East Buffalo Creek Mitigation Project

Baseline Monitoring Document and As-built Baseline Report
Graham County, North Carolina

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EXECUTIVE SUMMARY

The East Buffalo Creek site was restored through a full delivery contract with the North Carolina Ecosystem Enhancement Program (NCEEP). This report documents the completion of the project and presents base-line, as-built monitoring data for the five-year monitoring period. The goals for the restoration project were as follows:

- To create geomorphically stable conditions on the East Buffalo Creek project site;
- To reduce sediment loading through restoration of riparian areas and streambanks;
- To improve and restore hydrologic connections between the creek and floodplain;
- To restore and preserve headwater tributaries draining into East Buffalo Creek (and Lake Santeetlah); and
- To improve aquatic and terrestrial habitat along the project corridor.

To accomplish these goals, the following objectives were implemented:

- Restoration of incised, eroding, and channelized streams by creating a stable channel that has access to its floodplain;
- Relocate the perched stream channel from the side slope ditch to the low point of the valley to restore natural hydrology and geomorphic form;
- Improve water quality by establishing buffers for nutrient removal from runoff; relocating an eroded, unpaved driveway away from the stream channel and out of the riparian buffer to minimize the sediment supply to the stream; and by stabilizing stream banks to reduce bank erosion;
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools, developing areas that increase oxygenation, providing woody debris for habitat, and reducing bank erosion; and
- Improve terrestrial habitat by removing invasive species, planting riparian areas with native vegetation and protecting these areas with a permanent conservation easement so that the riparian area will increase storm water runoff filtering capacity, improve bank stability, provide shading to decrease water temperature and improve wildlife habitat.

The majority of the project site consists of forested uplands with a smaller proportion devoted to maintained pasture land. Although the project watershed has been impacted by logging activity and pasture development 100 or more years ago, most of the watershed has returned to a more natural state. Various sections of property on the lower slopes of the property have been developed for residential and agricultural use. The present landowners currently maintain several acres as grassland. There are three single-family residences located in the vicinity of the project streams.

During development of the land for agricultural and residential use, the lower reaches of East Buffalo Creek and three of its tributaries (UT2, UT5 and UT6), were impacted by channel relocation, channelization, and pasture conversion. The project area has also been impacted by road construction, riparian vegetation removal, and the installation of culverts on portions of East Buffalo Creek and its tributaries. The affects of these practices over time led to a decrease of in-stream habitat quality from a combination of changes, including channel incision, channel aggradation and embeddedness, reduced baseflow elevation (from disconnected hydrology), proliferation of invasive species within the riparian buffer, and reduced channel shading. Widespread or systemic channel incision has been limited by a combination of grade control from exposed bedrock, large cobble and boulder substrate that are frequently found throughout these stream systems. Existing woody vegetation along stream banks has kept portions of the banks from eroding although channel erosion was present where woody vegetation had been removed.

This Baseline Monitoring Report presents data on as-built stream parameters, stem count data from vegetation monitoring stations, and the number of times bankfull flows have been met or exceeded as measured by on-site crest gauges. The design proposed for the East Buffalo Creek mitigation site involved both restoration and enhancement approaches. The resulting design should ultimately yield a B3-type channel for UT2 and a B4-type channel for sections where UT6 was enhanced. Based on geomorphic and vegetation data collected, this site is currently on track to meet the hydrologic, vegetative, and stream success criteria specified in the East Buffalo Creek Mitigation Plan.

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1.0 PROJECT GOALS, BACKGROUND, AND ATTRIBUTES

The East Buffalo Creek mitigation site is located approximately three miles north of Robbinsville in Graham County, North Carolina (Figure 1). The project site is situated in the Little Tennessee River Basin, within North Carolina Division of Water Quality (NCDWQ) sub-basin 04-04-04 and United States Geologic Survey (USGS) hydrologic unit 06010204020030. The East Buffalo Creek mitigation project is located in a watershed that is predominantly forested but also contains a small number of residences near East Buffalo Creek and its tributaries. The vast majority of the watershed is in forested cover, with less than one percent of land being in open grassland. Over the past 100 years, various sections of property on the lower slopes and valley bottom have been developed for residential and agricultural use including the hillside where UT2 is located.

Restoration and enhancement activities were conducted predominantly along stream reaches bordering maintained pasture land. These streams have been degraded as a result of past channel relocation and buffer impacts from logging, road building and agricultural activities, but more recently from the maintenance of pasture land involving the mowing and removal of vegetation and driveway maintenance within the stream buffer. Such persistent disturbance to the buffer had allowed invasive plant communities to colonize and propagate throughout much of UT2, UT5 Reach 2, UT6 Reaches 2 and 3, and Reach 2 of East Buffalo Creek. Prior to the mitigation project, UT2 flowed through a ditch perched along the side of the valley wall beside a fence line located on the southern border of a field. This channel had been moved from the low point in the field to the edge of the field to allow for agriculture within the field in the past. Reaches 2 and 3 of UT6 also appeared to have been relocated to the edge of the valley in the past and was bordered by an unpaved gravel driveway that contributed sediment to the channel.

The project involved restoration or enhancement of 2,987 linear feet (LF) of four streams: East Buffalo Creek and three smaller unnamed tributaries (UT2, UT5 and UT6). In addition, 8,558 LF of East Buffalo Creek and other headwater tributaries were preserved. East Buffalo Creek and four of its tributaries included within the project area are identified as “blue-line” streams on the USGS topographic quadrangle (Robbinsville) that includes the site. In order to confirm stream determinations of these “blue-line” streams and all other project reaches included within the East Buffalo watershed, a field evaluation was conducted using the North Carolina Division of Water Quality (NCDWQ) stream assessment protocol. Based on this evaluation, Baker determined that two reaches, UT8 and UT11, were intermittent streams and upstream portions of UT3, UT4, UT5, and UT10 within the easement area were also intermittent. All other project reaches were confirmed to be perennial streams within the project area based on the assessment protocol. The restoration, enhancement, and preservation of 11,545 LF of stream within this project site has generated 3,311 stream mitigation units (SMUs); and 535 SMUs, or 16 percent of the total generated, were derived from intermittent streams, which is well within the 20 percent threshold required.

1.1 Restoration Summary

1.1.1 Location and Setting

The East Buffalo Creek mitigation site is located approximately three miles north of Robbinsville in Graham County, North Carolina. To reach the project site from Robbinsville, take U.S. Highway 129 north for approximately three miles and turn right on to East Buffalo Circle (SR1144). Continue on East Buffalo Circle for about a half mile and turn right on East Buffalo Road (SR1254) and continue to the end. East Buffalo Road transitions to a gravel road; the site is accessible from a gated private driveway located .18 miles past where the road becomes gravel and just past the driveway to a brick home.

East Buffalo Creek, UT6, and UT2 comprise the three main watersheds within the project area, having a combined total drainage area of 0.53 square miles. East Buffalo Creek and UT6 are the two largest drainages within the project watershed, each draining a number of smaller headwater catchments before converging with each other just downstream of the project limits. Unnamed Tributary 6 receives flow from contributing drainage areas of tributaries UT7, UT8, UT9, and UT10.

1.1.2 Project Goals and Objectives

The goals for the East Buffalo Creek restoration project are as follows:

- To create geomorphically stable conditions on the East Buffalo Creek project site;
- To reduce sediment loading through restoration of riparian areas and streambanks;
- To improve and restore hydrologic connections between the creek and floodplain;
- To restore and preserve headwater tributaries draining into East Buffalo Creek (and Lake Santeetlah); and
- To improve aquatic and terrestrial habitat along the project corridor.

To accomplish these goals, the following objectives were implemented:

- Restoration of incised, eroding, and channelized streams by creating a stable channel that has access to its floodplain;
- Relocate the perched stream channel from the side slope ditch to the low point of the valley to restore natural hydrology and geomorphic form;
- Improve water quality by establishing buffers for nutrient removal from runoff; relocating an eroded, unpaved driveway away from the stream channel and out of the riparian buffer to minimize the sediment supply to the stream; and by stabilizing stream banks to reduce bank erosion;
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools, developing areas that increase oxygenation, providing woody debris for habitat, and reducing bank erosion; and,
- Improve terrestrial habitat by removing invasive species, planting riparian areas with native vegetation and protecting these areas with a permanent conservation easement so that the riparian area will increase storm water runoff filtering capacity, improve bank stability, provide shading to decrease water temperature and improve wildlife habitat.

In addition to the objectives stated above, the following overarching design objectives guided the design of streams on this site:

- Make important design decisions based on geomorphic and substrate analyses;
- Use constructability as a guiding consideration in order to produce a realistic design that is possible to build given field constraints and construction tolerances. Design ideas are discussed with knowledgeable construction personnel to determine the constructability, likely footprint, and severity of impacts to on-site resources;
- Minimize disturbance to ecologically functional and physically stable areas; mimic the character of these areas and borrow materials from them where appropriate to create a more natural design; and
- Structures and over-all design will attempt to use native materials and minimize materials brought on-site in order to produce habitat favoring native flora and fauna, reduce compaction and site disturbance from material transport, and produce an aesthetically pleasing result with minimal evidence of site disturbance.

1.1.3 Project Structure, Restoration Type, and Approach

1.1.3.1 Project Structure

Please refer to Table 1 in Appendix A for a summarization of the project structure of East Buffalo Creek. Figure 2, also in Appendix A, illustrates restoration approaches by project reach.

1.1.3.2 Restoration Type and Approach

<u>UT2</u>

A Priority I Restoration approach was used on UT2 to re-locate this channel from the diversion ditch into a new channel located at the low point of the field as a step-pool system. Vertical and lateral stability was achieved by constructing a series of plunge pool structures with short riffles between each structure, creating a series of small grade control drops. Grade control structures dissipate stream flow energy and improve the quality of pool habitat within the constructed channel. A vegetated riparian buffer was also restored along UT2 through the pasture by planting native herbaceous and woody vegetation.

<u>UT6 (Reach 3)</u>

Enhancement Level I work was completed on Reach 3 of UT6 in an effort to improve in-stream habitat by minimizing sediment input to the stream from bank erosion and the adjacent unpaved driveway. Channel improvements consisted of slight adjustments to the dimension and pattern to improve lateral channel stability and the reduction of bank erosion through a combination of bank grading, seeding and matting along the left bank. Grade control structures were strategically placed in selected areas to narrow over-wide, aggrading sections and to improve pool habitat and bedform diversity while reinforcing vertical stability in the channel profile.

Another significant component of this approach involved the re-establishment of a wide, vegetated buffer along the left floodplain by relocating approximately 835 LF of an eroding, unpaved driveway, outside of the easement area. Sedimentation of the stream from the unpaved driveway should be minimized given the proposed increased buffer width and native buffer plantings which will help to improve floodplain sediment filtering capacity and also provide channel shading, bank stability, and vegetative diversity. Water bars and ditch turnouts were installed during construction of the new gravel driveway to diffuse concentrated storm flow, limit erosion and gullying, and to help maintain the integrity of the driveway. Vegetated roadside swales and culverts were also installed at specific locations to direct runoff away from UT6 and toward an existing natural low point possessing mature vegetation.

<u>East Buffalo Creek (Reach 2), UT5 (Reach 2), and UT6 (Reach 2)</u>

An Enhancement II approach was used to improve the riparian buffer by removing invasive, non-native vegetation and planting a diversity of native, woody vegetation where applicable. These native plantings will provide bank stabilization, stream shading and other riparian functions of the buffer zone.

<u>East Buffalo Creek (Reach 1), UT3, UT4, UT5(Reach 1), UT6 (Reach 1), UT7, UT8, UT9, UT10, UT11</u>

These project reaches were placed in Preservation. They are characterized by a wide buffer of mature trees scattered throughout the easement and having a dense herbaceous understory including ferns and mosses that line both banks.

During construction minor changes in the restoration approach were made to plans for UT6. Although the total stream length did not change, the length of the Enhancement I reach on UT6 was reduced while the reach length for an Enhancement II approach increased. The result is a reduction of 149 LF in the Enhancement I reach and 149 LF gain in the total length of

Enhancement II work performed on UT6. This modification was made based on further examination of existing bedform diversity and grade control present.

1.1.4 Project History, Contacts and Attribute Data

The East Buffalo Creek project area primarily drains forested land, with some small areas of grasslands and a few single family residences. The general area in which the project is located is remote and rural, and is not likely to change significantly in the foreseeable future.

The East Buffalo Creek watershed continues to support a few scattered residences as well as small areas of agriculture land. The largest percentage of land use in the watershed currently is in forest cover that provides wildlife habitat and timber production. Most of the forest land upslope of the project property is owned by U.S. Forest Service and is managed as the Nantahala National Forest. The project watershed is forested, with a small percentage of the watershed area developed for agriculture and residential land uses which occur on the lower slopes and within the valley of the watershed, beginning near the convergence of East Buffalo Creek with U2 and UT6, and continuing downstream.

Anthropogenic alteration in the East Buffalo Creek watershed, including channelization of streams for agricultural and residential purposes, has resulted in various stream corridor impairments. Incision, bank erosion, and other stream processes typical of unstable streams were found in various reaches of East Buffalo Creek and the unnamed tributaries within the project area.

In accordance with the approved mitigation plan for the site, construction activities were conducted in September 2010. Project activity on UT2 consisted of restoring a new channel with stable dimension, pattern, and profile at the low point of the valley. The newly constructed channel for UT2 features a step-pool morphology using a series of grade control structures, constructed riffles and a stable channel dimension that allows adequate floodplain connectivity. A Level I Enhancement approach was applied to Reach 3 of UT6. This approach resulted in a more stable channel dimension and profile through bank grading along the left bank, installation of a series of grade control structures, and moving a gravel driveway outside of the easement area. Minor pattern adjustments were also carried out by relocating a portion of the channel away from the valley wall to minimize further bank erosion. Buffer improvements were considerable along this reach. The unpaved gravel driveway was relocated away from UT6, was stabilized, and retrofitted with a series of culverts, waterbars, swales and turnouts that were designed to minimize sediment runoff into UT6. The newly expanded buffer area was also stabilized and enhanced using a permanent, herbaceous seed mixture and a variety of woody vegetation native to the region.

An Enhancement II approach was applied to East Buffalo Creek (Reaches 2a and 2b), UT5 (Reach 2) and UT6 (Reach 2). Riparian enhancements in these reaches were limited to the removal of dense stands of exotic, invasive vegetation and seeding and re-planting of the buffer with native vegetation where applicable.

Besides enabling stream flows larger than bankfull to access a floodplain, dissipating flow energies and reducing streambank stress, effort was also given to relocating a project reach to the low point of the valley and to improving channel profile. Given the steepness of the project area, creating a step-pool channel system was critical in achieving a more stable profile.

In-stream structures were used to control streambed grade, reduce stresses on streambanks, shift the thalweg toward the center of the stream and promote diversity of bedform and habitat. In-stream structures consisted of constructed riffles or cascades, and boulder steps. Reach-wide grade control was provided by the aforementioned in-stream structures, by bedrock or by other natural grade control. Structures were spaced at a maximum distance that results in the downstream header protecting the upstream footer to create a redundancy of protection that will ensure long term vertical stability.

Streambanks were stabilized using a combination of erosion control matting, temporary and permanent herbaceous seeding, bare-root planting, transplants, and live staking. Transplants will provide living root mass quickly to increase streambank stability and create shaded holding areas for aquatic organisms. Native vegetation was planted across the site, and the entire mitigation site is protected through a permanent conservation easement.

The chronology of the East Buffalo Creek mitigation project is presented in Table 2, located in Appendix A which also includes Tables 3 and 4. The contact information for designers, contractors and plant material suppliers is presented in Table 3. Relevant project background information is presented in Table 4. Total stream length across the project increased from approximately 11,156 LF to 11,545 LF. Additional stream length was acquired for some Preservation and Enhancement II reaches during post-processing and re-mapping of surveyed stream data for this report and is denoted in Table 2 of Appendix A.

2.0 SUCCESS CRITERIA

The five-year monitoring plan for the East Buffalo Creek mitigation project includes criteria to evaluate the success of the vegetation and stream components of the project. The specific locations of vegetation plots, permanent cross-sections, reference photo stations and crest gauges are shown on the as-built plans.

2.1.1 Morphologic Parameters and Channel Stability

Geomorphic monitoring of restored stream reaches will be conducted over the next five years to evaluate the effectiveness of the restoration practices installed. Monitored stream parameters include bankfull flows, stream dimension (cross-sections), pattern (longitudinal survey), profile (profile survey), and photographic documentation. The methods used and any related success criteria are described below for each parameter. For monitoring stream success criteria, eight permanent cross-sections and two crest gauges were installed.

2.1.1.1 Dimension

Eight permanent cross-sections were installed to help evaluate the success of the mitigation project. Permanent cross-sections were established throughout the project site as follows: four cross-sections were located on UT2, and four cross-sections were located on UT6. Cross-sections selected for monitoring were located in representative riffle and pool reaches and each cross-section was marked on both banks with permanent pins to establish the exact transect used. A common benchmark will be used for cross-sections and consistently referenced to facilitate comparison of year-to-year data. The cross-sectional surveys will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System.

There should be little change in the as-built cross-sections. If changes do take place, they will be evaluated to determine if they represent movement toward a more unstable condition (e.g., down-cutting or erosion) or movement toward increased stability (e.g., settling, vegetative changes, or deposition along the banks). At this time, cross-sectional measurements do not indicate any streambank or channel stability issues.

2.1.1.2 Pattern and Longitudinal Profile

A longitudinal profile was completed for the restored streams to provide a baseline for evaluating changes in channel bed conditions over time. A longitudinal profile was conducted for the entire project length on UT2 and UT6 involving restoration. Longitudinal profiles will be replicated annually during the five year monitoring period.

Measurements taken along the longitudinal profiles include thalweg, water surface, left and right channel, bankfull, and top of low bank, if the feature is present. The pools should remain deep with flat water surface slopes, and the riffles should remain steeper and shallower than the pools. Bed form observations should be consistent with those observed for channels of the design stream type. Profile data collected should reflect stable channel bedform and a diverse range of riffle and pool complexes.

All measurements will be taken at the head of each feature (e.g., riffle, and pool) and the maximum pool depth. Elevations of grade control structures will also be included in longitudinal profiles surveyed. Surveys will be tied to a permanent benchmark. Permanent cross-section and longitudinal profile data are provided in Appendix B.

The longitudinal profiles show that the bed features are stable; closely-spaced grade control structures should help maintain the overall profile desired. There is a section midway down UT2 where the stream flow goes subsurface through constructed riffles. Given the steepness in slope and the relatively large riffle material used to construct the step-pool channel system, it is likely that the flow will surface as interstitial spaces between the bed particles become filled with smaller particles, roots and organic material. This condition on UT2 will be monitored and if necessary, modifications implemented if surface flow does not begin after the second winter.

2.1.1.3 Substrate and Sediment Transport

Bed material analysis will consist of a pebble count taken in the same constructed riffle during annual geomorphic surveys of the project site. This sample, combined with evidence provided by changes in cross-sectional and profile data will reveal changes in sediment gradation that occur over time as the stream adjusts to upstream sediment loads. Significant changes in sediment gradation will be evaluated with respect to stream stability and watershed changes. As-built surveys do not reveal any significant areas of aggradation or degradation within the project area at this time.

2.1.2 Vegetation

Successful restoration of the vegetation on a site is dependent upon hydrologic restoration, active planting of preferred canopy species, and volunteer regeneration of the native plant community. In order to determine if the criteria are achieved, three vegetation monitoring quadrants were installed across the restoration site. The size of individual quadrants varies from 100 square meters for tree species to 1 square meter for herbaceous vegetation. Vegetation monitoring will occur in spring, after leaf-out has occurred, or in the fall prior to leaf fall. Individual quadrant data will be provided and will include stem diameter, height, density, and herbaceous coverage. Relative values will be calculated, and importance values will be determined. Individual seedlings will be marked to ensure that they can be found in succeeding monitoring years. Mortality will be determined from the difference between the previous year's living, planted seedlings and the current year's living, planted seedlings.

At the end of the first growing season, species composition, density, and survival will be evaluated. For each subsequent year, until the final success criteria are achieved, the restored site will be evaluated between June and November.

The interim measure of vegetative success for the site will be the survival of at least 320, planted trees per acre at the end of Year 3 of the monitoring period. The final vegetative success criteria will be the survival of 260, planted trees per acre at the end of Year 5. If the measurement of vegetative density proves to be inadequate for assessing plant community health, additional plant community indices may be incorporated into the vegetation monitoring plan as requested by the NCEEP.

Seeding applied to streambanks beneath the erosion matting sprouted within two weeks of application and has provided good ground coverage. Live stakes and bare root trees planted are also providing streambank stability. Bare-root trees were planted throughout the conservation easement with the exception of the preservation reaches. A minimum 30-foot buffer was established along the restored stream reach. In general, bare-root vegetation was planted at a target density of 680 stems per acre, in an 8-foot by 8-foot grid pattern. Planting of bare-root trees was completed in the winter of 2011. Species planted are listed below.

Riparian Buffer Plantings (Bare-Root and Live Stake Species)

Trees	
Sycamore	*(Platanus occidentalis)*
White Oak	*(Quercus alba)*
Red Oak	*(Quercus rubra)*
River birch	*(Betula nigra)*
Tulip Poplar	*(Liriodendron tulipifera)*
White Oak	*(Quercus alba)*
Mockernut Hickory	*(Carya alba)*
Yellow Buckeye	*(Aesculus octandra)*
Red Maple	*(Acer rubrum)*
Black Walnut	*(Juglans nigra)*
Alternate Species	
Tag Alder	*(Alnus serrulata)*
Flowering Dogwood	*(Cornus florida)*
Shrubs/small trees	
Witch Hazel	*(Hamamelis virginiana)*
Sweet Shrub	*(Calycanthus floridus)*
Redbud	*(Cercis canadensis)*
Clethra	*(Clethra spp.)*
Deerberry	*(Vaccinium stamineum)*
Woody Vegetation for Live Stakes	
Silky Willow	*(Salix sericea)*
Ninebark	*(Physocarpus opulifolia)*
Elderberry	*(Sambucus canadensis)*
Silky Dogwood	*(Cornus amomum)*
Buttonbush	*(Cephalanthus occidentalis)*

The restoration plan for the East Buffalo Creek Site specifies that the number of quadrants required will be based on the species/area curve method, as described in NCEEP monitoring guidance documents. The size of individual quadrants is 100 square meters for woody tree species, and 1 square meter for herbaceous vegetation. A total of three vegetation plots, each 10 by 10 meters or 5 by 20 meters in size, were established across the restored site. The initial planted density within each of the vegetation monitoring plots is given in Table 6, Appendix C. The average density of planted bare root stems, based on the data from the three monitoring plots, is 1,039 stems per acre which indicates that the Site is on track for meeting the minimum success interim criteria of 320 trees per acre by the end of Year 3 and the final success criteria of 260 trees per acre by the end of Year 5. The locations of the vegetation plots are shown on the as-built plan sheets.

2.1.3 Hydrology

2.1.3.1 Streams

The occurrence of bankfull events within the monitoring period will be documented by the use of a crest gauge and photographs. A crest gauge was installed on the floodplain of UT2 as well as UT6-Reach 3 at bankfull elevation. The crest gauges will record the highest watermark between site visits and will be checked at each site visit to determine if a bankfull event has occurred.

Photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

Two bankfull events, occurring in separate years, must be documented within the 5-year monitoring period.

2.1.4 Photographic Documentation of Site

Photographs will be used to document restoration success visually. Reference locations will be photographed during the as-built survey and for at least five years following construction. Reference photos will be taken once a year, from a height of approximately five to six feet. Permanent markers will be established and reference photographs used in the field to ensure that the same locations (and view directions) on the site are photographed during each monitoring period. Selected site photographs from the restoration, enhancement and preservation reaches are shown in Appendix B. Photographs were taken at the time Enhancement II reaches were being treated for exotic, invasive vegetation.

2.1.4.1 Lateral Reference Photos

Reference photo transects will be taken at each permanent cross-section. Photographs will be taken of both banks at each cross-section. A survey tape will be centered in the photographs of the bank. The water line will be located in the lower edge of the frame, and as much of the bank as possible will be included in each photo. Photographers will make an effort to consistently maintain the same area in each photo over time.

2.1.4.2 Structure Photos

Photographs of constructed grade control structures (i.e. vanes and weirs) along the restored streams are included within the photographs taken at reference photo stations. Photographers will make every effort to consistently maintain the same area in each photo over time.

Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, structure function and stability, and effectiveness of erosion control measures subjectively. Lateral photos should not indicate excessive erosion or degradation of the banks. A series of photos over time should indicate successive maturation of riparian vegetation and consistent structure function.

2.2 Areas of Concern

At this time the only area of concern is lack of water in a section of UT2. As noted in Section 2.1.1.2, we believe that the surface flow is presently flowing beneath and through the channel bed material. The flow should surface once more as interstitial spaces between the constructed riffles become filled by smaller particles and organic material. UT2 will be monitored and if necessary, modifications will be made to establish surface flow throughout the project reach.

3.0 MAINTENANCE AND CONTINGENCY PLANS

Maintenance requirements vary from site to site and are generally driven by the following conditions:

- Projects without established, woody floodplain vegetation are more susceptible to erosion from floods than those with a mature, hardwood forest;
- Projects with sandy, non-cohesive soils are more prone to short-term bank erosion than cohesive soils or soils with high gravel and cobble content;
- Alluvial valley channels with wide floodplains are less vulnerable than confined channels;

- Wet weather during construction can make accurate channel and floodplain excavations difficult;
- Extreme and/or frequent flooding can cause floodplain and channel erosion;
- Extreme hot, cold, wet, or dry weather during and after construction can limit vegetation growth, particularly temporary and permanent seed; and
- The presence and aggressiveness of invasive species, which can affect the extent to which a native buffer can be established.

Maintenance issues and recommended remediation measures will, if needed, be detailed and documented in future monitoring reports. Factors that may have caused any maintenance needs, including any of the conditions listed above, shall be discussed. NCEEP will be notified prior to any remedial action.