TRIBUTARY TO REEDY FORK CREEK STREAM RESTORATION

GUILFORD COUNTY, NORTH CAROLINA

CONTRACT # D06028-A

Prepared For:

Ecosystem Enhancement Program
Department of Environment and Natural Resources
1652 Mail Service Center
Raleigh, NC 27699-1652

ANNUAL MONITORING REPORT (YEAR 1 OF 5)

JANUARY 2009

Owner

NCDENR
Ecosystem Enhancement Program
Department of Environment and Natural Resources
1652 Mail Service Center
Raleigh, NC 27699-1652

EEP Project Manager: Guy Pearce
Phone: (919) 715-1656

Design and Monitoring Firm

Mulkey Engineers and Consultants
6750 Tryon Road
Cary, North Carolina 27518
Phone: (919) 851-1912
Fax: (919) 851-1918

Project Manager: Wendee B. Smith
Phone: (919) 858-1833

Project Engineer: Scott Hunt
Phone: (919) 858-1825

Table of Contents

Figures

Tables

Appendices

1.0 Executive Summary

This annual monitoring report details the first year monitoring activities and their results for the Tributary to Reedy Fork Creek Stream Restoration Site (RFC). All of the monitoring activities were conducted and the subsequent results are reported in accordance with the approved mitigation plan (Mulkey Engineers and Consultants, 2008) for RFC. The content and format of this report were developed in accordance with the contract requirements for the Full Delivery RFP 16-D06028 (NCEEP, 2005). Accordingly, this report includes project background information, project monitoring results, and description of the project monitoring methodology.

Mulkey Engineers & Consultants (Mulkey) submitted RFC for the Full Delivery RFP 16-D06028 to provide 7,000 Stream Mitigation Units (SMUs). Mulkey was awarded the stream restoration contract by the Ecosystem Enhancement Program Department of Environment and Natural Resources (NCEEP) and began work on the project on November 26, 2007. The primary goals of RFC were to improve water quality, to reduce bank erosion, to reestablish a floodplain along each of the stream reaches, and to improve the aquatic and terrestrial wildlife habitat. These goals were met through the following objectives:

- By using natural channel design to restore stable pattern, dimension, and profile for approximately 7,511 linear feet of stream channel
- By establishing a conservation easement, which will protect the streams from cattle intrusion and future development activities
- By establishing a floodplain or reconnecting the stream back to its historic floodplain, or a combination of both, for each project stream reach
- By creating or restoring floodplain features such as vernal pools, off channel ponds, or riparian wetlands
- By increasing the amount of aquatic habitat through the addition of rock and wood structures
- By reestablishing native plant communities throughout the conservation easement, whereby reintroducing shading, cover areas, and travel corridors.

RFC located in Guilford County, North Carolina near the Town of Gibsonville and is situated in the Cape Fear River Basin. Past land use practices, including extensive cattle farming and clearing of the riparian buffers resulted in substantial degradation of the stream systems at RFC. RFC is comprised of seven stream reaches totaling approximately 7,511 feet of restored stream channel. All of the analyses, design, and restoration at RFC were accomplished using natural stream channel design methods. In addition to stream channel restoration, the restored stream banks and the riparian and upland buffer areas along RFC were also replanted with native species vegetation.

The survivability of the planted vegetation at RFC will be monitored at representative vegetation plots as well as project-wide. Stem counts, photo documentation and comparison, and visual assessment will be utilized. Bare root stock were planted at a density of 680 stems per acre (eight foot by eight foot spacing) and live stakes were planted on the stream banks at a density of 1,742 stems per acre (five foot by five foot spacing). A

total of 16 representative vegetation plots were installed at RFC based on the recommendations set forth by NCEEP regarding the acreage contained in the conservation easement. The survivability of the planted woody vegetation at RFC will be monitored using annual stem counts at each of the plots. In addition to the stem counts, annual photos will be taken at each of the plots and also from eight other permanent photo reference points. The vegetation plot photos will be used for photo documentation and comparison of the vegetation growth at each plot. The photo documentation at the reference points will be employed to assist in a project-wide visual assessment of the vegetation at RFC. Survivability will be based on achieving a minimum of 320 stems per acre, the rate required to be present during the third year of monitoring, across the project site. The stem counts will be conducted during the latter part of the growing season months (August, September, and October) to insure survival throughout a complete growing season while still allowing for relative ease in identification.

In late September 2008, the vegetation monitoring for Monitoring Year 1 was conducted using the methodologies described above, including stem counts, photo documentation, and visual assessment. The stem counts for the 16 vegetation plots ranged from 121 to 972 stems per acre, with an average survivability of 478 stems per acre. These results indicate that the survivability of the planted woody vegetation at RFC may not meet the success criteria of achieving at least 320 stems per acre after three years and 260 stems per acre after five years at RFC. Based on the results of the stem counts, supplemental plantings of bare root seedlings will be conducted by Mulkey during the 2008 – 2009 planting season to ameliorate any deficiencies. The comparisons of the baseline and Monitoring Year 1 photos at both the 16 vegetation plot photo reference points and the eight permanent photo reference points did not reveal any concerns, problems, or negative trends. No vegetation problem areas were observed or documented during the project-wide visual assessment. Beyond the described supplemental plantings, Mulkey does not propose any additional recommendations or actions other than to proceed with the annual vegetation monitoring.

Stream dimension, pattern, profile, stream bed material, bank stability, and bankfull hydrology will be monitored to evaluate the success of stream restoration at RFC. The limits of the project stream reaches to be monitored at RFC were determined using the sampling rates outlined by the USACE *et al.* (2003). The monitoring will be conducted using annual field surveys, pebble counts, crest gage recordation, visual assessment and photo documentation. Baseline conditions for comparison of the stream parameters to be monitored were established from data gathered immediately after construction through the as-built survey process. Longitudinal profiles and Modified Wolman pebble counts were conducted for all reaches and a total of seven permanent cross sections were surveyed and photo documented across RFC. A total of three crest gages across RFC were installed for hydrologic monitoring to verify the occurrence of bankfull storm events. Annual photo documentation will used for stream monitoring to complement and validate the other stream monitoring practices from eight permanent reference photo points. Annual project wide visual assessment will be conducted using field observation and pedestrian surveys to identify any specific problem areas. Since it is only required during Monitoring Year 3 and Monitoring Year 5, the BEHI information will only be collected during those years. Stream restoration success at RFC will be evaluated by comparison of the annual monitoring results

against those same parameters as predicted, specified, and required in the proposed design and as implemented during the construction process represented by the as-built or baseline conditions. Success is achieved when all such comparisons reveal positive trends toward overall stream stability. In late September 2008, the stream monitoring for Monitoring Year 1 was conducted using the methodologies described above. The results of the stream dimension, pattern, and profile monitoring demonstrated that all of the reaches were experiencing the expected minor adjustments indicative of movement toward increased stream stability and are attributed to vegetation establishment and natural channel adjustments. Fluctuations in bed materials were expected to occur during the early years following construction. Fining of the bed materials was documented by the stream bed material monitoring. Mulkey believes that this fluctuation is attributed to the deposition of finer bed materials (sands and silts) mobilized during construction and during subsequent storm events. At this time, Mulkey still believes that the stream bed materials will coarsen as stream bank stability increases. The monitoring results suggest that on-site sediment supply from RFC is being greatly reduced as a result of the restoration. Fluctuations in bed materials will likely continue to occur and several years may be needed to observe a consistent bed material. Two of the three crest gages recorded flood stages in excess of the bankfull stage. The evidence recorded by the crest gages indicates that a storm event producing a stage in excess of the bankfull storm occurred at RFC during Monitoring Year 1. This documented the first of two required bankfull events over the five year monitoring period in order to achieve success with regards to hydrologic monitoring at RFC. No stream problems were documented through the photo documentation comparison process or through the conduction of the project-wide visual assessment along each of the project stream reaches. RFC experienced no stream problem areas and was deemed a success for Year 1 Monitoring.

Therefore, based on the positive results of both the vegetative and the stream monitoring for Monitoring Year 1 at RFC, Mulkey does not propose any additional recommendations or actions other than to conduct the proposed supplemental plantings and to proceed with the annual stream monitoring.

2.0 Project Background

2.1 Project Location and Setting

RFC located in Guilford County, North Carolina approximately five miles north of the Town of Gibsonville, approximately one half mile east of the intersection of NC Highway 61 and Sockwell Road (SR 2735) and immediately south of SR 2735 (Figure 1). RFC is situated in the Cape Fear River Basin 8-digit cataloging unit 03030002 and the 14-digit cataloging unit 03030002020070. Mulkey proposed to provide 7,000 Stream Mitigation Units (SMUs) with RFC under the Full Delivery RFP 16-D06028 issued by NCEEP. Mulkey acquired and installed permanent fencing along an easement covering 19.64 acres, which encompasses the streams and associated buffers at RFC.

2.2 Project Goals and Objectives

The primary goals of RFC were to improve water quality, to reduce bank erosion, to reestablish a floodplain along each of the stream reaches, and to improve the aquatic and terrestrial wildlife habitat.

These goals will be met through the following objectives:

- By using natural channel design to restore stable pattern, dimension, and profile for approximately 7,511 linear feet of stream channel
- By establishing a conservation easement, which will protect the streams from cattle intrusion and future development activities
- By establishing a floodplain or reconnecting the stream back to its historic floodplain, or a combination of both, for each project stream reach
- By creating or restoring floodplain features such as vernal pools, off channel ponds, or riparian wetlands
- By increasing the amount of aquatic habitat through the addition of rock and wood structures
- By reestablishing native plant communities throughout the conservation easement, whereby reintroducing shading, cover areas, and travel corridors.

2.3 Project Restoration Approach and Mitigation Type

RFC is comprised of three main reaches (R2-1, R2-2, R2-3) and four tributaries (R1, R2-4A, R2-4b, and R2-4c). Prior to construction, these seven reaches were identified and proposed for restoration due to their distinct stream characteristics and drainage areas. These seven existing reaches totaled approximately 7,093 linear feet. A total of approximately 7,511 linear feet of stream channel was restored at RFC within the 19.64 acre conservation easement.

Analyses, design, and restoration of the stream channels at RFC was accomplished using Natural Stream Channel design methods developed by Rosgen (Rosgen, D. L., 1994, 1996, 1998). The proposed Rosgen channel type for each the stream reaches was a C4 channel. A combination of Priority Level I and II methods were used to construct these reaches.

The most significant stream restoration component at RFC involved reconstruction of each of the stream reaches such that stream flows greater than bankfull are allowed to access the restored stream's floodplain. Two different approaches were used to insure such floodplain access. The first approach involved relocating and raising the stream bed such that the historic floodplain is accessed by stream flows greater than bankfull (the sections of the project stream reaches that were restored using Priority Level I methodologies). A second approach was used where site constraints prevented such relocation and raising of the stream bed. The second approach involved building a floodplain at a level lower than the historic floodplain through the construction of bankfull benches (the sections of the project stream reaches that were restored using Priority Level II methodologies). In-stream structures were installed along each of the stream reached to provide grade control and stream bank

protection, and to increase in-stream habitat diversity. The in-stream structures that were installed included rock cross vanes, j-hook rock vanes, rock vanes, constructed riffles, and root wads. Stream banks were further stabilized through the installation of coir fiber erosion control matting, temporary and permanent seeding, and the installation of native species vegetation in the form of transplants, live stakes, and bare root seedlings. All areas of the site that were disturbed during construction activities were stabilized using temporary and permanent seeding. The riparian and upland buffer communities along RFC were also restored with native species vegetation using a target community which will emulate the Piedmont/Low Mountain Alluvial Forest described by Shafale and Weakley (1990). The conservation easement was fenced to permanently protect the restored stream and buffer areas. Information regarding the restoration approach and mitigation type for each of the seven project stream reaches is detailed in Table 1.

2.4 Project History

The existing conditions at RFC prior to restoration were a result of cattle use for the past 50 years. When Mulkey initially became involved with this project, there were approximately 150 dairy cattle utilizing the pastures and directly accessing the stream channels. This continual livestock access to the streams resulted in substantial erosion along the stream banks, incision of the channels, channel widening in some areas, and heavy siltation throughout RFC, as well as reduced water quality due to large quantities of fecal matter into the stream system. As a result of these land and water quality issues, Mulkey Engineers & Consultants (Mulkey) submitted RFC for the Full Delivery RFP 16-D06028 to provide 7,000 Stream Mitigation Units (SMUs). Mulkey was awarded the stream restoration contract by the NCEEP and began work on the project on November 26, 2007. The project activity and reporting history are detailed in Table II. Table III lists the contacts for the designer, contractor, relevant suppliers, and monitoring firm for RFC. Table IV provides a complete listing of project background information.

2.5 Project Monitoring Plan View

Mulkey conducted monitoring baseline surveys along the entire length of each of the restored project stream reaches using total station survey equipment. These surveys were conducted to establish and document baseline conditions for the newly restored stream channels for future monitoring activities. As-built drawings were developed using the results of the monitoring baseline surveys. These drawing depicted the post construction condition of RFC and are included in Appendix A. The as-built drawings consisted of plan sheets that include the following:

- Title sheet
- Legend sheet
- As-built planimetric drawings and profiles developed from the baseline monitoring field surveys

The as-built drawings illustrate the location of all major project elements, including, but not limited to the:

- Restored stream channel thalweg, normal edges of water, constructed bankfull channel limits, and the constructed cut slope limits
- Conservation easement boundaries
- Permanent fencing limits
- Topography
- In-stream structures
- Photo points
- Crest gages
- Vegetation plots locations
- Permanent cross sections
- Project survey control
- Monitoring profile survey limits
- Relevant structures and utilities

3.0 Project Condition and Monitoring Results

3.1 Project Vegetation Monitoring

3.1.1 Vegetation Monitoring Methodology

The survivability of the planted vegetation at RFC, including both woody and herbaceous species, will be monitored at representative vegetation plots as well as project-wide. Monitoring at representative vegetation plots will focus primarily on planted woody vegetation and will be conducted using stem counts and photo documentation. Project-wide monitoring of planted vegetation will include both woody and herbaceous species and will be accomplished using visual assessment as well as photo documentation.

Major grading and channel construction was completed in mid-April 2008. Throughout construction, appropriate temporary and permanent seeding was conducted to stabilize areas disturbed during construction. Appropriate existing native species vegetation was also salvaged, where feasible, in the form of transplants and live stakes, throughout the construction process. Immediately following the completion of the major grading and channel construction activities, all remaining plant material was installed during the months of March and April 2008, with all such planting being completed by mid-April 2008. These remaining plant materials consisted of native species bare root seedlings and live stakes and were installed, as appropriate, to restore the riparian and upland buffer communities along RFC within the conservation easement area. A complete listing of the planting zones, their corresponding acreages, and the corresponding vegetation species was included in the approved mitigation report (Mulkey Engineers and Consultants, 2008). The bare root stock were planted at a density of 680 stems per acre (eight foot by eight foot spacing) and the lives stakes were planted on the stream banks at a density of 1,742 stems per acre (five foot by five foot spacing).

As-Built Surveys were initiated immediately following the installation of plant materials. In the period between March and May 2008, during the as-built surveys and after the

completion of planting, a total of 16 representative vegetation plots (vegetation plots one through 16) were installed randomly across RFC. An iron pipe was installed at each plot corner for monumentation and a polyvinyl chloride (PVC) pipe, along with a label specifying the plot number, was also installed at one of the corners of each plot. The plot corners were strategically located such that each plot has a total area of approximately 100 square meters. Between April and May 2008, after the establishment of the plots, the species of each planted stem in each plot was identified. Each of these stems was then tallied, by species, and marked with loosely tied survey flagging (on lateral branches) to facilitate future identification. The survivability of the planted woody vegetation at RFC will be monitored using annual stem counts at each of the plots. During the annual stem counts, the planted stems will re-flagged as required to insure that all planted stems were accounted for and considered in the survivability calculations. In addition to the stem counts, photos will be taken at each of the plots. Where necessary, the corner of each plot will be remarked with the PVC pipe and the plot number relabeled. This PVC plot corner will be used as the reference point from which the annual vegetation plot photos were taken from the same orientation for each plot. The photos will be compared to the photos from the previous year to validate and document vegetation success. In addition to the photo reference points established at each of the vegetation plots, a total of eight additional permanent photo reference points were installed across RFC. These photo reference points were monumented using steel rebar and PVC pipe and will be used for additional photo documentation of vegetation growth across RFC. Photos will be taken from each of the eight permanent photo reference points with the same orientation each year and used for photo documentation and annual comparison of the vegetation growth across RFC. This exercise will help to further validate and document vegetation success at RFC. Between April and May 2008, after installation of the described eight photo reference points, photos were taken from each of the photo reference points to document the baseline conditions at RFC with regards to planted vegetation. Project-wide visual assessment will also be used for vegetation monitoring at RFC. A visual assessment will be conducted using annual field observation and pedestrian surveys to identify any specific vegetation problem areas at RFC during the monitoring period. Any problem areas where vegetation is lacking or exotic vegetation is present, will be identified and categorized as bare bank, bare bench, bare floodplain, or invasive population. Such areas will be documented using representative photos and their locations will be mapped.

3.1.2 Vegetation Monitoring Success Criteria

Vegetation success at RFC will be measured by stem survivability. Survivability will be based on achieving at least 320 stems per acre, the rate required to be present during Year 3 Monitoring. The stem counts will be conducted during the latter part of the growing season months (August, September, and October) to insure survival throughout a complete growing season while still allowing for relative ease in identification. As described above, photo documentation and visual assessment will be used to complement the stem counts as part of the vegetation monitoring protocol at RFC. If during any given year, the planted species are not anticipated to meet final criteria established for vegetation, supplemental plantings will be considered. In the event that this occurs, a remedial planting plan will be developed that achieves the survivability goals established for Years 3 and 5.

3.1.3 Vegetative Monitoring Results for Year 1 of 5

In late September 2008, the vegetation monitoring for Monitoring Year 1 was conducted. The methodologies described in the Vegetation Monitoring Methodology Section above were used for the vegetation monitoring at RFC for Monitoring Year 1. Stem counts were conducted at each of the 16 vegetation plots. Table V presents the results of these stem counts for each of the plots. This table includes and compares the results of the initial stem counts from the original planting and the results of the Monitoring Year 1 stem counts. Photos were taken from the photo reference points at each of the 16 vegetation plots. Appendix B compares these photos with the initial baseline photos taken from the photo reference points at each of the 16 vegetation plots. Photos were also taken from each of the eight permanent photo reference points. Appendix C compares these photos with the initial baseline photos taken from the original eight permanent photo reference points. A project-wide visual assessment was also conducted to identify any specific vegetation problem areas. Table VI summarizes the results of the project-wide vegetation visual assessment.

The results of the Monitoring Year 1 stem counts show that the counts for the 16 vegetation plots ranged from 121 to 972 stems per acre, with an average survivability of 478 stems per acre. These results indicate that the survivability of the planted woody vegetation at RFC may not meet the success criteria of achieving at least 320 stems per acre after three years and 260 stems per acre after five years at RFC. Based on the results of the stem counts, supplemental plantings of bare root seedlings will be conducted by Mulkey during the 2008 – 2009 planting season to ameliorate any deficiencies. The comparisons of the baseline and Monitoring Year 1 photos at both the 16 vegetation plot photo reference points and the eight permanent photo reference points did not reveal any concerns, problems, or negative trends. No vegetation problem areas were observed or documented during the project-wide visual assessment. No significant volunteer woody species were observed at any of the 16 vegetation plots. Beyond these supplemental plantings, Mulkey does not propose any additional recommendations or actions other than to proceed with the annual vegetation monitoring.

3.2 Project Stream Monitoring

3.2.1 Stream Monitoring Methodology

Stream dimension, pattern, profile, stream bed material, bank stability, and bankfull hydrology will be monitored to evaluate the success of the stream restoration activities at RFC. The monitoring of stream dimension, pattern, and profile, or morphometric monitoring, along with the monitoring of stream bed material, will be conducted using annual field surveys along with visual assessment. The morphometric, stream bed material, and stream bank stability monitoring will be conducted along representative sections of the project stream reaches. Hydrologic monitoring will consist of field measurements of bankfull events using crest gages. Project-wide stream monitoring will be accomplished using visual assessment as well as photo documentation.

Major grading and channel construction were completed in mid-April 2008. Immediately following the completion of the major grading and channel construction activities, all remaining plant material was installed during the months of March and April 2008. The as-built surveys of all of the stream reaches at RFC were initiated immediately following the installation of plant materials and were conducted utilizing total station surveys while following the protocols set forth by the 2003 USACE Stream Mitigation guidelines (USACE *et al.*, 2003). In addition to documenting the construction of RFC for comparison to the proposed design, the results of the as-built surveys were also used to establish baseline morphology for the proposed monitoring. This information is presented in Table VII. A summary of the restored stream channel lengths is outlined in Table I. A complete set of As-Built Drawings including a monitoring plan view and longitudinal profile for the as-built conditions of the restored channels can be found in Appendix A. After the completion of the as-built surveys, the limits and corresponding lengths of the project stream reaches to be monitored at RFC were determined using the sampling rates outlined by the USACE *et al.* (2003). A total of 3,060 linear feet of all restored stream channels will be surveyed annually during the monitoring period. This amount satisfies the 3,000 linear feet required minimum. Based on these the sampling rates, the limits of the project stream reaches to be surveyed annually for monitoring are as follows:

Reach R1 – 600 Linear Feet Total (Stations 0+00-R1- through 6+00-R1-)
Reach R2-2 – 453 Linear Feet Total (Stations 18+43-R2- through 22+96-R2-)
Reach R2-3 – 1,633 Linear Feet Total (Stations 2+10-R2- through 18+43-R2-)
Reach R2-4a – 174 Linear Feet Total (Stations 0+36-R2- through 2+10-R2-)
Reach R2-4b – 100 Linear Feet Total (Stations 0+31-R2-4b- through 1+31-R2-4b-)
Reach R2-4c – 100 Linear Feet Total (Stations 0+00-R2-4c- through 1+00-R2-4c-)

The upstream and downstream limits of these reaches were monumented in the field using steel rebar/PVC pin. Each pin was also labeled with an aluminum tag identifying the respective reach and the correct descriptor ("begin" or "end").

A total of seven permanent cross sections, consisting of both riffles and pools, were established across RFC and surveyed during the as-built surveys. The number of cross sections was determined using the sampling rates outlined by the USACE *et al.* (2003). The left and right ends of each cross section were monumented with a steel rebar pin and PVC pipe. An aluminum tag identifying the cross section number was also installed at the pin on the left side of the channel. In addition to the cross section surveys, photos were taken at each of the seven cross sections, looking across the stream from left to right, to document the baseline conditions at each respective cross section. Specific stations along each permanent cross section were established during the as-built surveys to promote replication and consistency during the subsequent annual cross section surveys. The stationing for each cross section was established to always begin on the left side of the channel, facing downstream, at the left rebar/PVC pin, and to continue across the stream channel to the rebar/PVC pin on the right side. The as-built surveys of the seven cross sections established the baseline conditions with regards to stream dimension. All of the seven cross sections will be surveyed each year during the five-year monitoring period and the resulting parameters will be compared annually. The parameters to be monitored include bankfull

width, floodprone width, bankfull cross sectional area, bankfull mean depth, bankfull max depth, width to depth ratio, entrenchment ratio, wetted perimeter, and hydraulic radius. Photos will be taken annually at each of the seven cross sections, with the same orientation, looking across the stream from left to right and will be compared annually to the photos from the previous year to document stream condition at each respective cross section.

The pattern for all of the stream reaches was surveyed and baseline conditions were established as part of the as-built surveys. Monitoring surveys for stream pattern will be limited to the project stream reaches specified above for annual monitoring surveys. The stream pattern parameters resulting form the annual monitoring surveys will include sinuosity, belt width, radii of curvature, meander wavelength, and meander width ratio. These parameters will be compared annually.

The as-built surveys included longitudinal profile survey along the entire length of all restored stream reaches. Longitudinal profiles were surveyed by identifying each stream feature (riffle, run, pool, or glide) and surveying specific points at each feature. These specific locations included top of bank, bankfull, water's edge or surface, and thalweg). The as-built surveys were used to establish the baseline conditions with regards to longitudinal profile. The longitudinal profiles surveys conducted each year will be limited to the project stream reaches specified above for annual monitoring surveys. The parameters resulting from the yearly surveys of the longitudinal profile will be compared on an annual basis. The parameters to be monitored will include bankfull slope, riffle length, riffle slope, pool length, and pool to pool spacing.

During the as-built surveys, Modified Wolman pebble counts were conducted at each of the project stream reaches to classify the stream bed materials. The pebble counts for the larger project stream reaches (R2-2 and R2-3) were conducted at each of the permanent cross sections by performing an equal number of counts at each cross section and then combining the results into a reach-wide count. These larger reaches were sampled at a minimum rate of 25 counts per cross section such that a minimum of 100 counts were made for each of the larger reaches. Reach-wide pebble counts were conducted along the smaller project stream reaches (R1, R2-4a, R2-4b, and R2-4c). A minimum of 100 counts were made for each of these smaller reaches. The stream bed materials will be monitored at RFC by repeating these same pebble count procedures on an annual basis. The results of the pebble counts for each specified project stream reach will be compared on an annual basis.

BEHI information was collected during the existing condition surveys and sediment transport rates were subsequently developed. The resulting information served as baseline data for stream bank stability at RFC. Stream bank stability monitoring using these parameters is required in Monitoring Year 3 and 5. Data collected during these years will be compared with pre-construction conditions to determine the change in bank erosion hazard indices and sediment export rates for each reach assessed. Positive change, namely reduction, in both the stream bank erosion rates and sediment transport rates at RFC are expected as a result of restoration and will be documented as described to demonstrate success.

During the as-built surveys, a total of three crest gages were installed across RFC, with two along Reach R2 and one at Reach R1. At the base of each crest gage a permanent vertical datum was installed. The locations of each crest gage along with the elevation of the permanent vertical datum were surveyed during the as-built surveys. The crest gages will be used for the hydrologic monitoring at RFC to verify the occurrence of bankfull storm events. Each crest gage was set during its initial installation and baseline photos were taken. The crest gages will be checked annually and the flood stage(s) recorded by each gage and measured relative to the permanent vertical datum of the respective gage. The results of these measurements will be used to document the occurrence of significant storm events, with the goal of specifically documenting the occurrence of bankfull and larger stream flow events.

Photo documentation and project-wide visual assessment will be used for stream monitoring at RFC to complement the other stream monitoring practices. A total of eight permanent reference photo points were installed across RFC during the as-built surveys. These photo points were monumented using steel rebar/PVC pins. Photos were taken at that time to provide photo documentation of baseline stream conditions. Photos will be taken from each of the eight permanent photo reference points with the same orientation each year and will be used for photo documentation and annual comparison of the stream conditions across RFC. This exercise will help to further validate and document stream restoration success at RFC. The visual assessment will be conducted using annual field observation and pedestrian surveys to identify any specific problem areas along the streams at RFC during the monitoring period. Any such problem areas will be identified and organized under appropriate categories. Such areas will be documented using representative photos, where applicable, and their locations will be mapped. The suspected cause and appropriate remedial action for each problem will be determined. If during any given year, the streams are not anticipated to meet the final established monitoring criteria, corrective actions will be considered. Such modifications will be documented and discussed with NCEEP.

3.2.2 Stream Monitoring Success Criteria

Stream dimension, pattern, profile, stream bed material, bank stability, and bankfull hydrology will be monitored annually for the project stream reaches as described in detail above. Stream restoration success at RFC will be evaluated by comparison of those annual results against those same parameters as predicted, specified, and required in proposed design. Success will be achieved when all such comparisons reveal positive trends toward overall stream stability. The stream monitoring results should show that the stream channels at RFC are of the proposed stream channel type (Rosgen 1994).

Stream dimension parameters including bankfull width, floodprone width, bankfull cross sectional area, bankfull mean depth, bankfull max depth, width to depth ratio, entrenchment ratio, wetted perimeter, and hydraulic radius will be measured and/or calculated for each of the permanent cross sections. The described dimension parameters are expected to remain consistent from year to year and should fall within the ranges established by the original proposed design parameters. It is expected and acceptable that minor adjustments in dimension will occur such as the development of point bars and the subsequent deepening of

pools. As vegetation becomes established and the stream banks are stabilized, the anticipation is that the width depth ratios will decrease and the entrenchment ratios will increase slightly, both within the normal ranges for C and E stream channel types (Rosgen, 1994).

Stream pattern parameters including sinuosity, belt width, radii of curvature, meander wavelength, and meander width ratio will be measured and/or calculated. Stream pattern measurements are expected to remain consistent from year to year and to fall within the originally proposed design parameters. As vegetation becomes established and the stream banks are stabilized, it is anticipated that the sinuosity of the streams will also adjust, likely becoming more sinuous with time.

Stream longitudinal profile parameters including bankfull slope, riffle length, riffle slope, pool length, and pool to pool spacing will be measured. Longitudinal profiles parameters are expected to remain relatively consistent from year to year. The stream profiles should not show aggrading or degrading conditions during the five-year monitoring period, however, minor profile adjustments such as deepening of pools is expected.

Stream bed material will be monitored using the described Modified Wolman pebble counts. The success criteria for the bed material will be determined at the end of the five-year monitoring period when data can be reviewed and compared to the proposed channel material types. Fluctuations in bed materials will likely occur during the early years following construction and several years may be needed to observe a consistent bed material. Bed materials should ultimately reflect the proposed design conditions for each reach at RFC.

Stream bank stability will be monitored using BEHI and sediment transport estimates during Monitoring Years 3 and 5. Data collected during these years will be compared with pre-construction conditions to determine the change in bank erosion hazard indices and sediment export rates for each reach assessed. Positive change, namely reduction, in both stream bank erosion rates and sediment transport rates at RFC are expected as a result of restoration and will be documented as described to demonstrate success.

Hydrologic monitoring success will be based on the ability to document the occurrence of bankfull storm events at RFC. A minimum of two bankfull events, each occurring in two separate monitoring years, are required to be documented within the five-year monitoring period. The described crest gauges will be used to determine and document the occurrence of these bankfull events.

As described above, photo documentation and visual assessment will be used to complement the other stream monitoring practices as part of the stream monitoring protocol at RFC. If during any given year, the streams are not anticipated to meet the final established monitoring criteria, corrective actions will be considered. Such modifications will be documented and discussed with NCEEP.

3.2.3 Stream Monitoring Results for Year 1 of 5

In late September 2008, the stream monitoring for Monitoring Year 1 was conducted. The methodologies described in the Stream Monitoring Methodology Section above were used for the stream monitoring at RFC for Monitoring Year 1. Detailed surveys were conducted along the project stream reaches specified to be surveyed for annual monitoring as described in detail above. The results of these surveys were used as the basis for the morphometric monitoring, including stream dimension, patter and profile.

All of the seven cross sections were surveyed to measure the bankfull width, floodprone width, bankfull cross sectional area, bankfull mean depth, bankfull max depth, width to depth ratio, entrenchment ratio, wetted perimeter, and hydraulic radius. The results of the cross section surveys are presented in Table VIII. Appendix D compares photos taken during Monitoring Year 1 with the initial baseline photos at each of the seven cross sections. Appendix E provides an overlay of the Monitoring Year 1 and baseline conditions along with the raw data for each cross section. The comparison of the baseline and Monitoring Year 1 stream dimension morphometric data for each of the project stream reaches showed very positive results, all of which were comparable to the originally proposed design parameters. The results showed that all of the reaches were experiencing the expected minor adjustments including decreasing width to depth ratios, increasing entrenchment ratios, and minor increases in depth. Each of these trends was indicative of movement toward increased stream stability and was attributed to vegetation establishment and natural channel adjustments. The comparison of the Year 1 Monitoring cross section photos to the as-built cross section photos strongly complement these suggestions, as no concerns, problems, or negative trends were documented.

The pattern for all of the stream reaches was surveyed to measure the parameters of sinuosity, belt width, radii of curvature, meander wavelength, and meander width ratio. The results of the pattern surveys are presented in Table VIII. The comparison of the baseline and Monitoring Year 1 stream pattern morphometric data for each of the project stream reaches showed very positive results, all of which were comparable to the originally proposed design parameters. The results showed that all of the reaches were experiencing the expected minor adjustment attributed to vegetation establishment and natural channel adjustments. This adjustment included slightly increasing radii of curvature, indicative of movement toward increased stream stability. These minor adjustments can be viewed through the overlays included in Appendix A.

Longitudinal profile surveys were conducted along each of the project stream reaches specified for annual monitoring surveys. The surveys were performed to measure the parameters of bankfull slope, riffle length, riffle slope, pool length, and pool to pool spacing. The results of the longitudinal profile surveys are presented in Table VIII. The comparison of the baseline and Monitoring Year 1 longitudinal profiles for each of the monitored project stream reaches showed very positive results, all of which were comparable to the originally proposed design parameters. The results showed that all of the reaches were experiencing the expected minor adjustment attributed to vegetation establishment and natural channel adjustments, including deepening of pools. The comparison of the baseline and Monitoring

Year 1 longitudinal profiles did not show excessive aggrading or degrading. Overlays can be found in Appendix E along with the raw data from both the baseline and Monitoring Year 1 conditions.

Modified Wolman pebble counts were repeated at each of the project stream reaches to classify the stream bed materials for comparison to the baseline conditions. The results of the pebble counts are presented in Table VIII while the raw data and overlays of the percent accumulation graphs can be viewed in Appendix E. Fluctuations in bed materials were expected to occur during the early years following construction. This expectation was observed in comparing the results of the baseline and Monitoring Year 1 pebble counts. Specifically, the bed material d50 and d84 for each of the stream reaches decreased. Mulkey believes that this fluctuation is attributed to the deposition of finer bed materials (sands and silts) mobilized during construction that have been subsequently deposited during storm events. At this time, Mulkey still believes that the stream bed materials will coarsen as stream bank stability increases with additional vegetation establishment and as the finer bed materials are concurrently flushed through the stream systems at RFC. The monitoring results suggest that on-site sediment supply from RFC is being greatly reduced as a result of the restoration. As noted earlier, the success criteria for the bed material will be determined at the end of the five-year monitoring period when data can be reviewed and compared to the proposed channel material types. Fluctuations in bed materials will likely continue to occur and several years may be needed to observe a consistent bed material.

Stream bank stability monitoring was not conducted, as this monitoring practice is scheduled to be performed using BEHI and sediment transport estimates during Monitoring Years 3 and 5. BEHI information was collected during the existing condition surveys and sediment transport rates were subsequently developed. The resulting information will serve as baseline data for stream bank stability at RFC and is presented in Table IX. The raw data for this table can be viewed in Appendix E.

Each of the three crest gages were checked during the Monitoring Year 1 surveys to monitor hydrology at RFC. Wrack lines were observed well above the bankfull stage across RFC during the Monitoring Year 1 surveys, suggesting that a flood event in excess of the bankfull event. One of the crest gages along Reach R2 was apparently washed away during this flood event. The two remaining crest gages (one each at Reach R1 and Reach R2) recorded flood stages in excess of the bankfull stage. Both of the remaining crest gages were reset after checking stage measurements to record future events. Table X lists the information related to the verification of bankfull events at RFC for Monitoring Year 1 while the raw data can be found in Appendix E. The evidence recorded by the crest gages indicated a storm event producing a stage in excess of the bankfull storm occurred at RFC during Monitoring Year 1. This was further validated through conversations with the land owner, Mr. George Teague, as he noted he had not seen a flood event of that magnitude in decades. This documentation of the first bankfull event at RFC during the monitoring period suggests success with regards to hydrologic monitoring at RFC.

Photo documentation and project-wide visual assessment were used to complement the other Monitoring Year 1 stream monitoring practices. Photos were taken from each of the eight

permanent photo reference points. Appendix C includes all of the described photos and provides comparison of the photos with the initial baseline photos taken from the eight permanent photo reference points. No stream problems were documented through the photo comparison process. A project-wide visual assessment was conducted along each of the project stream reaches to identify any specific stream problem areas. The project-wide visual assessment did not reveal any specific stream problem areas. Table XI presents the results of the project-wide visual assessment. Table XII presents the findings of no stream problem areas. Based on the results of the stream monitoring for Monitoring Year 1 at RFC, Mulkey does not propose any additional recommendations or actions other than to proceed with the annual stream monitoring.

4.0 Project Monitoring Methodology

Success criteria for stream mitigation sites are based on guidelines established by the USACE, US Environmental Protection Agency (USEPA), NC Wildlife Resources Commission (NCWRC) and the NCDWQ (USACE *et. al,* 2003). These guidelines establish criteria for monitoring both hydrologic conditions and vegetation survival. These same guidelines were used to develop the monitoring methods, frequencies, and success criteria discussed herein for RFC and further described in detail in the approved mitigation report (Mulkey Engineers and Consultants, 2008). RFC site conditions will be monitored annually during the latter part of the growing season months (August, September, and October) over the five-year monitoring period. This monitoring period complies with the requirements set fourth in the Full Delivery RFP 16-D06028. Monitoring results will be documented on an annual basis, with the associated reports submitted to the NCEEP as evidence that the established project goals and objectives are being achieved. The results of annual monitoring will be used to evaluate the degree of success RFC has achieved in meeting the said goals and objectives. In the event that goals are not being met, Mulkey will coordinate with the NCEEP to develop a plan for ameliorating the areas of concern.

5.0 References

Mulkey Engineers and Consultants. 2008. Tributary to Reedy Fork Creek Stream Restoration Mitigation Report. July 2008.

NCEEP. 2005. Content, Format, and Data Requirements for NCEEP Monitoring Reports. Version 1.1, September 16, 2005. NCDENR, NCEEP. 17 pp.

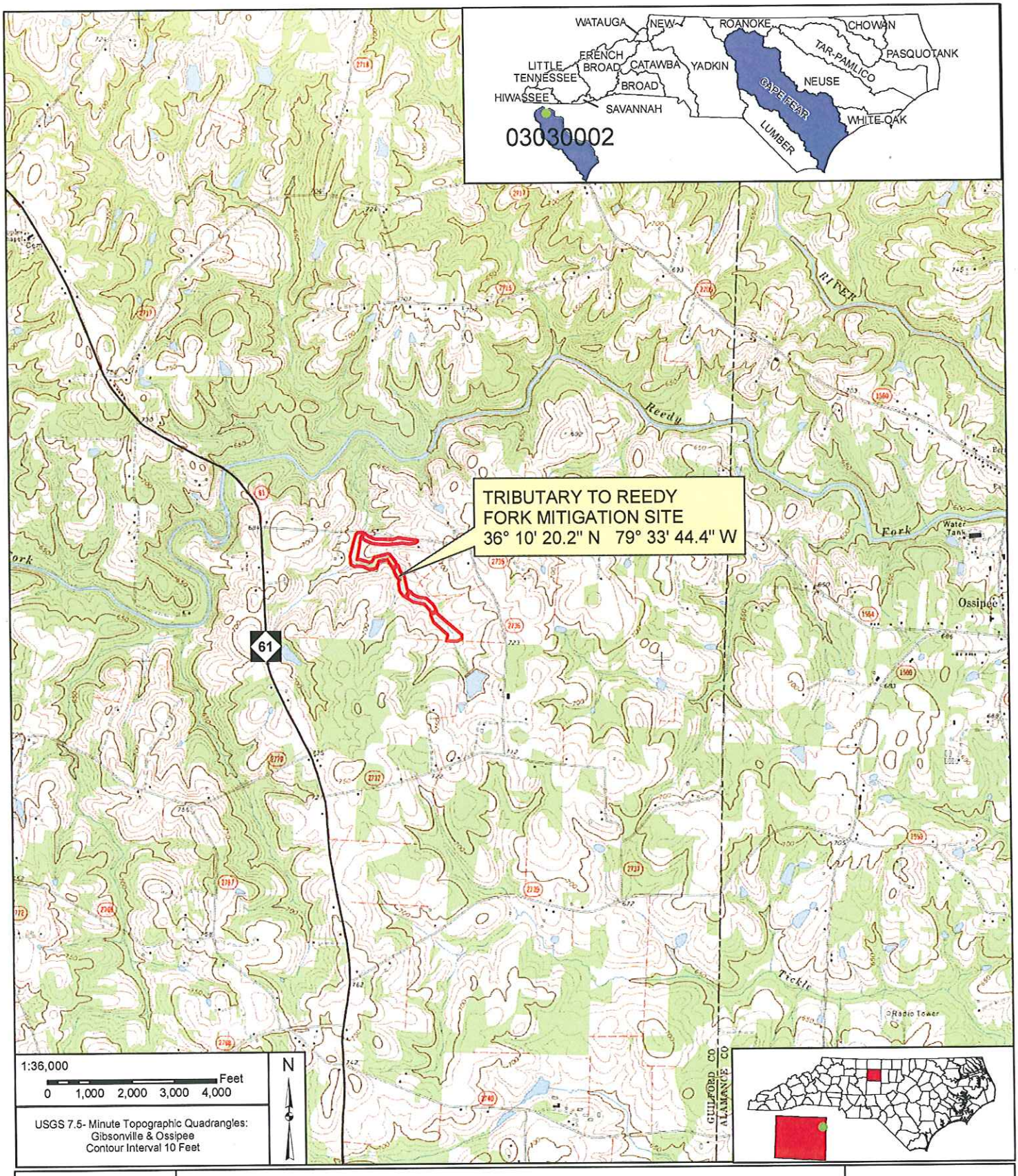
Rosgen, D.L. 1994. A Classification of Natural Rivers. Catena, 22:169-199.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Rosgen, D.L. 1998. The Reference Reach – A Blueprint for Natural Channel Design. From Proceedings of the Wetlands and Restoration Conference, March 1998, Denver CO. Wildland Hydrology, Pagosa Springs, CO.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina, Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment, Health and Natural Resources.

USACE, USEPA, NCWRC, and NCDWQ. 2003. Stream Mitigation Guidelines. April 2003.



LOCATION MAP

TRIBUTARY TO REEDY FORK

GUILFORD COUNTY, NORTH CAROLINA

May 30, 2008

Figure

1

Ecosystem Enhancement Program

MULKEY ENGINEERS & CONSULTANTS

PROJECT NO. D06028-A

Exhibit Table I. Project Restoration Approach and Mitigation Type Table Tributary to Reedy Fork Creek Stream Restoration / D06028-A						
Stream Reach ID	**Restoration Approach**	**Mitigation Type**	**Original Channel Length (lf)**	**Restored Channel Length (lf)**	**Stream Mitigation Units (SMU)***	**Comments**
R1	P1/P2	R	1,409	1,632	1,600	Includes both P1 (connection to historic floodplain) and P2 (channel relocation with floodplain excavation)
R2-1	P2	R	906	819	819	P2 (channel relocation with floodplain excavation)
R2-2	P1/P2	R	2,522	853	853	Includes both P1 (connection to historic floodplain) and P2 (channel relocation with floodplain excavation)
	P2	EII		418	167	Includes both P2 (channel relocation with floodplain excavation) and EII
	P1/P2	R		1,273	1,213	Includes both P1 (connection to historic floodplain) and P2 (channel relocation with floodplain excavation)
R2-3	P2	R	1,584	1,771	1,741	P2 (channel relocation with floodplain excavation)
R2-4a	P2	R	289	231	195	P2 (channel relocation with floodplain excavation)
R2-4b	P2	R	226	307	276	P2 (channel relocation with floodplain excavation)
R2-4c	P2	R	157	208	208	P2 (channel relocation with floodplain excavation)
		Totals	7,093	7,512	7,072	

* Stream Mitigation Units do not include restored channel outside of easement and within crossings.

R = Restoration
EII = Enhancement II
P1 = Priority I
P2 = Priority II

Exhibit Table II. Project Activity and Reporting History Tributary to Reedy Fork Creek Stream Restoration / D06028-A			
Activity or Report	**Scheduled Completion**	**Data Collection Completion**	**Actual Completion or Delivery**
Restoration Plan Prepared	Dec-06	Oct-06	10-Jul-07
Restoration Plan Approved	Jan-07	N/A	30-Jul-07
Final Design - 90%	Feb-07	N/A	10-Aug-07
Construction	Aug-07	N/A	14-Apr-08
Temporary S&E mix applied to entire project area	Aug-07	N/A	14-Apr-08
Permanent seed mix applied to entire project area	Aug-07	N/A	14-Apr-08
Planting live stakes	Dec-07	N/A	14-Apr-08
Planting bare roots	Dec-07	N/A	14-Apr-08
End of Construction	Dec-07	N/A	14-Apr-08
Survey of As-built conditions (Year 0 Monitoring - Baseline)	Jan-08	May-08	28-May-08
Monitoring			
Year 1 - 2008	Dec-08	Sep-08	Dec-08
Year 2 - 2009	Dec-09	N/A	N/A
Year 3 - 2010	Dec-10	N/A	N/A
Year 4 - 2011	Dec-11	N/A	N/A
Year 5 - 2012	Dec-12	N/A	N/A

Bolded items represent those events or deliverables that are variable. Non-bolded items represent events that are standard components over the course of a typical project.

Exhibit Table III. Project Contacts Tributary to Reedy Fork Creek Stream Restoration / D06028-A	
Designer	
Mulkey Engineers and Consultants	6750 Tryon Road Cary, NC 27518 Contact: William Scott Hunt, III Tel. 919.858.1825
Construction Contractor	
Vaughan Contracting, LLC	P.O. Box 796 Wadesboro, NC 28170 Contact: Tommy Vaughan Tel. 704.694.6450
Planting Coordinator	
Bruton Nurseries and Landscapes	150 Black Creek Road Fremont, NC 27830 Contact: Charles Bruton, Jr. Tel. 919.242.6555
Seeding Contractor	
Vaughan Contracting, LLC	P.O. Box 796 Wadesboro, NC 28170 Contact: Tommy Vaughan Tel. 704.694.6450
Seed Mix Sources	
Evergreen Seed	P.O. Box 669 Willow Spring, NC 27592 Contact: Wister Heald Tel. 919.567.1333
Nursery Stock Suppliers	
North Carolina Forestry Service Claridge Nursery	762 Claridge Nursery Road Goldsboro, NC 27530 Contact: James West Tel. 919.731.7988
Monitoring Performers	
Mulkey Engineers and Consultants	6750 Tryon Road Cary, NC 27518 Contact: William Scott Hunt, III Tel. 919.858.1825

Exhibit Table IV. Project Background Tributary to Reedy Fork Creek Stream Restoration / D06028-A	
Project County	Guilford County, North Carolina
Drainage Area [sq. mi(acres)]	
R1	0.028 (17.71)
R2-1	0.92 (591.5)
R2-2	0.51 (326.1)
R2-3	0.33 (210.9)
R2-4a	0.09 (55.7)
R2-4b	0.09 (55.7)
R2-4c	0.09 (55.7)
Drainage Impervious cover estimate (%)	
R1	2
R2-1	2
R2-2	2
R2-3	2
R2-4a	2
R2-4b	2
R2-4c	2
Stream Order	
R1	1
R2-1	2
R2-2	2
R2-3	2
R2-4a	1
R2-4b	1
R2-4c	1
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Rosgen Classification (As-built)	
R1, R2-1, R2-2, R2-3, R2-4a, R2-4b, R2-4c	C4
Cowardin Classification	R3UB3*
Dominat Soil Types	Enon-Mecklenburg
Reference Site ID	UT to Wells Creek
USGS HUC for Project and Reference	
Project	03030002
Reference	03030002
NCDWQ Sub-basin for Project and Reference	
Project	03-06-02 (Cape Fear)
Reference	03-06-04 (Cape Fear)
NCDWQ Classification for Project and Reference	
Project	C NSW
Reference	C NSW
Any portion of any project segement 303d?	Yes
Any portion of any project segement upstream of a 303d listed segment?	Yes
Reasons for 303d listing or stressor	Imparied Biological Integrity
Percent of project easement fenced	100

*(R) Riverine (3) Upper Perennial (UB) Unconsolidated Bottom (3) Cobble-Gravel

Exhibit Table V. Stem Counts Monitoring Year 1 for Each Species Arranged by Plot
Tributary to Reedy Fork Creek Stream Restoration / D06028-A

Species	Plots																Initial Totals	Initial Totals Adjusted [A]	Year 1 Totals	Survival %
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
Shrubs																				
Cornus amomum															1		1	1	1	100%
Trees																				
Betula nigra		2	5			1		4	3	1			0			1	24	23	17	74%
Diospyros virginiana		2		1			2				4	1	5	1	1		25	26	17	65%
Juglans nigra																	0	0	0	TBP
Pinus echinata		1		0	2								1			2	19	15	6	40%
Pinus strobus		2		0									2				14	14	4	29%
Pinus virginiana		1		2			0						3	1		1	11	15	8	53%
Prunus serotina				0													4	4	0	0%
Plantanus occidentalis																	0	0	0	TBP
Quercus alba		2		2	2				2		3	2			3	1	20	23	17	74%
Quercus falcata		2		1	2	3	1	9		2	3		0	1		1	32	45	25	56%
Quercus michauxii			5			1	1	3	5				5	1	3	4	28	32	28	88%
Quercus nigra				0	1	10	1	3	5	2						2	52	37	24	65%
Quercus phellos	13	0	5	3	1	7	1	5		2					2	1	62	57	40	70%
Salix nigra									2								2	2	2	100%
Totals	13	12	15	9	8	22	6	24	17	7	10	3	16	4	10	13	294	294	189	64%
																	Stems Per Acre Summary			
Plot Acreage	0.025	0.025	0.025	0.025	0.025	0.025	0.024	0.025	0.025	0.025	0.025	0.025	0.024	0.026	0.025	0.025	Min	Ave	Max	
Stems/Acre	522.1	487.8	612.2	358.6	321.3	887.1	251	971.7	693.9	285.7	398.4	121	655.7	155	403.2	524.2	121	478	972	

[A] Initial Totals (Adjusted) represents the most accurate species occurrence, following corrections for misidentification and other issues during the initial counting process.
TBP - Additional species that will be planted in Year 1 to supplement planting quantities at the site.

Exhibit Table VI. Vegetative Problem Areas Triburary to Reedy Fork Creek Stream Restoration / D06028-A			
Feature/Issue	**Station / Range**	**Probable Cause**	**Photo No. (If Available)**
Scattered bare root planting mortality	All project reaches	Drought	N/A

Exhibit Table VII. Baseline Morphology and Hydraulic Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R1 (1,632 ft)

PARAMETERS	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension - Riffle	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BKF Width (ft)	--	--	--	--	--	--	3.0	8.1	5.6	6.2	8.6	7.2	--	--	6.9	7.0	9.1	8.0
Floodprone Width (ft)	--	--	--	--	--	--	3.5	26.7	15.1	15.3	25.0	20.5	13.4	28.0	20.5	34.3	52.3	43.3
BKF Cross Sectional Area (sq. ft.)	--	--	--	--	--	--	3.2	7.8	5.5	3.9	6.3	5.4	--	--	4.0	3.8	4.4	4.1
BKF Mean Depth (ft)	--	--	--	--	--	--	0.97	1.06	1.01	0.56	1.02	0.79	--	--	0.58	0.49	0.54	0.52
BKF Max Depth (ft)	--	--	--	--	--	--	1.15	1.75	1.45	0.64	1.38	1.02	0.47	1.01	0.75	0.89	1.16	1.03
Width/Depth Ratio	--	--	--	--	--	--	2.9	8.4	5.6	6.1	12.6	9.1	--	--	12.0	12.9	18.5	15.7
Entrenchment Ratio	--	--	--	--	--	--	1.1	3.3	2.2	1.9	4.1	3.0	1.9	4.1	3.0	3.8	7.5	5.7
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	7.59	--	--	--	--	--	8.1	7.5	9.3	8.4
Hydraulic Radius (ft)	--	--	--	--	--	--	--	--	0.73	--	--	--	--	--	0.49	0.47	0.50	0.49
Pattern	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	--	--	--	--	--	--	--	--	--	10.0	35.0	20.9	9.7	33.9	20.3	3.7	32.4	12.2
Radius of Curvature (ft)	--	--	--	--	--	--	--	--	--	2.3	31.8	13.5	2.2	30.8	13.1	7.1	26.0	14.7
Meander Wavelength (ft)	--	--	--	--	--	--	--	--	--	35.0	70.0	50.0	33.9	67.9	48.5	32.5	66.4	45.4
Meander Width Ratio	--	--	--	--	--	--	--	--	--	1.4	4.9	2.9	1.4	4.9	2.9	0.5	4.1	1.5
Profile	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	--	--	--	--	--	--	9.1	67.7	38.4	2.5	25.4	13.8	2.4	24.7	13.4	2.3	10.8	5.2
Riffle Slope (ft/ft)	--	--	--	--	--	--	0.014	0.075	0.029	0.016	0.085	0.040	0.016	0.083	0.039	0.011	0.102	0.040
Pool Length (ft)	--	--	--	--	--	--	35.7	96.9	66.0	7.3	27.5	14.6	7.1	26.6	14.2	7.2	20.9	13.5
Pool Spacing (ft)	--	--	--	--	--	--	134.2	253.1	180.5	16.5	62.8	36.5	16.0	60.9	35.4	19.1	52.9	35.1
Substrate																		
d50 (mm)		--			--			1.1			6.2			1.1			4.9	
d84 (mm)		--			--			16.8			72.7			16.8			25.7	
Additional Reach Parameters																		
Bankfull Slope (ft/ft)		--			--			0.0237			0.0199			0.0197			0.0198	
Channel Length(ft)		--			--			1409			496			1693			1632	
Valley Length (ft)		--			--			1311			352			1311			1311	
Sinuosity		--			--			1.07			1.41			1.29			1.24	
Rosgen Classification		--			--			Degraded E5b			C4/1			C4/1			C4/1	

Exhibit Table VII. cont. Baseline Morphology and Hydraulic Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-1 (819 ft)

PARAMETERS	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BKF Width (ft)	--	--	--	7.0	27.0	14.0	10.6	11.4	11.0	6.2	8.6	7.2	--	--	15.8	--	--	15.8
Floodprone Width (ft)	--	--	--	--	--	--	48.9	50.6	49.8	15.3	25.0	20.5	30.5	64.0	46.7	--	--	66.1
BKF Cross Sectional Area (sq. ft.)	--	--	--	9.0	40.0	21.0	17.0	21.2	19.1	3.9	6.3	5.4	--	--	20.0	--	--	18.3
BKF Mean Depth (ft)	--	--	--	0.90	2.30	1.70	1.60	1.86	1.73	0.56	1.02	0.79	--	--	1.26	--	--	1.15
BKF Max Depth (ft)	--	--	--	--	--	--	1.75	2.47	2.13	0.64	1.38	1.02	1.03	2.22	1.64	--	--	1.94
Width/Depth Ratio	--	--	--	--	--	--	6.1	6.6	6.4	6.1	12.6	9.1	--	--	12.5	--	--	13.8
Entrenchment Ratio	--	--	--	--	--	--	4.4	4.6	4.5	1.9	4.1	3.0	1.9	4.1	3.0	--	--	4.2
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	14.5	--	--	--	--	--	18.3	--	--	16.7
Hydraulic Radius (ft)	--	--	--	--	--	--	--	--	1.32	--	--	--	--	--	1.09	--	--	1.09
Pattern	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	--	--	--	--	--	--	4.3	44.6	24.3	10.0	35.0	20.9	22.1	77.5	46.3	17.9	39.7	28.3
Radius of Curvature (ft)	--	--	--	--	--	--	19.8	54.3	33.8	2.3	31.8	13.5	5.1	70.4	29.9	24.2	85.6	41.1
Meander Wavelength (ft)	--	--	--	--	--	--	53.6	114.7	79.9	35.0	70.0	50.0	77.5	154.9	110.7	94.3	143.2	115.4
Meander Width Ratio	--	--	--	--	--	--	0.4	4.1	2.2	1.4	4.9	2.9	1.4	4.9	2.9	1.1	2.5	1.8
Profile	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	--	--	--	--	--	--	9.0	104.8	38.4	2.5	25.4	13.8	5.6	56.3	30.5	6.2	11.6	9.6
Riffle Slope (ft/ft)	--	--	--	--	--	--	0.0078	0.0362	0.0169	0.016	0.085	0.040	0.005	0.028	0.013	0.003	0.031	0.017
Pool Length (ft)	--	--	--	--	--	--	14.2	75.5	36.7	7.3	27.5	14.6	16.2	60.8	32.4	20.2	36.4	26.7
Pool Spacing (ft)	--	--	--	--	--	--	44.34	165.18	97.35	16.5	62.8	36.5	36.6	139.0	80.8	38.0	82.9	64.6
Substrate																		
d50 (mm)	--			--			17.5			6.2			17.5			3.0		
d84 (mm)	--			--			81.3			72.7			81.3			19.3		
Additional Reach Parameters																		
Bankfull Slope (ft/ft)	--			--			0.0067			0.0199			0.0074			0.0075		
Channel Length(ft)	--			--			906			496			802			819		
Valley Length (ft)	--			--			745			352			745			745		
Sinuosity	--			--			1.22			1.41			1.08			1.10		
Rosgen Classification	--			--			Degraded E4/1			C4/1			C4/1			C4/1		

Exhibit Table VII. cont. Baseline Morphology and Hydraulic Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-2 (2,544 ft)

PARAMETERS	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BKF Width (ft)	--	--	--	5.5	20.0	11.0	14.1	15.5	14.8	6.2	8.6	7.2	--	--	15.8	13.5	14.8	14.3
Floodprone Width (ft)	--	--	--	--	--	--	46.1	82.5	64.3	15.3	25.0	20.5	30.5	64.0	46.7	61.1	85.0	73.6
BKF Cross Sectional Area (sq. ft.)	--	--	--	6.0	28.0	15.5	19.6	21.6	20.6	3.9	6.3	5.4	--	--	20.0	14.5	17.6	15.7
BKF Mean Depth (ft)	--	--	--	0.75	2.00	1.40	1.27	1.53	1.40	0.56	1.02	0.79	--	--	1.26	0.99	1.31	1.03
BKF Max Depth (ft)	--	--	--	--	--	--	1.59	2.11	1.79	0.64	1.38	1.02	1.03	2.22	1.64	1.53	2.23	1.79
Width/Depth Ratio	--	--	--	--	--	--	9.2	12.2	10.7	6.1	12.6	9.1	--	--	12.5	10.3	14.8	13.3
Entrenchment Ratio	--	--	--	--	--	--	3.0	5.8	4.4	1.9	4.1	3.0	1.9	4.1	3.0	4.1	6.3	5.2
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	17.6	--	--	--	--	--	18.3	15.1	15.5	15.3
Hydraulic Radius (ft)	--	--	--	--	--	--	--	--	1.17	--	--	--	--	--	1.09	0.96	1.17	1.03
Pattern	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	--	--	--	--	--	--	10.3	94.8	39.6	10.0	35.0	20.9	22.1	77.5	46.3	14.3	65.6	33.4
Radius of Curvature (ft)	--	--	--	--	--	--	15.9	76.7	45.6	2.3	31.8	13.5	5.1	70.4	29.9	17.3	66.8	33.0
Meander Wavelength (ft)	--	--	--	--	--	--	73.2	238.2	139.3	35.0	70.0	50.0	77.5	154.9	110.7	79.1	133.5	107.8
Meander Width Ratio	--	--	--	--	--	--	0.7	6.4	2.7	1.4	4.9	2.9	1.4	4.9	2.9	1.0	4.6	2.3
Profile	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	--	--	--	--	--	--	6.43	91.81	28.91	2.5	25.4	13.8	5.58	56.3	30.47	3.9	17.1	9.5
Riffle Slope (ft/ft)	--	--	--	--	--	--	0.009	0.040	0.020	0.016	0.085	0.040	0.008	0.041	0.019	0.006	0.041	0.018
Pool Length (ft)	--	--	--	--	--	--	6.8	119.7	46.0	7.3	27.5	14.6	16.2	60.8	32.4	15.3	69.9	34.7
Pool Spacing (ft)	--	--	--	--	--	--	35.3	343.6	143.8	16.5	62.8	36.5	36.6	139.0	80.8	37.2	99.6	63.5
Substrate																		
d50 (mm)		--			--			50.9			6.2			50.9			6.0	
d84 (mm)		--			--			152.5			72.7			152.5			29.1	
Additional Reach Parameters																		
Bankfull Slope (ft/ft)		--			--			0.0092			0.0199			0.0094			0.0096	
Channel Length(ft)		--			--			2522			496			2490			2544	
Valley Length (ft)		--			--			2116			352			2116			2116	
Sinuosity		--			--			1.19			1.41			1.18			1.20	
Rosgen Classification		--			--			Degraded E4/1			C4/1			C4/1			C4/1	

Exhibit Table VII. cont. Baseline Morphology and Hydraulic Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-3 (1,771 ft)

PARAMETERS	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BKF Width (ft)	--	--	--	4.5	18.0	9.0	4.2	4.4	4.3	6.2	8.6	7.2	--	--	10.0	10.6	10.6	10.6
Floodprone Width (ft)	--	--	--	--	--	--	7.8	32.7	20.3	15.3	25.0	20.5	19.3	40.5	29.5	78.5	78.7	78.6
BKF Cross Sectional Area (sq. ft.)	--	--	--	5.0	20.0	10.0	4.1	5.2	4.6	3.9	6.3	5.4	--	--	8.0	7.3	8.4	7.8
BKF Mean Depth (ft)	--	--	--	0.6	1.7	1.1	0.93	1.23	1.08	0.56	1.02	0.79	--	--	0.80	0.69	0.79	0.74
BKF Max Depth (ft)	--	--	--	--	--	--	1.11	1.76	1.35	0.64	1.38	1.02	0.65	1.40	1.04	1.19	1.34	1.27
Width/Depth Ratio	--	--	--	--	--	--	3.4	4.7	4.1	6.1	12.6	9.1	--	--	12.5	13.4	15.3	14.4
Entrenchment Ratio	--	--	--	--	--	--	1.8	7.8	4.8	1.9	4.1	3.0	1.9	4.1	3.0	7.4	7.4	7.4
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--	11.6	10.9	11.1	11.0
Hydraulic Radius (ft)	--	--	--	--	--	--	--	--	0.71	--	--	--	--	--	0.69	0.67	0.76	0.72
Pattern	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	--	--	--	--	--	--	3.0	67.0	26.9	10.0	35.0	20.9	14.0	49.0	29.3	5.9	61.6	26.8
Radius of Curvature (ft)	--	--	--	--	--	--	12.2	76.6	30.7	2.3	31.8	13.5	3.2	44.5	18.9	14.9	64.7	24.8
Meander Wavelength (ft)	--	--	--	--	--	--	46.8	149.4	83.2	35.0	70.0	50.0	49.0	98.0	70.0	55.8	147.2	83.6
Meander Width Ratio	--	--	--	--	--	--	0.7	15.6	6.3	1.4	4.9	2.9	1.4	4.9	2.9	0.6	5.8	2.5
Profile	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	--	--	--	--	--	--	4.3	42.3	18.7	2.5	25.4	13.8	3.5	35.6	19.3	5.5	15.2	8.9
Riffle Slope (ft/ft)	--	--	--	--	--	--	0.008	0.082	0.026	0.016	0.085	0.040	0.006	0.031	0.014	0.005	0.023	0.012
Pool Length (ft)	--	--	--	--	--	--	4.8	85.2	31.8	7.3	27.5	14.6	10.2	38.4	20.5	15.9	27.7	20.9
Pool Spacing (ft)	--	--	--	--	--	--	71.1	296.3	149.8	16.5	62.8	36.5	23.1	87.9	51.1	27.6	83.2	41.9
Substrate																		
d50 (mm)	--			--			0.2			6.2			0.2			6.5		
d84 (mm)	--			--			6.1			72.7			6.1			18.4		
Additional Reach Parameters																		
Bankfull Slope (ft/ft)	--			--			0.0080			0.0199			0.0075			0.0073		
Channel Length(ft)	--			--			1584			496			1734			1771		
Valley Length (ft)	--			--			1291			352			1305			1305		
Sinuosity	--			--			1.23			1.41			1.33			1.36		
Rosgen Classification	--			--			Degraded E5			C4/1			C4/1			C4/1		

Exhibit Table VII. cont. Baseline Morphology and Hydraulic Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-4a (231 ft)

PARAMETERS	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BKF Width (ft)	--	--	--	--	--	--	--	--	--	6.2	8.6	7.2	--	--	7.1	--	--	--
Floodprone Width (ft)	--	--	--	--	--	--	--	--	--	15.3	25.0	20.5	13.6	28.6	20.9	--	--	--
BKF Cross Sectional Area (sq. ft.)	--	--	--	--	--	--	--	--	--	3.9	6.3	5.4	--	--	4.0	--	--	--
BKF Mean Depth (ft)	--	--	--	--	--	--	--	--	--	0.56	1.02	0.79	--	--	0.57	--	--	--
BKF Max Depth (ft)	--	--	--	--	--	--	--	--	--	0.64	1.38	1.02	0.46	0.99	0.73	--	--	--
Width/Depth Ratio	--	--	--	--	--	--	--	--	--	6.1	12.6	9.1	--	--	12.5	--	--	--
Entrenchment Ratio	--	--	--	--	--	--	--	--	--	1.9	4.1	3.0	1.9	4.1	3.0	--	--	--
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hydraulic Radius (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pattern	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	--	--	--	--	--	--	--	--	--	10.0	35.0	20.9	9.9	34.6	20.7	12.5	25.4	18.1
Radius of Curvature (ft)	--	--	--	--	--	--	--	--	--	2.3	31.8	13.5	2.3	31.5	13.4	12.1	28.2	18.3
Meander Wavelength (ft)	--	--	--	--	--	--	--	--	--	35.0	70.0	50.0	34.6	69.3	49.5	59.4	75.2	65.4
Meander Width Ratio	--	--	--	--	--	--	--	--	--	1.4	4.9	2.9	1.4	4.9	2.9	--	--	--
Profile	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	--	--	--	--	--	--	--	--	--	2.5	25.4	13.8	2.5	25.2	13.6	4.1	13.4	7.5
Riffle Slope (ft/ft)	--	--	--	--	--	--	--	--	--	0.016	0.085	0.040	0.006	0.031	0.014	0.005	0.026	0.015
Pool Length (ft)	--	--	--	--	--	--	--	--	--	7.3	27.5	14.6	7.2	27.2	14.5	5.8	29.5	17.2
Pool Spacing (ft)	--	--	--	--	--	--	--	--	--	16.5	62.8	36.5	16.4	62.2	26.1	32.9	53.8	44.3
Substrate																		
d50 (mm)		--			--			0.2			6.2			0.2			0.4	
d84 (mm)		--			--			6.1			72.7			6.1			7.3	
Additional Reach Parameters																		
Bankfull Slope (ft/ft)		--			--			0.0069			0.0199			0.0035			0.0080	
Channel Length(ft)		--			--			289			496			226			231	
Valley Length (ft)		--			--			215			352			178			178	
Sinuosity		--			--			1.35			1.41			1.27			1.30	
Rosgen Classification		--			--			n/a			C4/1			C4/1			C4/1	

Exhibit Table VII. cont. Baseline Morphology and Hydraulic Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-4b (307 ft)

PARAMETERS	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension - Riffle	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BKF Width (ft)	--	--	--	--	--	--	--	--	--	6.2	8.6	7.2	--	--	7.1	--	--	10.4
Floodprone Width (ft)	--	--	--	--	--	--	--	--	--	15.3	25.0	20.5	13.6	28.6	20.9	--	--	44.4
BKF Cross Sectional Area (sq. ft.)	--	--	--	--	--	--	--	--	--	3.9	6.3	5.4	--	--	4.0	--	--	7.7
BKF Mean Depth (ft)	--	--	--	--	--	--	--	--	--	0.56	1.02	0.79	--	--	0.57	--	--	0.74
BKF Max Depth (ft)	--	--	--	--	--	--	--	--	--	0.64	1.38	1.02	0.46	0.99	0.73	--	--	1.45
Width/Depth Ratio	--	--	--	--	--	--	--	--	--	6.1	12.6	9.1	--	--	12.5	--	--	14.0
Entrenchment Ratio	--	--	--	--	--	--	--	--	--	1.9	4.1	3.0	1.9	4.1	3.0	--	--	4.3
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.1
Hydraulic Radius (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.70
Pattern	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	--	--	--	--	--	--	--	--	--	10.0	35.0	20.9	9.9	34.6	20.7	3.3	29.8	12.6
Radius of Curvature (ft)	--	--	--	--	--	--	--	--	--	2.3	31.8	13.5	2.3	31.5	13.4	11.9	29.5	16.4
Meander Wavelength (ft)	--	--	--	--	--	--	--	--	--	35.0	70.0	50.0	34.6	69.3	49.5	40.5	55.6	47.7
Meander Width Ratio	--	--	--	--	--	--	--	--	--	1.4	4.9	2.9	1.4	4.9	2.9	0.3	2.9	1.2
Profile	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	--	--	--	--	--	--	--	--	--	2.5	25.4	13.8	2.5	25.2	13.6	4.4	5.2	4.8
Riffle Slope (ft/ft)	--	--	--	--	--	--	--	--	--	0.016	0.085	0.040	0.006	0.031	0.014	0.009	0.046	0.032
Pool Length (ft)	--	--	--	--	--	--	--	--	--	7.3	27.5	14.6	7.2	27.2	14.5	9.6	18.3	12.6
Pool Spacing (ft)	--	--	--	--	--	--	--	--	--	16.5	62.8	36.5	16.4	62.2	26.1	24.4	41.6	31.2
Substrate																		
d50 (mm)	--			--			0.2			6.2			0.2			5.7		
d84 (mm)	--			--			6.1			72.7			6.1			15.4		
Additional Reach Parameters																		
Bankfull Slope (ft/ft)	--			--			0.0155			0.0199			0.0155			0.0178		
Channel Length(ft)	--			--			226			496			334			307		
Valley Length (ft)	--			--			213			352			267			267		
Sinuosity	--			--			1.06			1.41			1.25			1.15		
Rosgen Classification	--			--			n/a			C4/1			C4/1			C4/1		

Exhibit Table VII. cont. Baseline Morphology and Hydraulic Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-4c (208 ft)

PARAMETERS	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension - Riffle	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
BKF Width (ft)	--	--	--	--	--	--	--	--	--	6.2	8.6	7.2	--	--	7.1	--	--	8.7
Floodprone Width (ft)	--	--	--	--	--	--	--	--	--	15.3	25.0	20.5	13.6	28.6	20.9	--	--	42.6
BKF Cross Sectional Area (sq. ft.)	--	--	--	--	--	--	--	--	--	3.9	6.3	5.4	--	--	4.0	--	--	6.0
BKF Mean Depth (ft)	--	--	--	--	--	--	--	--	--	0.56	1.02	0.79	--	--	0.57	--	--	0.68
BKF Max Depth (ft)	--	--	--	--	--	--	--	--	--	0.64	1.38	1.02	0.46	0.99	0.73	--	--	1.23
Width/Depth Ratio	--	--	--	--	--	--	--	--	--	6.1	12.6	9.1	--	--	12.5	--	--	12.9
Entrenchment Ratio	--	--	--	--	--	--	--	--	--	1.9	4.1	3.0	1.9	4.1	3.0	--	--	4.9
Wetted Perimeter (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9.3
Hydraulic Radius (ft)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.65
Pattern	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	--	--	--	--	--	--	--	--	--	10.0	35.0	20.9	9.9	34.6	20.7	5.7	18.2	11.6
Radius of Curvature (ft)	--	--	--	--	--	--	--	--	--	2.3	31.8	13.5	2.3	31.5	13.4	14.0	21.8	16.6
Meander Wavelength (ft)	--	--	--	--	--	--	--	--	--	35.0	70.0	50.0	34.6	69.3	49.5	46.0	57.4	50.8
Meander Width Ratio	--	--	--	--	--	--	--	--	--	1.4	4.9	2.9	1.4	4.9	2.9	0.7	2.1	1.3
Profile	Min	Max	Med	LL	UL	Eq	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	--	--	--	--	--	--	--	--	--	2.5	25.4	13.8	2.5	25.2	13.6	4.7	5.5	5.2
Riffle Slope (ft/ft)	--	--	--	--	--	--	--	--	--	0.016	0.085	0.040	0.006	0.031	0.014	0.008	0.040	0.028
Pool Length (ft)	--	--	--	--	--	--	--	--	--	7.3	27.5	14.6	7.2	27.2	14.5	6.5	14.7	9.9
Pool Spacing (ft)	--	--	--	--	--	--	--	--	--	16.5	62.8	36.5	16.4	62.2	26.1	26.9	38.9	34.7
Substrate																		
d50 (mm)		--			--			0.2			6.2			0.2			4.0	
d84 (mm)		--			--			6.1			72.7			6.1			9.7	
Additional Reach Parameters																		
Bankfull Slope (ft/ft)		--			--			0.0144			0.0199			0.0048			0.0075	
Channel Length(ft)		--			--			157			496			232			208	
Valley Length (ft)		--			--			148			352			187			187	
Sinuosity		--			--			1.07			1.41			1.24			1.11	
Rosgen Classification		--			--			n/a			C4/1			C4/1			C4/1	

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R1 (1,632 ft)

PARAMETERS	Cross Section 7 Pool																										
Dimension	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
BKF Width (ft)	7.8																													
Floodprone Width (ft)	78.0																													
BKF Cross Sectional Area (sq. ft.)	5.3																													
BKF Mean Depth (ft)	0.69																													
BKF Max Depth (ft)	1.57																													
Width/Depth Ratio	11.2																													
Entrenchment Ratio	10.1																													
Wetted Perimeter (ft)	8.6																													
Hydraulic Radius (ft)	0.62																													

PARAMETERS	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	6.1	24.8	11.5												
Radius of Curvature (ft)	7.2	20.8	11.8												
Meander Wavelength (ft)	28.4	50.1	38.8												
Meander Width Ratio	--	--	--												
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	1.4	6.0	4.1												
Riffle Slope (ft/ft)	0.019	0.177	0.063												
Pool Length (ft)	7.0	13.9	10.7												
Pool Spacing (ft)	23.2	68.8	37.1												
Substrate															
d50 (mm)		0.04													
d84 (mm)		4													
Additional Reach Parameters															
Bankfull Slope (ft/ft)		0.0196													
Monitored Channel Length (ft)		627													
Monitored Valley Length (ft)		499													
Sinuosity		1.26													
Total Channel Length (ft)		1632													
Rosgen Classification		C6													

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-2 (2,544 ft)

PARAMETERS	No Cross Section																										
Dimension	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
BKF Width (ft)	--																													
Floodprone Width (ft)	--																													
BKF Cross Sectional Area (sq. ft.)	--																													
BKF Mean Depth (ft)	--																													
BKF Max Depth (ft)	--																													
Width/Depth Ratio	--																													
Entrenchment Ratio	--																													
Wetted Perimeter (ft)	--																													
Hydraulic Radius (ft)	--																													

PARAMETERS	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	6.6	64.4	36.4												
Radius of Curvature (ft)	23.6	42.6	30.1												
Meander Wavelength (ft)	81.3	102.4	90.8												
Meander Width Ratio	--	--	--												
Profile				Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	5.4	14.6	9.6												
Riffle Slope (ft/ft)	0.009	0.066	0.029												
Pool Length (ft)	16.5	60.3	29.7												
Pool Spacing (ft)	21.4	99.2	55.7												
Substrate															
d50 (mm)		0.06													
d84 (mm)		6.47													
Additional Reach Parameters															
Bankfull Slope (ft/ft)		0.0108													
Monitored Channel Length (ft)		476													
Monitored Valley Length (ft)		356													
Sinuosity		1.34													
Total Channel Length (ft)		2544													
Rosgen Classification		C6													

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-3 (1,771 ft)

PARAMETERS	Cross Section 3 Pool					Cross Section 4 Riffle					Cross Section 5 Riffle					Cross Section 6 Pool														
Dimension	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
BKF Width (ft)	10.1					10.8					9.95					10.87														
Floodprone Width (ft)	71.78					60.27					76.64					92.77														
BKF Cross Sectional Area (sq. ft.)	10					6.19					6.29					10.05														
BKF Mean Depth (ft)	0.99					0.57					0.63					0.92														
BKF Max Depth (ft)	1.82					1.07					1.1					1.89														
Width/Depth Ratio	10.2					19					15.79					11.82														
Entrenchment Ratio	7.11					5.56					7.7					8.53														
Wetted Perimeter (ft)	11.12					11.2					10.38					11.7														
Hydraulic Radius (ft)	0.9					0.55					0.61					0.86														

PARAMETERS	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	3.4	43.2	25.2												
Radius of Curvature (ft)	14.3	37.2	22.7												
Meander Wavelength (ft)	57.7	98.0	79.8												
Meander Width Ratio	0.3	4.2	2.4												
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	3.5	16.5	10.0												
Riffle Slope (ft/ft)	0.009	0.056	0.021												
Pool Length (ft)	11.2	30.4	19.7												
Pool Spacing (ft)	24.3	95.9	56.6												
Substrate															
d50 (mm)		0.06													
d84 (mm)		6.47													
Additional Reach Parameters															
Bankfull Slope (ft/ft)		0.0076													
Monitored Channel Length (ft)		1608													
Monitored Valley Length (ft)		1305													
Sinuosity		1.23													
Total Channel Length (ft)		1771													
Rosgen Classification		C6													

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-4a (231 ft)

PARAMETERS	No Cross Section																											
Dimension	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
BKF Width (ft)	--																													
Floodprone Width (ft)	--																													
BKF Cross Sectional Area (sq. ft.)	--																													
BKF Mean Depth (ft)	--																													
BKF Max Depth (ft)	--																													
Width/Depth Ratio	--																													
Entrenchment Ratio	--																													
Wetted Perimeter (ft)	--																													
Hydraulic Radius (ft)	--																													

PARAMETERS	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	10.1	21.6	14.8												
Radius of Curvature (ft)	15.1	35.4	21.6												
Meander Wavelength (ft)	58.9	66.4	62.2												
Meander Width Ratio															
Profile	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	6.1	8.8	7.4												
Riffle Slope (ft/ft)	0.004	0.033	0.016												
Pool Length (ft)	14.2	18.0	16.1												
Pool Spacing (ft)	25.1	54.8	78.3												
Substrate															
d50 (mm)		0.04													
d84 (mm)		0.25													
Additional Reach Parameters															
Bankfull Slope (ft/ft)		0.0074													
Monitored Channel Length (ft)		169													
Monitored Valley Length (ft)		147													
Sinuosity		1.15													
Total Channel Length (ft)		231													
Rosgen Classification		C6													

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-4b (307 ft)

PARAMETERS	Cross Section 1 Riffle																										
Dimension	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
BKF Width (ft)	9.38																													
Floodprone Width (ft)	37.18																													
BKF Cross Sectional Area (sq. ft.)	4.5																													
BKF Mean Depth (ft)	0.48																													
BKF Max Depth (ft)	0.84																													
Width/Depth Ratio	19.54																													
Entrenchment Ratio	3.97																													
Wetted Perimeter (ft)	9.7																													
Hydraulic Radius (ft)	0.47																													

PARAMETERS	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	8.4	17.1	13.2												
Radius of Curvature (ft)	13.2	39.3	20.4												
Meander Wavelength (ft)	46.1	56.5	51.3												
Meander Width Ratio	0.9	1.8	1.4												
Profile				Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	4.0	12.0	6.6												
Riffle Slope (ft/ft)	0.004	0.048	0.025												
Pool Length (ft)	5.03	13.29	9.16												
Pool Spacing (ft)	23.92	40.72	33.48												
Substrate															
d50 (mm)		0.7													
d84 (mm)		7.11													
Additional Reach Parameters															
Bankfull Slope (ft/ft)		0.0212													
Monitored Channel Length (ft)		119													
Monitored Valley Length (ft)		104													
Sinuosity		1.15													
Total Channel Length (ft)		307													
Rosgen Classification		C5													

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary
Tributary to Reedy Fork Creek Stream Restoration / D06028-A
Reach R2-4c (208 ft)

PARAMETERS	Cross Section 2 Riffle																													
Dimension	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5	MY1	MY2	MY3	MY4	MY5
BKF Width (ft)	8.06																													
Floodprone Width (ft)	42.63																													
BKF Cross Sectional Area (sq. ft.)	6.0																													
BKF Mean Depth (ft)	0.74																													
BKF Max Depth (ft)	1.26																													
Width/Depth Ratio	10.89																													
Entrenchment Ratio	5.29																													
Wetted Perimeter (ft)	8.6																													
Hydraulic Radius (ft)	0.69																													

PARAMETERS	MY-01 (2008)			MY-02 (2009)			MY-03 (2010)			MY-04 (2011)			MY-05 (2012)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	5.3	17.3	13.1												
Radius of Curvature (ft)	14.9	24.5	18.3												
Meander Wavelength (ft)	48.7	58.1	53.4												
Meander Width Ratio	0.7	2.1	1.6												
Profile				Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Riffle Length (ft)	5.9	8.1	7.3												
Riffle Slope (ft/ft)	0.004	0.009	0.006												
Pool Length (ft)	11.72	13.02	12.37												
Pool Spacing (ft)	30.76	40.6	36.59												
Substrate															
d50 (mm)		0.04													
d84 (mm)		1.00													
Additional Reach Parameters															
Bankfull Slope (ft/ft)		0.0047													
Monitored Channel Length (ft)		117													
Monitored Valley Length (ft)		101													
Sinuosity		1.15													
Total Channel Length (ft)		208													
Rosgen Classification		C6													

Exhibit Table IX. BEHI and Sediment Export Estimates
Tributary to Reedy Fork Creek Stream Restoration / D06028-A

Time Point	Segment / Reach[1]	Linear Footage or Acreage	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export
			ft	%	ft	%	ft	%	ft	%	ft	%	ft	%	tons/yr
Preconstruction 2006	R1	1409	1409	100											126.8
	R2-1	906	906	100											81.5
	R2-2	2522	2522	100											126.1
	R2-3	1584	1584	100											110.9
	R2-4a	289													n/a
	R2-4b	226													n/a
	R2-4c	157													n/a
	TOTAL	7092	6420	91	0	0	0	0	0	0	0	0	0	0	445
Monitoring Y3 2010 **(NOT APPLICABLE)**	R1	1632													
	R2-1	819													
	R2-2	2544													
	R2-3	1771													
	R2-4a	231													
	R2-4b	307													
	R2-4c	208													
	TOTAL	7512	0	0	0	0	0	0	0	0	0	0	0	0	0
Monitoring Y5 2012 **(NOT APPLICABLE)**	R1	1632													
	R2-1	819													
	R2-2	2544													
	R2-3	1771													
	R2-4a	231													
	R2-4b	307													
	R2-4c	208													
	TOTAL	7512	0	0	0	0	0	0	0	0	0	0	0	0	0

Exhibit Table X. Verification of Bankfull Events Tributary to Reedy Fork Creek Stream Restoration / D06028-A			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo No. (If Available)**
9/22/08-9/24/08	Unknown	Crest Guages	N/A

Exhibit Table XI. Categorical Stream Feature Visual Stability Assessment Tributary to Reedy Fork Creek Stream Restoration / D06028-A						
Reach R1 (1,632 ft)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%				
Pools	100%	100%				
Thalwegs	100%	100%				
Meanders	100%	100%				
Bed General	100%	100%				
Structures	100%	100%				
Rootwads	100%	100%				
Reach R2-1 (819 ft)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%				
Pools	100%	100%				
Thalwegs	100%	100%				
Meanders	100%	100%				
Bed General	100%	100%				
Structures	100%	100%				
Rootwads	100%	100%				
Reach R2-2 (2,544 ft)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%				
Pools	100%	100%				
Thalwegs	100%	100%				
Meanders	100%	100%				
Bed General	100%	100%				
Structures	100%	100%				
Rootwads	100%	100%				
Reach R2-3 (1,771 ft)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%				
Pools	100%	100%				
Thalwegs	100%	100%				
Meanders	100%	100%				
Bed General	100%	100%				
Structures	100%	100%				
Rootwads	100%	100%				

Reach R2-4a (231 ft)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%				
Pools	100%	100%				
Thalwegs	100%	100%				
Meanders	100%	100%				
Bed General	100%	100%				
Structures	100%	100%				
Rootwads	100%	100%				
Reach R2-4b (307 ft)						
Feature	**Initial**	**MY-01**	**MY-02**	**MY-03**	**MY-04**	**MY-05**
Riffles	100%	100%				
Pools	100%	100%				
Thalwegs	100%	100%				
Meanders	100%	100%				
Bed General	100%	100%				
Structures	100%	100%				
Rootwads	100%	100%				

Exhibit Table XII. Stream Problem Areas Tributary to Reedy Fork Creek Stream Restoration / D06028-A			
Feature/Issue	**Station / Range**	**Probable Cause**	**Photo No. (If Available)**
None observed	N/A	N/A	N/A

Click on the Desired Link Below

Appendices