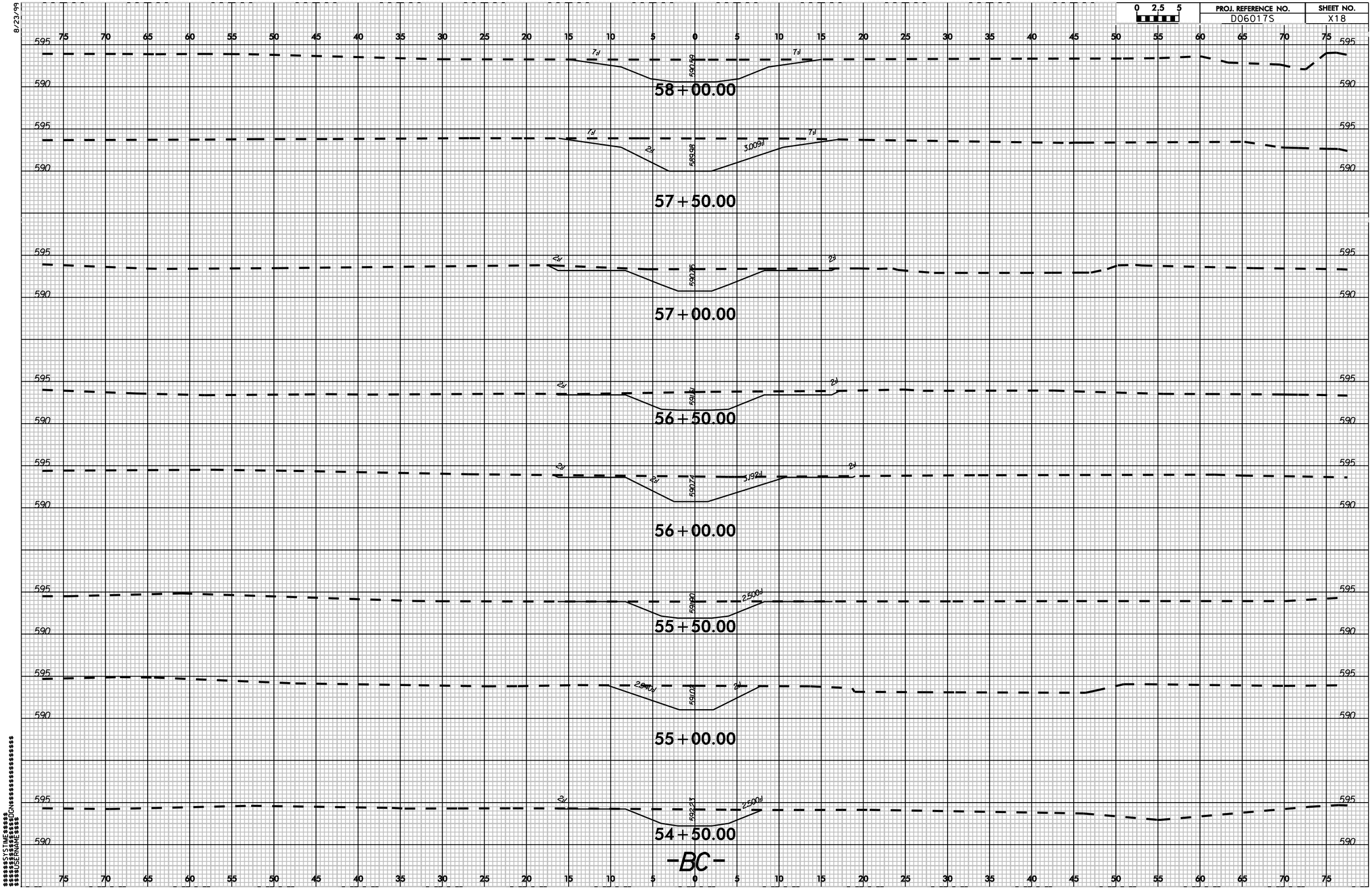

8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X18
58+00.00
57+50.00
57+00.00
56+50.00
56+00.00
55+50.00
55+00.00
54+50.00
-BC-

8/23/99

0 2.5 5

| PROJ. REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | X19 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

595 590 585

587.55

61+00.00

587.08

60+50.00

588.56

60+00.00

588.86

59+50.00

588.57

59+00.00

589.55

58+50.00

-BC-

$$$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X20 |

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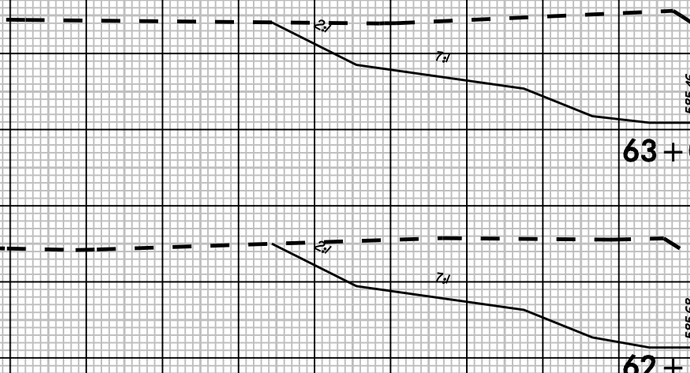
595
590
585



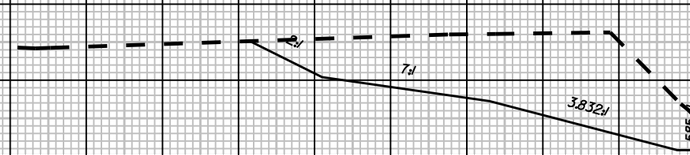

63+00.00

595
590
585



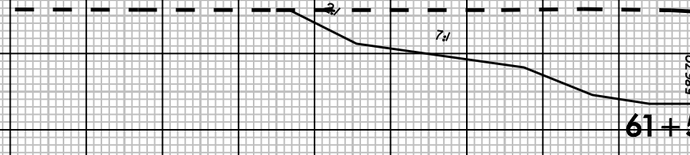

62+50.00

595
590
585




62+00.00

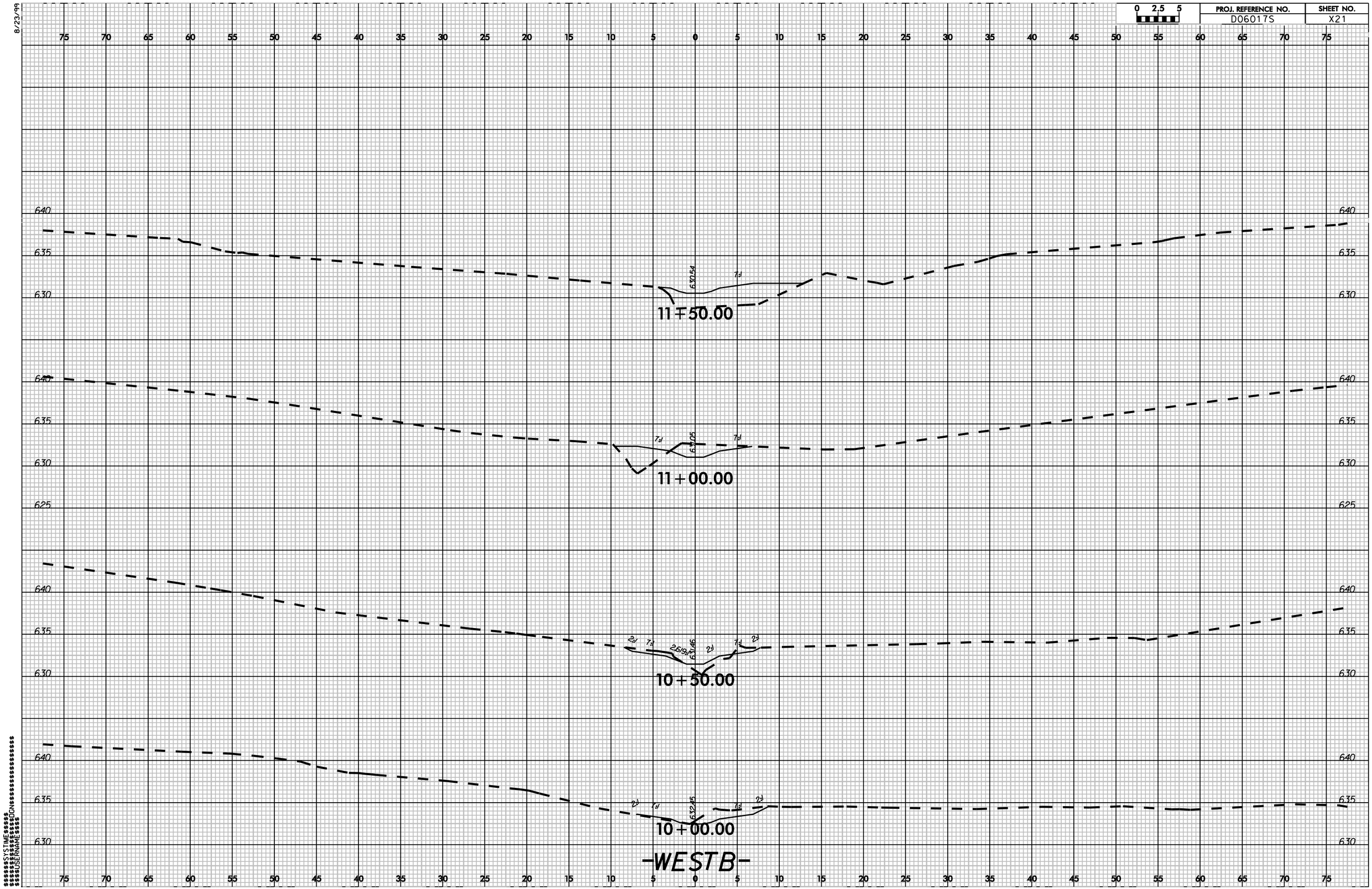
595
590
585




61+50.00

-BC-

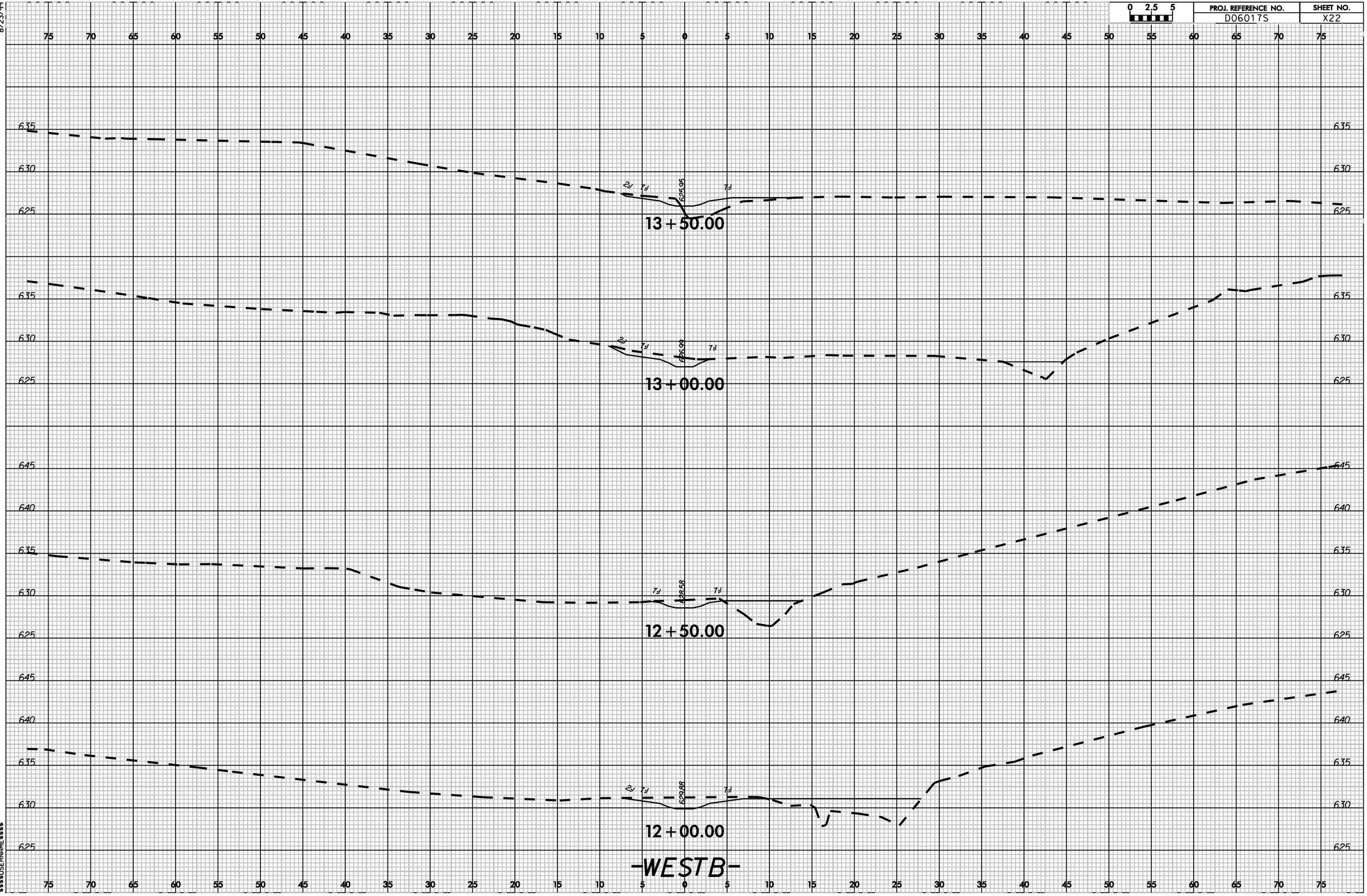
$$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$



8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X21
11+50.00
11+00.00
10+50.00
10+00.00
-WESTB-

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X22 |




$$$$$$$SYSTIMES$$$$$$
$$$$$$$$$$$$$$$$$$$$DGNS$$$$$$$$$$$$$$$$$$
$$$$USERNAMES$$$$

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X23 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

635
630
625
620

7d 6229 7d
15+50.00

635
630
625
620

7d 6227G 7d
15+00.00

630
625
620

2d 7d 2d 6236J 3265d 7d
14+50.00

630
625
620

2d 7d 6246J
14+00.00

-WESTB-

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

$$$$$$$SYSTIME$$$$$$
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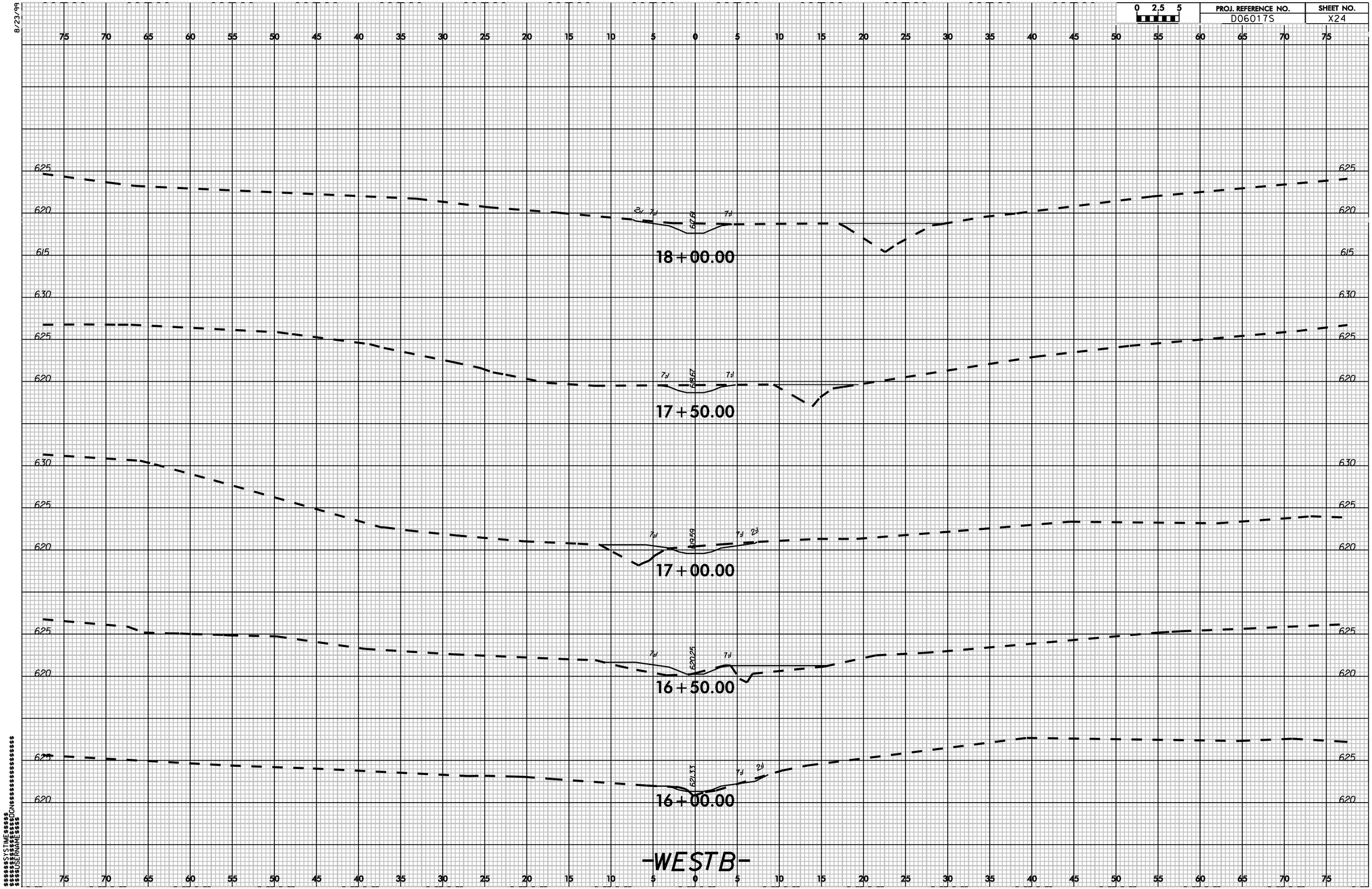

8/23/99
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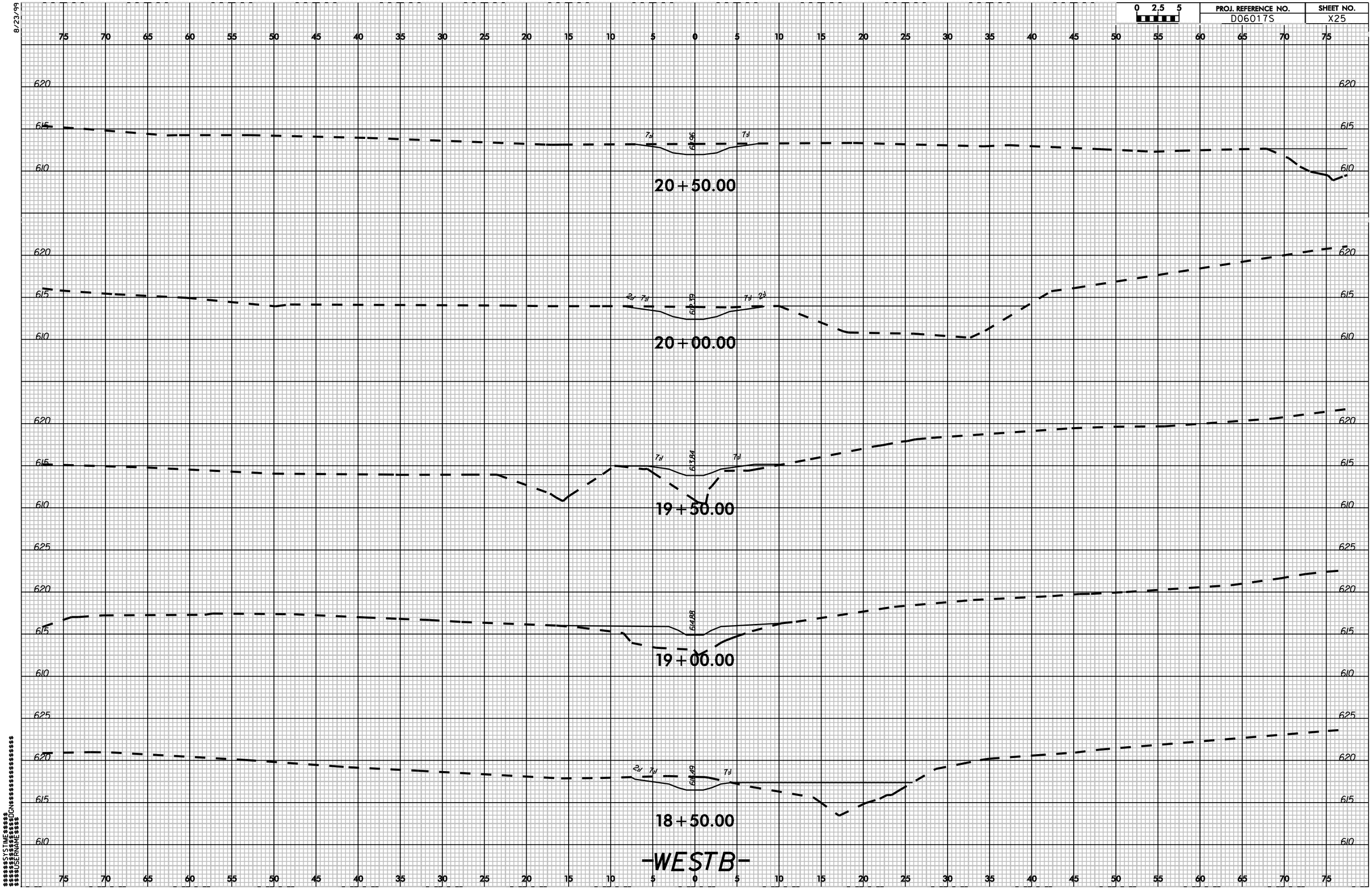
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X24
18+00.00
17+50.00
17+00.00
16+50.00
16+00.00
-WESTB-



8/23/99
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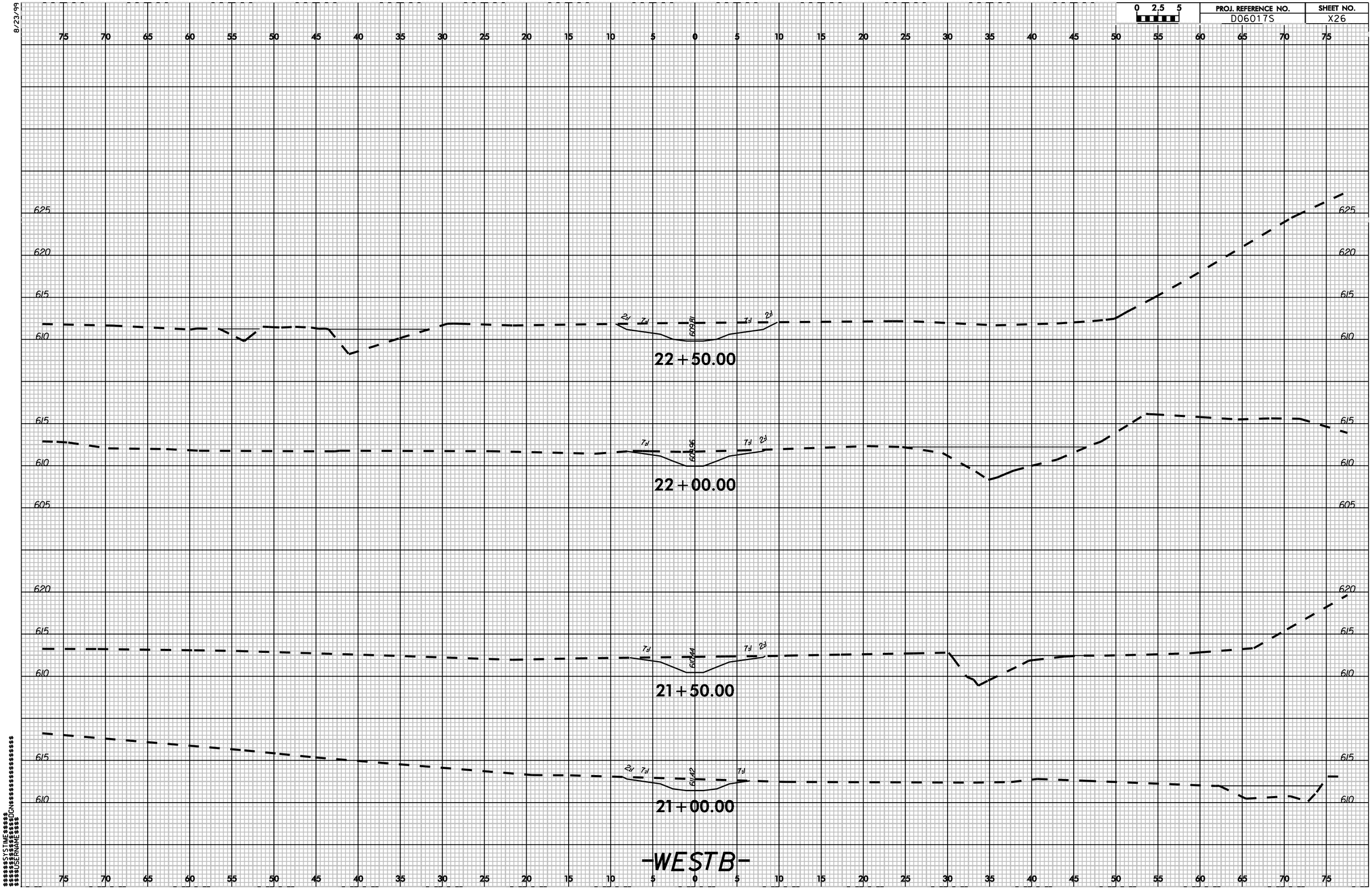
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X25
20+50.00
20+00.00
19+50.00
19+00.00
18+50.00
-WESTB-



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PROJ. REFERENCE NO.
D06017S
SHEET NO.
X26
75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
625
620
615
610
605
2:1
7:1
609.81
22+50.00
609.96
22+00.00
610.44
21+50.00
611.42
21+00.00
-WESTB-
$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$

8/23/99

0 2.5 5

| PROJ. REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | X27 |

24+50.00

24+00.00

23+50.00

23+00.00

-WESTB-

$$$$$$SYSTIMES$$$$$$
$$$$$$$$$$$$$$$$$$$$DGNS$$$$$$$$$$$$$$$$$$$$
$$$$USERNAMES$$$$

8/23/99

0 2.5 5

| PROJ. REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | X28 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

610
605
610
605
610
605
600

606.90
26+00.00

605.86
25+50.00

606.12
25+00.00

-WESTB-

$$$$$$$SYSTIMES$$$$$
$$$$$$$$$$$$$$$$$$DGNS$$$$$$$$$$$$$$$$$$
$$$$USERNAMES$$$$

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

8/23/99

0 2.5 5

| PROJ. REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | X29 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

615
610
620
615
610
620
615

615.31

11+00.00

615.30

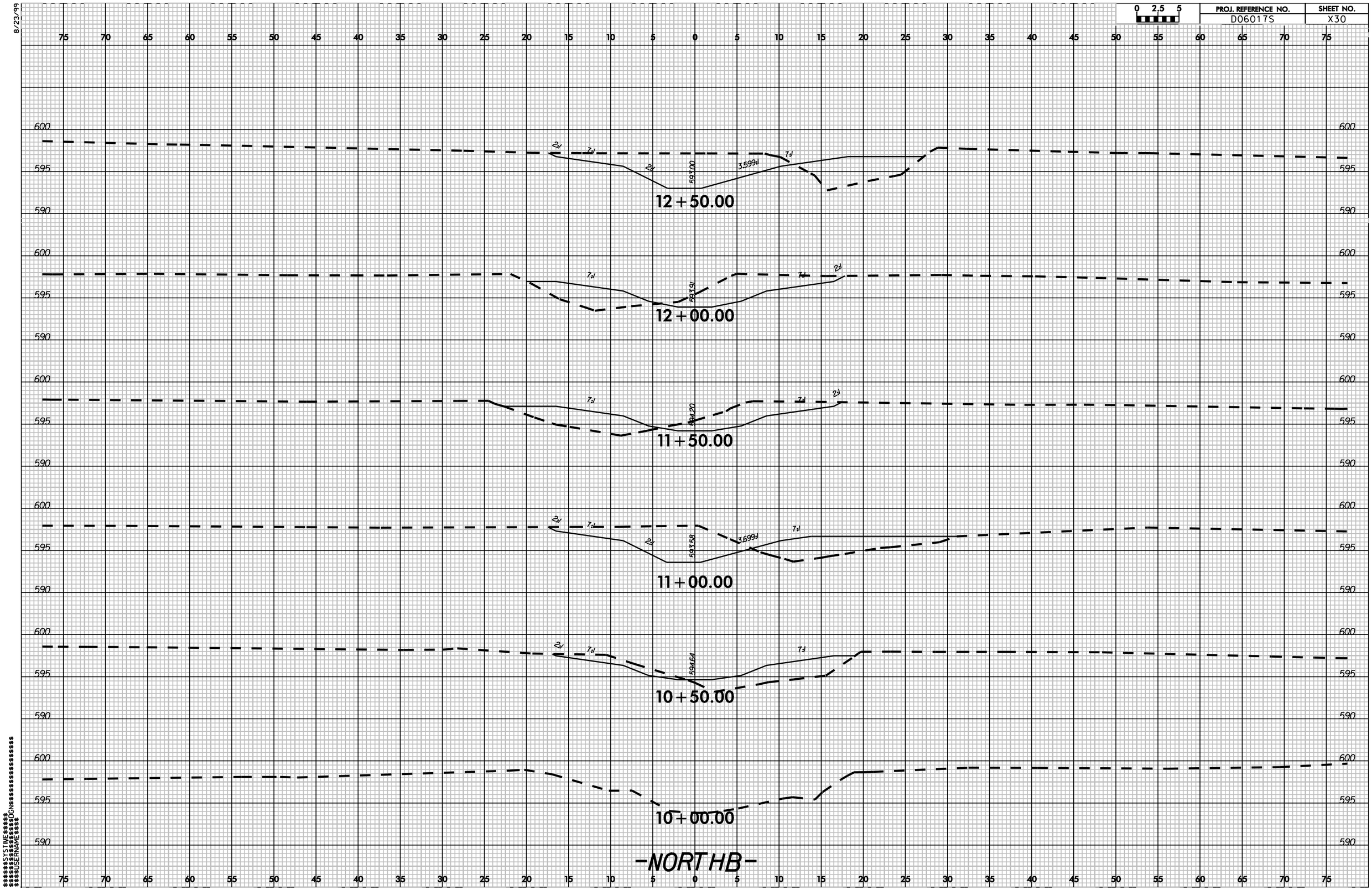
10+50.00

10+00.00

-UTWESTB-

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

$$$$$$$SYSTIME$$$$$$
$$$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$



8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X30
12+50.00
12+00.00
11+50.00
11+00.00
10+50.00
10+00.00
-NORTHB-

8/23/99

0 2.5 5

| PROJ. REFERENCE NO. | SHEET NO. |
|---|---|
| D06017S | X31 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

600 595 590

7F1 7F1 592.85

15+50.00

600 595 590

7F1 7F1 7F1 592.08

15+00.00

600 595 590

7F2 7F1 7F1 592.92

14+50.00

600 595 590

7F1 7F1 591.25

14+00.00

600 595 590

7F1 7F1 7F2 7F2 592.71

13+50.00

600 595 590

7F2 7F1 7F1 593.24

13+00.00

-NORTHB-

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

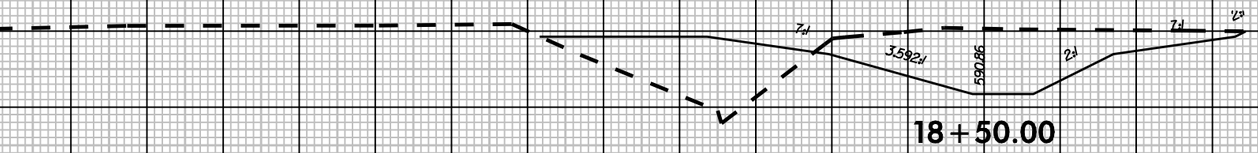
$$$$$$$SYSTIME$$$$$$
$$$$$$$

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X32 |

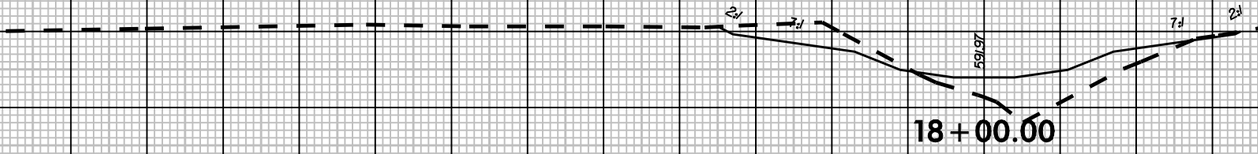
75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

595
590



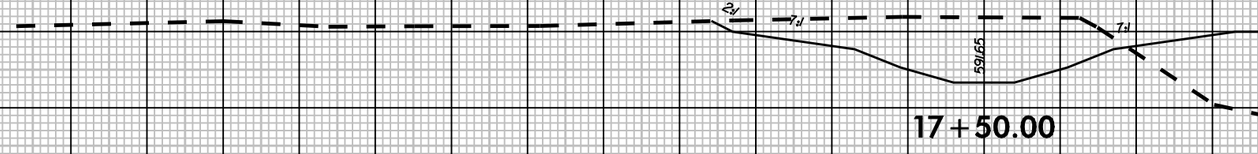

18+50.00

595
590



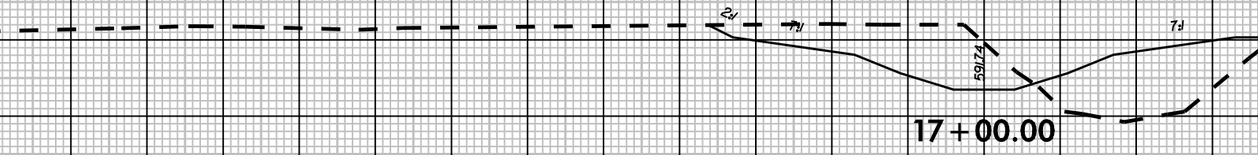

18+00.00

595
590



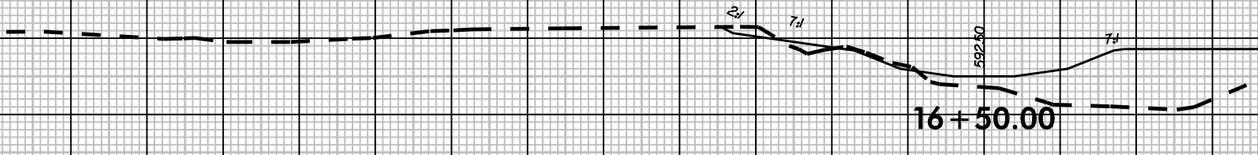

17+50.00

595
590



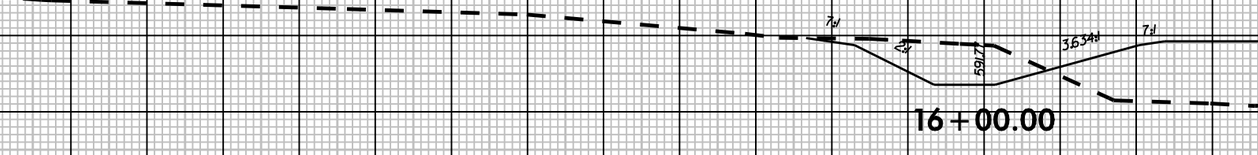

17+00.00

595
590




16+50.00

600
595
590

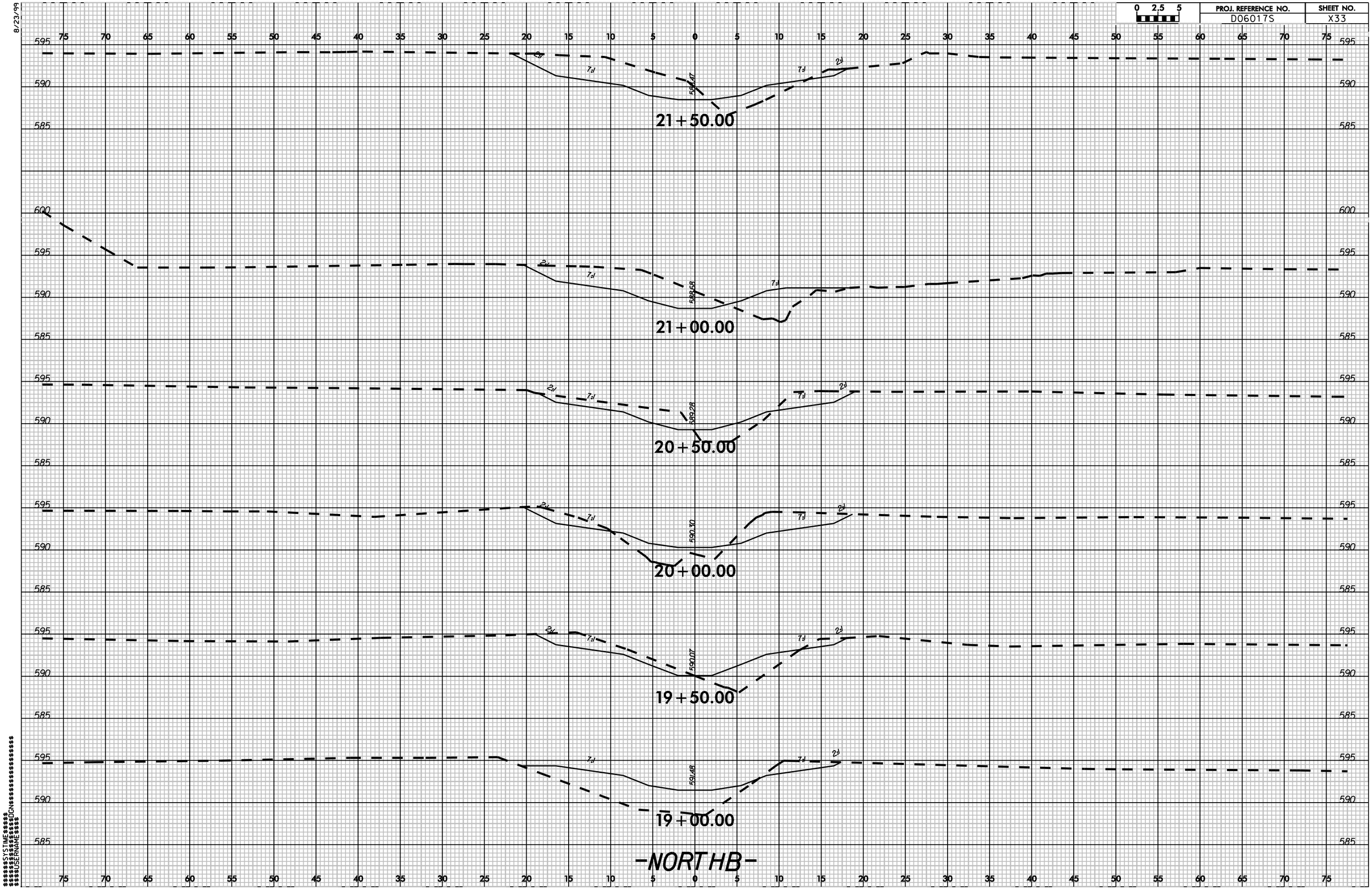



16+00.00

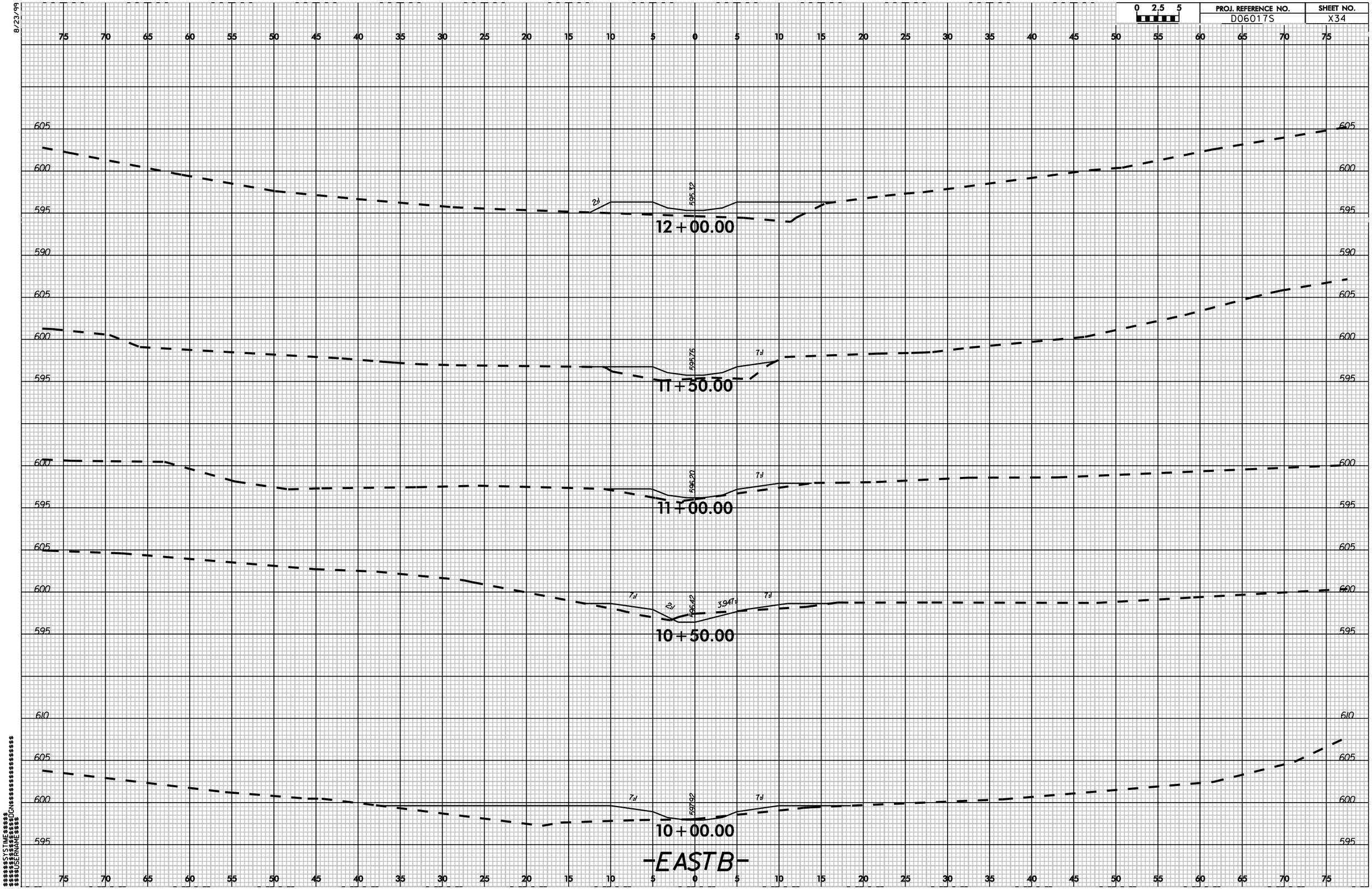
-NORTHB-

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

$$$$$$$$SYSTIME$$$$$
$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$



8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X33
21+50.00
21+00.00
20+50.00
20+00.00
19+50.00
19+00.00
-NORTHB-



8/23/99
0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X34
12+00.00
595.32
11+50.00
595.76
11+00.00
596.20
10+50.00
596.42
10+00.00
597.92
-EAST B-

8/23/99

| 0 2.5 5 | PROJ. REFERENCE NO. | SHEET NO. |
|---|---|---|
| | D06017S | X35 |

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

610
605
600
595
590

593.99

13+50.00

610
605
600
595
590

594.41

13+00.00

610
605
600
595
590

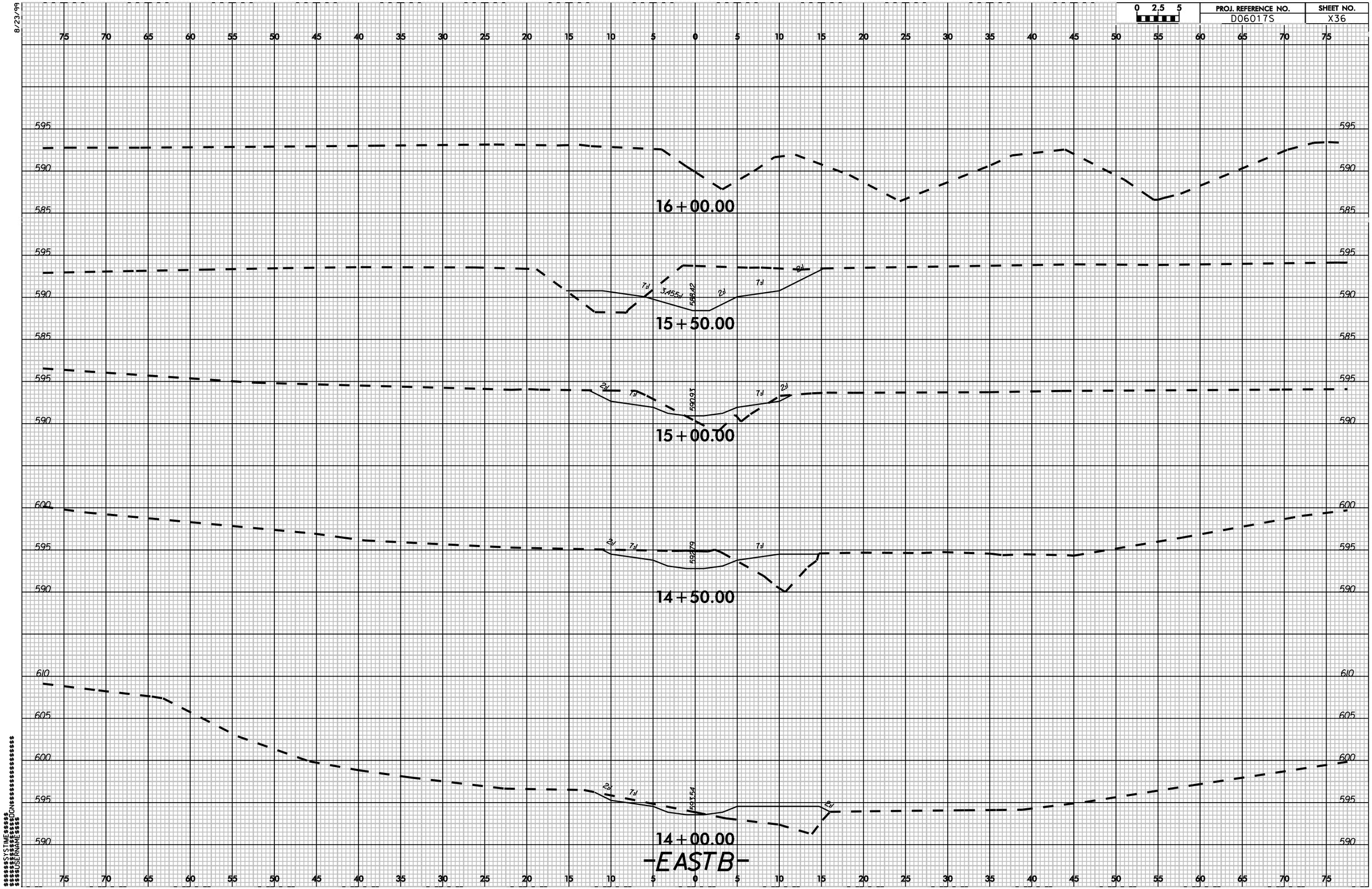
594.87

12+50.00

-EAST B-

75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75

$$$$$$$SYSTIME$$$$$$
$$$$$$$$$$$$$$$$$$$$DGN$$$$$$$$$$$$$$$$$$
$$$$USERNAME$$$$



0 2.5 5
PROJ. REFERENCE NO.
D06017S
SHEET NO.
X36
8/23/99
16+00.00
15+50.00
15+00.00
14+50.00
14+00.00
-EAST B-