Snowbird Creek Tributaries Mitigation Project

Year 5 Monitoring Report
Graham County, North Carolina

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Prepared for: North Carolina Division of Mitigation Services (NCDMS)

NCDMS Project Manager: Paul Wiesner

NCDMS Contract Number: 000613 NCDMS Project Number: 92764

Project Construction: 2010

Year 5 Data Collection: 2015

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EXECUTIVE SUMMARY

The Snowbird Creek Tributaries site was restored through a full delivery contract with the North Carolina Division of Mitigation Services (NCDMS). This report documents the completion of the project and presents Year 5 monitoring data for the five-year monitoring period. The goals for the restoration project were as follows:

- Promote and recreate geomorphically stable conditions at the Snowbird Creek Tributaries project site;
- The reduction of sediment and nutrient inputs through restoration of riparian areas and streambanks; and
- To improve aquatic and terrestrial habitat along the project corridor.

To accomplish these goals, the following objectives were implemented:

- Restoration of an incised, channelized, and eroding stream by creating a stable channel that has access to its floodplain; enhancement of a previously disturbed stream reach by replanting the riparian corridor with native woody vegetation;
- Improve water quality by establishing buffers for nutrient removal from runoff;
- 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.

One vegetation monitoring plot 100 square meters (m^2) (10m x 10m) in size was used to predict the survival of woody vegetation planted on-site. The Year 5 monitoring of vegetation indicated an average survival of 688 stems per acre. The data indicates that the Site has met both the interim stem survival criteria for Year 3 (320 stems per acre) and has significantly exceeded the final success criteria of 260 trees per acre at the end of Year 5.

The design implemented at the Snowbird Creek Tributaries mitigation project site involved Priority Level 1 Restoration, Enhancement Level II and Preservation approaches. The channels on UT3 Reach 2 was built to be consistent with, or evolve to, a stable B3-type channel and to maintain the B4-type channel in the section of UT2 that was enhanced. Restoration and enhancement work were completed in accordance with the approved design approach provided in the mitigation plan for the tributaries. Longitudinal profile and cross-section data indicate that the project streams have remained stable since baseline monitoring data were collected in February 2011. Multiple bankfull events have now been documented (in separate years) over the course of the five year monitoring period, thereby satisfying the hydrologic success criteria. Photo logs included in this report confirm that the woody and herbaceous vegetation at the project site is flourishing, and is promoting bank and floodplain stability. Based on geomorphic and hydrologic data presented in Appendix D and E, this Site has met the stream and hydrologic success criteria specified in the Snowbird Creek Tributaries Mitigation Plan.

Summary information/data related to potential threats to restoration values, such as encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. There were no vegetation areas of concern identified at this site during the Year 5 monitoring period. Photographs are included in Appendix F that show the recovery of an area noted as being of concern in previous years.

Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report (formerly Mitigation Plan) and in the Mitigation Plan (formerly Restoration Plan) documents available on DMS's website. All raw data supporting the tables and figures in the appendices is available from DMS upon request.

NCDMS received comments in the past that requested the installation and monitoring of additional vegetation plots. Baker agreed to implement one additional random temporary vegetation plot on UT2 at the enhancement reach to document the number of live woody stems and include the results in the Year 4 & Year 5 Monitoring Report. To assist with determining vegetation success on UT2 Reach 2, two additional photograph stations were installed to visually document changes in the riparian corridor over the course of the monitoring period. Based on observations, woody vegetation is reestablishing where the riparian area was disturbed on Reach 2 of UT2. During Year 4 monitoring of the UT2 enhancement reach a temporary vegetation plot was established and all trees that appeared to be less than 4 years old were counted. The Year 5 count indicated that the density is approximately 890 trees per acre on the UT2 enhancement reach. Woody vegetation observed within the plot included Elderberry (*Sambucus nigra*), tuliptree (*Liriodendron tulipifera*), Sweet birch (*Betula lenta*), northern red oak (*Quercus rubra*) and black gum (*Nyssa sylvatica*).

1.0 PROJECT BACKGROUND AND ATTRIBUTES

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina (Figure 1, Appendix A). The project site is situated in the Little Tennessee River Basin, within what was formerly referred to as the North Carolina Division of Water Resources (NCDWR) sub-basin 04-04-04 and United States Geologic Survey (USGS) hydrologic unit 06010204020010. The Snowbird Creek Tributaries mitigation project is located in a watershed that is predominantly forested, but also contains a small number of residences near the tributaries and Hooper Branch. The vast majority of the watershed is in forested cover, with less than one percent of land being in agricultural use. Over the past 100 years, land within the project area has been impacted by logging activities as well as residential and agricultural land use within the valley bottom.

Anthropogenic land use alteration and channelization of streams in the Snowbird Creek Tributaries project watersheds have resulted in various stream corridor impairments. Incision, bank erosion, and other ongoing stream processes typical of adjusting streams were found in various reaches of UT3 and other tributaries within the project area. However, it was determined that the benefits of stream and riparian enhancement further upslope in the watershed would not be significant enough to justify further disturbance of the watershed which continues to revert to a more natural state in the absence of intensive logging activities.

In accordance with the approved mitigation plan for the site, construction activities were conducted in August 2010. Project activity on UT2 consisted of improving bank stability and riparian conditions along a small section of UT2 that had been degraded by previous logging activities. An Enhancement II approach was used to stabilize this reach; efforts included removal of debris from the channel that was contributing to channel disturbance and planting native woody vegetation in an area previously disturbed during logging activities. Re-vegetation of the riparian corridor will improve shading and provide high quality biomass to the stream in addition to other habitat improvements.

A Priority I Restoration approach was used on Reach 2 of UT3 to address prior manipulation and relocation of the reach by restoring a channel with step-pool morphology in the low part of the valley. The restoration of this reach of UT3 eliminated bank erosion, aggradation of fines, and lack of native riparian vegetation and rootmass that characterized the former location of Reach 2 on UT3. The new channel has improved connectivity to its floodplain and channel bedform was improved by constructing a series of step-pool and riffle-pool sequences using grade control structures. These grade control structures will aid in dissipating streamflow energy, decrease pool-to-pool spacing and improve the quality of in-stream habitat. Given the steepness of the project area, creating a step-pool channel system was critical in achieving a more stable profile and preventing self-propagating headcuts. A vegetated riparian buffer was also planted which will support streambank stability along the new reach while serving a variety of terrestrial and aquatic habitat functions.

The project involved the restoration of 543 linear feet (LF) of UT3 (Reach 2) and the enhancement of 171 LF of UT2 (Reach 2). In addition, 7,497 LF of UT1, UT2 and UT3 were preserved with a conservation easement deed. The restoration, enhancement, and preservation of 8,211LF of stream within this project site will generate 2,035 stream mitigation units (SMUs). Other general information about the project is located in Tables 1-4 of Appendix A.

1.1 Location and Setting

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina. To reach the project site from the intersection of NC Highways 143 and 129, turn south onto N.C. Highway 129. At the first stop light past the Microtel, turn right onto East Main Street, continue for approximately 0.3 miles, and turn left onto Atoah Street. Atoah Street becomes Snowbird Road (both are NC Highway 143). Snowbird Road (NC 143) will come to parallel Santeetlah Reservoir (an inundated portion of Snowbird Creek). At the intersection of IU Gap Road and Snowbird Road, the property will be situated to the east. The last house on the left before you get to this intersection is the property owners and just before you get to this house there is a gated dirt road that leads to UT1 and UT2. To get to UT3, turn left on IU Gap Rd., go .15 miles, the UT3 property is on the left and the access drive is on the left just past a small rental farm house.

2.0 METHODOLOGY AND RESULTS

The five-year monitoring plan for the Snowbird Creek Tributaries mitigation project includes criteria to evaluate the success of the geomorphic, vegetative and hydrologic components of the project. The specific locations of the cross-sections, sediment sampling location, vegetation plot, crest gauge installation and permanent reference photo stations, are shown on the current condition plan view submitted with this report.

2.1 Stream Assessment

2.1.1 Morphologic Parameters and Channel Stability

Geomorphic monitoring of restored stream reaches has been conducted over a five year period to evaluate the effectiveness of the restoration practices installed. Monitored stream parameters include channel dimension (cross-sections), profile (longitudinal survey), pattern (to a lesser degree for reasons noted below), bed composition, bank stability, bankfull flows, and stability of photo points documented by photographs (USACE 2003). A crest gauge, as well as high flow marks, were used to document the occurrence of bankfull events. The methods used and any related success criteria are described below for each parameter.

2.1.1.1 Dimension

Four permanent cross-sections were installed in representative riffle and pool reaches on the restoration reach of UT3 to help evaluate the success of the mitigation project. Each cross-section was established by installing permanent pins on each bank to establish a consistent and repeatable transect from year-to-year. The cross-sectional surveys capture points at all breaks in slope and includes typical features such as top of bank, bankfull (if different from top of bank), inner berm, edge of water, and thalweg. Cross-sections are provided in Exhibit 3 of Appendix D and are depicted with an orientation looking downstream. Riffle cross-sections are classified using the Rosgen Stream Classification System. The project was built with a larger-than-typical entrenchment ratio for B-type channels, however Baker has determined that the B classification is still most appropriate based on other channel characteristics, namely width-depth ratio, sinuosity, and slope.

There should be little change in the as-built cross-sections. Any changes will be evaluated to determine their cause and whether they represent movement toward a more unstable

condition (e.g., down-cutting or erosion) or movement toward increased stability (e.g., settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio).

2.1.1.1.1 Results

As-built cross-section data for stream stability was collected in February 2011 (for the YR0 – 2010 report). The four permanent cross-sections along UT3 were re-surveyed in October 2015 to document stream dimensions for Year 5 Monitoring. Cross-sectional data is presented in Table 8 (Appendix D) and the location of cross-sections is shown on the CCPV sheets submitted with this report.

The cross-sections show that there has been little to no adjustment to stream dimension on Reach 2 of UT3 since construction. Cross-section 4 showed an increase in depth over the 5 years but the banks do not appear unstable and these changes likely represent minor, localized changes to channel morphology. This may be due to the movement of cobble in and out of the transect. At this time, cross-sectional measurements and photographs do not indicate any streambank or channel stability issues.

2.1.1.2 Pattern and Longitudinal Profile

As-built profile monitoring data for stream stability was collected in February 2011. A longitudinal profile was conducted for the entire project length on Reach 2 of UT3. This longitudinal profile was re-surveyed during October 2015; the profile is provided in Exhibit 4 of Appendix D. This longitudinal profile has been replicated annually during the five year monitoring period.

Measurements taken along the longitudinal profile include thalweg, water surface, and top of left and right bank. Pools should remain relatively 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 should reflect stable channel bedform and a diverse range of riffle and pool complexes.

All measurements were taken at the head of each feature (e.g., riffle, run, pool, and glide) and the maximum pool depth. Elevations of grade control structures were also included in the longitudinal profiles surveyed. Surveys were tied to a permanent benchmark. Although pattern adjustments were made on Reach 2 of UT3 for channel alignment considerations, such as following the low point of the valley, pattern adjustments were not made with the intent to increase sinuosity. Unnamed Tributary 3 is an A/B-type stream characterized as having a step-pool morphology. Consequently, pattern information is not provided in Appendix D, as the parameters present are generally associated with meandering, riffle-pool channels and not step-pool channels. However, as the site was monitored, reaches were evaluated for significant changes in pattern.

2.1.1.2.1 Results

The longitudinal profile shows that the bed features are stable; grade control structures continue to help maintain the overall profile desired. As noted in the Stream Reach Morphology Data Tables in Appendix D (Table 9), riffle and pool characteristics do not appear to have changed much since construction; the riffle slope and pool spacing measurements obtained for Year 5 are acceptable when compared to design data provided for Reach 2 of UT3. Channel depth does indicate minor deepening at some locations along the profile. This likely reflects increased sediment movement with higher flows experienced some years. Bedform diversity, particularly max pool depths and pool spacing features, appears to have improved with the restoration of the channel; grade control structures have helped maintain vertical stability in Reach 2 of UT3 as the channel adjusts to a more natural B-type channel.

There was little to no change in the profile of Reach 2 of UT3 since construction. There is some piping around the second step of a boulder step structure near station 0+95 when flow is low; however, during higher discharge we flows go over this step. At this time, the structure is not considered to be an area of concern and it has exhibited similar functioning over the monitoring period. No other stream problem areas were observed during Monitoring Year 5. There were no signs of bank or channel instability observed during the Monitoring Year 5 survey.

2.1.1.3 Substrate and Sediment Transport

Bed material analysis consists 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 transport and bed gradation that occur over time as the stream adjusts to upstream sediment loads and cross-sections evolve into a more permanent stable dimension. Significant changes in bed load composition are evaluated with respect to stream stability and watershed changes.

2.1.1.3.1 Results

For this project, a pebble count was collected on UT3. Visual observations of UT3 and a review of pebble count data collected during Year 5 monitoring do not yield any signs that sediment transport functions have been impaired by the mitigation project; specifically, no significant areas of aggradation or degradation within the project area were observed. The pebble count data (Exhibit 5, Appendix D) indicates that the stream is moving fines through the system and larger pebbles are making up a greater percentage of the bed material. Between the time pebble count data was taken during the as-built and YR1 the bed material became more course. Over the last five years bed material has remained very similar having the bed material size that might be expected for a small, high slope stream. Year 5 showed a slight increase in the smaller size classes but also a greater percentage of many of the larger size classes also. This does not indicate an issue for which we need to be concerned.

2.1.2 Hydrology

2.1.2.1 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 UT3 at the bankfull elevation. The crest gauge recorded the highest flow elevation between site visits and was checked at each site visit to determine if a bankfull event had occurred. Photographs were used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring site visits.

Two bankfull flow events must be documented within the 5-year monitoring period. The two bankfull events must occur in separate years; otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years or we reach the end of the monitoring period. If we reach the end of the monitoring period without two bankfull events occurring, the IRT will decide how to proceed.

2.1.2.1.1 Results

The site was found to have at least one bankfull event over the Year 5 monitoring period based on a crest gauge reading. A total of at least five bankfull events have now been documented onsite within the five year monitoring period (with at least one event documented per monitoring period). These bankfull events were documented to have occurred in five separate years and thus fulfills the hydrology success criteria for this stream mitigation project site. Information on these events is provided in Table E10 (Appendix E).

2.1.3 Photographic Documentation of Site

Photographs will be used to document restoration success visually. Photo reference point sites were photographed during the as-built survey; photographing these sites has been repeated for the last five years. Photographs were taken once a year, from a height of approximately five to six feet. Permanent field markers and reference photographs for field use will ensure that the same locations (and view) are utilized during each monitoring period. Site photo logs with photo point photographs are shown in Appendix B.

Lateral and structure photographs are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, structure function and stability, and effectiveness of erosion control measures. 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. Photo documentation of the site during Year 5 monitoring reflects stable site conditions in restored and enhanced areas.

2.1.3.1 Lateral Reference Photos

Reference photos of transects were taken of the right and left banks at each permanent cross-section. A survey tape was shown in the photographs and represents the cross-section line located perpendicular to the channel flow. The water surface was located in the lower edge of the frame in order to document bank and riparian conditions. Photographers will make an effort to consistently maintain the same area in each photo over time.

2.1.3.2 Structure Photos

Photographs of primary 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.

2.1.3.2.1 Results

Photographs of the restoration project were taken in November 2015. The photographs illustrate stable conditions across the project site. Vegetative growth along the streambanks and riparian buffers has become dense and improved since construction was completed in 2011. Structures are functioning as designed.

2.1.4 Stream Stability Assessment

In-stream structures installed within the restored streams consisted of boulder steps. Table 11 in Appendix F provides a comprehensive visual assessment of morphological stability throughout the restored area (Reach 2 of UT3). The Year 5 visual observations of these structures indicate that little or no changes have occurred since the baseline survey was performed; structures are functioning as designed and are holding their elevation and grade. The close spacing of grade control structures on UT3 and favorable bank heights are allowing for both vertical and lateral energy dissipation of the stream during flood events; no structures were found to be in need of repair at this time. No stream problem areas were identified during MY5.

Quantitative reference reach and design data used to determine the restoration approach, as well as the Year 5 data collected during the project's post-construction monitoring period are summarized in Appendix D.

2.2 Vegetation Assessment

2.2.1 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. The restoration plan for the Snowbird Creek Tributaries Site specifies that the number of vegetation monitoring quadrants required will be based on the species/area curve method (Peet 1998 and Lee 2007), as described in NCDMS monitoring guidance documents. The size of individual quadrants is 100 square meters for woody tree species, and 1 square meter for herbaceous vegetation. Level 1 CVS vegetation monitoring will occur in spring, after leaf-out has occurred, or in the fall prior to leaf fall.

At the end of the first growing season during baseline surveys, species composition, density, and survival were evaluated. Individual quadrant data provided during subsequent monitoring events will include diameter, height, density, and coverage quantities. Individual stems were marked to ensure that they could be found in succeeding monitoring years. Mortality was determined from the difference between the previous year's living, planted stems and the current year's living, planted stems.

Photographs were used to document vegetation success in sample plots. Reference photos of tree and herbaceous condition within plots have been taken at least once per year. Photos of the plots are included in Appendix B of this report.

The interim measure of vegetative success for the site is the survival of at least 320 trees per acre at the end of Year 3 of the monitoring period. The final vegetative success criteria is the survival of 260 planted trees per acre at the end of Year 5 of the monitoring period.

Seeding applied to streambanks sprouted within two weeks of application and has provided excellent ground coverage. Live stakes and bare root trees are also flourishing and increasingly contribute to streambank stability and shading. 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 late March-early April 2011. Species planted are included in the proposed list below.

Proposed Bare-Root and Live Stake Species (may also include seed or container species)				
Snowbird Creek Tributaries Mitigation Plan-NCDMS Project #92764				
Common Name	**Scientific Name**	**% Planted by Species**	**Planting Density**	**Wetness Tolerance**
Riparian Buffer Plantings				
Trees Overstory				
Sycamore	*Platanus occidentalis*	8	54	FACW-
River Birch	*Betula nigra*	7	48	FACW
White Oak	*Quercus alba*	5	34	FACU
Red Maple	*Acer rubrum*	5	34	FAC
Tulip Poplar	*Liriodendron tulipifera*	5	34	FAC
Yellow Birch	*Betula alleghaniensis (lutea)*	5	34	FACU+
Black (Sweet) Birch	*Betula lenta*	5	34	FACU
Northern Red Oak	*Quercus rubra*	5	34	FACU
Yellow Buckeye	*Aesculus octandra*	5	34	N/A
Mockernut Hickory	*Carya alba (tomentosa)*	3	20	N/A

Proposed Bare-Root and Live Stake Species (may also include seed or container species)				
Snowbird Creek Tributaries Mitigation Plan-NCDMS Project #92764				
Common Name	**Scientific Name**	**% Planted by Species**	**Planting Density**	**Wetness Tolerance**
Scarlet Oak	*Quercus coccinea*	2	14	N/A
Trees Understory				
Highland Doghobble	*Leucothoe fontanesiana (axilarris var. editorum)*	5	34	N/A
Mountain Laurel	*Kalmia latifolia*	5	34	FACU
Flame Azalea	*Rhododendron calendulaceum*	5	34	N/A
Black Willow	*Salix nigra*	2	14	OBL
Ironwood	*Carpinus caroliniana*	3	20	FAC
Witch Hazel	*Hamamelis virginiana*	2	14	FACU
Sourwood	*Oxydendrum arboreum*	5	34	FACU
Flowering Dogwood	*Cornus florida*	5	34	FACU
Rhododendron	*Rhododendron maximum*	3	20	FAC-
Tag Alder	*Alnus serrulata*	5	34	FACW+ or OBL
Redbud	*Cercis canadensis*	5	34	FACU
Shrubs				
Rivercane (giant cane)	*Arundinaria gigantea*	15	102	FACW
Spicebush	*Lindera benzoin*	15	102	FACW
Deerberry	*Vaccinium stamineum*	15	102	FACU
Eastern Sweetshrub, Sweetshrub	*Calycanthus floridus, Calycanthus spp.*	10	68	FACU
Sweetpepperbush	*Clethra spp.*	15	102	N/A
Winterberry	*Ilex verticillata*	10	68	FACW
Virginia Sweetspire	*Itea virginica*	15	102	FACW+
Chokeberry	*Photinia*	5	34	N/A
Alternate Species				
Riparian Livestake Plantings				
Ninebark	*Physocarpus opulifolius*	15	102	FAC-
Elderberry	*Sambucus canadensis*	20	136	FACW-
Buttonbush	*Cephalanthus occidentalis*	15	102	OBL
Silky Willow	*Salix sericea*	25	170	OBL
Silky Dogwood	*Cornus amomum*	25	170	FACW+
Note: Species selection may have changed due to refinement or availability at the time of planting.				

In order to determine if the vegetation criteria was achieved, one vegetation monitoring quadrant, 10 by 10 meters in size, was installed on Reach 2 of UT3 in April 2011 as prescribed by the DMS monitoring guidance that was required for this project (CVS-DMS protocol dated 11/06/06). This plot includes a 1 square meter sub-quadrant for visually documenting the success of herbaceous vegetation.

2.2.1.1.1 Results

Tables 5 through 7b in Appendix C present information on vegetation success criteria, vegetation metadata, and stem counts for the vegetation plot. Vegetation data was collected in November 2015. Data from the Year 5 monitoring event indicates that approximately 86.1% of the stems surveyed were in fair to excellent condition and 86% of the stems in the plot showed no signs of damage. The average density of planted bare root stems, based on data collected from the plot during Year 5 monitoring is 688 stems per acre or 17 stems per plot. The site was originally planted with approximately 1,012 bare root stems per acre after construction (as cited in the Baseline Monitoring Document), or 25 stems per plot. Therefore, between the Baseline and Year 5 monitoring periods, an average mortality of eight stems has been observed. An average density of 688 stems per acre indicates that the Site has met the final success criteria of ≥260 trees per acre by the end of Year 5. Additionally, six (6) volunteer Tag Alders (*Alnus serrulata*) were observed within this vegetation plot. The volunteers were not included on tables 7 and 7b as a result of the vegetation analysis module in the CVS-DMS program that was utilized. The location of the vegetation plot is shown on the Current Condition Plan View.

On Reach 2 of UT2 (the Enhancement II Reach), two additional photography points, 3a and 3b, were established in monitoring Year 2 to help monitor the changes in the riparian buffer where logging debris was originally removed. Photographs for these stations are displayed in Exhibit 1 of Appendix B and their locations are georeferenced in Figures 2. Photographs will be taken on an annual basis to visually document changes in the riparian corridor over the course of the monitoring period. Additionally in monitoring Year 4, as an alternative to establishing a vegetation monitoring plot in this reach (due to issues associated with doing this, as recorded in earlier reports) Baker began conducting temporary counts of young living trees. In Year 5 two observers independently counted all trees that appeared to be less than 5 years old throughout a 10m x 10m area (temporarily marked at each corner). A total of 21 and 23 trees were counted by the observers, respectively, resulting in an average of 22 trees. This indicates that the density is approximately 890 trees per acre on the UT2 enhancement reach. Woody vegetation observed within the plot included Elderberry (*Sambucus nigra*), tuliptree (*Liriodendron tulipifera*), Sweet birch (*Betula lenta*), northern red oak (*Quercus rubra*) and black gum (*Nyssa sylvatica*).

2.3 Areas of Concern

There are no Areas of Concern at this time.

In the Monitoring Year 4 Report we explained that an area of concern reported in previous years, located along the left bank floodplain of the UT3-Restoration reach (near station 0+10 to 1+40), had been repaired. The path within the easement was approximately 15 feet wide by 130 feet long. We moved this path outside of the easement and replanted the area with larger trees in March 2015. There have been no further encroachments into this area and the planted vegetation is growing well. This area is no long considered an Area of Concern.

3.0 REFERENCES

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Peet, R.K., T.R. Wentworth and P.S. White. 1998. “A flexible, multipurpose method for recording vegetation composition and structure.” Castanea 63:262-274.

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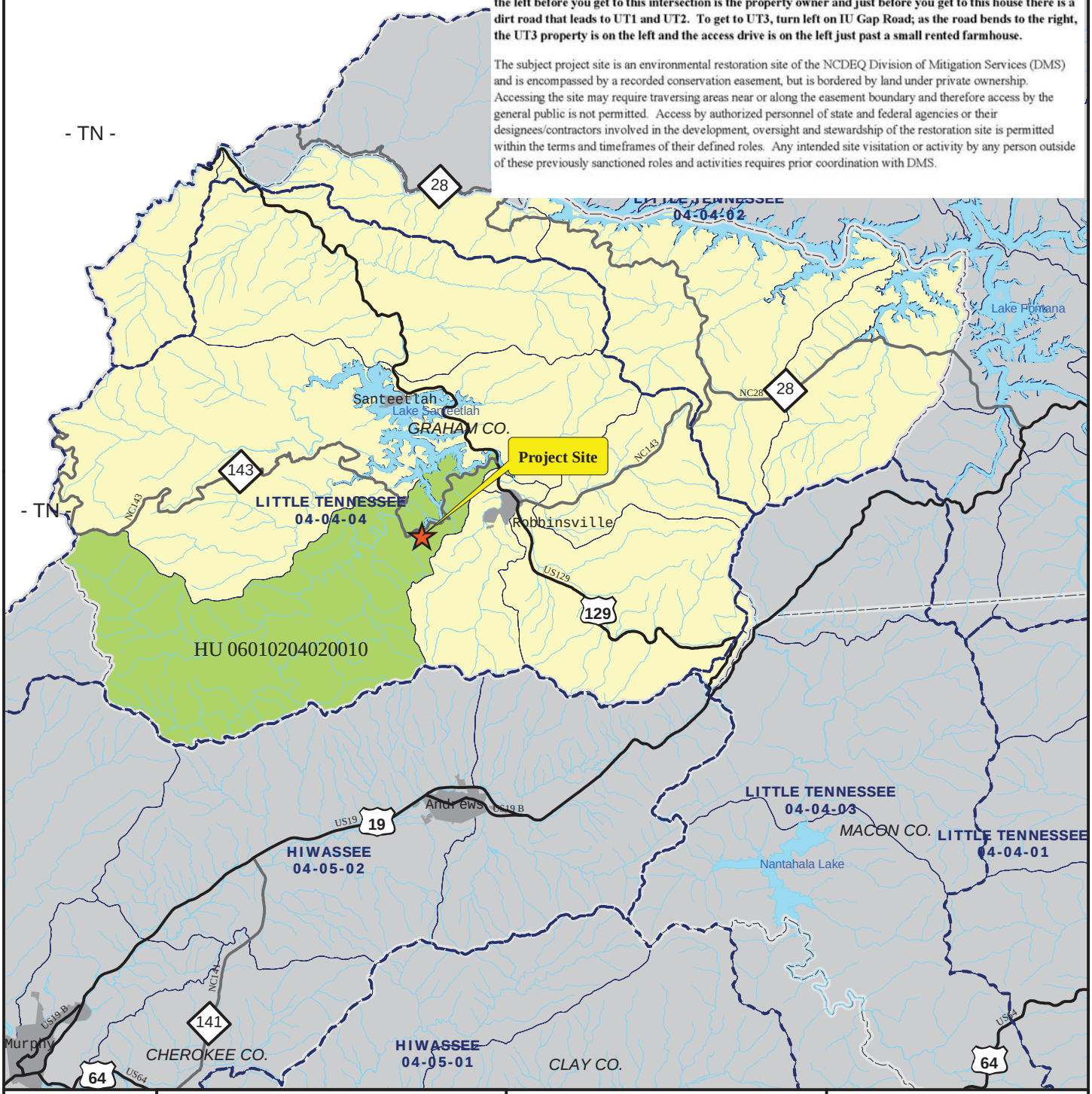
APPENDIX A
FIGURE & GENERAL TABLES

LOCATION MAP
TABLES 1-4

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina. To reach the project site from the intersection of N.C. Highways 143 and 129 in Robbinsville, turn south onto N.C. Highway 129. At the first stop light past the Microtel, turn right onto East Main Street, continue for approximately .3 miles, and turn left onto Atoah Street. Atoah Street becomes Snowbird Road (both are N.C. Highway 143). Snowbird Road (N.C. Highway 143) will come to parallel Santeetlah Reservoir (an inundated portion of Snowbird Creek). At the intersection of IU Gap Road and Snowbird Road, the property will be situated to the east. The last house on the left before you get to this intersection is the property owner and just before you get to this house there is a dirt road that leads to UT1 and UT2. To get to UT3, turn left on IU Gap Road; as the road bends to the right, the UT3 property is on the left and the access drive is on the left just past a small rented farmhouse.

The subject project site is an environmental restoration site of the NCDEQ Division of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with DMS.



North Carolina Division of Mitigation Services

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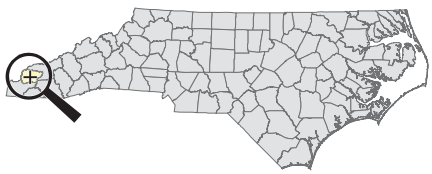


Graham County, NC

LEGEND:

- NCDWR Sub-basin
- Counties
- USGS Hydrologic Unit
- Project Hydrologic Unit
- Graham County

0 1 2 4 Miles

Figure 1. Project Vicinity Map

Snowbird Creek Tributaries Project
Graham County, NC

Michael Baker INTERNATIONAL

Figure 1. Notes

The Snowbird Creek Tributaries mitigation site is located approximately one and a half miles southwest of Robbinsville in Graham County, North Carolina. To reach the project site from the intersection of N.C. Highways 143 and 129 in Robbinsville, turn south onto N.C. Highway 129. At the first stop light past the Microtel, turn right onto East Main Street, continue for approximately .3 miles, and turn left onto Atoah Street. Atoah Street becomes Snowbird Road (both are N.C. Highway 143). Snowbird Road (N.C. Highway 143) will come to parallel Santeetlah Reservoir (an inundated portion of Snowbird Creek). At the intersection of IU Gap Road and Snowbird Road, the property will be situated to the east. The last house on the left before you get to this intersection is the property owner and just before you get to this house there is a dirt road that leads to UT1 and UT2. To get to UT3, turn left on IU Gap Road; as the road bends to the right, the UT3 property is on the left and the access drive is on the left just past a small rented farm house.

The subject project site is an environmental restoration site of the NCDEQ Division of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, oversight and stewardship of the restoration site is permitted within the terms and timeframes of their defined roles. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with DMS.

Table 1A. Project Components and Mitiation Credits (Old Format)									
Snowbird Creek Tributaries Mitigation Project-NCDMS Project #92764									
Project Segment or Reach ID	**Existing Feet/Acres**	**Mitigation Type**	**Approach**	**Target Stream Type**	**Footage or Acreage**	**Mitigation Ratio**	**Mitigation Units**	**Stationing**	**Comment**
UT1	3,213LF	P	-	-	3,213 LF	5:1	643	-	No channel alteration (preservation).
UT2 - Reach 1	1,033 LF	P	-	-	1,033 LF	5:1	207	-	No channel alteration (preservation).
UT2 - Reach 2	171 LF	EII	-	B3a	171 LF	2.5:1	68	-	Removal of woody debris; stabilize streambanks; replanting with native vegetation.
UT2 - Reach 3	675 LF	P	-		675 LF	5:1	135	-	No channel alteration (preservation).
UT3 - Reach 1	2,576LF	P	-	-	2,576LF	5:1	515	-	No channel alteration (preservation).
UT3 - Reach 2	543 LF	R	PII	Aa+	467 LF	1:1	467	-	Relocate channel in lowest point of the valley; establish a step-pool channel with stable banks and floodplain connectivity.

Mitigation Unit Summations					
Stream (SMU)	Riparian Wetland (WMU)	Nonriparian Wetland (WMU)	Total Wetland (WMU)	Buffer (BMU)	Comment
2,035	NA	NA	NA	NA	
Notes:					

Table 1B. Project Components and Mitigation Credits New Format

Snowbird Creek Tributaries Mitigation Project-NCDMS Project #92764

Mitigation Credits

	Stream		Riparian Wetland		Non-Riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	535	1,500	NA	NA	NA	NA	NA	NA	NA

Project Components

Project Component or Reach ID	Stationing/Location	Existing Footage/Acreage	Approach (PI, PII etc.)	Restoration or Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
UT1		3,213 LF	-	P	3,213 LF	5:1
UT2 - Reach 1		1,033 LF	-	P	1,033 LF	5:1
UT2 - Reach 2		171 LF	Bank St/plant	EII	171 LF	2.5:1
UT2 - Reach 3		675 LF	-	P	675 LF	5:1
UT3 - Reach 1		2,576 LF	-	P	2,576 LF	5:1
UT3 - Reach 2		543 LF	PII	R	467 LF	1:1

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Reverine	Non-Riverine			
Restoration	467	NA	NA	NA	NA	NA
Enhancement		NA	NA	NA	NA	NA
Enhancement I	0					
Enhancement II	171					
Creation		NA	NA	NA		NA
Preservation	7,497	NA	NA	NA		NA
High Quality Preservation	0	NA	NA	NA		NA

BMP Elements

Element	Location	Purpose/Function	Notes
NA	NA	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

BMP Elements

BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond: DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

Table 2. Project Activity and Reporting History Snowbird Creek Tribs Mitigation Project-NCDMS Project #92663		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Restoration Plan		October 2009
Final Design-90%		November 2009
Construction		August 2010
Temporary S&E mix applied to entire project area		August 2010
Permanent seed mix applied to project site		August 2010; February 2011
Bare root plantings set out		March 2011
Installation of crest gauges		March 2011
Mitigation Plan / As-built (Year 0 Monitoring – baseline)	Apr-11	November 2011 (last of plantings completed in March)
Year 1 Monitoring	Jan-12	March 2012
Year 2 Monitoring	Feb-13	March 2013
Year 3 Monitoring	Jan-14	March 2014
Year 4 Monitoring	Nov-14 to Feb-15	March 2015
Supplemental Planting		March 2015
Year 5 Monitoring		Dec-15

Table 3. Project Contacts Table **Snowbird Creek Tributaries Mitigation Project-NCDMS Project #92764**	
Designer	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 Contact: Micky Clemmons, Tel. 828.412.6100
Construction Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 600, Cary, NC 27518 Contact: Bill Wright, Tel. 919.818.6686
Planting & Seeding Contractor	
River Works, Inc.	8000 Regency Parkway, Suite 600, Cary, NC 27518 Contact: George Morris, Tel. 919.818.6686
Seed Mix Sources	Green Resources
Nursery Stock Suppliers	Arborgen and Hillis Nursery
Monitoring	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201, Asheville, NC 28806 Contact: Micky Clemmons, Tel. 828.412.6100

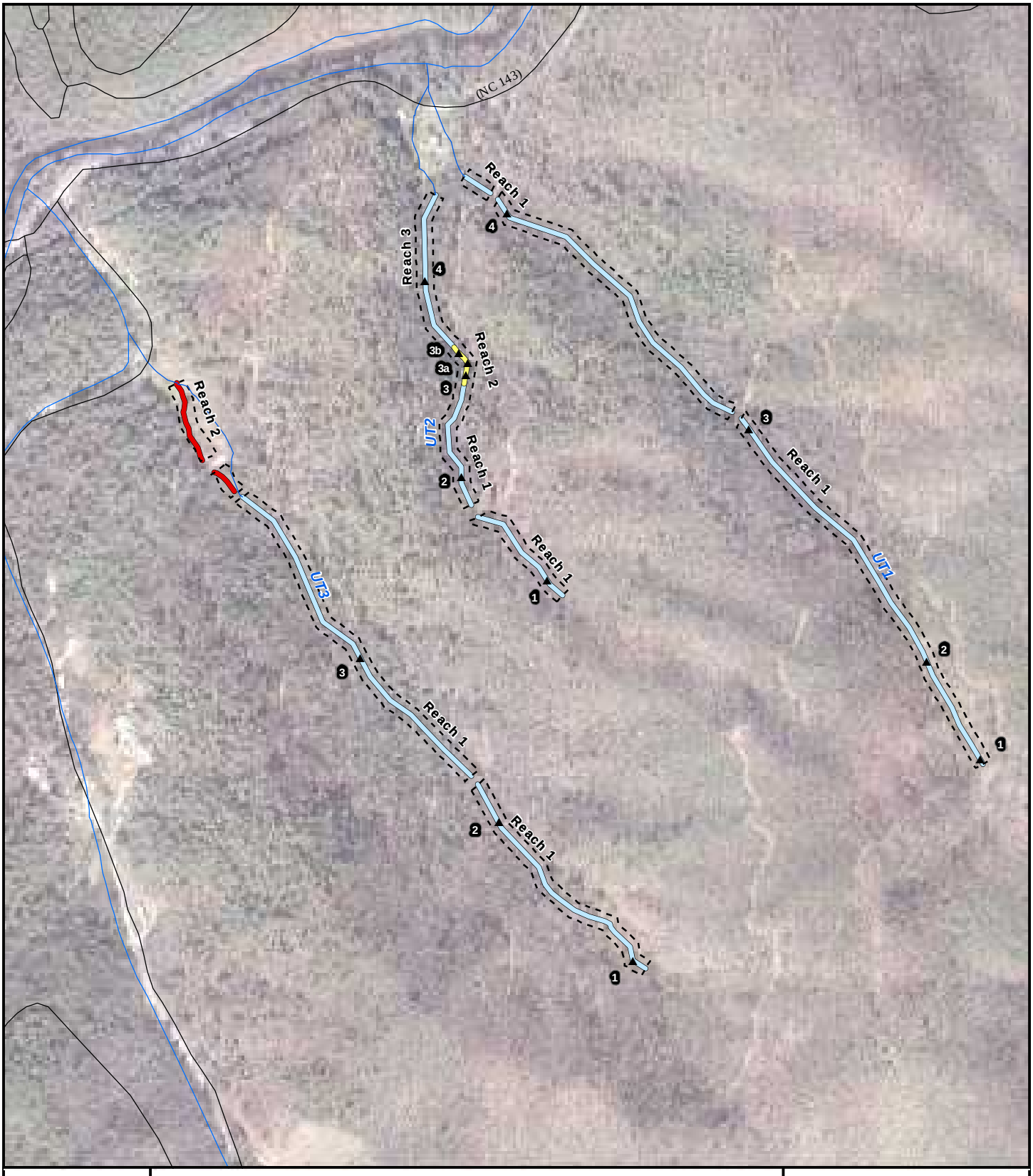
Table 4. Project Background Table Sink Hole Creek Mitigation Project-NCDMS Project #92663	
Project County	Graham County, NC
Physiograhic Region	Blue Ridge
Ecoregion	Blue Ridge Mountains-Southern Metasedimentary Mountains
Project River Basin	Little Tennessee
USGS HUC for Project	6010204020010
NCDWR Sub-basin for Project	04-04-04
Within extent of DMS Watershed Plan?	No local or targeted watershed plans currently available
WRC Class	Cold
NCDWR classification	C; Tr, HQW (Snowbird Cr.); C (Hooper Br.)
% of Project Easement Fenced or Demarcated	0% (post-construction)
Beaver Activity Observed During Design Phase	No
Drainage Area (Square Miles)	
UT1	.13 mi^2
UT2 Reach 1	.05 mi^2
UT2 Reach 2	.06 mi^2
UT2 Reach 3	.08 mi^2
UT3 Reach 1	.15 mi^2
UT3 Reach 2	.18 mi^2
Stream Order	
UT1	1st (Perennial)
UT2 Reach 1	1st (Perennial)
UT2 Reach 2	1st (Perennial)
UT2 Reach 3	1st (Perennial)
UT3 Reach 1	1st (Perennial)
UT3 Reach 2	1st (Perennial)
Restored Length	
UT1	3,212 LF
UT2 Reach 1	1,033 LF
UT2 Reach 2	171 LF
UT2 Reach 3	675 LF
UT3 Reach 1	2,576 LF
UT3 Reach 2	467 LF
Perennial or Intermittent	Perennial
Watershed Type	Rural (Predominantly Forested)
Watershed LULC Distribution (Percent area)	
Deciduous Forest	80%

Evergreen Forest	8.68%			
Mixed Forest	11%			
Developed Open Space	<1%			
Drainage Impervious Cover Estimate (%)	<10%			
NCDWR AU/Index #	2-190-9 (15.5)			
303d Listed / Upstream of 303d Listed Segment	No/ No			
Reasons for 303d Listing or Stressor	-			
Total Acreage of Easement	13.1			
Total Vegetated Acreage w/in Easement	100% (Easement vegetated with exception of stream channel)			
Total Planted Acreage within the Easement	~.86 Acres			
Rosgen Classification (Pre-existing)/As-Built				
UT1	Aa^{+}/Aa^{+}			
UT2 Reach 1	B3a/B3a			
UT2 Reach 2	B3a/B3a			
UT2 Reach 3	B3a/B3a			
UT3 Reach 1	A4a+/A4a+			
UT3 Reach 2	B/B3a			
Valley Type	II			
Valley Slope	.094 (UT3)			
Trout Waters Designation	No			
Species of Concern	No			
Dominant Soil Series and Characteristics				
Snowbird loam/ Thurmont-Dillard/ Soco-Stecoah/ Spivey-Whiteoak				
	Depth (in.)	% Clay	K Factor	T Factor
UT1	>80”	5-18/ 5-24	.10-.17/ .02-.1	3-Feb
UT2 Reach 1	~80/>60”	18-May	.10-.17/.1	5
UT2 Reach 2	>80”	18-May	.10-.17	5
UT2 Reach 3	>80”	5-18/ 5-24	.10-.17/ .02-.1	5
UT3 Reach 1	>80”	24-May	.02-.1/ .03-.1	5
UT3 Reach 2	>60”	25-May	.17-.24	5

*This format is the format that has been used since monitoring began on this project. It does not conform to present guidelines but continues existing reporting formal.

APPENDIX B

Figure 2 Project Component Map
Exhibit 1-2 Reference Station and
Vegetation Plot Photologs



North Carolina Division of Mitigation Services

LEGEND:

Proposed Project Components
- Preservation
- Enhancement II
- Restoration (Priority 1)

Streams

Easement Boundary

3▲ Photo Points (EII & Preservation Reaches)*

* Photo Points for the restored reach, UT3 Reach 2, can be found on the CCPV, Figure 3 of Appendix F.

0 200 400 800 Feet

Figure 2. Restoration Summary Map, NCDMS Project #92764

Snowbird Creek Tributaries Project Graham County, NC

Michael Baker INTERNATIONAL

Snowbird Creek
Photo Log - Reference Photo Points

Notes: Photos for Snowbird Creek were taken November 5, 2015.

1. Photo point locations are shown on the plan views in the actual location the picture was taken.
2. All points are marked with a wooden stake and flagging. For channel points, the stake is set up on an adjacent bank.

Photo Point 1: looking downstream

Intentionally left blank

Photo Point 2: looking downstream

Photo Point 2: looking upstream

Photo Point 3: looking downstream

Photo Point 3: looking upstream

Photo Point 4: looking downstream

Photo Point 4: looking upstream

Photo Point 5: looking downstream

Photo Point 5: looking upstream

Photo Point 6: looking downstream (out of easement)

Photo Point 6: looking upstream

UT1 Reach 1 (Preservation)
Photo Log - Reference Photo Points

Notes: Photos were taken November 5, 2015.

1. Photo point locations are shown on the plan sheets in the actual location the picture was taken.
2. All points are marked with flagging tape and recorded with GPS points. For channel points, the flagging is tied on an adjacent bank.

Photo Point 1: looking downstream

Photo Point 1: looking upstream

Photo Point 2: looking downstream

Photo Point 2: looking upstream

Photo Point 3: looking downstream

Photo Point 3: looking upstream

Photo Point 4: looking downstream

Photo Point 4: looking upstream

UT2 (Preservation & Enhancement II)
Photo Log - Reference Photo Points

Notes: Photos were taken November 5, 2015.

1. Photo point locations are shown on the plan sheets in the actual location the picture was taken.
2. All points are marked with flagging tape and recorded with GPS points. For channel points, the flagging is tied on an adjacent bank.
3. Photo point 3, 3a, and 3b are located in the Enhancement II Reach.

Photo Point 1: looking downstream

Photo Point 1: looking upstream

Photo Point 2: looking downstream

Photo Point 2: looking upstream

Photo Point 3: looking downstream

Photo Point 3: looking upstream

Photo Point 3a: looking down valley along right bank

Photo Point 3a: looking up valley along right bank

Photo Point 3b: looking down valley along right bank

Photo Point 3b: looking up valley along right bank

Photo Point 4: looking downstream

Photo Point 4: looking upstream

UT3 (Preservation)
Photo Log - Reference Photo Points

Notes: Photos were taken November 5, 2015.

1. Photo point locations are shown on the plan sheets in the actual location the picture was taken.
2. All points are marked with flagging tape and recorded with GPS points. For channel points, the flagging is tied on an adjacent bank.

Photo Point 1: looking downstream

Photo Point 1: looking upstream

Photo Point 2: looking downstream

Photo Point 2: looking upstream

Photo Point 3: looking downstream

Photo Point 3: looking upstream

Snowbird Creek Tributaries Mitigation Project
Photo Log - Vegetation Plot Photos

Notes: Photos for Vegetation Plots were taken November 5, 2015.

1. Vegetation plots marked by t-posts at corners; herbaceous plot marked by stake within larger plot.
2. Planted vegetation flagged and tagged for future identification.

Photo 1: Veg Plot 1

Photo 2: Veg Plot 1-Herbaceous Plot

APPENDIX C
VEGETATION SUMMARY DATA
TABLES 5-7b

Table 5. Vegetation Plot Criteria Attainment
Snowbird Creek Mitigation Project-#92764

Vegetation Plot ID	Vegetation Survival Threshold Met for YR5?
1	Y

Table 6. Vegetation Metadata
East Buffalo Creek Mitigation Project-#92763

Report Prepared By	Micky Clemmons
Date Prepared	12/7/2015 12:22
database name	cvs-eep-entrytool-v2.3.1_Snowbird.mdb
database location	L:\projects\113112 Snowbird Cr. FD\Monitoring\Year 5\Veg
computer name	ASHELMCLEMMONS
file size	44515328

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.

PROJECT SUMMARY----------

Project Code	92764
project Name	Snowbird Tributaries
Description	Restoration: 466 LF, Enhancement II:171 LF, Preservation: 7,497 LF
River Basin	Little Tennessee
length(ft)	466
stream-to-edge width (ft)	30
area (sq m)	2597.31
Required Plots (calculated)	1
Sampled Plots	1

Table 7. Stem Count Arranged by Plot
Snowbird Creek Tributaries Mitigation Project #92764

Tree Species	Common Name	Species Type	Plot 1	As-built Totals	MY 1 Totals	MY 2 Totals	MY 3 Totals	MY 4 Totals	MY 5 Totals	Survival %	Probable Cause
Acer rubrum	Red Maple	Tree	1	1	2	2	1	1	1	100%	
Alnus serrulata [1]	Hazel Alder	Tree									misidentified
Betula lenta [2]	Sweet Birch	Tree									misidentified
Betula nigra	River Birch	Tree	2	2	0	0	0	0	0	100%	
Carpinus caroliniana	American hornbeam	Tree	4	4	4	4	4	3	3	100%	
Carya alba [3]	Mockernut Hickory	Tree									misidentified
Fraxinus pennsylvanica	green ash	Tree	5	5	5	5	4	4	4	100%	
Liriodendron tulipifera	tuliptree	Tree	1	1	1	1	1	1	1	100%	
Platanus occidentalis [4]	Sycamore	Tree	6	6	5	6	5	5	4	100%	
Quercus rubra	Red Oak	Tree	3	3	2	2	2	2	2	100%	
Shrub Species											
Cercis canadensis	Redbud	Tree	1	1	0	0	0	0	0	100%	
Hamamelis virginiana [5]	Witch Hazel	Shrub									misidentified
Viburnum dentatum	southern arrowwood	Shrub	2	2	2	2	2	2	2	100%	
Stems/plot			25	25	21	22	19	18	17	17	
Stems/acre			1012	1012	850	890	769	728	688	688	

1 Determined that these stems were misidentified in previous years: Both are now identified as Carpinus caroliniana - American hornbeam or Ironwood.

2 Determined that these stems were misidentified in previous years: Two are now identified as Green Ash and one was identified as American hornbeam or Ironwood.

3 Determined that these stems were misidentified in previous years: Two are now identified as Green Ash and one was identified as southern arrowwood.

4 Determined that one of these stems were misidentified in previous years: It is now identified as southern arrowwood.

5 Determined that these stem was misidentified in previous years: It is now identified as tuliptree.

Numbers per species per year was ajusted to account for corrections to species identifications

Table 7b. Stem Count Arranged by Plot
Snowbird Creek Tributaries Mitigation Project #92764

			Current Plot Data (MY5 2015)			Annual Means																	
		Species	E92764-01-0001			MY5 (2015)			MY4 (2014)			MY3 (2013)			MY2 (2012)			MY1 (2011)			MY0 (2010)		
Scientific Name	Common Name	Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1
Alnus serrulata [1]	hazel alder	Shrub							2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Betula lenta [2]	sweet birch	Tree							3	3	3	3	3	3	4	4	4	4	4	4	4	4	4
Betula nigra	River birch	Tree																			2	2	2
Carpinus caroliniana	American hornbeam	Tree	3	3	3	3	3	3															
Carya alba [3]	mockernut hickory	Tree							3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cercis canadensis	Redbud	Tree																			1	1	1
Fraxinus pennsylvanica	green ash	Tree	4	4	4	4	4	4															
Hamamelis virginiana [4]	American witchhazel	Tree							1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Liriodendron tulipifera	tuliptree	Tree	1	1	1	1	1	1															
Platanus occidentalis	American sycamore	Tree	4	4	4	4	4	4	6	6	6	6	6	6	7	7	7	6	6	6	7	7	7
Quercus rubra	northern red oak	Tree	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
Viburnum dentatum	southern arrowwood	Shrub	2	2	2	2	2	2															
	Stem count		17	17	17	17	17	17	18	18	18	19	19	19	22	22	22	21	21	21	25	25	25
	size (ares)		1			1			1			1			1			1			1		
	size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.02			0.02		
	Species count		7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	9	9	9
	Stems per ACRE		688	688	688	688	688	688	728	728	728	769	769	769	890	890	890	850	850	850	1012	1012	1012

1 Determined that these stems were misidentified in previous years: Both are now identified as Carpinus caroliniana - American hornbeam or Ironwood.

2 Determined that these stems were misidentified in previous years: Two are now identified as Green Ash and one was identified as American hornbeam or Ironwood.

3 Determined that these stems were misidentified in previous years: Two are now identified as Green Ash and one was identified as southern arrowwood.

4 Determined that these stem was misidentified in previous years: It is now identified as tuliptree.

Note: Changes for species misidentifications were only made in MY5 (2015).

Exceeds requirements by 10%

APPENDIX D

MORPHOLOGICAL SUMMARY DATA

EXHIBIT 3 – CROSS-SECTIONS (WITH ANNUAL OVERLAYS)

EXHIBIT 4 – LONGITUDINAL PROFILE (WITH ANNUAL OVERLAYS)

EXHIBIT 5 – RIFFLE PEBBLE COUNT SIZE CLASS DISTRIBUTION

TABLE 8 – CROSS-SECTION MORPHOLOGY DATA TABLE

TABLE 9 – STREAM REACH MORPHOLOGY DATA TABLE

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B3	3.9	7.47	0.52	0.96	14.42	1.1	5.8	2045.4	2045.52

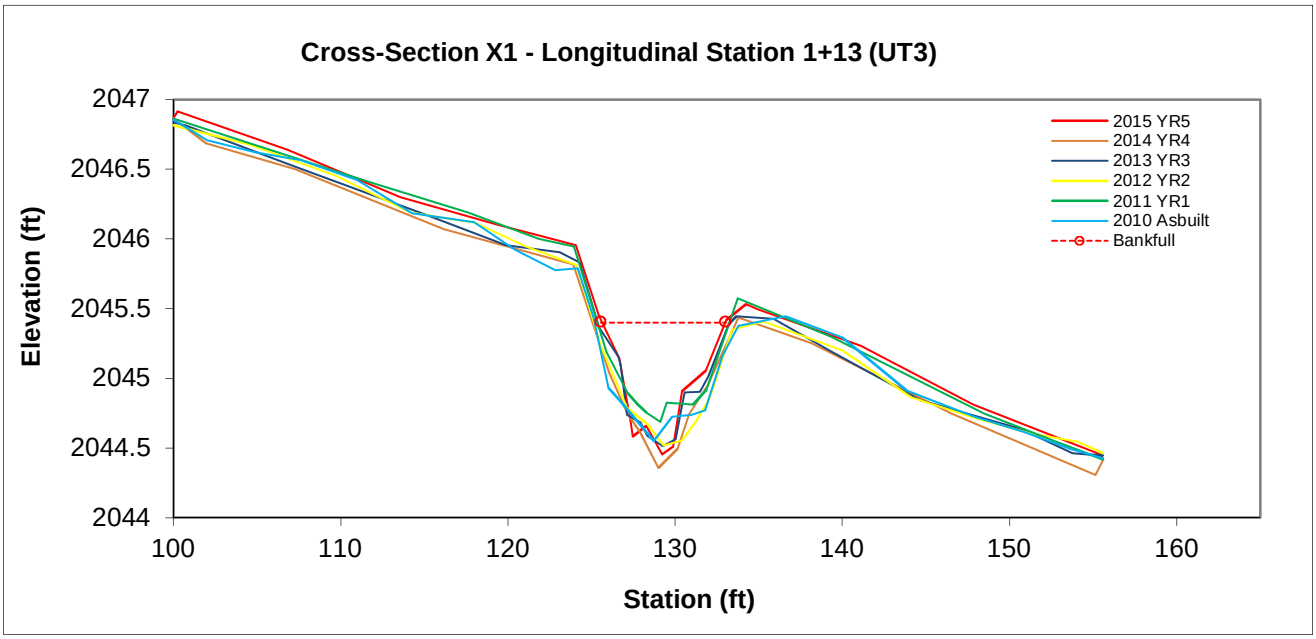


Photo 1: XS-1 facing right bank

Photo 2: XS-1 facing left bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B3	7.9	12.29	0.64	1.18	19.19	1	4.1	2030.02	2030.02

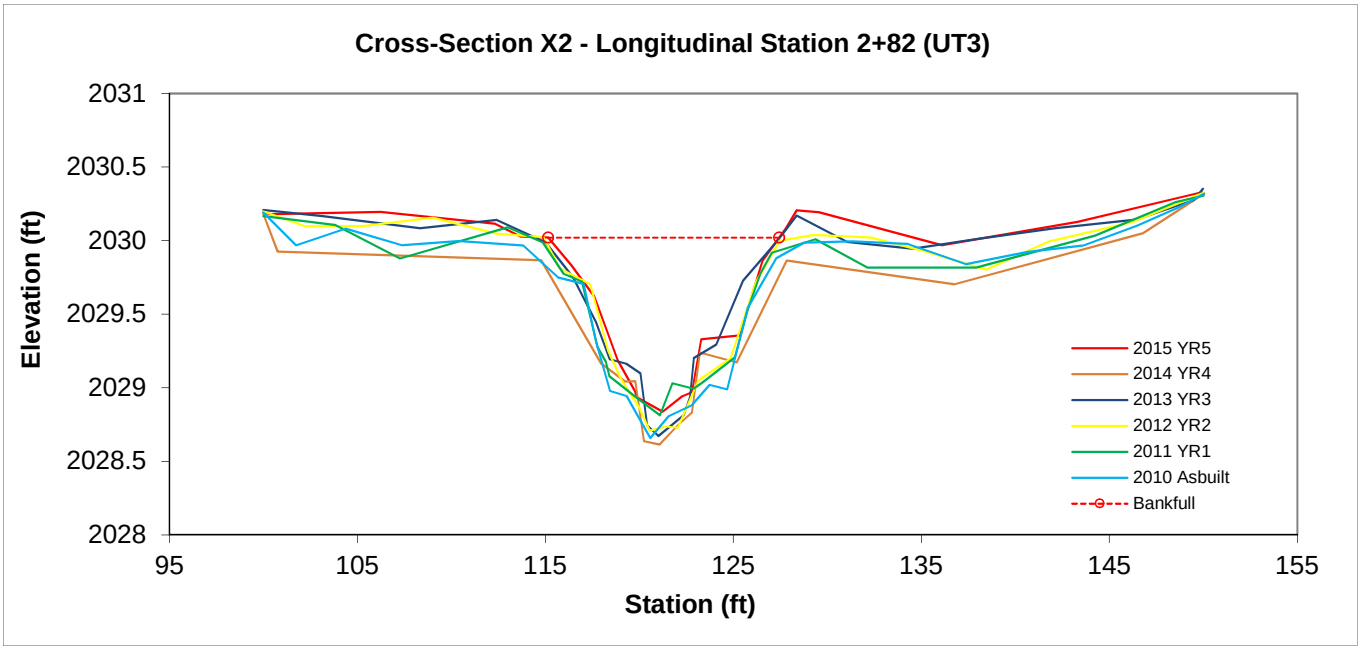


Photo 3: XS-2 facing right bank

Photo 4: XS-2 facing left bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool	B3	7.9	12.19	0.65	1.54	18.69	1	4	2021.12	2021.12

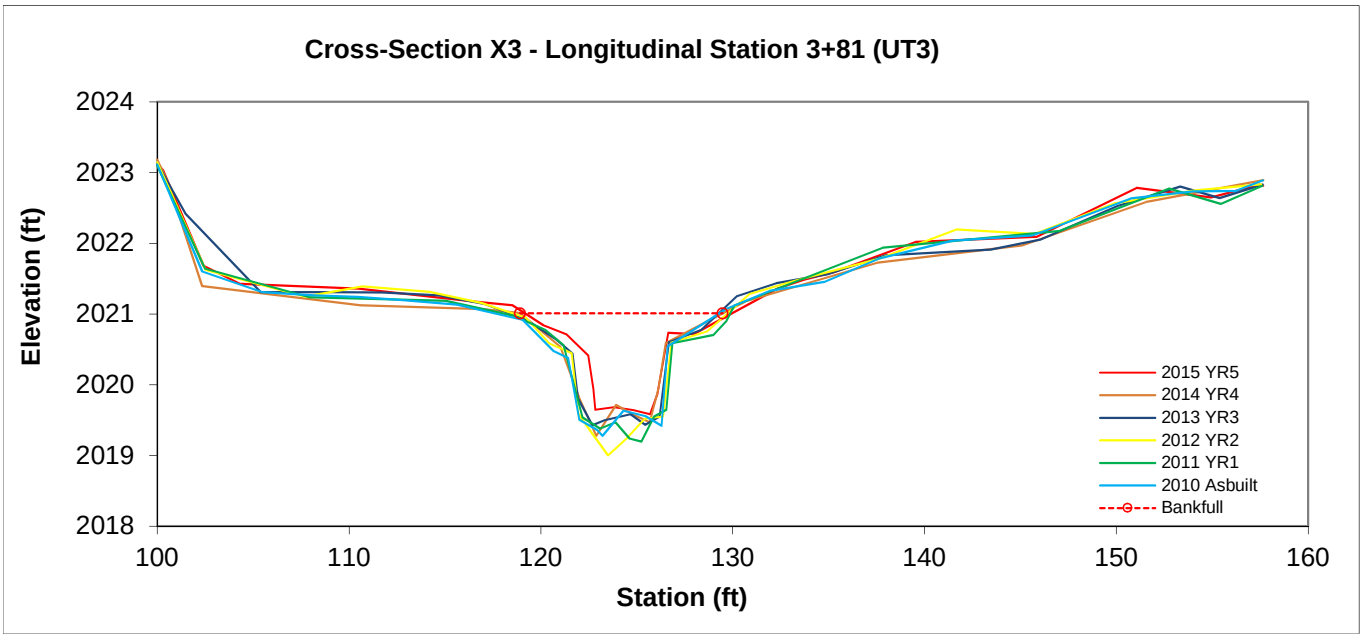


Photo 5: XS-3 facing right bank

Photo 6: XS-3 facing left bank

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	B3	14.2	15.82	0.9	2.01	17.63	1.1	4	2015.35	2015.61

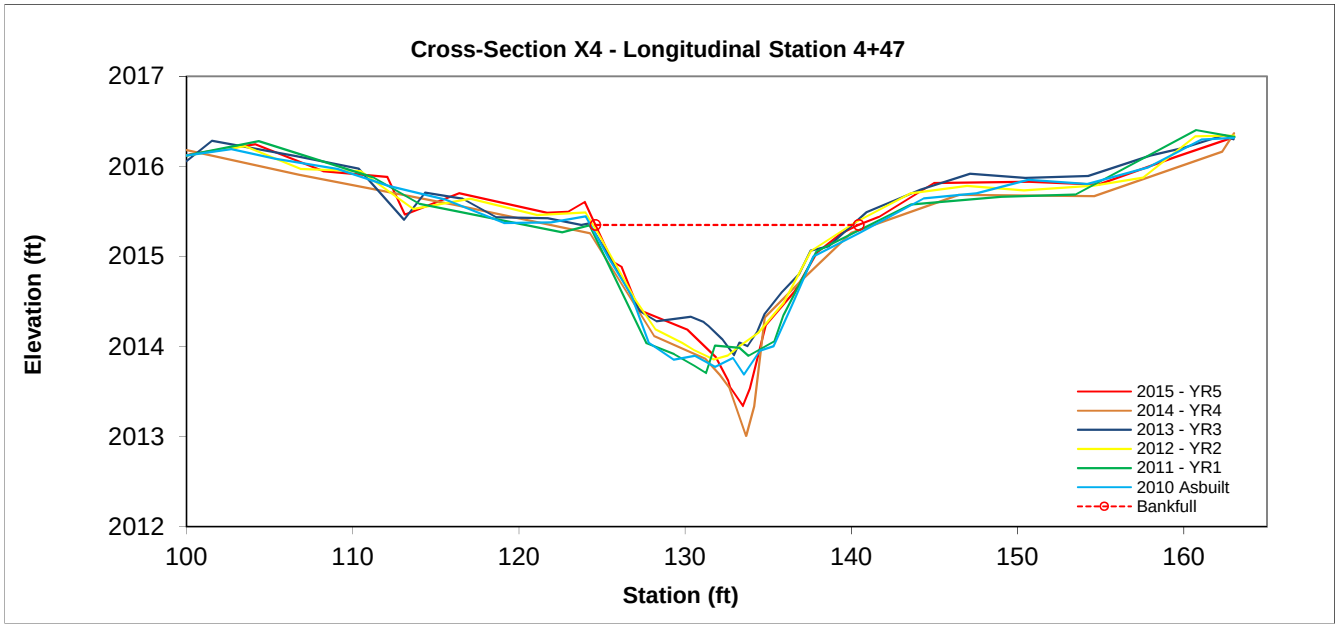
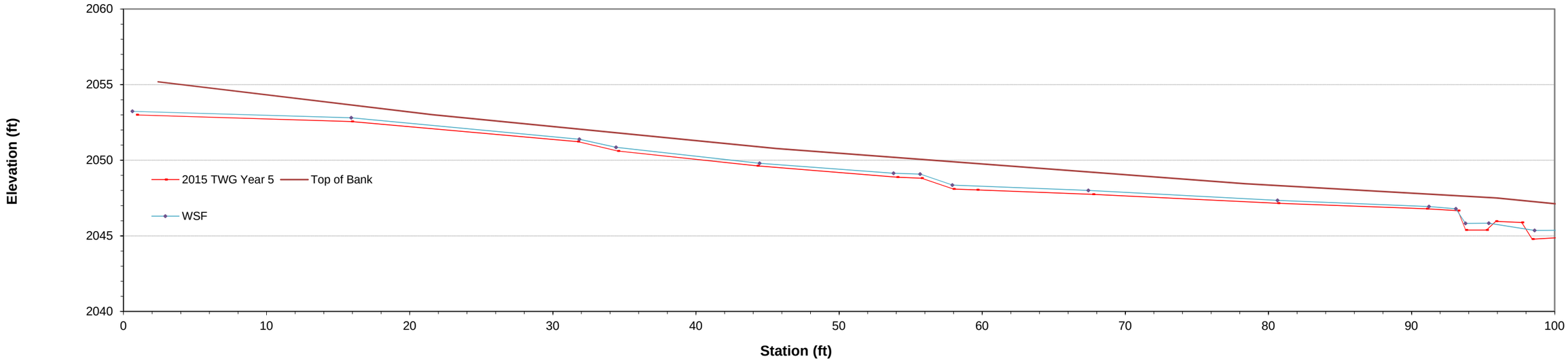


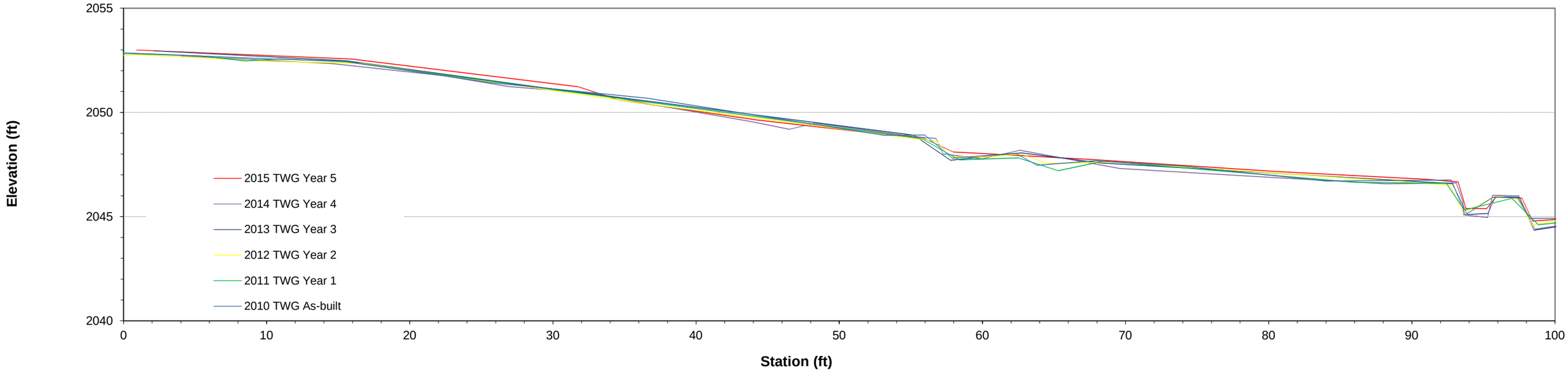
Photo 7: XS-4 facing right bank

Photo 8: XS-4 facing left bank

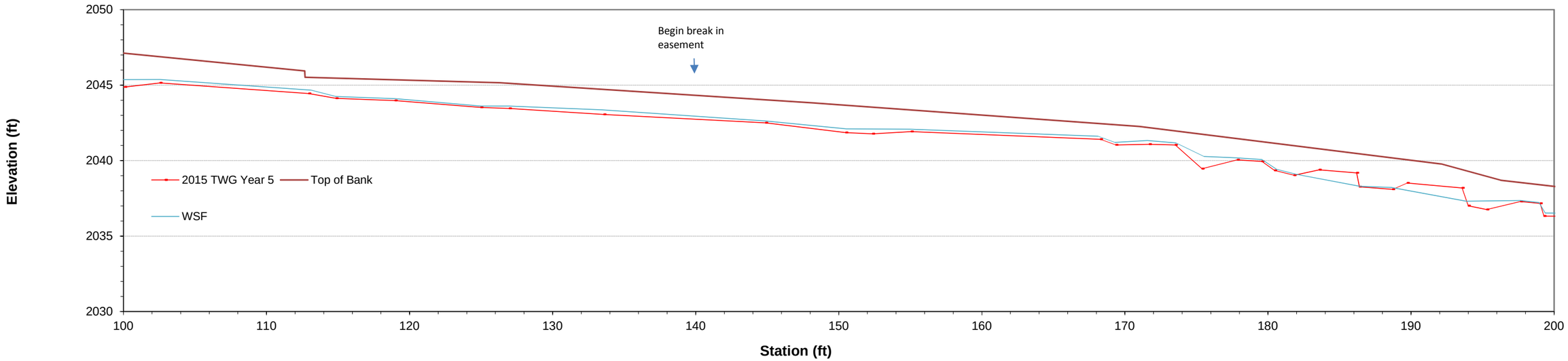
Longitudinal Profile - UT3 (Reach 2) for Year 5 Monitoring
Sta: 0+00 - 1+00



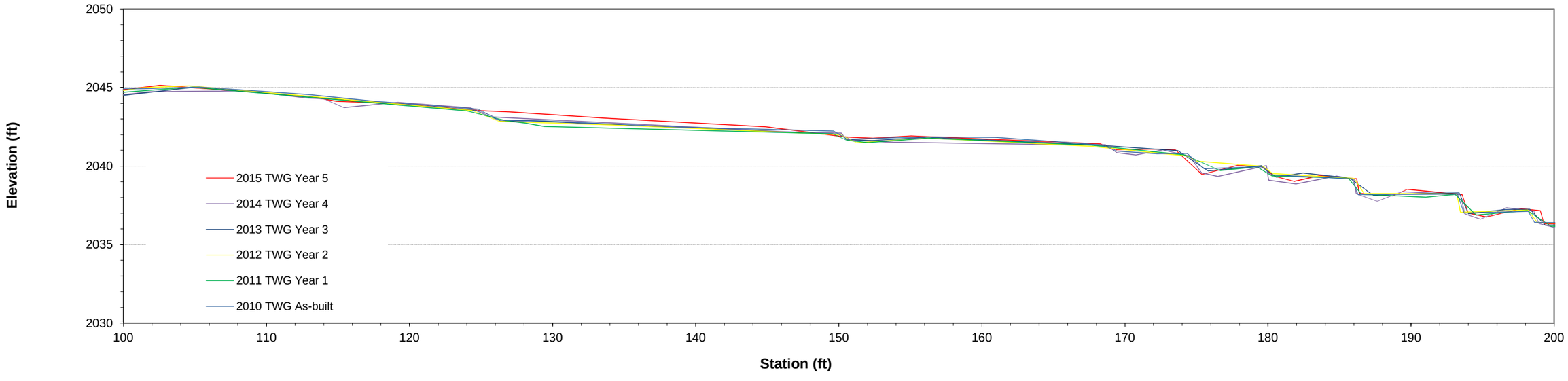
Longitudinal Profile - UT3 (Reach 2) for all Years
Sta: 0+00 - 1+00

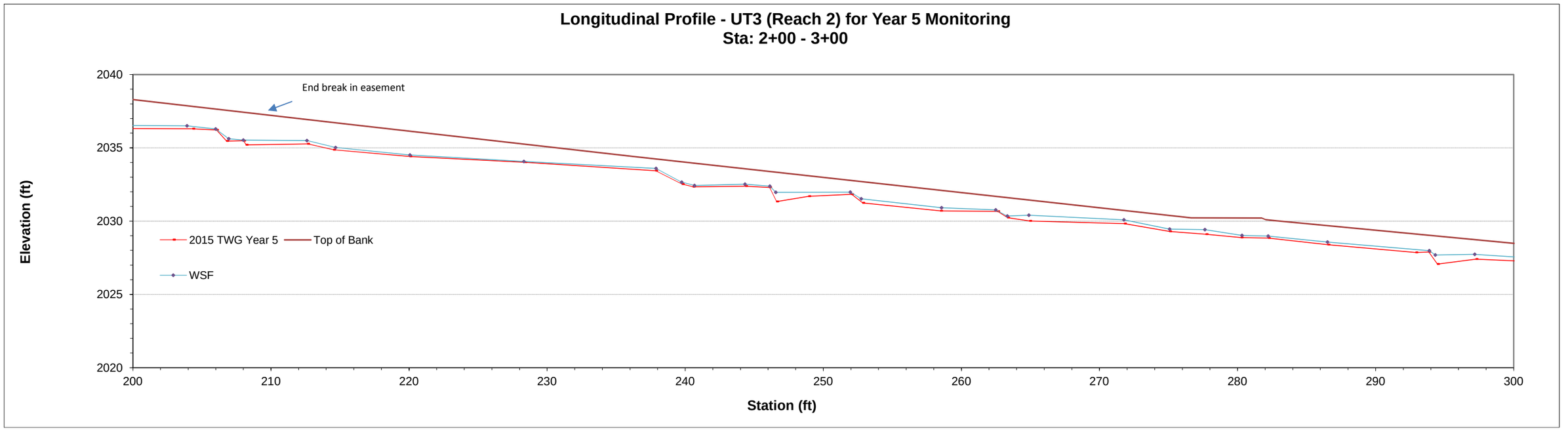


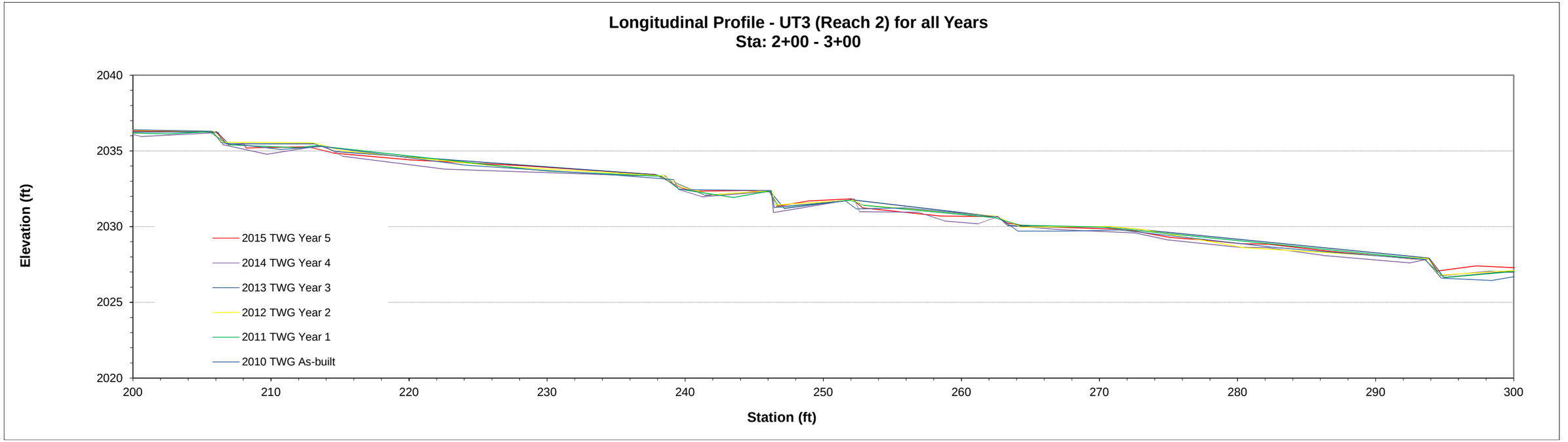
Longitudinal Profile - UT3 (Reach 2) for Year 5 Monitoring
Sta: 1+00 - 2+00



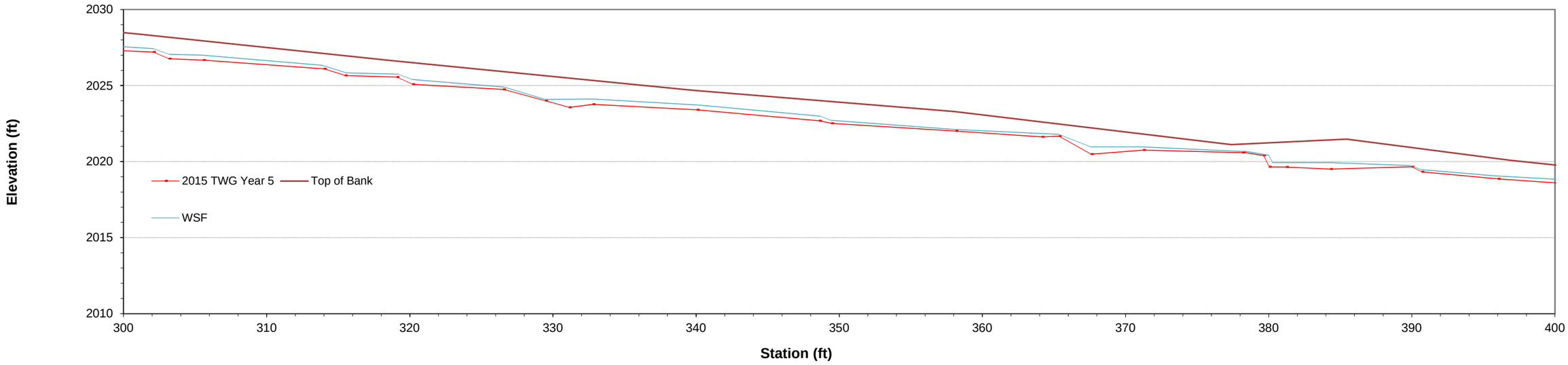
Longitudinal Profile - UT3 (Reach 2) for all Years
Sta: 1+00 - 2+00



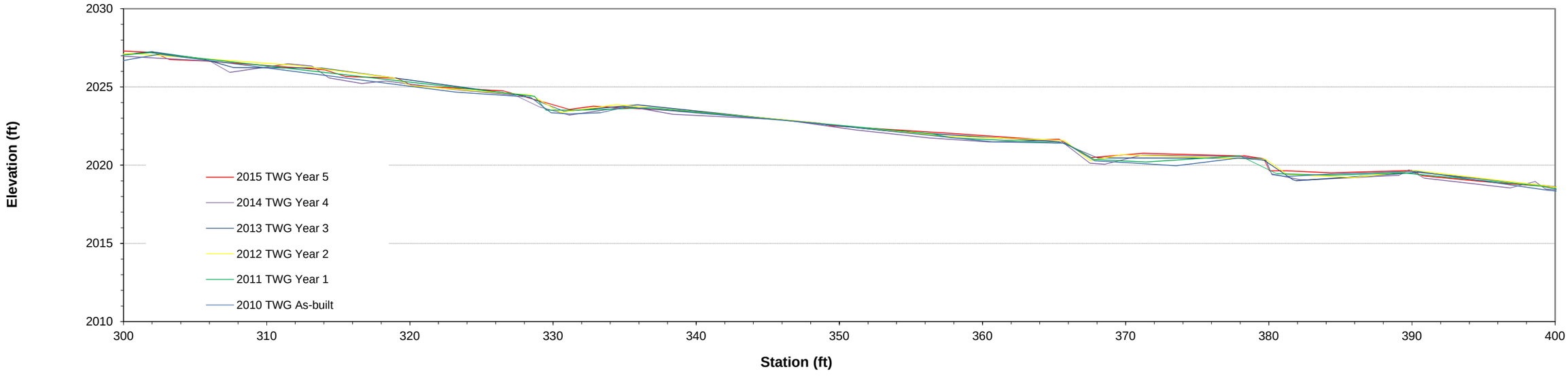

Longitudinal Profile - UT3 (Reach 2) for Year 5 Monitoring
Sta: 2+00 - 3+00
End break in easement
2015 TWG Year 5
Top of Bank
WSF
Elevation (ft)
Station (ft)
2040
2035
2030
2025
2020
200
210
220
230
240
250
260
270
280
290
300


Longitudinal Profile - UT3 (Reach 2) for all Years
Sta: 2+00 - 3+00
2015 TWG Year 5
2014 TWG Year 4
2013 TWG Year 3
2012 TWG Year 2
2011 TWG Year 1
2010 TWG As-built
Elevation (ft)
Station (ft)
2040
2035
2030
2025
2020
200
210
220
230
240
250
260
270
280
290
300

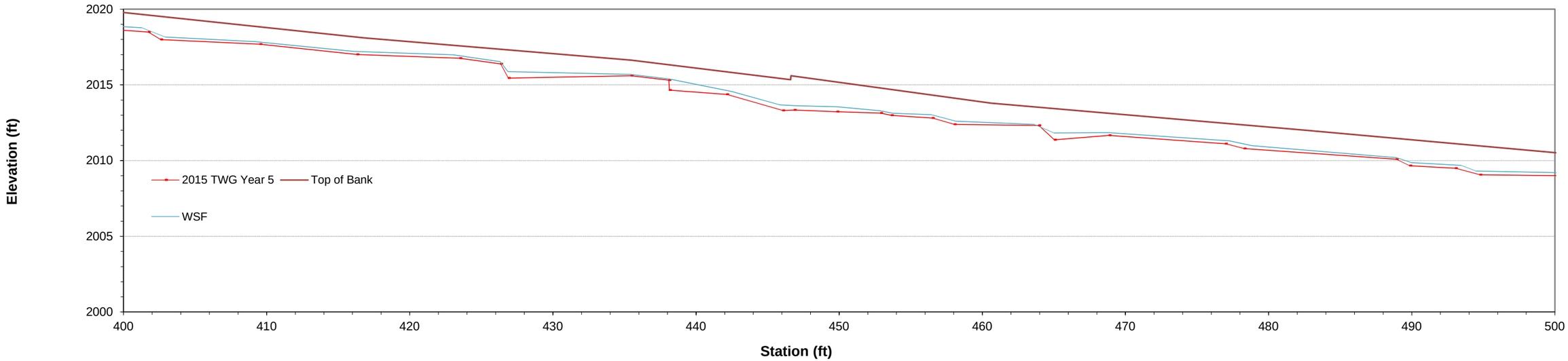
Longitudinal Profile - UT3 (Reach 2) for Year 5 Monitoring
Sta: 3+00 - 4+00



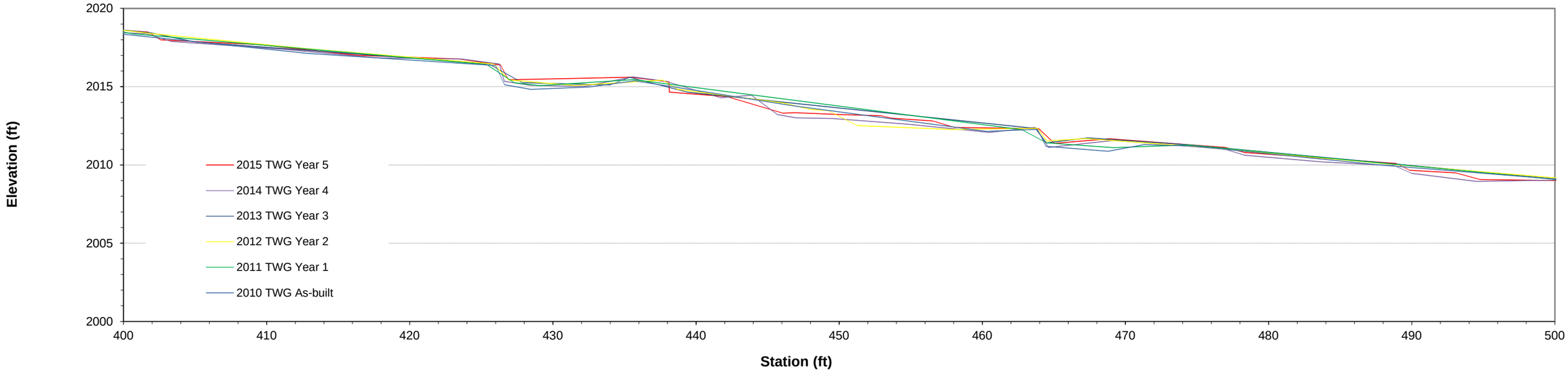
Longitudinal Profile - UT3 (Reach 2) for all Years
Sta: 3+00 - 4+00

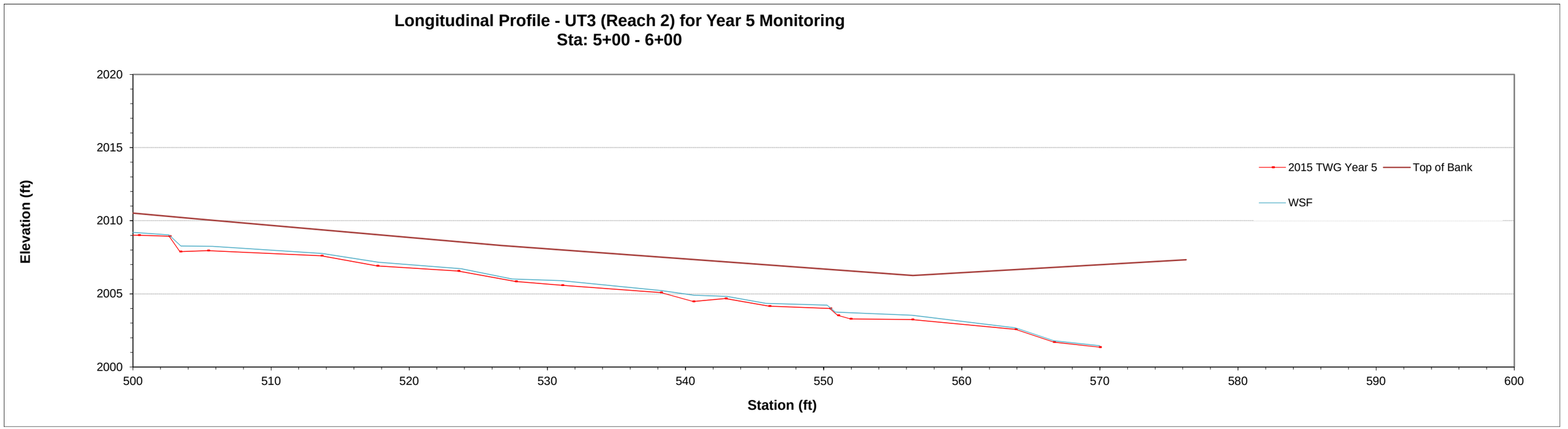


Longitudinal Profile - UT3 (Reach 2) for Year 5 Monitoring
Sta: 4+00 - 5+00



Longitudinal Profile - UT3 (Reach 2) for all Years
Sta: 4+00 - 5+00




Longitudinal Profile - UT3 (Reach 2) for Year 5 Monitoring
Sta: 5+00 - 6+00
Elevation (ft)
2020
2015
2010
2005
2000
500
510
520
530
540
550
560
570
580
590
600
Station (ft)
2015 TWG Year 5
Top of Bank
WSF

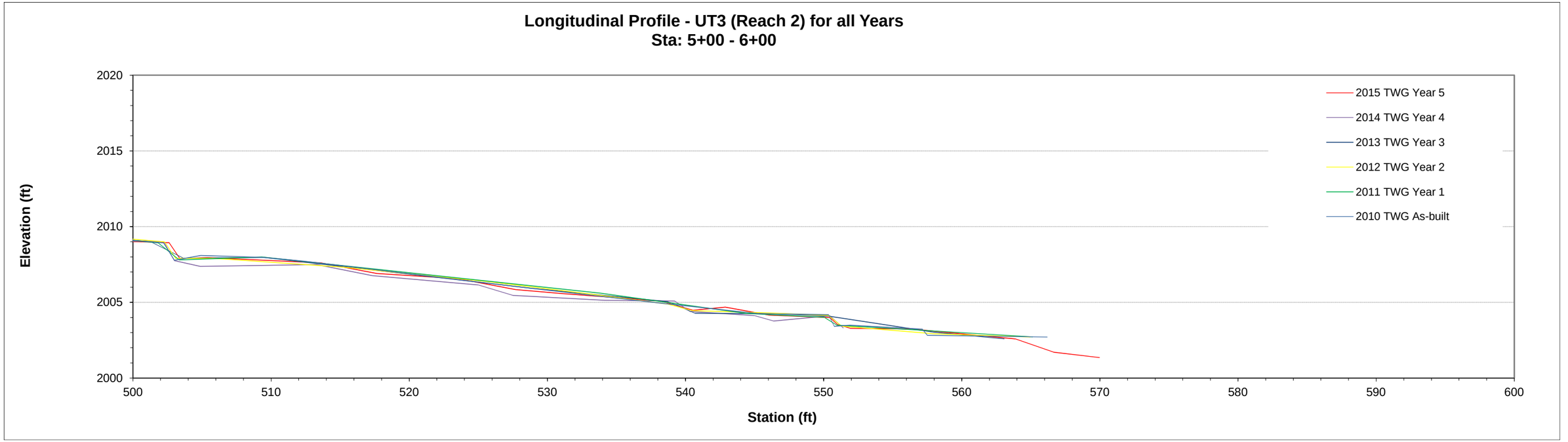

Longitudinal Profile - UT3 (Reach 2) for all Years
Sta: 5+00 - 6+00
Elevation (ft)
2020
2015
2010
2005
2000
500
510
520
530
540
550
560
570
580
590
600
Station (ft)
2015 TWG Year 5
2014 TWG Year 4
2013 TWG Year 3
2012 TWG Year 2
2011 TWG Year 1
2010 TWG As-built

Exhibit 5. Cross-Section Pebble Count (UT3 to Hooper Branch)
Snowbird Creek Tributaries Mitigation Project, DMS#92764

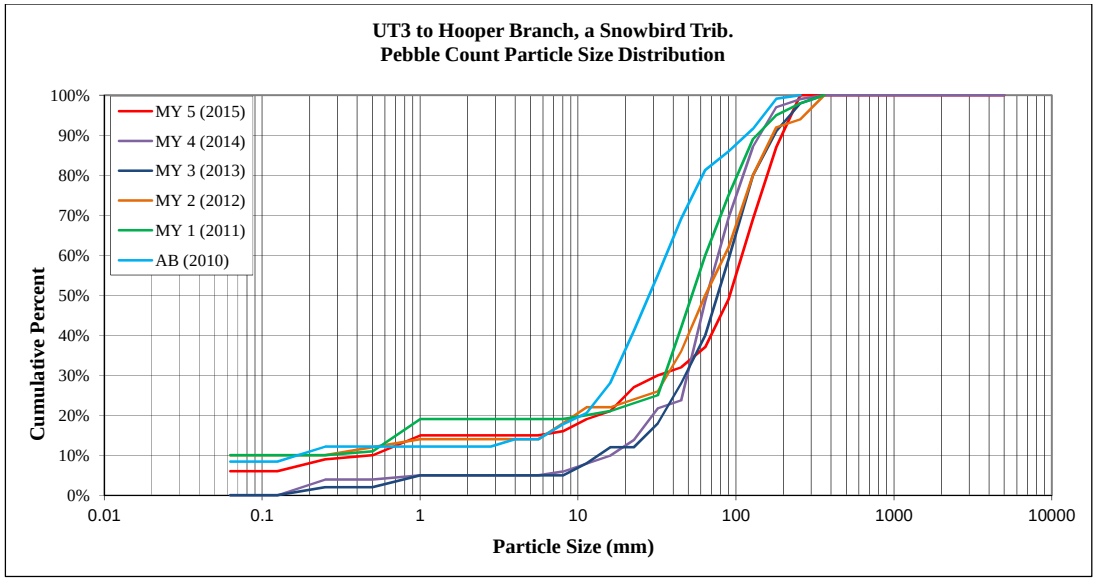
SITE OR PROJECT:	Snowbird Creek Tributaries
REACH/LOCATION:	UT3 across from veg plot
DATE COLLECTED:	27-Oct-15
FEATURE:	Riffle

MY5 (2015)

MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum
SILT/CLAY	Silt / Clay	< .063	6	6%	6%
SAND	Very Fine	.063 - .125			6%
	Fine	.125 - .25	3	3%	9%
	Medium	.25 - .50	1	1%	10%
	Coarse	.50 - 1.0	5	5%	15%
	Very Coarse	1.0 - 2.0			15%
GRAVEL	Very Fine	2.0 - 2.8			15%
	Very Fine	2.8 - 4.0			15%
	Fine	4.0 - 5.6			15%
	Fine	5.6 - 8.0	1	1%	16%
	Medium	8.0 - 11.0	3	3%	19%
	Medium	11.0 - 16.0	2	2%	21%
	Coarse	16.0 - 22.6	6	6%	27%
	Coarse	22.6 - 32	3	3%	30%
	Very Coarse	32 - 45	2	2%	32%
	Very Coarse	45 - 64	5	5%	37%
COBBLE	Small	64 - 90	12	12%	49%
	Small	90 - 128	20	20%	69%
	Large	128 - 180	18	18%	87%
	Large	180 - 256	13	13%	100%
BOULDER	Small	256 - 362			100%
	Small	362 - 512			100%
	Medium	512 - 1024			100%
	Large-Very Large	1024 - 2048			100%
BEDROCK	Bedrock	> 2048			100%
		Total	100	100%	

Channel materials			
D_{16} =	8.00	D_{84} =	170.06
D_{35} =	55.59	D_{95} =	223.57
D_{50} =	91.60	D_{100} =	180 - 256

Largest particles: 240 mm
(riffle)



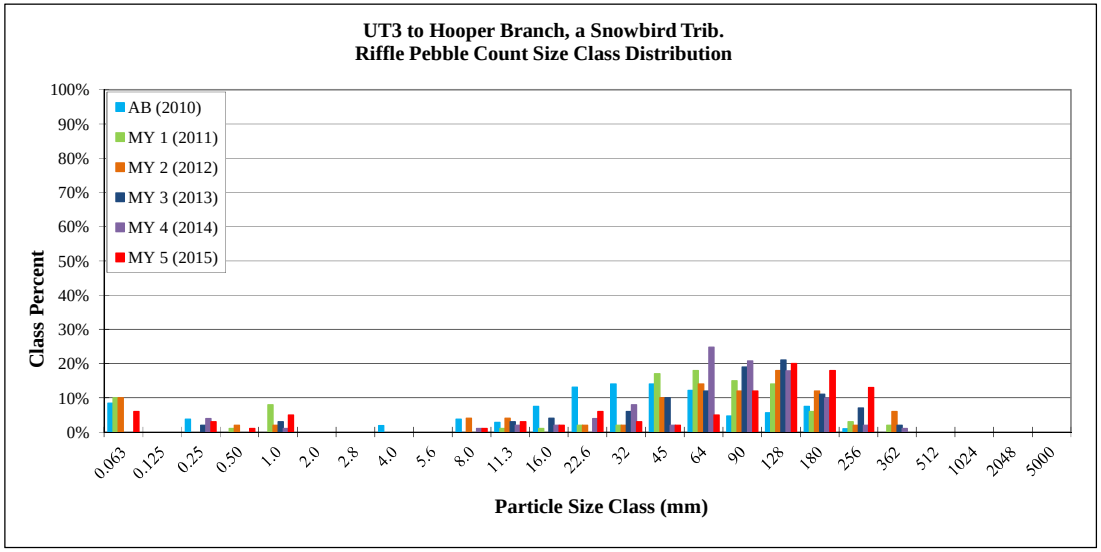


Table D8. Cross-Section Morphology Data Table

Snowbird Creek Tributaries Mitigation Project #92764

	UT3																							
Parameter	Cross Section 1 Riffle						Cross Section 2 Riffle						Cross Section 3 Pool						Cross Section 4 Riffle					
	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5	AB	MY1	MY2	MY3	MY4	MY5
Dimension																								
BF Width (ft)	8.5	8.8	8.2	8.4	8.3	7.5	9.5	11.8	12.5	15.7	13.0	12.3	9.7	10.5	10.2	12.6	10.6	12.2	12.4	12.9	12.2	12.3	15.7	15.8
Floodprone Width (ft)	41.5	45.1	40.7	44.9	>45.7	>43.6	50.0	50.0	50.0	50.0	50.0	>50.0	49.1	50.4	57.2	57.0	54.7	49.2	62.5	63.1	56.7	56.5	63.0	>63
BF Cross Sectional Area (ft2)	4.5	5.1	4.3	4.3	4.6	3.9	6.3	7.7	8.7	9.8	8.5	7.9	8.1	8.5	9.1	9.8	8.2	7.9	10.7	11.2	9.5	8.1	14.6	14.2
BF Mean Depth (ft)	0.53	0.58	0.53	0.51	0.56	0.52	0.66	0.65	0.70	0.62	0.65	0.64	0.84	0.81	0.89	0.78	0.77	0.65	0.87	0.87	0.77	0.66	0.93	0.90
BF Max Depth (ft)	0.83	0.89	0.83	0.93	1.01	0.96	1.05	1.11	1.29	1.47	1.25	1.18	1.64	1.71	1.94	1.70	1.73	1.54	1.31	1.35	1.21	1.16	2.25	2.01
Width/Depth Ratio	16.3	15.4	15.3	16.4	15.0	14.4	14.3	18.1	17.8	25.2	20.0	19.2	11.6	12.9	11.5	16.1	13.6	18.7	14.3	14.8	15.8	18.7	16.8	17.6
Entrenchment Ratio	4.9	5.1	5.0	5.3	5.5	5.8	5.3	4.2	4.0	3.2	3.8	4.1	5.1	4.8	5.6	4.5	5.1	4.0	5.1	4.9	4.6	4.6	4.5	4.0
Wetted Perimeter (ft)	9.6	10.0	9.2	9.5	9.5	8.5	10.8	13.1	13.9	17.0	14.3	13.6	11.4	12.1	12.0	14.1	12.1	13.5	14.1	14.6	13.8	13.6	17.6	17.6
Hydraulic Radius (ft)	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.7	0.7	0.6	0.8	0.8	0.7	0.6	0.8	0.8
Substrate																								
d50 (mm)																								
d84 (mm)																								

Parameter	AB (2010)			MY-1 (2011)			MY-2 (2012)			MY-3 (2013)			MY-4 (2014)			MY-5 (2015)		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Pattern																		
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																		
Riffle length (ft)	24	33	26	23	27	27	23	28	26	23	28	26	9	60	30	10	37	28
Riffle Slope (ft/ft)	0.058	0.102	0.072	0.044	0.120	0.104	0.047	0.118	0.092	0.041	0.113	0.087	0.045	0.104	0.077	0.038	0.116	0.073
Pool Length (ft)	3	6	4	3	7	7	4	10	4	5	9	8	3.2	15.7	7.4	3.4	14.2	6.5
Pool Spacing (ft)	8	41	35	8	47	29	8	55	34	8	52	32	4.7	54.0	20.4	4.6	73.1	18.7
Substrate																		
d50 (mm)		28			53			64			77			65.60			91.60	
d84 (mm)		78			113			143			145			120.30			170.06	
Additional Reach Parameters																		
Valley Length (ft)*		538			541			538			538			538			538	
Channel Length (ft)*		566			576			566			566			566			566	
Sinuosity		1.05			1.07			1.05			1.05			1.05			1.05	
Water Surface Slope (ft/ft)		0.089			0.087			0.088			0.090			0.090			0.091	
BF Slope (ft/ft)*		0.093			0.093			0.092			0.094			0.094			0.096	
Rosgen Classification		B3a			B3a			B3a			B3a			B3a			B3a	

Notes: * Past reports gave these numbers based on removing channel length at crossings, this has been corrected to reflect reach VL and CL. Corrections to BF Slope were also made.

Table D9. Stream Reach Morphology Data Table
Snowbird Creek Tributaries Mitigation Project #92764

Stream Reach Data Summary
UT3

Parameter	Regional Curve Equation	Reference Reach(es) Data			Design			(As-Built)			Yr 1			Yr 2			Yr 3			Yr 4			Yr 5		
Dimension - Riffle	Eq.	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bankfull Width (ft)	10.1	7.4	17.5	27.6	-----	9.9	-----	8.5	10.1	12.4	8.8	11.2	12.9	8.2	10.9	12.5	8.4	12.2	15.7	8.3	10.9	13.0	7.5	12.0	15.8
Floodprone Width (ft)	-----	12.2	25.4	38.6	20.0	35.0	50.0	41.5	51.4	62.5	45.1	52.7	63.1	40.7	49.1	56.7	44.9	50.5	56.5	45.7	53.4	63.0	43.6	51.5	63.0
Bankfull Mean Depth (ft)	0.65	0.87	0.99	1.10	-----	0.66	-----	0.53	0.69	0.87	0.58	0.70	0.87	0.53	0.67	0.77	0.51	0.60	0.66	0.56	0.70	0.8	0.52	0.68	0.9
Bankfull Max Depth (ft)	-----	1.09	1.35	1.60	-----	0.90	-----	0.83	1.06	1.31	0.9	1.12	1.4	0.83	1.11	1.29	0.83	1.19	1.47	1.01	1.50	2.1	0.96	1.42	2.01
Bankfull Cross Sectional Area (ft2)	6.7	7.0	20.0	33.0	-----	6.5	-----	4.5	7.1	10.7	5.1	8.0	11.2	4.3	7.5	9.5	4.3	7.4	9.8	4.6	8.3	11.7	3.9	8.5	14.2
Width/Depth Ratio	-----	7.6	17.3	27.0	-----	15.1	-----	14.3	14.9	16.3	14.8	16.1	18.1	15.3	16.3	17.8	16.4	19.5	25.2	13.6	16.3	20.0	14.4	17.5	19.2
Entrenchment Ratio	-----	1.3	1.6	2.0	2.0	3.5	5.0	4.9	5.1	5.3	4.2	4.7	5.1	4.0	4.5	5.0	3.2	4.4	5.3	3.8	4.7	5.5	4.0	4.5	5.8
Bank Height Ratio	-----	1.1	1.1	1.2	-----	1.0	-----	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0	1.4	2.1	1.0	1.1	1.1	1.0	1.05	1.1
Bankfull Velocity (fps)	-----	-----	-----	-----	-----	4.6	-----	----	3.4	----	----	3.0	----	----	3.2	----	----	3.2	----	----	2.9	----	----	2.8	----
Pattern																									
Channel Beltwidth (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Radius of Curvature (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Wavelength (ft)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Meander Width Ratio	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Profile																									
Riffle Length (ft)	-----	-----	-----	-----	-----	-----	-----	24	27	33	23	26	27	23	26	28	22.9	25.8	28.4	8.9	29.0	59.8	10.4	26.2	36.8
Riffle Slope (ft/ft)	-----	0.136	0.152	0.167	0.048	0.101	0.153	0.058	0.075	0.102	0.044	0.094	0.120	0.047	0.086	0.118	0.0408	0.0867	0.1127	0.0450	0.0740	0.1040	0.0377	0.0751	0.1159
Pool Length (ft)	-----	-----	-----	-----	-----	-----	-----	3	4	6	3	7	7	4	6	10	5	7	9	3.2	7.8	15.7	3.4	7.6	14.2
Pool Spacing (ft)	-----	42	99	157	5	27	48	8	27	41	8	26	47	8	29	55	8	28	52	4.7	24.2	54.0	4.6	24.7	73.1
Substrate and Transport Parameters																									
d16 / d35 / d50 / d84 / d95	-----	5.6/9.5/11/100/200			-----			6.8/19/28/78/150			.7/39/53/113/180			6.7/43/64/143/271			29/55/77/145/220			25/53/66/120/168			8/56/92/170/224		
Reach Shear Stress (competency) lb/f2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Stream Power (transport capacity) W/m2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Additional Reach Parameters																									
Channel length (ft)	-----	-----	-----	-----	-----	466	-----	-----	566	-----	-----	576	-----	-----	566	-----	-----	566	-----	-----	566	-----	-----	566	-----
Drainage Area (SM)	-----	0.13	0.87	1.60	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----	-----	0.18	-----
Rosgen Classification	-----	-----	B4a	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----	-----	B3	-----
Bankfull Discharge (cfs)	27	-----	-----	-----	20	30	40	----	24	----	----	24	----	----	24	----	----	24	----	----	24	----	----	24	----
Sinuosity	-----	-----	1.10	-----	----	1.10	----	-----	1.05	-----	-----	1.07	-----	-----	1.05	-----	-----	1.05	-----	-----	1.05	-----	-----	1.05	-----
BF slope (ft/ft)	-----	-----	-----	-----	-----	-----	-----	-----	0.093	-----	-----	0.093	-----	-----	0.092	-----	-----	0.094	-----	-----	0.094	-----	-----	0.096	-----

Table D9. Stream Reach Morphology Data Table
UT3-R2, Comparing each year sampled

APPENDIX E

TABLE 10-VERIFICATION OF BANKFULL EVENTS

Table E10. Verification of Bankfull or Greater than Bankfull Events
Snowbird Creek Tributaries Mitigation Project-#92764

Date of Data Collection	Date of Event	Method of Data Collection	Gauge Watermark Height (feet above bankfull)
			UT3 (Reach 2)
MY 1 (January 6, 2012	April 8th, 2011 (crest gauge installation for asbuilt) January 6, 2012	Gauge measurement	0.15
MY 2 (February 6, 2013)	January 6, 2012 – February 6, 2013	Gauge measurement	0.22
MY 3 (January 20, 2014)	February 6, 2013- January 20, 2014	Gauge measurement	0.16
MY 4 (March 9, 2015)	January 20, 2014- March 9, 2015	Gauge measurement	0.54
MY 5 (November 5, 2015)	March 9, 2015 - November 5, 2015	Gauge measurement	0.27

Photo of cork at 3.25 inches, or 0.27 feet above the floodplain.

APPENDIX F

PROJECT PROBLEM AREAS

FIGURE 3 – VEGETATION PROBLEM AREAS CCPV

TABLE 11 – VISUAL MORPHOLOGICAL STABILITY ASSESSMENT

TABLE 12 – VEGETATION PROBLEM AREAS

EXHIBIT 6 – VEGETATION PROBLEM AREAS PHOTOLOG

LEGEND

- CONSERVATION EASEMENT
- DESIGNED CENTERLINE
- DESIGNED STREAM BANK
- CROSS SECTION
- PHOTO POINT

PROJECT CONDITION

- VEG PLOT CRITERIA MET
- VEG PLOT CRITERIA UNMET (NO PLOTS CURRENTLY MEETING THIS CRITERIA)
- VEGETATION PROBLEM AREA (VPA) (BARE FLOOD PLAIN)
- STREAM PROBLEM AREAS (NO STREAM PROBLEM AREAS)

IMAGE SOURCE: NC STATEWIDE ORTHOIMAGERY, 2010

SNOWBIRD UT3 REACH 2
CURRENT CONDITION
PLAN VIEW
YEAR 5 MONITORING

25 0 25 50

Michael Baker Engineering Inc.
NC Engineering License F-1084
797 Haywood Road, Suite 201
Asheville, North Carolina 28806
Phone: 828.350.1408
Fax: 828.350.1409

Michael Baker INTERNATIONAL

SNOWBIRD CREEK TRIBUTARIES PROJECT
GRAHAM COUNTY, NORTH CAROLINA
CURRENT CONDITION PLAN VIEW
YEAR 5 MONITORING

NORTH CAROLINA DIVISION OF MITIGATION SERVICES

Prepared for:
Division of Mitigation Services
217 West Jones St, Suite 3000A
Raleigh, NC 27603
Phone: 919-707-8976
Fax: 828-232-4420

DMS Project No. 92764
Baker Project No. 113112
Date: 12/8/2015
DESIGNED: JPM
DRAWN: MMC
APPROVED: MMC
Monitoring Year: 5 of 5

Table 11. Visual Morphological Stability Assessment Snowbird Creek Tributaries Mitigation Project: Project No. 92764 UT3 Reach 2 (467 LF)						
Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	/ feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	14	14	N/A	100	
	2. Armor stable (e.g. no displacement)?	14	14	N/A	100	
	3. Facet grades appears stable?	14	14	N/A	100	
	4. Minimal evidence of embedding/fining?	14	14	N/A	100	
	5. Length appropriate?	14	14	N/A	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	24	24	N/A	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	24	24	N/A	100	
	3. Length appropriate?	24	24	N/A	100	**100%**
C. Thalweg[1]	1. Upstream of pool (structure) centering?	36	36	N/A	100	
	2. Downstream of pool (structure) centering?	36	36	N/A	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	N/A	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	N/A	
	3. Apparent Rc within spec?	N/A	N/A	N/A	N/A	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	N/A	**N/A**
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0/0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	N/A	N/A	0/0	100	**100%**
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	0/0	100	**100%**
G. Rock/Log Drop Structures[2]	1. Free of back or arm scour?	24	24	N/A	100	
	2. Height appropriate?	24	24	N/A	100	
	3. Angle and geometry appear appropriate?	24	24	N/A	100	
	4. Free of piping or other structural failures?	23	24	N/A	96	**99%**
H. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

[1] Thalweg feature is scored according to the centering of the thalweg over inverts of drop structures above pools and through the constructed riffle below pools since this reach is a step-pool channel without meander bends.

[2] Vane feature category was replaced with rock/log drop structures since there are no vanes present on this reach.

Table 12. Vegetation Problem Areas Snowbird Creek Tributaries Mitigation Project: Project No. 92764 UT3 Reach 2			
Feature Issue	**Station No.**	**Suspected Cause**	**Photo Number**
No Vegetation Problem Areas in YR5	N/A	N/A	N/A
Corrected Bare Floodplain (reported in YR4 Report)	0+10 to 1+40 (left floodplain)	REPAIR OF THIS FORMER PROBLEM: ISSUE: Easement encroachment by vehicles accessing existing cistern just upstream of project reach limits. Baker hired a contractor who created an alternate vehicle access path located outside the easement to avoid further encroachment. The impacted buffer within the easement has been replanted. Large trees were planted and are growing in the impacted area, as well as thick herbaceous vegetation.	Photos 1 and 2

EXHIBIT 6 – Former Vegetation Problem Area (VPA) Photos

Photo 1 – Impacted area planted with trees and shrubs in March 2015. Trees are between 5 and 10 feet tall and spaced approximately 10 feet apart along the impacted path.

Photo 2 – The same area shown above after growing season. The planted trees have survived and are growing in the old path area. Herbaceous vegetation has also established a good stand in this area. Access to the well house, which is to the right of where this photo was taken, is over the rerouted path.