MONITORING YEAR 1 AND 2 REPORT

PHILLIPS–WILLIS SITE
MIDDLE FORK CREEK

Madison County, North Carolina

FINAL

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1 Executive Summary

This report summarizes the 2007 monitoring year 1 (MY1) and 2008 monitoring year 2 (MY2) condition of the Phillips-Willis stream mitigation project, in Madison County, North Carolina. Conservation easements were acquired on Middle Fork Creek (MFC), McKinney Branch (MB), an unnamed tributary (UT), and Walker Branch (WB); total project area consists of 7.2 acres, including the stream channels. The riparian buffer as measured from the bankfull elevation to the conservation easement boundary encompasses 5.5 acres. A total of 5,383 ft of stream channel is contained within the four easements. The left and right bank riparian areas were protected by fencing on MB; whereas, the conservation easement boundaries on the other three project reaches were marked with 4 in. X 4 in. posts. Project objectives were to acquire a permanent conservation easement, remove all foreign materials from the easement area, and re-vegetate the area with native herbaceous and woody plants were accomplished. Project objectives to reduce bank erosion by reshaping both channel banks to a stable slope and restoring several meander bends to a stable radius of curvature have been achieved. Project construction was completed in October 2003.

Channel geomorphology data were collected at pre-established locations during the MY1 and MY2 surveys. Riffle bankfull widths on MFC ranged from 27 to 36 ft in MY1 and 27 to 34 ft in MY2. These values closely approximate the 27 to 36 ft range found in the as-built survey (MY0) survey. Riffle cross-sectional areas ranged from 58 to 79 ft^2 during the MY0 survey; mean riffle cross-sectional areas fell just below the MY0 range during the MY1 and MY2 surveys. Riffle mean and maximum depths at bankfull ranged from 1.7 to 2.3 ft and 3.0 to 4.2 ft during the MY0 survey, 1.3 to 2.2 ft and 3.1 to 3.9 ft for the MY1 survey, and 1.3 to 2.2 and 3.1 to 3.9 ft for the MY2 survey. The mean bank height ratio was 1.7 in MY1 and MY2. The water surface slope has remained unchanged at 0.006 ft/ft since the pre-construction survey. Over the course of monitoring, the D50 particle size of the reach-wide pebble count for MFC has ranged from 13.0 mm to 20.0 mm and has been found to be consistently in the gravel range for particle sizes at each of the MFC riffle cross-sections. Channel geomorphology values for the three tributaries are presented in the body of the report.

Following construction in January 2004, the project site was revegetated with native plants. Herbaceous plants were established using a perennial seed mixture; whereas, woody vegetation was established by installing live stakes and bare-root shrubs and trees. Eight vegetation survey plots were established in MY1 to identify and enumerate planted stems, five on MFC and three on MB. The one vegetation plot on WB received no planted stems. The average density of planted woody stems was found to be 374 stems per acre in the MY1 and MY2 survey. Natural recruitment of woody stems was observed in all nine vegetation monitoring plots. The addition of the recruited stems resulted in a total stem density of 1,736 per acre.

The MY1 and MY2 geomorphic, vegetative, and visual assessment surveys of the mitigation site generally were found to be within the design criteria for this C4 type stream channel. With only isolated areas of aggradation of the channel bed or channel bank instability observed, the Phillips-Willis mitigation site is meeting all morphometric success criteria five years removed from project completion.

2 Project Goals, Background, and Attributes

2.1 Location and Setting

The Phillips-Willis stream mitigation project is a 7.2 acre site (Phillips = 5.7 acres; Willis = 1.5 acres) in the southeastern portion of Madison County, North Carolina (Appendix Figures A.1-A.2). The site is located off of SR 1540, beginning on Middle Fork Creek (MFC) just upstream of its confluence with Walker Branch (WB), approximately 2.5 miles east of Mars Hill. The project site is located in the U.S. Geological Survey 14 digit hydrologic unit 06010105110020, has a 14.0 mi^2 drainage area, is a fourth order stream at the project location, and is on a tributary to the French Broad River. Three tributaries to MFC also are included in the mitigation project. Walker Branch, the northern most and largest tributary has a drainage area of 1.0 mi^2. An unnamed tributary (UT) and McKinney Branch (MB) are both unnamed blue line channels on the Mars Hills 1:24,000 U.S. Geological Survey quadrangle map and have drainage areas of 0.2 mi^2 and 0.1 mi^2. The UT flows through the Neal Willis property. McKinney Branch, named for convenience, is adjacent to McKinney Road (SR 1536) and is the southernmost tributary to MFC. The project site is in a rural setting of pasture, farmland, and low density dwellings.

2.2 Project Goals and Objectives

Project objectives for the Phillips-Willis mitigation site, as stated in the restoration design plan document (NCWRC 2003), were as follows:

- Establish a conservation easement on both stream banks of MFC and three tributaries for the entire length of the restoration project to protect vegetation and channel morphology;
- Stop excessive bank erosion and improve sediment transport in MFC; realign the eroding channel reach to a more sinuous pattern to increase channel length and decrease channel slope;
- Remove automobile bodies from the banks of MFC and slope vertical banks to provide stability; install natural structures to protect banks and enhance aquatic habitat; lower the bank height in areas where the floodplain cannot be accessed by flood flows;
- Connect the MB tributary to its floodplain by lowering the banks in locations where the channel is incised; re-establish proper channel dimension, pattern, and profile in other areas where banks are eroding along this tributary;
- Repair minor erosion problems on the two northernmost tributaries and protect their existing habitat value;
- Place fish habitat improvement structures where needed in and along the MFC channel;
- Plant native trees, shrubs, and ground cover to stabilize the creek banks, shade the stream, and provide wildlife cover and food;
- Construct a permanent stream crossing on MFC;
- Install easement fencing and a livestock watering system to exclude livestock from the stream and the stream banks.

2.3 Project Structure, Restoration Type, and Approach

Channel morphology on all reaches within the project were modified by implementing Priority III restoration component activities (Appendix Table A.1; USACE 2003).

Middle Fork Creek

Channel restoration involved removing nonnative invasive vegetation and lowering the existing stream banks to create a bench so that bankfull or greater flows can access the floodplain. Channel narrowing was accomplished along the inside portion of meander bends to aid in channel sinuosity and point bar formation. One J-hook rock vane was installed at the point of curvature in five of the ten meander bends for near bank protection; two J-hooks were installed in the upper most meander bend, one at the point-of-curvature and one at the point-of-tangency. Root-wad structures were installed in nine of ten outside meander bends to provide added bank protection and aquatic habitat diversity. Overall, the project included 1,888 ft of Priority III stream channel restoration to repair bank sloughing, lateral channel migration, and channel incision (Appendix Table A.1; NSCRI 2003).

Walker Branch

In-channel work was completed along only two short sections of WB. The channel was narrowed along the middle (right bank, < 100 ft) and lower portions (left bank, < 50 ft) of the reach. The 375 ft of channel downstream of the SR 1540 crossing was protected by establishing a conservation easement on both sides of the channel (Appendix Table A.1).

Unnamed Tributary

Minimal in-channel work was conducted along the UT with the exception of channel narrowing at one short section along the left and right banks in the lower portion of the reach. A total of 269 ft of channel downstream of the SR 1540 crossing was protected by establishing a conservation easement on both sides of the channel (Appendix Table A.1).

McKinney Branch

Channel restoration on MB involved narrowing the right bank from the beginning of the project downstream to the first culvert crossing. Channel narrowing was again accomplished on the left bank in between the first and second culvert crossing. Channel narrowing using coir logs (right bank) and bank shaping was accomplished downstream of the second culvert. A single cross vane was constructed for grade control at this same location. The section of MB between the third culvert crossing and the SR 1540 box culvert was modified by narrowing the existing channel and reshaping both channel banks, and single cross vane was constructed for grade control. From the SR1540 crossing to the confluence with MFC, both the left and right channel banks were reshaped and narrowed. Overall, 2,851 ft of the MB channel was placed in a permanent conservation easement (Appendix Table A.1).

2.4 Project History, Contacts, and Attribute Data

Prior to the project, the MFC channel was destabilized by removal of riparian vegetation and channelizing. Channel banks on MB were degraded from livestock hoof-shear, and riparian vegetation was sparse. Landowners attempted to stabilize sloughing vertical banks on MFC using automobile bodies as armor, but this approach was ineffective and in most areas created additional problems. The UT and WB channels were generally stable with well vegetated riparian buffers. However the channels were incised, likely from past dredging and channelizing practices employed to remove water rapidly from adjoining row crops. Both the UT and WB showed evidence of bank scour in the area immediately downstream of the box culverts under SR 1540.

The North Carolina Wildlife Resources Commission (NCWRC) performed the initial site assessment, prepared the mitigation design and construction plans, and provided construction oversight (NCWRC 2003). This work was completed under a previous agreement with the North Carolina Department of Transportation (NCDOT). The NCDOT acquired the site from two landowners (Bruce Phillips and Neal Willis). Responsibility for the project site was transferred to the North Carolina Ecosystem Enhancement Program (NCEEP) in 2005. Construction of the Phillips-Willis project took place from 8 Sept to 1 Oct 2003. Stream and riparian conditions were improved using the Rosgen (1996) natural channel design techniques, by eliminating livestock access to the creek, and by removing the automobile bodies from within the project footprint. The as-built survey and revegetation of the riparian area were completed in January 2004. Additional project details regarding project history, timeline, background, contact information, and general physical and water quality characteristics can be found in Appendix Tables A.2-A.4.

2.5 Monitoring Plan Views

The as-built report describes the baseline condition of the MFC and MB geomorphology, stability, and vegetation following construction (NCWRC 2005). A single cross-section was surveyed on WB for post-construction baseline assessment. Survey work was not performed on the UT pre- or post-construction. For MY1 (2007) and MY2 (2008) the ten original cross-sections on MFC (5 riffles, 5 pools), the five original cross-sections on MB and one on WB were resurveyed to compare channel dimensions and stability over time. The channel longitudinal profile of the entire reach of MFC was resurveyed during MY1 and MY2. The entire length of the MB longitudinal profile was surveyed in MY1, the first time this had occurred since the projects inception; MB was not resurveyed in MY2. Road improvement activities (culvert replacement and paving of McKinney Road) by NCDOT prohibited direct comparison with the MY1 data so photo documentation and visual inspection of the channel was performed in lieu of a physical channel survey. The MY1 physical survey of the MB reach, along with other key assessment elements, including the location of the conservation easement boundary is provided for reference (Appendix Figure A.3). The longitudinal profile of the UT and WB channels were not surveyed pre- or post-construction, but were monitored in MY1 and MY2. The MY2 plan view drawings reveal the current condition of the three surveyed channels (MFC, WB, and UT; Appendix Figure A.3). Although morphological data were collected during the MY1 survey, a separate MY1 plan view drawing was not developed for this monitoring report because there was minimal change in channel stability between MY1 and MY2. However, the MY2 plan view drawing does show the MY1 thalweg overlay for comparison.

3 Methods

3.1 Stream Morphology

Post-construction conditions for the Phillips-Willis mitigation site were determined during December 2007 (MY1) and October 2008 (MY2). Representative cross-sectional dimension and longitudinal profile data were collected using standard stream channel survey techniques (Harrelson et al. 1994; NCSRI 2003). The geomorphology of the stream was classified using the Rosgen (1996) stream classification system. Project site conditions were analyzed using RIVERMorph stream assessment and restoration software, Version 4.3 (RSARS 2009). Plan view drawings for this report were developed using AutoCAD, Version 2009 (CAD 2009). U.S. Geological Survey 1:24,000 topographical maps were used to determine stream drainage area. Bed material composition and mobility was assessed by doing reach-wide counts on MFC and MB. Five riffle cross-section pebble counts were collected on MFC (NCSRI 2003). References to the left and right channel banks in this document are oriented when viewing the channel in the downstream direction.

3.2 Hydrology

Hydrologic monitoring using a simple crest gauge was established in 2008 on MFC prior to the MY2 survey to gauge stream crest during high flow events. Photographs of bankfull events also will be used to verify bankfull events.

3.3 Vegetation

Nine permanent vegetation monitoring plots were establish on this site; five on MFC, three on MB, and one plot on WB. Surveys were conducted following protocols for the Carolina Vegetation Survey (Lee et al. 2006). Plots were 100 m^2 in area (Appendix Figure A.3).

4 Project Conditions and Monitoring Results

4.1 Morphological Stream Assessment

4.1.1 Bank Stability Assessment

Bank erosion hazard index (BEHI) and near bank stress (NBS) assessments are only conducted in the existing conditions survey and in monitoring year 5. A BEHI and NBS assessment was not conducted at this site pre-construction; therefore, Table B.1 is only a place holder and will not be populated with data during the monitoring of this project site.

4.1.2 Stream Problem Areas

Widespread physical impairments of the four channels comprising the project site were not numerous during the MY1 or MY2 surveys. In large part, channel banks appeared stable and in-stream structures were intact and functioning as constructed in 2003.

The few problem areas that were observed and photo documented were confined to the MFC channel (Appendix Table B.2.1). Problem areas such as bank sloughing or scour were typically <25 ft in length. Three mid-channel bars were noted along the MFC reach. Bank sloughing likely caused by a field drain appears to have resulted in the formation of one mid-channel bar. The others appear to be the result of a combination of beaver dam construction and the heavy bed load being transported from upstream areas. Beaver dam removal and animal eradication have occurred at the project site on two separate occasions; once the beaver dams were removed, the channel cut through the sediments deposited when the dams were ponding stream flows. Beaver dams also created two observed over-wide areas in the channel. These over-wide points along the channel have resulted in bank scour and bar formation problem areas.

A separate problem areas plan view was not generated for the MY1-MY2 report, but the location of the beaver dam present in the MY2 survey along with areas of mid-channel bar formation and bank scour are presented in the plan view drawing (Appendix Figure A.3).

4.1.3 Fixed Point Photographs

Fixed point photographs from eight location on MFC and two on MB were taken during each of the three monitoring surveys (MY0-MY2) at the Phillips-Willis site (Appendix B.9). Fixed point photographs demonstrate the performance of the riparian vegetation, stability of the channel banks, and general condition of the project site over time. Overall, the ten fixed point photographs reveal that the project site has performed as desired through MY2.

4.1.4 Stability Assessment

A visual stability assessment of the project reach was not performed to during the MY0 survey. Therefore, direct comparison of the MY0 morphological stability of the channel with MY1 and MY2 stability assessments was not possible; MY0 categorical features were determined from the as-built report and plan view drawing and assumed to be stable immediately following construction (Appendix B.3; NCWRC 2005). As such, channel features, including meanders, stream bed, stream banks, and in-stream structures were examined for stability and enumerated during MY1 and MY2 surveys (Appendix Table B.3.2). Based on the morphological data and the visual stability assessment, the majority of stream feature categories were found to be stable (Appendix Table B.3.1).

4.1.5 Quantitative Measures Summary

Monitoring year 1 and MY2 morphological data obtained from established survey stations were compared with pre-existing, design, and as-built data (Appendix B.4). The baseline stream data summary presented in Appendix Table B.4.1 is from riffle cross-sections 1, 2, 6, 9, and 10 on MFC. Morphological and hydraulic summary data presented in Appendix Table B.4.2 reflect dimensions for the 16 individual cross sections initially monitored following construction - 10 on

MFC, five on MB, and one on WB. Cross-sectional dimension, longitudinal profile, and pebble count survey data plot overlays were used to evaluate the degree of departure of the channel from the as-built condition (Appendices B.5-B.6 and B.8).

4.1.5.1 Dimension

Middle Fork Creek.—Channel dimensions data from 10 cross-sections were collected along the project reach and then plotted for visual comparison (Appendix B.5). Channel dimensions from riffle cross-sections (n = 5) resurveyed during MY1 and MY2 were compared with the range of values for the design and as-built conditions for each parameter (Appendix Table B.4.1). The design value for riffle bankfull width was 34 ft; a range of values for the design data was not available. Values from the as-built survey ranged from 27 to 36 ft. Bankfull widths for MY1 and MY2 ranged from 27 to 36 ft and 27 to 34 ft (Table B.4.1). Minimal variation in riffle bankfull width has been observed in the three monitoring years post-construction with widths generally at or slightly below the design value. Riffle cross-section 2 has had the lowest bankfull width (27 ft) each of three monitoring years (Appendix Table B.4.2).

The design value for riffle cross-sectional area was 88 ft^2. Bankfull cross-sectional area ranged from 58 to 79 ft^2 for the as-built channel. Each of the five riffle cross-sections surveyed during MY1 (41 to 60 ft^2) and MY2 (42 to 66 ft^2) were below the design and as-built values (Table B.4.1). It is thought that this reduction in bankfull area following construction has resulted from channel narrowing below the bankfull elevation. Material deposition and the formation of innerberm features were observed during the MY1 and MY2 surveys. Moreover, these depositional features have become stabilized with vegetation resulting in the reduced dimensional area at the surveyed cross-sections.

Mean depth at bankfull for as-built riffle cross-sections ranged from 1.7 to 2.3 ft (Appendix Table B.4.1). Mean depth at bankfull for MY1 and MY2 riffle cross-sections ranged from 1.3 to 2.2 ft for both monitoring years. All riffle cross-sections surveyed post-construction have been found to be below the design mean depth (2.6 ft). Cross-section 2 had the highest observed mean depth of 2.2 ft, slightly below the design value (Appendix Table B.4.2). Cross-section 6 had the lowest mean depth (1.3 ft) during MY0-MY2. Because the as-built mean depths at riffle cross-sections were all below the design mean depth it is suspected that mean depths for the channel never attained the design value and have likely trended downward in the six years since construction due to the developing depositional features discussed above.

The riffle bankfull maximum depth design value was 4.0 ft (Appendix Table B.4.1). The as-built bankfull maximum depth values ranged from 3.0 to 4.2 ft. Bankfull maximum depths for the five resurveyed riffle cross-sections ranged from 3.1 to 3.9 ft in both MY1 and in MY2. Cross-section 10 had a maximum depth of 3.9 ft (MY1 and MY2) and was the only riffle that approximated the design value for bankfull maximum depth (Appendix Table B.4.2). The maximum bankfull depths during the as-built survey for cross-sections 9 and cross-section 10 (4.2 and 4.1 ft) exceeded the design value but have decreased slightly during the two recent monitoring years. Channel aggradation at the riffle cross-sections is not apparent from the cross-section plot overlays and is not thought to have resulted in the lower maximum depths when compared to the design value (Appendix B.5). The apparent lower maximum depths could be the result of bankfull elevation field measurements being measured 0.1 to 0.9 ft lower than during the as-built survey. Prominent bankfull benches were constructed, but not along the entire reach of MFC. As a result, the bankfull elevation at some locations was subjectively identified; this could have resulted in the underestimation of the bankfull maximum depths.

Bank height ratio (BHR), a measure of vertical stability of the channel banks, remained relatively unchanged from the existing conditions survey (BHR = 1.4) to the post-construction condition (MY0 BHR = 1.6; Appendix Table B.4.1). Mean bank height ratios for MY1 and MY2 were the same (BHR = 1.7) and approximated the values from previous pre- and post-construction surveys. Bank height ratios >1.5 suggest highly unstable vertical banks. All cross-sections had individual bank height ratios ≥1.1 (moderately unstable) during each of the three post-construction surveys (Appendix Table B.4.2). These results for MFC are somewhat misleading as bank conditions observed at riffle cross-sections provide evidence that the channel banks are intact and not in jeopardy of potential collapse. In fact, riparian vegetation and the associated root assemblages have sequestered soils, providing for added protection of the channel banks. However, there are a couple meander bends that do exhibit high vertical banks with some active sloughing. Project constraints (e.g., adjacent land practices and easement width) limited the amount of bank shaping and bench construction in these areas. Larger easement widths in these areas would have allowed the banks to be reshaped, decreasing slopes and reducing the risk of bank failure.

The channel entrenchment ratio (ER), a measure of vertical containment, was improved from the pre-existing condition (ER = 2.9) by reshaping the banks and excavating bankfull benches during construction. Mean entrenchment ratios taken from measurements at riffle cross-sections for MY1 and MY2 were 14.3 and 14.6 (Appendix Table B.4.1). Appendix Table B.4.2 provides entrenchment ratios for each of the 10 cross-sections.

Walker Branch.—Pre-existing and design values were not generated for WB. Modification of the WB channel was addressed by narrowing channel width. Bank shaping and coir logs were used to narrow the channel width on the left bank (sta. 1+50-2+00) and on the right bank (sta. 3+25-3+50). A single cross-section (sta. 1+57) was surveyed to monitor channel dimension and stability following construction. Minimal variation in bankfull width has been observed in the three monitoring years. The MY0 bankfull width was 6.7 ft. Bankfull widths for MY1 and MY2 were 6.4 ft and 6.2 ft (Table B.4.2).

Bankfull cross-sectional area on WB was 6.6 ft^2 for the MY0 survey (Appendix Table B.4.2). Cross-sectional area decreased in MY1 to 5.9 ft^2 and again in MY2 to 4.9 ft^2. The MY0 bankfull maximum depth value was 1.4 ft. Bankfull maximum depth was found to be 1.3 ft in MY1 and 1.0 ft in MY2 (Appendix Table B.4.2). Bank height ratios have trended upward each monitoring year from 2.8 in MY0 to 3.2 in MY1 and to 3.2 in MY2. Channel entrenchment ratios have been similar each of the three monitoring years ranging from 1.6 to 1.7.

Based on the trends of bankfull cross-sectional area, bank height ratios, and particularly bankfull maximum depth, the bankfull indicator or elevation at which bankfull was judged in the field has likely differed slightly over the course of the three surveys. The decrease in maximum depth and increase in bank height ratio supports the notion that the bankfull elevation has been recorded slightly lower in elevation during each monitoring survey. Although the channel is moderately entrenched, the cross-section plot overlays show the well-vegetated banks are stable with no obvious sign of bank erosion, channel aggradation, or degradation (Appendix B.5).

Unnamed Tributary.—Dimension data has not been collected on this channel during any of the pre- or post-construction surveys. Although the channel is moderately entrenched from past modifications, the banks are well-vegetated and stable with no obvious sign of bank erosion, channel aggradation, or degradation.

McKinney Branch.—Channel features on MB are not so distinct that riffles, runs, glides, or even pools could be clearly categorized; this is in large part due to the small size of the channel. As such, a statistical summary of the five cross-sections was not attempted, only values from each individual cross-section are presented (Appendix Table B.4.2). Design values for MB were not incorporated into Table B.4.1; design values for MB were taken from the stream mitigation site construction plan (NCWRC 2003).

Bankfull widths on MB for MY1 and MY2 ranged from 4.2 ft to 6.7 over the two monitoring years (Appendix Table B.4.2). Bankfull widths generally decreased in an upstream progression with the width at cross-section 1 being the greatest; whereas, cross-section 4 was found to have the smallest bankfull width. The design bankfull width for MB was 5.5 ft; the MY1 and MY2 survey have approximated this value falling just above and below the proposed width. The channel dimension data from the five cross-sections on MB were plotted for visual comparison (Appendix B.5).

Bankfull cross-sectional area proposed for MB was 5.0 ft^2. Cross-section 1 (downstream most cross-section) approximated the design cross-sectional area (5.4-6.5 ft^2), but the four upstream cross-section all fell below 5.0 ft^2, ranging from 1.6 to 4.7 ft^2 during MY0-MY2 surveys (Appendix Table B.4.2).

Mean depth at bankfull for MY0-MY2 ranged from 0.4 to 1.0 ft and have generally fell below the design mean bankfull depth 0.9 ft (Appendix Table B.4.2).

The bankfull maximum depth design value for MB was 1.5 ft. Bankfull maximum depths for the five cross-sections have ranged from 0.8 to 1.7 ft in each of the three monitoring surveys (Appendix Table B.4.2). Again, cross-section 1 was nearest to the design value with a bankfull maximum depth of 1.5 ft; the other four cross-sections fell below the proposed value in MY0-MY2.

A bank height ratio of 1.00 to 1.05 is the desirable target value for a post-construction stability rating. Bank height ratios for the five MB cross-section ranged from 1.4 to 2.9 during MY0-MY2, indicating potential bank instability (Appendix Table B.4.2). Although the potential exists for bank instability due to the top of the banks being up to 2.9 times higher than the bankfull elevation, evidence of bank scour and active erosion was not observed during MY0-MY2 surveys. In fact, riparian vegetation and the associated root assemblages have sequestered soils, providing for added protection of the channel banks along the majority of the reach.

The channel entrenchment ratio proposed for MB was 3.6. Entrenchment ratios from measurements at the five cross-sections for MY0-MY2 have ranged from 2.4 to 5.3 (Appendix Table B.4.2). Entrenchment values >2.2 are desirable, indicating low channel entrenchment. Due to the small size of the channel and narrow floodplain and bankfull widths, the entrenchment values for MB are inherently low compared to what might be expected on a larger channel. All cross-sections have consistently revealed low channel entrenchment values during each of the three monitoring surveys.

4.1.5.2 Pattern

Middle Fork Creek.—Pattern geometry measurements derived from the MY2 channel survey on MFC revealed values that approximated the minimum and maximum design values for channel belt width and meander wavelength (Appendix Tables B.4.1 and B.6.1). Channel belt width and meander wavelength design values ranged from 60 to 94 ft and 250 to 370 ft (NCWRC 2003). Mean values for channel belt width (87 ft) and meander wavelength (298 ft) fell within the range of design values. Measurements for radius of curvature in the post-construction surveys were consistently larger when compared to the design radius of curvature minimum and maximum values of 60 and 82 ft. The smallest meander bend measured had a radius of curvature of 111. Although the radius of curvature pattern data reveals values outside the design range, the meander bends are in large part stable and performing as desired five years removed from project construction. Based on stream length and valley length, MFC had a sinuosity of 1.2 in MY1 and MY2.

Walker Branch.—Design values were not generated for WB because no work influencing channel pattern was planned. Two short portions of the channel were narrowed, but that work did not influence pattern geometry. Overall, the WB reach has only two meanders and a sinuosity of 1.0. Nonetheless, pattern geometry from the MY2 survey was generated for inclusion into this monitoring report (Appendix Table B.6.1).

Unnamed Tributary.—Design values for were not generated for the UT because no work influencing channel pattern was planned. The UT to MFC on the Willis property was too straight to provide meaningful values of pattern geometry. Sinuosity of the UT was determined to be 1.0.

McKinney Branch.—Pattern geometry measurements derived from the MY2 channel survey on MB revealed values that approximated the design value (25 ft) for channel belt width, with belt widths ranging from 15 to 50 ft (Appendix Table B.6.1). Six radiuses of curvature were measured during the MY2 survey, two of which exceeded the design radius of curvature range. Four of the measurements fell within or just below the design value range of 30 to 44 ft for radius of curvature. Meander wavelength values determined from the MY2 survey fell within or exceeded the design value range of 40 to 75 ft. The MB tributary had a sinuosity of 1.2.

4.1.5.3 Profile

Middle Fork Creek.—The entire 1,888 ft of stream channel was surveyed in MY1 and MY2 to obtain longitudinal profile data (Appendix Figure A.3; Appendix B.7). This was not true with the as-built survey where the survey began just below the upper property and easement boundary and concluded just upstream of the constructed stream crossing (sta. 17+75), approximately 100 ft short of the lower property and easement boundary. Feature lengths, slopes, depths, and spacing were calculated following each monitoring survey (Appendix Table B.4.1). From the as-built survey through MY2, riffle lengths have ranged from 31 to 96 ft, generally exceeding the design value of 49 ft. Riffle slopes have ranged from 0.005 ft/ft to 0.026 ft/ft over the course of the three monitoring surveys. Mean riffle slope calculations have been very close to the design value of 0.015 ft/ft, with the MY1 mean riffle slope the same as the design value. Pool lengths have ranged above and below the 46 ft design value, ranging from 27 to 102 ft over the three monitoring years. Mean pool length exceeded the design value (46 ft) in MY0 and MY2 and was 40 ft in MY1, just below the design value. Pool-to-pool spacing values were within the design range of 229 to 342 ft in MY0, but the minimum and maximum values observed for MY1 and MY2 were outside the design range. Mean values for pool-to-pool spacing have been within the design range each of the three monitoring years. Overall, thalweg alignment and edge of water survey points that define the location of the active channel indicate some isolated lateral movement of the channel during the MY1 and MY2 surveys. Channel slope determined from the MY2 survey was 0.006 ft/ft.

Walker Branch.—The entire length (375 ft) of the longitudinal profile was surveyed during MY1 and MY2 (Figure A.3; Appendix B.7). Profile feature design values for WB were not available for inclusion into this report, and the channel was not surveyed in MY0. Moreover, channel homogeneity does not provide distinct features that can be measured in a traditional manner or that would provide meaningful results. Channel slope determined from the MY2 survey was 0.016 ft/ft.

Unnamed Tributary.—The entire 269 ft of the stream channel was surveyed during MY1 and MY2 to obtain longitudinal profile data (Appendix Figure A.3; Appendix B.7). Profile feature design values for the UT were not available for inclusion into this report, and the channel was not surveyed in MY0. Moreover, channel homogeneity does not provide distinct features that can be measured in a traditional manner or that would provide meaningful results. Channel slope determined from the MY2 survey data was 0.019 ft/ft.

McKinney Branch.—The entire 2,851 ft of the stream channel was surveyed during MY1 to obtain longitudinal profile data (Appendix Figure A.3; Appendix B.7). The small size of MB and the lack of distinct profile features prohibited the measurement of feature slopes, lengths, and spacing. The overall channel slope determined from the MY1 survey was 0.043 ft/ft. The longitudinal profile of MB was not resurveyed in MY2. A visual assessment of MB in MY2 revealed little to no change in channel profile with no head- or down-cutting observed. Channel banks were stable with no apparent areas of active erosion. Encroachment within the conservation easement resulting from roadside mowing had occurred in multiple locations just prior to the MY2 survey. This issue is further discussed in the Vegetation Problem Areas section below.

4.1.5.4 Substrate Data

Middle Fork Creek.—Reach-wide substrate particle data were not available from the pre- or post-construction surveys. Reach-wide substrate particle analysis revealed that the D50 and D84 in MY1 were 19.8 mm and 99.5 mm and 13.0 mm and 69.3 mm in MY2 (Appendix B.8). The D50 values are in the coarse gravel and medium gravel particle categories. The D84 values fell within the small cobble particle categories during both MY1 and MY2. The D50 and D84 particles sizes decreased between MY1 and MY2 but remained in the gravel and cobble particle size categories. Overall, substrate particle size has varied little between the two monitoring years. Aggradation in the form of mid-channel bars has been observed but do not appear to have had a negative influence on substrate particle size at the reach-wide scale. Plots of the MY1 and MY2 cumulative percent of particles finer than a specific particle size for the reach-wide pebble counts are summarized in Appendix B.8.

Substrate particle counts also were conducted at each of the ten established cross-sections. Particle data from the five riffle cross-sections were pooled to generate statistical values for each monitoring year. Riffle particle size data were not available for MY0. The mean D50 particle size was 34.0 mm in MY1 and 14.7 mm in MY2 (Appendix Table B.4.1). The decrease in the D50 mean particle size from MY1 to MY2 resulted in the particle size category shifting from very coarse gravel to medium gravel. With a single exception, all riffle pebble counts for the D50 particle size were in the gravel category; cross-section 10 in MY1 was categorized as being sand (Appendix Table B.4.2). The D50 particle size for each of the five pool cross-sections also are summarized in Appendix Table B.4.2. Plots of the MY1-MY2 cumulative percent of particles finer than a specific particle size for each of the ten cross-section pebble counts are summarized in Appendix B.8. Substrate data combined with field observations reveals the stream channel is made up in large part by gravel, cobble, and to lesser extent sand. Aggradation or the accumulation of finer particle sizes such as fine sand or silt have been observed in proximity to the former beaver dam locations but does not appear to be resulting in a shift in particle size on the reach-wide scale.

Walker Branch.—A single pebble count was performed along the one established cross-section on WB in MY2. The D50 particle size was 8.0 mm, medium gravel (Appendix Table B.4.2). Substrate particle size evaluations were not conducted on WB prior to construction, during MY0, or MY1. A plot of the MY2 cumulative percent of particles finer than a specific particle size is summarized in Appendix B.8. A reach-wide particle analysis has never been performed on WB.

Unnamed Tributary.—Substrate particle size evaluations were not conducted on the UT prior to construction nor have substrate data collections been conducted during the three monitoring surveys.

McKinney Branch.—Pre-existing substrate particle data were not available for MB nor were pebble counts performed during the MY0 survey. A reach-wide substrate analysis was performed during MY1 and MY2 (Appendix B.8). The D50 particle size was within the fine gravel category both years but declined from 6.5 mm to 4.8 from MY1 to MY2. Substrate particle collections were performed at each of the five established cross-sections during MY1 and MY2 (Appendix Table B.4.2; Appendix B.7). The D50 substrate particle size at each of the five cross-sections was in the gravel category during MY1 and MY2 with one exception at cross-section 1 in MY2. At that location, the D50 particle size decreased from 7.0 in MY1 to 0.9 mm in MY2. As a result, the D50 particle size was then categorized as coarse sand.

4.2 Hydrologic Criteria

To document bankfull events on MFC a simple crest gauge was installed in 2008 on the right bank (sta. 0+00) upstream of cross-section 10 and adjacent to a large multi-trunk sycamore. With the widespread drought conditions experienced in the mountain region during the 2007 and 2008 monitoring years, no bankfull events were documented. In the four years post-construction and prior to the establishment of the crest gauge, bankfull events were not photo documented. Even in 2004 when multiple bankfull events were observed in nearby drainages, bankfull flow documentation for MFC is lacking. Therefore, Appendix B.10 and Appendix Table B.10.1 do not include photos or bankfull event data but serve as place holders for future bankfull event documentation.

In the absence of a stream gauge in the project drainage, the Ivy River stream gage was used as a surrogate (Appendix B.10). The Ivy River gauge, USGS Hydrologic Unit 06010105, is located at 1,700 ft above mean sea level and has a drainage area of 158 mi^2. Based on the N.C. rural mountain regional hydraulic geometry curves, a discharge at the Ivy River gage of 450-500 cfs correlates to a potential bankfull flow at the project location (Harman et al. 2000). A review of the USGS data for the period between October 2003 and September 2008 revealed there were numerous flows exceeding 450-500 cfs; six flow events at the Ivy River gage ≥2,000 cfs (USGS 2008). Although photo documentation or crest gauge corroboration has not occurred, data from the surrogate gauges suggests there have been multiple bankfull flows at the project site.

4.3 Vegetation Assessment

The Phillip-Willis mitigation site was revegetated during January 2004 with a variety of plant types including annual and perennial native seed mixes, live stakes, and bare-root woody species. For additional information regarding the revegetation of the project site following construction refer to the as-built report (NCWRC 2005). A number of mature trees representing a variety of species were not disturbed during construction. Most of the undisturbed areas were located along WB and the UT. They were retained because they were contributing to bank stability, providing shade to the stream, and would be a seed source that would contribute to natural revegetation of the project area.

Vegetation monitoring plots were not established following plant installation, and vegetation monitoring was not conducted prior to MY1. Vegetation monitoring plots were established in MY1. Nine permanent vegetation monitoring plots were establish; five on MFC, three on MB, and one plot on WB. Plots were 100 m^2 in area. The plots were resurveyed in MY2. Planted stems versus naturally recruited stems were determined based on the list of known species planted and the size of the stem encountered. Vegetation metadata, stem counts, plant vigor, and plant damage was assessed for each plot (Appendix C, Tables C.1.1.-C.1.7).

Middle Fork Creek Vegetation Plot 1.-Four planted stems (162 stems per acre) were documented in vegetation plot 1 during the MY1 survey. Three woody stems were found in MY2, reducing the planted stem density of vegetation plot 1 to 121 stems per acre (Appendix Table C.1.6). Numerous non-planted species have recruited into vegetation plot 1 including American plum *Prunus americana*, black locust *Robinia pseudoacacia*, and staghorn sumac

Rhus typhina. Inclusion of those stems resulted in a stem density of 1,821 stems per acre (Appendix Table C.1.7).

Middle Fork Creek Vegetation Plot 2.-Five planted stems consisting of two species were found in vegetation plot 2 (202 stems per acre) in MY1 and MY2 (Appendix Table C.1.6). Non-planted woody stems increased the total stem count in MY2 to 16 and increased the species diversity from two species to six species. Total stem density for vegetation plot 2 in MY2 was 648 stems per acre (Appendix Table C.1.7).

Middle Fork Creek Vegetation Plot 3.-In vegetation plot 3, 16 planted stems were recorded (648 stems per acre) in MY1. Eleven of the woody stems counted in vegetation plot 3 were silky dogwood *Cornus amomum* that had been planted as live stakes; one less stem (607 stems per acre) was counted in MY2 (Appendix Table C.1.6). Inclusion of non-planted stems in the counts increased species diversity from four to ten species. The total stem count increased from 16 to 42. The density of all stems counted for MY2 was 1,700 stems per acre.

Middle Fork Creek Vegetation Plot 4.—One planted stem (41 stems per acre) was documented in vegetation plot 4 during the MY1 and MY2 surveys (Appendix Table C.1.6). Numerous non-planted species have recruited into vegetation plot 4 including black walnut *Juglans nigra*, black gum *Nyssa sylvatica*, black willow *Salix nigra*, and southern arrowwood *Viburnum dentatum*, which increased the total stem density to 526 stems per acre (Appendix Table C.1.7).

Middle Fork Creek Vegetation Plot 5.—A single silky dogwood stem (41 stems per acre) was documented in vegetation plot 5 during the MY1 and MY2 surveys (Appendix Table C.1.6). Species diversity within vegetation plot 5 was increased when seven non-planted species identified in the MY2 survey were included. The addition of the non-planted species increased the total stem count to 38 and density of the plot to 1,538 stems per acre (Appendix Table C.1.7).

The average woody stem density for the five vegetation plots on MFC was 211 stems per acre in MY1 and 202 stems per acre in MY2 for planted stems (Appendix Table C.1.6). Because the mitigation site is five years removed from construction and plant installation, planted woody stem densities should meet or exceed 260 stems per acre success criteria (USACE 2003). Consequently, the planted vegetation density on the MFC portion of the project has not met the year-5 success criteria. Vegetation plot 3 is the only plot that did meet the year-4 and year-5 success criteria with densities of 648 and 607 stems per acre recorded. Natural regeneration and recruitment of woody stems into the MFC vegetation plots has helped to offset the planted stem densities; the average density for all stems counted in MY2 was 1,247 stems per acre (Appendix C.1.7).

McKinney Branch Vegetation Plot 1.-Six planted silky dogwood stems (243 stems per acre) were documented in vegetation plot 1 during the MY1 survey. Two stems were overlooked in MY1 and eight silky dogwood stems were found in MY2, increasing the planted stem density of vegetation plot 1 to 324 stems per acre (Appendix Table C.1.6). Seven additional non-planted species have recruited into vegetation plot 1 in the five years following plant installation.

Inclusion of the naturally recruited plants increased the total stem count to 45, resulting in a total stem density of 1,821 stems per acre (Appendix Table C.1.7).

McKinney Branch Vegetation Plot 2.-Nine planted stems consisting of three species were found in vegetation plot 2 (364 stems per acre) in MY1 and MY2 (Appendix Table C.1.6). Non-planted woody stems increased the total stem count in MY2 to 21 and increased the species diversity from three to seven species. Total stem density for vegetation plot 2 in MY2 was 850 stems per acre (Appendix Table C.1.7).

McKinney Branch Vegetation Plot 3.-In vegetation plot 3, 32 planted stems were recorded (1,295 stems per acre) in MY1 (Appendix Table C.1.6). The same number of stems was again recorded in MY2. Thirty of the thirty-two stems counted in vegetation plot 3 were silky dogwood and planted as live stakes; the other two stems were sycamores *Platanus occidentalis*. Non-planted stems increased species diversity from two to nine, and the total stem count was increased from 32 to 49. The density of all stems counted for MY2 was 1,983 stems per acre.

The average planted woody stem density for the three MB vegetation plots was 634 stems per acre in MY1 and 661 stems per acre in MY2 (Appendix Table C.1.6). Because the mitigation site is five years removed from construction and plant installation, planted woody stem densities should meet or exceed 260 stems per acre success criteria (USACE 2003). Planted vegetation density on the MB portion of the project on average has met the year-5 success criteria. However, Vegetation plot 1 fell short of the year-4 success criteria (288 stems per acre) in MY1 with a density of 243 stems per acre recorded. Vegetation plot 1 rebounded in MY2 and exceeded the year-5 success criteria having a density of 324 stems per acre with two additional stems recorded that were likely overlooked in MY1. Natural regeneration and recruitment of woody stems into the MB vegetation plots has increased to total number of stems present in the vegetation plots; the average density for all stems counted in MY2 was 1,551 stems per acre (Appendix C.1.7).

Walker Branch Vegetation Plot 1.-Although bare-root woody stems were not installed in the riparian area of the WB, a vegetation plot was established to record the density of the naturally existing vegetation. Three species of plants and 117 stems were recorded in MY2. White basswood *Tilia americana* of various sizes accounted for 103 stems of the total stems counted. The total stem density was 4,735 stems per acre (Appendix Table C.1.7).

4.3.1 Vegetative Problem Areas

4.3.1.1 Vegetation Problem Areas Table Summary

One important occurrence to note regarding vegetation condition or problem areas occurred following the MY1 surveys when the NCDOT using a long-arm mower cut and slashed the vegetation within the conservation easement on MB that was adjacent to McKinney Branch Road (Appendix Table C.2.1). The station information in Appendix Table C.2.1 and the accompanying photo only reflects the condition at the upper most portion of the conservation easement on MB. Unfortunately, the long-arm mower was used along the entire length of McKinney Branch Road and encroached into the conservation easement in multiple locations.

Clumps of Chinese privet *Ligustrum sinense* and multiflora rose *Rosa multiflora* were observed during the MY1 site assessment. The observed non-native vegetation most likely regenerated from parent stock remaining in the soil following ground clearing. A single non-native suppression herbicidal treatment occurred following the MY1 survey during the summer of 2008. Much of the sporadic occurrence of Chinese privet and multiflora rose was treated following the suppression efforts. The lower most portion of the left bank (Sta. 17+75) on MFC has the highest density of Chinese privet and multiflora rose remaining of which some mature stems were not removed during construction and are in need of additional treatment (Appendix Table C.2.1.).

4.3.1.2 Vegetative Problem Areas Photographs

Vegetative problem areas photographs were taken following MY1 to document the condition of the conservation easement following the roadside maintenance along McKinney Branch Road (Appendix Table C.2.1). Pictures were taken during the MY2 survey to provide a visual record of the occurrence, size, and dispersal of non-native vegetation (Appendix Table C.2.1). No significant problems with the planted vegetation were observed in 2008.

4.3.1.3 Vegetative Problem Areas Plan View

A vegetation problem areas plan view was not generated for MY1 or MY2 because ground cover vegetation and planted stems have performed satisfactorily since installation; there have been no areas of the conservation easement that were devoid of vegetation coverage. Some areas on MFC are sparse in terms of woody vegetation as noted in the vegetation plot stem counts and would benefit from targeted replanting. Replanting would enhance the existing vegetative condition and help to increase the stem counts to meet the required woody stem success criteria.

4.3.2 Vegetative Monitoring Plot Photographs

Vegetative monitoring plot photographs were taken during each of the two vegetation monitoring surveys to record the performance of the vegetation plots over time (Appendix C.3). Location, orientation, and dimension information for each of the vegetation monitoring plots is located in Appendix Table C.3.1.

4.4 Farm Management Plan

Multiple farm management plan improvements were installed at the Phillips-Willis mitigation site. These included livestock exclusion fencing along the conservation easement boundary, a livestock watering system, and an improved stream crossing on the lower portion of MFC.

Livestock exclusion fencing was erected along both the left and right banks of MB upstream of SR 1540. The portion of MB downstream of SR 1540 was not fenced. Fencing on MB denotes the actual conservation easement boundary. Fencing along the conservation easement on MFC, the UT, and WB was not necessary because livestock are not pastured there. There is a provision in the conservation easement document that allows for future fencing on MFC, the UT, and WB if future activities in the adjoining fields endanger the habitat values of the conservation easement (NCWRC 2003; 2005). The conservation easement boundary turns on MFC, the UT, and WB were marked using 4 in. X 4 in. treated posts erected adjacent to each survey pin.

A watering system was constructed to provide sufficient water for the cattle pastured adjacent to MB. A well, storage tank, and five watering tanks were installed. Water is pumped to the storage tank whereby the water is gravity fed to the cattle waterers. Water supply lines were buried underground. To reduce erosion, filter fabric and washed stone were installed around each cattle waterer.

The existing stream crossing on the lower portion of MFC was enhanced as part of the agriculture BMP work. The existing stream crossing was improved by placing a polyurethane terra-cell matrix on the left and right bank approaches to the stream crossing. The terra-cell material was backfilled with washed gravel to provide a hardened surface for farm equipment passage and to reduce erosion at the crossing.

4.5 Summary

Monitoring surveys in fourth (MY1) and fifth (MY2) years post-construction reveal that MFC and the three tributaries within the project area are performing as designed with minimal to no change in any of the major morphological components. Dimension, pattern, and profile parameters measured on MFC suggest the stream channel has remained stable since construction. Although substrate particle size has fluctuated slightly since construction, the bed material generally has remained in the gravel and cobble categories. There has been some aggradation of fine particle sizes in the form of mid-channel bars. It is thought that most of the bar formation has occurred due to the presence of beaver activity within the project reach. Isolated areas of minor bank sloughing have been observed that also could be contributing to mid-channel bar formation. Constructed stream structures remain stable and performing as desired. Planted vegetation performance has been marginal with just four of the eight planted vegetation monitoring plots meeting the success criteria five years post-installation. However, the MY2 average density (374 stems per acre) for all eight plots combined exceeded the year-5 minimum success criteria for planted stems. With the addition of natural stem contributions, the vegetation plots had an average stem density of 1,736 stems per acre in MY2. Overall, the project reach continues to perform as desired with only minor changes observed in form or function.

5 Acknowledgements

S. Loftis, J. Ferguson, T. Ewing, and B. Burgess of the NCWRC collected and analyzed the field data; S. Loftis and J. Ferguson prepared this report. J. Borawa improved the report with his thorough review and thoughtful suggestions.

6 References

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Appendix A General Tables and Figures

Figure A.1 Vicinity Map.

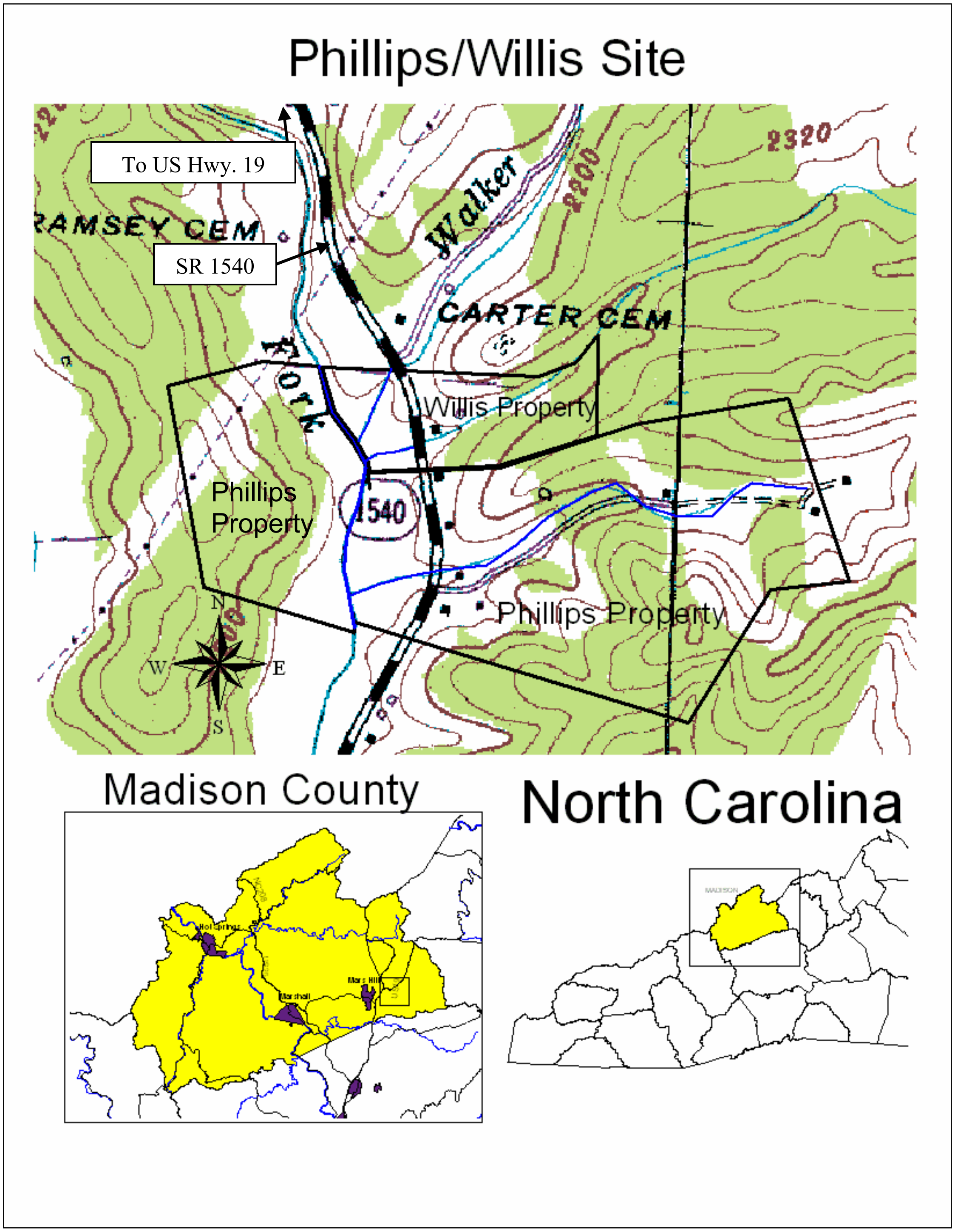
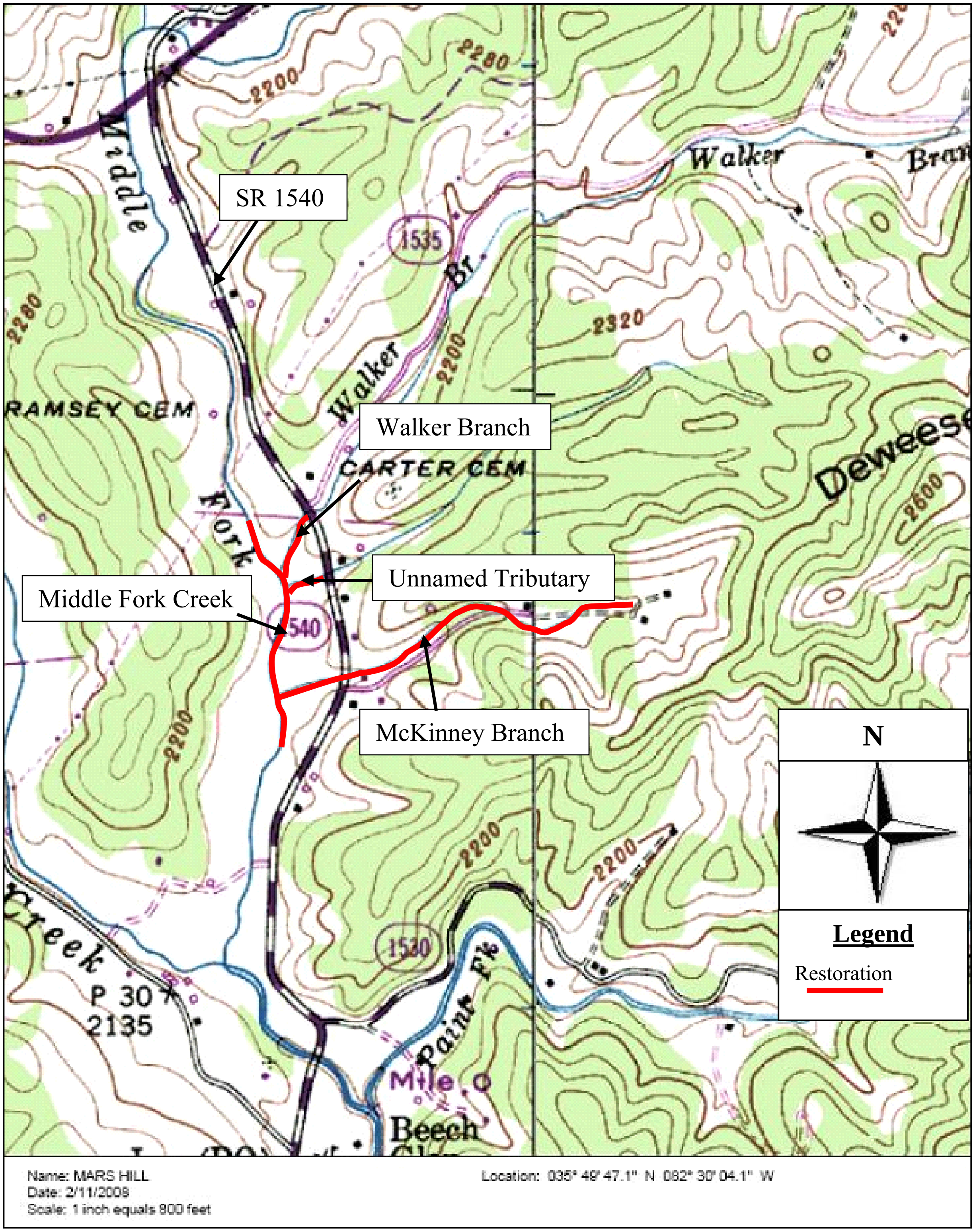


Figure A.2 Project Component and Asset Map.



Monitoring Pin Coordinates

Project# 92703:

Middle Fork Creek (MFC)
Walker Branch (WB)
McKinney Branch (MB)
Unnamed Tributary (UT)

Cross Sections:

Location	Latitude(N)	Longitude(W)
MFC-XS1-LB	35.82726533°	82.50562562°
MFC-XS1-RB	35.82728434°	82.50582962°
MFC-XS2-LB	35.82795586°	82.50580020°
MFC-XS2-RB	35.82787397°	82.50594710°
MFC-XS3-LB	35.82815576°	82.50591488°
MFC-XS3-RB	35.82811017°	82.50611086°
MFC-XS4-LB	35.82881766°	82.50559351°
MFC-XS4-RB	35.82885855°	82.50583661°
MFC-XS5-LB	35.82930119°	82.50555573°
MFC-XS5-RB	35.82930392°	82.50548940°
MFC-XS6-LB	35.82955811°	82.50539970°
MFC-XS6-RB	35.82943240°	82.50555573°
MFC-XS7-LB	35.82999667°	82.50549755°
MFC-XS7-RB	35.82997193°	82.50568790°
MFC-XS8-LB	35.83040034°	82.50605288°
MFC-XS8-RB	35.83029974°	82.50617920°
MFC-XS9-LB	35.83066590°	82.50610820°
MFC-XS9-RB	35.83065901°	82.50626174°
MFC-XS10-LB	35.83085812°	82.50622669°
MFC-XS10-RB	35.83079550°	82.50636615°
WB-XS1-LB	35.83058741°	82.50533750°
WB-XS1-RB	35.83061710°	82.50543322°
MB-XS1-LB	35.82771409°	82.50531082°
MB-XS1-RB	35.82778539°	82.50533832°
MB-XS2-LB	35.82790361°	82.50371752°
MB-XS2-RB	35.82794377°	82.50375720°
MB-XS3-LB	35.82898598°	82.50206602°
MB-XS3-RB	35.82906227°	82.50206442°
MB-XS4-LB	35.82913781°	82.49940313°
MB-XS4-RB	35.82919376°	82.49943711°
MB-XS5-LB	35.82925511°	82.49890297°
MB-XS5-RB	35.82930782°	82.49890574°

Vegetation Plots:

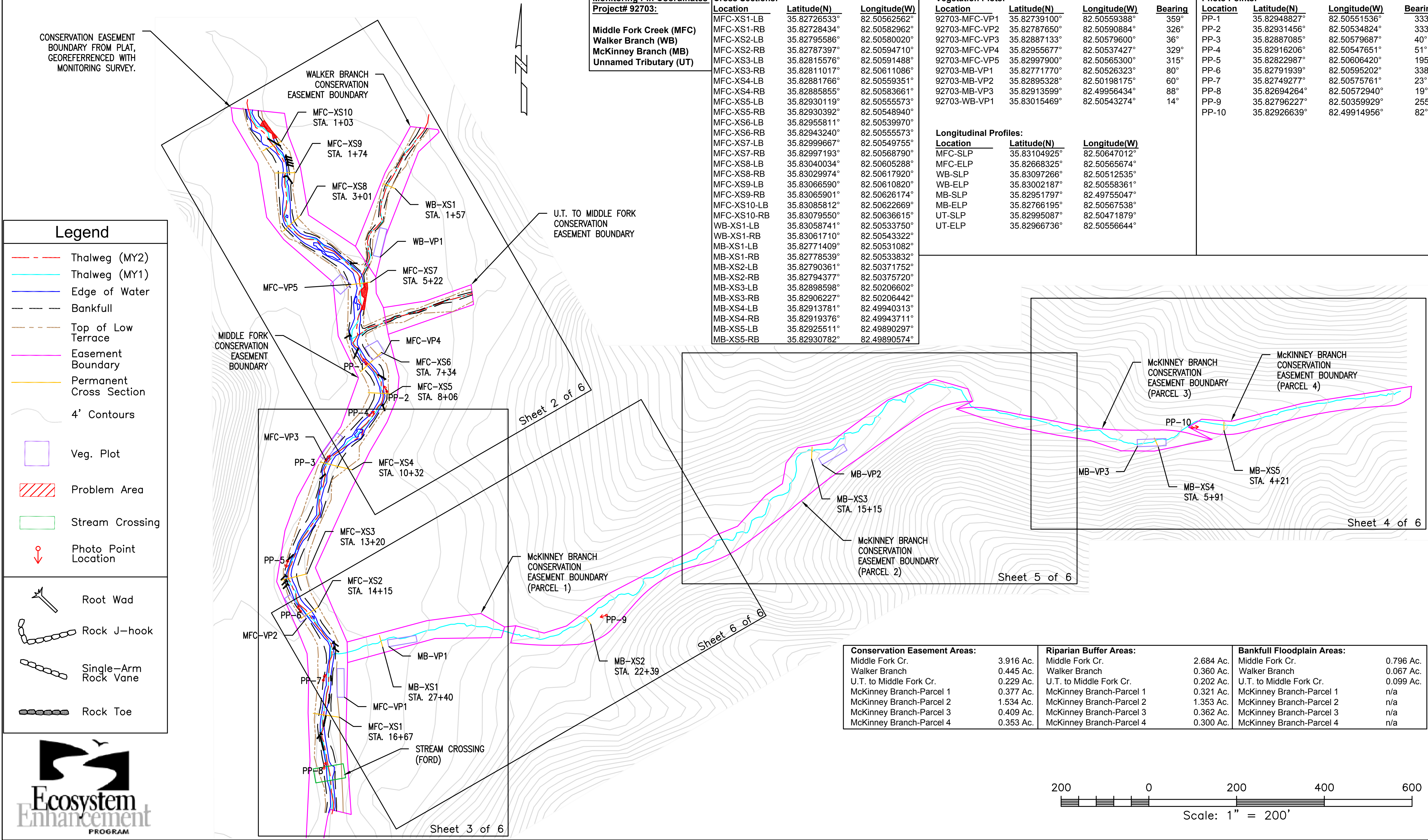
Location	Latitude(N)	Longitude(W)	Bearing
92703-MFC-VP1	35.82739100°	82.50559388°	359°
92703-MFC-VP2	35.82787650°	82.50590884°	326°
92703-MFC-VP3	35.82887133°	82.50579600°	36°
92703-MFC-VP4	35.82955677°	82.50537427°	329°
92703-MFC-VP5	35.82997900°	82.50565300°	315°
92703-MB-VP1	35.82771770°	82.50526323°	80°
92703-MB-VP2	35.82895328°	82.50198175°	60°
92703-MB-VP3	35.82913599°	82.49956434°	88°
92703-WB-VP1	35.83015469°	82.50543274°	14°

Longitudinal Profiles:

Location	Latitude(N)	Longitude(W)
MFC-SLP	35.83104925°	82.50647012°
MFC-ELP	35.82668325°	82.50565674°
WB-SLP	35.83097266°	82.50512535°
WB-ELP	35.83002187°	82.50558361°
MB-SLP	35.82951797°	82.49755047°
MB-ELP	35.82766195°	82.50567538°
UT-SLP	35.82995087°	82.50471879°
UT-ELP	35.82966736°	82.50556644°

Photo Points:

Location	Latitude(N)	Longitude(W)	Bearing
PP-1	35.82948827°	82.50551536°	333°
PP-2	35.82931456°	82.50534824°	333°
PP-3	35.82887085°	82.50579687°	40°
PP-4	35.82916206°	82.50547651°	51°
PP-5	35.82822987°	82.50606420°	195°
PP-6	35.82791939°	82.50595202°	338°
PP-7	35.82749277°	82.50575761°	23°
PP-8	35.82694264°	82.50572940°	19°
PP-9	35.82796227°	82.50359929°	255°
PP-10	35.82926639°	82.49914956°	82°



Conservation Easement Areas:		Riparian Buffer Areas:		Bankfull Floodplain Areas:	
Middle Fork Cr.	3.916 Ac.	Middle Fork Cr.	2.684 Ac.	Middle Fork Cr.	0.796 Ac.
Walker Branch	0.445 Ac.	Walker Branch	0.360 Ac.	Walker Branch	0.067 Ac.
U.T. to Middle Fork Cr.	0.229 Ac.	U.T. to Middle Fork Cr.	0.202 Ac.	U.T. to Middle Fork Cr.	0.099 Ac.
McKinney Branch-Parcel 1	0.377 Ac.	McKinney Branch-Parcel 1	0.321 Ac.	McKinney Branch-Parcel 1	n/a
McKinney Branch-Parcel 2	1.534 Ac.	McKinney Branch-Parcel 2	1.353 Ac.	McKinney Branch-Parcel 2	n/a
McKinney Branch-Parcel 3	0.409 Ac.	McKinney Branch-Parcel 3	0.362 Ac.	McKinney Branch-Parcel 3	n/a
McKinney Branch-Parcel 4	0.353 Ac.	McKinney Branch-Parcel 4	0.300 Ac.	McKinney Branch-Parcel 4	n/a

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WATERSHED ENHANCEMENT GROUP

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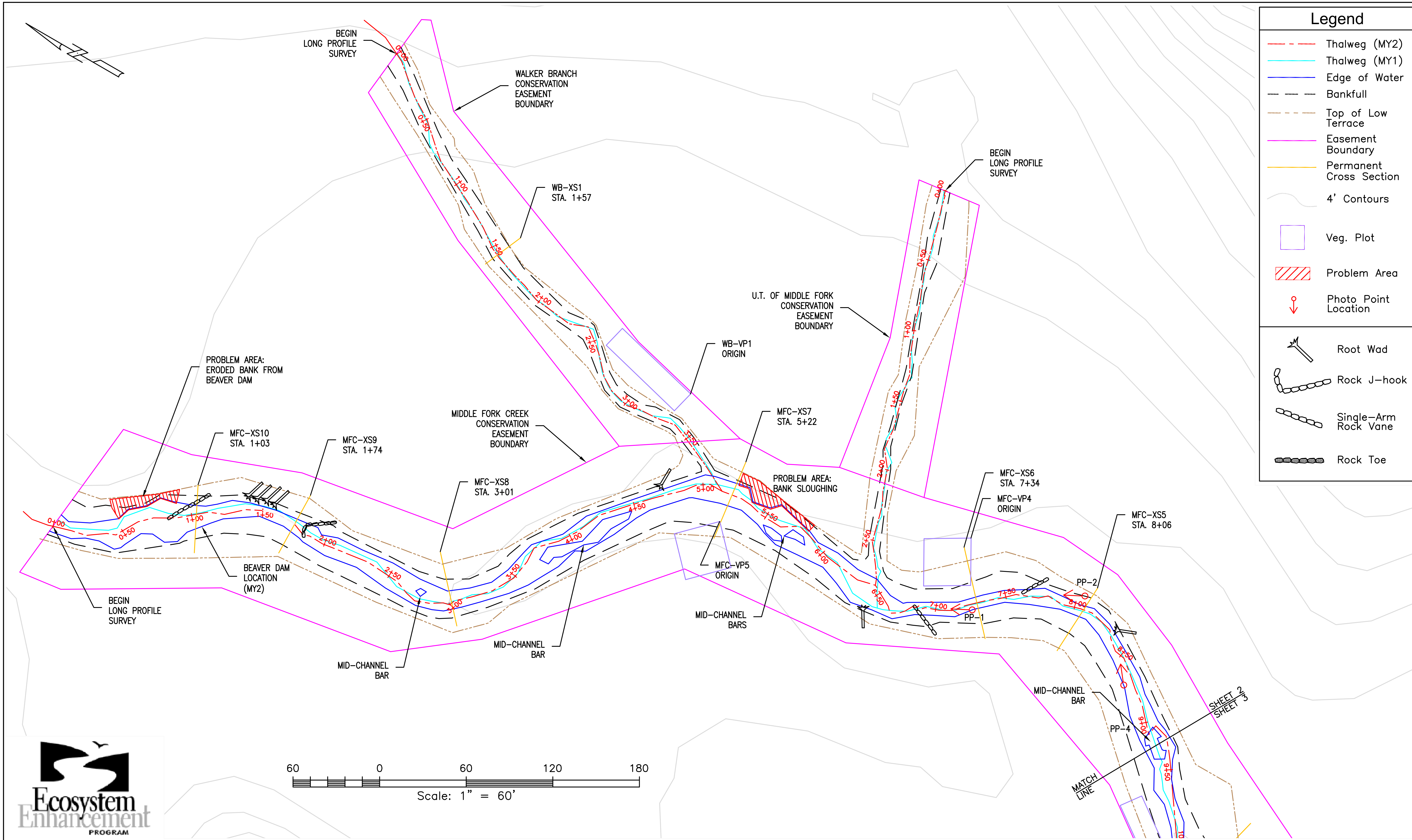
828.452.7772 FAX

Middle Fork Creek — Project #: 92703
Madison County — Phillips-Willis Site
MY2 Survey
Overall Plan View

DRAWN BY: JCF	DATE: 05-2009
APPROVED:	DATE:
SURVEY BY: CSL, JCF, ABB	DATE: 10-2008
CAD FILE ID: PWMY2.dwg	

SHEET 1 OF 6

FIGURE A.3 — Phillips-Willis Mitigation Site, Middle Fork Creek, French Broad River Basin, Madison County, NC, EEP Project #92703, MY2 Plan View



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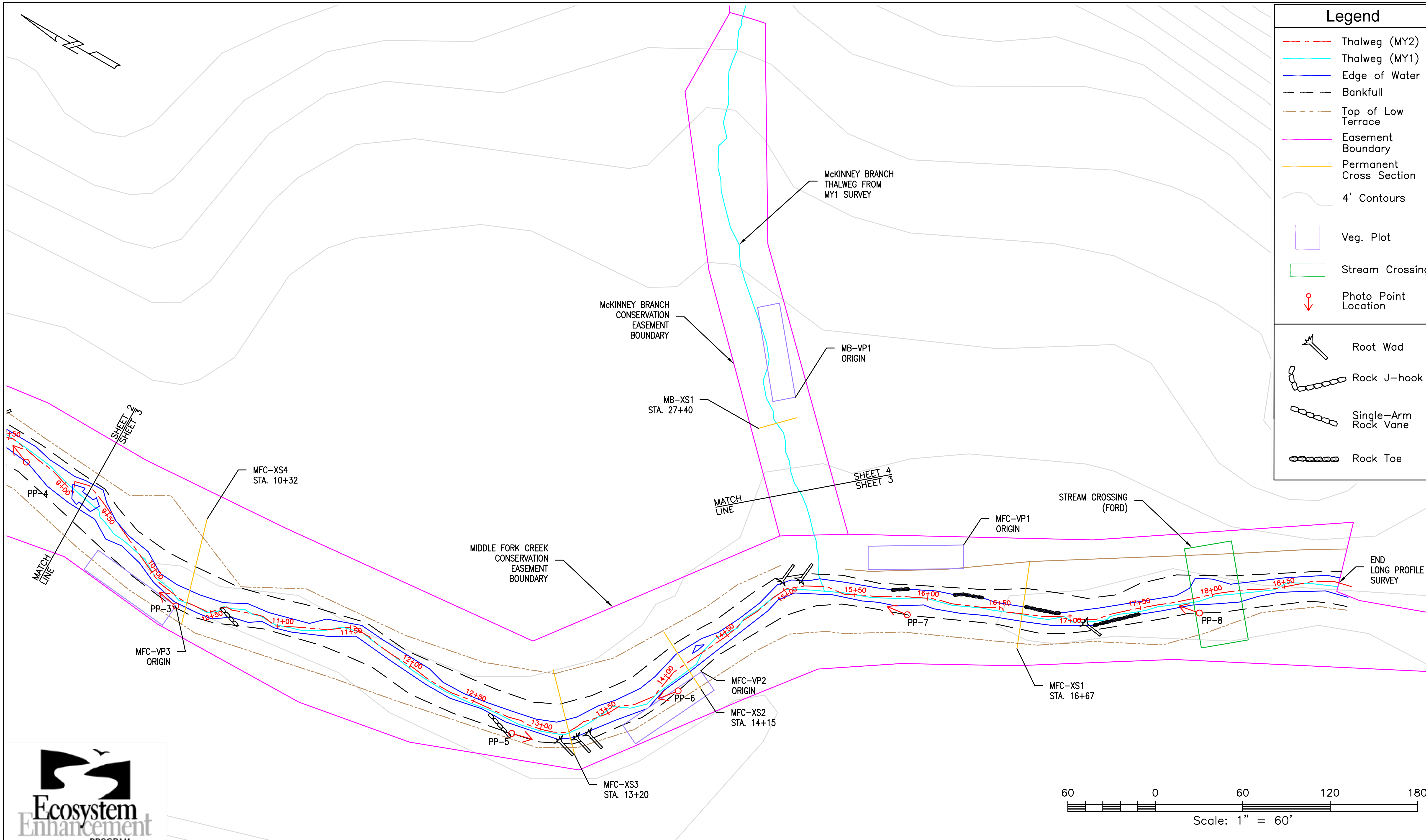
Middle Fork Creek — Project#: 92703
Madison County — Phillips-Willis Site

MY2 Survey - Plan View
Middle Fork Cr., Walker Branch & UT to Middle Fork Cr.

DRAWN BY: JCF	DATE: 05-2009
APPROVED:	DATE:
SURVEY BY: CSL, JCF, ABB	DATE: 10-2008
CAD FILE ID: PKMY2.dwg	

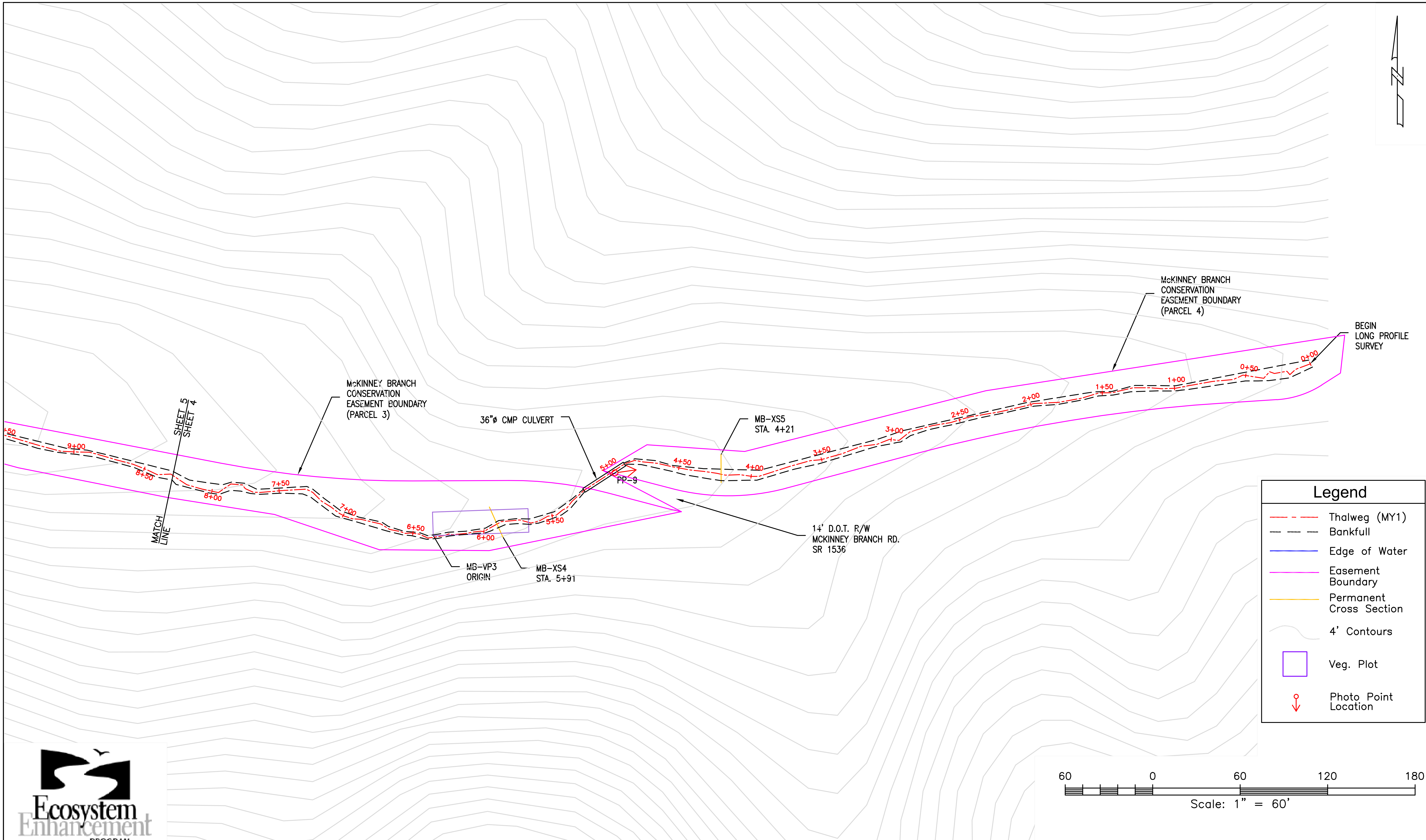
SHEET 2 OF 6

FIGURE A.3(continued) — Phillips-Willis Mitigation Site, Middle Fork Creek, French Broad River Basin, Madison County, NC, EEP Project #92703, MY2 Plan View



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION WATERSHED ENHANCEMENT GROUP 20830 GREAT SMOKY MOUNTAIN EXPRESSWAY, WAYNESVILLE, NORTH CAROLINA 28786 828.452.6191 Ext.26 OFFICE 828.452.7772 FAX	Middle Fork Creek — Project#: 92703 Madison County — Phillips-Willis Site MY2 Survey - Plan View Middle Fork Cr., Walker Branch & UT to Middle Fork Cr.	DRAWN BY: JCF APPROVED: SURVEY BY: CSL, JCF, ABB CAD FILE ID: PKMY2.dwg	DATE: 05-2009 DATE: DATE: 10-2008	SHEET 3 OF 6

FIGURE A.3(continued) — Phillips-Willis Mitigation Site, Middle Fork Creek, French Broad River Basin, Madison County, NC, EEP Project #92703, MY2 Plan View



Ecosystem Enhancement PROGRAM

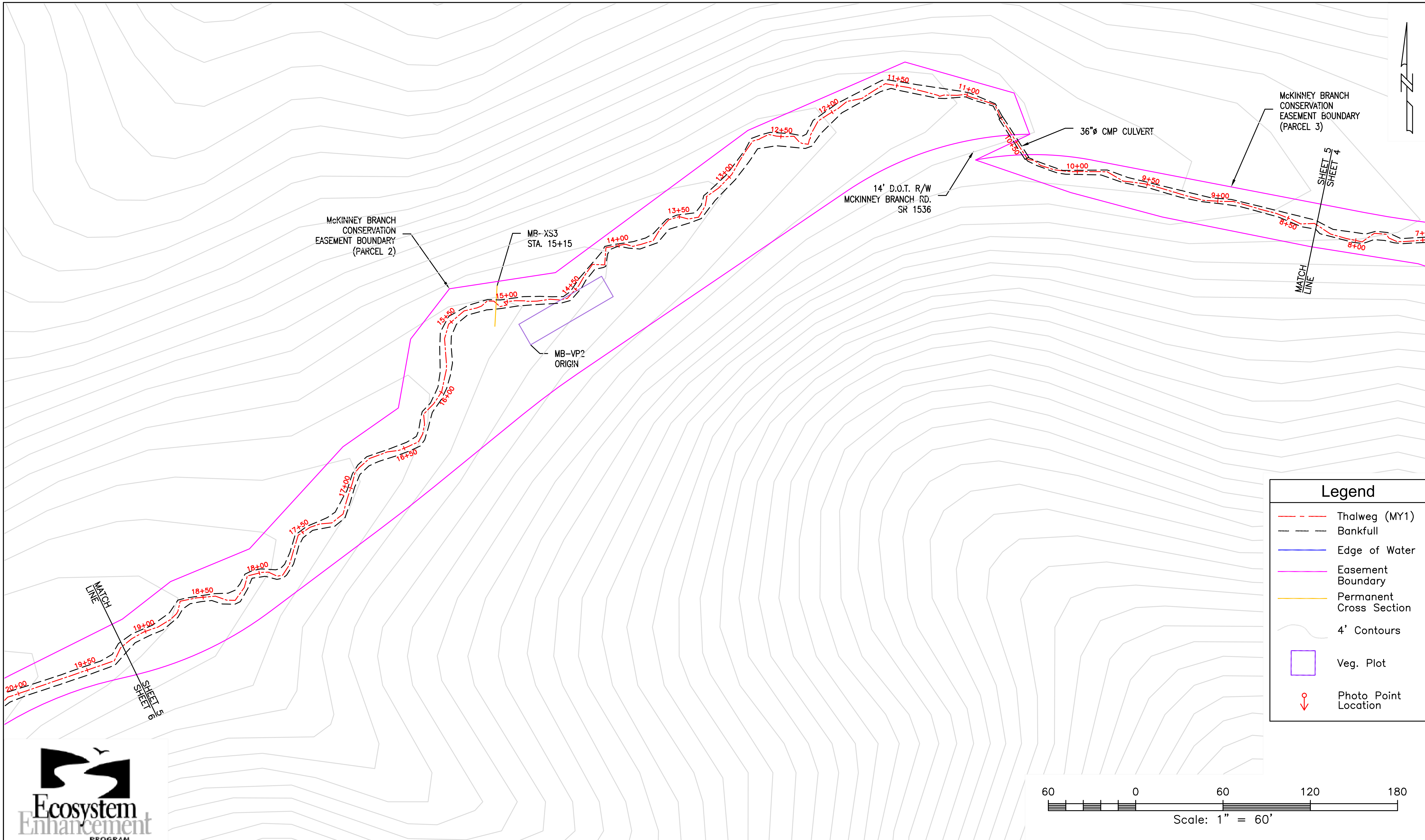
NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
WATERSHED ENHANCEMENT GROUP
20830 GREAT SMOKY MOUNTAIN EXPRESSWAY
WAYNESVILLE, NORTH CAROLINA 28786
828.452.6191 Ext.26 OFFICE
828.452.7772 FAX

Middle Fork Creek — Project#: 92703
Madison County — Phillips-Willis Site
MY1 Survey - Plan View
McKinney Branch

DRAWN BY: JCF	DATE: 05-2009
APPROVED:	DATE:
SURVEY BY: CSL, JCF, ABB	DATE: 10-2007
CAD FILE ID: PW07.dwg	

SHEET 4 OF 6

FIGURE A.3(continued) — Phillips-Willis Mitigation Site, Middle Fork Creek, French Broad River Basin, Madison County, NC, EEP Project #92703, MY1 Plan View



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
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20830 GREAT SMOKY MOUNTAIN EXPRESSWAY
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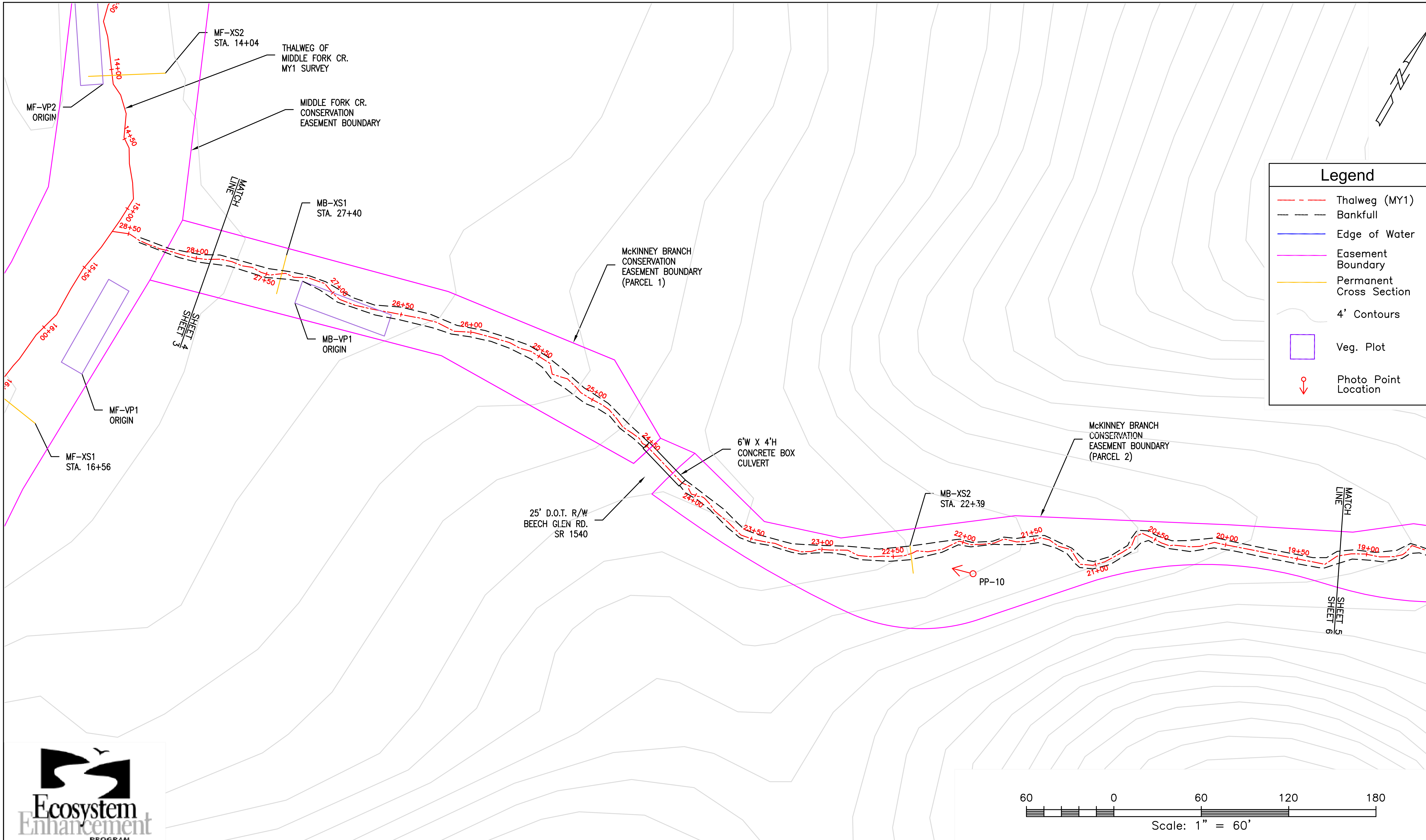
Middle Fork Creek — Project#: 92703
Madison County — Phillips-Willis Site

MY1 Survey - Plan View
McKinney Branch

DRAWN BY: JCF	DATE: 05-2009
APPROVED:	DATE:
SURVEY BY: CSL, JCF, ABB	DATE: 10-2007
CAD FILE ID: PW07.dwg	

SHEET 5 OF 6

FIGURE A.3(continued) — Phillips-Willis Mitigation Site, Middle Fork Creek, French Broad River Basin, Madison County, NC, EEP Project #92703, MY1 Plan View



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION
WATERSHED ENHANCEMENT GROUP

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WAYNESVILLE, NORTH CAROLINA 28786

828.452.6191 Ext.26 OFFICE
828.452.7772 FAX

Middle Fork Creek — Project#: 92703
Madison County — Phillips-Willis Site

MY1 Survey - Plan View
McKinney Branch

DRAWN BY: JCF	DATE: 05-2009
APPROVED:	DATE:
SURVEY BY: CSL, JCF, ABB	DATE: 10-2007
CAD FILE ID: PW07.dwg	

SHEET
6
OF 6

FIGURE A.3(continued) — Phillips-Willis Mitigation Site, Middle Fork Creek, French Broad River Basin, Madison County, NC, EEP Project #92703, MY1 Plan View

Table A.1 Project Restoration Components.

Phillips-Willis Site (EEP project number 92703)							
Project Segment or Reach ID	**Existing Feet/Acres**	**Restoration Level[a]**	**Approach[b]**	**Restored Feet/Acres**	**Stationing**	**Riparian Buffer Acres[c]**	**Comment**
Reach I (MFC)	1,888	R	P3	1,888	0+00 to 18+88	2.7	Mainstem of Middle Fork Creek
Reach II (WB)	375	R	P3	375	0+00 to 3+75	0.4	Walker Branch
Reach III (UT)	269	R	P3	269	0+00 to 2+69	0.2	Unnamed Tributary
Reach II (MB)	2,851	R	P3	2,851	0+00 to 28+51	2.3	McKinney Branch

Component Summations							
Restoration Level	Stream (lf)	Riparian Wetland (Acres)		Non-Riparian Wetland (Acres)	Upland Wetland (Acres)	Buffer (Acres)	BMP
		Riverine	Non-Riverine				
Restoration	5,383						
Enhancement I							
Enhancement II							
Creation							
Preservation							
HQ Preservation							
Totals	**5,383**	**0.0**		**0.0**	**0.0**	**5.6**	**BMP Count**

= Non-Applicable

R = Restoration
EI = Enhancement I
EII = Enhancement II
S = Stabilization
P1 = Priority 1
P2 = Priority 2
P3 = Priority 3
SS = Stream Bank Stabilization
C = Creation
P = Preservation

[a]Source: USACE (2003)
[b]Source: Rosgen (2006)
[c]Defined as the area of the conservation easement measured post-construction from the bankfull elevation nearest to the active stream channel to the easement boundary.

Table A.2 Project Activity and Reporting History.

Phillips–Willis Site (EEP project number 92703)		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Conservation easement acquired (by N.C. Department of Transportation)		August 2002
Restoration plan	January 2002	September 2002
Final design		May 2003
Construction		October 2003
Temporary seed mix applied to entire project area		October 2003
Permanent seed mix applied to entire project area		October 2003
Bare-root plantings installed over entire project area		January 2004
As-built physical survey		January 2004
As-built vegetation survey	NA	NA
Mitigation/As-built plan (Year 0 monitoring - baseline)	January 2004	January 2005
Year 1 Monitoring	December 2007	June 2009
Year 2 Monitoring	October 2008	June 2009
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		
Structural maintenance	NA	NA
Supplemental planting of containerized material	NA	NA

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

Table A.3 Project Contact Table.

Phillips–Willis Site (EEP project number 92703)	
Designer(s): North Carolina Wildlife Resources Commission Watershed Enhancement Group Balsam Field Office	**Firm Information/Address:** Mr. Micky Clemmons (NCWRC, separated) 20830 Great Smoky Mountain Expressway Waynesville, NC 28786 (828) 452-6191 ext. 26
Construction Contractor: J and N Construction	**Firm Information/Address:** Mr. John Mathis 3122 Beaver Creek Road Boomer, NC 28606 (336) 973-3734
Seeding Contractor: North Carolina Wildlife Resources Commission Watershed Enhancement Group Balsam Field Office	**Company Information/Address:** Mr. Brent Burgess, NCWRC 20830 Great Smoky Mountain Expressway Waynesville, NC 28786 (828) 452-6191 ext. 27
Seed Mix Sources Ernst Conservation Seeds, LLP	**Company Information/Address:** 1-800-873-3321
Planting Contractor: North Carolina Wildlife Resources Commission Watershed Enhancement Group Balsam Field Office	**Company and Contact Phone:** Mr. Brent Burgess, NCWRC 20830 Great Smoky Mountain Expressway Waynesville, NC 28786 (828) 452-6191 ext. 27
Nursery Stock Suppliers North Carolina Division of Forest Resources Coastal Plain Conservation Nursery	**Company and Contact Phone:** 919-857-4801 Ellen Colodney, 252-482-4987
Monitoring Performers: Stream Monitoring POC	**Firm Information/Address:** Mr. Scott Loftis, NCWRC 20830 Great Smoky Mountain Expressway Waynesville, NC 28786 (828) 452-6191 ext. 26
Vegetation Monitoring POC	Mr. Scott Loftis, NCWRC 20830 Great Smoky Mountain Expressway Waynesville, NC 28786 (828) 452-6191 ext. 26
Wetland Monitoring POC	NA

Table A.4 Project Attribute Table.

Phillips-Willis Site (EEP project number 92703)					
Project County	Madison				
Physiographic Region	Blue Ridge Mountains				
Ecoregion (Reference: USACE 2003)	Southern Crystalline Ridges and Mountains				
Project River Basin	French Broad River				
USGS HUC for Project (14 digit)	06010105110020				
NCDWQ Sub-basin for Project	Lower French Broad 04-03-04				
Within extent of EEP Watershed Plan?	No				
NCWRC Class (Warm, Cool, Cold)	Cold				
Percent of project easement fenced or demarcated	53% (only left bank and right bank of McKinney Branch)				
Beaver activity observed during design phase?	No (Beaver activity observed during MY1 and MY2 and were removed both times)				
	Reach I Middle Fork Creek	Reach II McKinney Branch	Reach III (UN Trib)	Reach IV Walker Branch	
Drainage Area (mi^2)	14.0	0.4	0.6	1.1	
Stream Order	4	1	1	2	
Restored length (ft)	1,888	2,851	269	375	
Perennial or Intermittent	Perennial	Perennial	Perennial	Perennial	
Watershed type (Rural, Urban, Developing, etc.)	Rural	Rural	Rural	Rural	
Watershed LULC Distribution (e.g.) (percent)					
Residential	10	5	10	10	
Ag-Row Crop	5	<5	<5	<5	
Ag-Livestock	10	10	10	10	
Forested	75	75	75	75	
Etc.					
Watershed impervious cover (percent)	<5	<5	<5	<5	
NCDWQ AU/Index number	6-96-10-1A				
NCDWQ Classification	WSII, HQW	NA	NA	WSII, HQW	
303d listed?	No	No	No	No	
Upstream of 303d listed segment?	Yes	Yes	Yes	Yes	
Reasons for 303d listing or stressor	AL	AL	AL	AL	
NCDWQ 401 Water Quality Certification Number	401 certification was inclusive under USACE permit for the A-10 (I-26) road project.				
USACE 404 Action ID Number	199505135				
Total acreage of conservation easement (including stream channel)	3.916	2.673	0.229	0.445	
Total (undisturbed) vegetated acreage within easement	<0.1	<0.1	0.229	0.445	
Total riparian buffer acreage as part of the restoration	2.684	2.336	0.202	0.360	
Rosgen stream classification of pre-existing	C4	E4b	NA	B4c	
Rosgen stream classification of as-built	C4	E4b	NA	NA	
Valley Type	VIII, alluvial				
Valley Slope	0.008	0.049	0.033	0.022	
Valley side slope range (e.g. 2-3%)	<10 %	>10%	<10 %	<10 %	
Valley toe slope range (e.g. 2-3%)	<5 %	>2%	<5 %	<5 %	
Cowardin classification (Reference: Cowardin 1979)					
Trout waters designation (NCWRC)	No	No	No	No	
Species of concern, endangered, etc.? (Y/N)	No	No	No	No	
Dominant soil series and characteristics					
Series	Reddies				
Depth (in)	30-40				
Clay (%)	25				
K					
T					

(NA = not available)

Appendix B Morphological Summary Data

B.1 Bank Stability Assessment

Table B.1 BEHI and Sediment Export Estimates.

Phillips–Willis Site (EEP project number 92703)																
Time Point	**Segment/Reach**	**Linear Footage or Acreage**	**Extreme**		**Very High**		**High**		**Moderate**		**Low**		**Very Low**		**Sediment Export**
			FT	**%**	**FT**	**%**	**FT**	**%**	**FT**	**%**	**FT**	**%**	**FT**	**%**	**Ton/year**

B.2 Representative Stream Problem Area Photographs

Table B.2.1 Stream Problem Areas.

Phillips–Willis Site (EEP project number 92703)			
Feature/Issue	**Station numbers**	**Suspected Cause**	**Photo number**
Aggradation/Bar Formation	4+00 5+50 9+25	MFC, beaver dams and bank sloughing MFC, beaver dams and bank sloughing MFC, beaver dams and bank sloughing	1 2 4
Bank Scour and sloughing	5+50	MFC, Beaver, field drain	2
Over-wide channel	1+00	MFC, Beaver dam	3
Engineered structures - back or arm scour, etc.			

Stream problem area 1, mid-channel bars, 4 Dec 2007.

Stream problem area 2, bank scour, 4 Dec 2007.

Table B.2.1 Continued.

Stream problem area 3, beaver dam, 14 Oct 2008.

Stream problem area 4, channel bar, 14 Oct 2008.

B.3 Qualitative Visual Stability Assessment

Table B.3.1 Categorical Stream Feature Visual Stability Assessment Summary.

Phillips–Willis Site (EEP project number 92703)						
	MFC Entire Reach (sta. 0+00 to 18+88)					
Features	**As-built 2004**	**MY1 2007**	**MY2 2008**	**MY3**	**MY4**	**MY5**
A. Riffles	100%	96%	96%			
B. Pools	100%	80%	80%			
C. Thalweg	100%	80%	80%			
D. Meanders	100%	90%	90%			
E. Bed General	100%	95%	95%			
F. Bank Condition	100%	95%	95%			
G. Vanes/J-hooks etc.	100%	75%	75%			
F. Wads and Boulders	100%	90%	90%			

Table B.3.2 Visual Morphological Stability Assessment.

MY2 Phillips–Willis Site (EEP project number 92703) MFC Sta. 0+00 to 18+88 (1,888 ft)						
Feature Category	Metric (per As-built and reference baselines)	Number Performing as Intended	Total Number per As-built	Total Number and feet in unstable state[a]	Percent Perform in Stable Condition[b]	Feature Perform Mean or Total[c]
A. Riffles	1. Present?[d]	10	10	NA	100	
	2. Armor stable (e.g. no displacement)?	10	10	NA	100	
	3. Facet grade appears stable?	10	10	NA	100	
	4. Minimal evidence of embedding/fining?	8	10	NA	80	
	5. Length appropriate?	10	10	NA	100	96.0
B. Pools	1. Present? (e.g. not subject to severe aggrad. or migrat.)?[d]	8	10	NA	80	
	2. Sufficiently deep (Max Pool D:Mean Bkf D >1.6)?	4	5	NA	80	
	3. Length appropriate?	10	10	NA	80	80.0
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?[e]	8	10	NA	80	
	2. Downstream of meander (glide/inflection) centering?[e]	8	10	NA	80	80.0
D. Meanders	1. Outer bend in state of limited/controlled erosion?	8	10	NA	80	
	2. Of those eroding, number w/concomitant point bar formation?	10	10	NA	100	
	3. Apparent Rc within specifications?	10	10	NA	100	
	4. Sufficient floodplain access and relief?	8	10	NA	80	90.0
E. Bed General	1. General channel bed aggradation areas (bar formation)?	NA	NA	5/200	90	
	2. Channel bed degradation – areas of increasing down cutting or head cutting?	NA	NA	0/0	100	95.0
F. Bank[f]	1. Actively eroding, wasting, or slumping bank?	NA	NA	1,888/100	95	95.0
G. Vanes	1. Free of back or arm scour?	6	7	NA	86	
	2. Height appropriate?	5	7	NA	71	
	3. Angle and geometry appear appropriate?	5	7	NA	71	
	4. Free of piping or other structural failures?	5	7	NA	71	74.8
H. Wads/ Boulders	1. Free of scour?	8	9	NA	89	
	2. Footing stable?	6	7	NA	86	87.5

[a]Metrics that are spatial estimates that are continuous variables should be entered as: The number of locals over the reach for which the failing condition is observed, followed by the total linear distance (feet) or area for which the failing or unstable condition is observed.

[b]In the case of categorical metrics for which a feature count is involved, this is simply calculated as the number of functional features that are in a state of stability as a percentage of the total. In the case of those metrics based on footage or aerial extent it is that amount in a state of failure or instability expressed as a proportion of the total amount of that feature. The resulting proportion is then subtracted from 1 and then multiplied by 100 to give a percentage that represents the proportion of that feature category in a state of apparent stability.

[c]The mean of the metrics for a given feature category.

[d]Was the feature actually present as compared to the As-built or has the feature been completely obscured (aggraded) of removed (degraded).

[e]Is the thalweg centering up on the channel between meander bends?

[f]Amount of active bank failure/erosion. This should be the tally of all stressed and failing banks from the problem area plan view, which can then be calculated as indicated in footnote [a] above.

B.4 Morphological Summary Tables

Table B.4.1 Baseline Stream Data Summary.

Phillips-Willis Site (EEP project number 92703) Middle Fork Creek (1,888 ft)																	
Parameter (Riffles Only)	**Gauge**	**Regional Curve Interval**			**Pre-Existing Condition[a]**						**Reference Reach(es) Data[b]**						**Design[a]**		
Dimension and Substrate		LL	UL	Eq.	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n	Min	Max	**Med**
Bankfull Width (ft)					30.6												34.0		
Floodprone Width (ft)					90.0												140.0		
Bankfull Cross-Sectional Area (ft^2)					73.5												88.0		
Bankfull Mean Depth (ft)					2.4												2.6		
Bankfull Max Depth (ft)					4.6												4.0		
Width/Depth Ratio					12.7												13.1		
Entrenchment Ratio					2.9												4.1		
Bank Height Ratio					1.4												1.0		
Bankfull Wetted Perimeter (ft)					34.3												34.3		
Hydraulic Radius (ft)					2.3												2.3		
D50 (mm)					32.0												32.0		
Profile																			
Riffle Length (ft)					137.0												49.0		
Riffle Slope (ft/ft)					0.012												0.015		
Pool Length (ft)					28.0	130.0		66.0									46.0		
Pool Max Depth (ft)					5.0												8.0		
Pool to Pool Spacing (ft)					77.0	484.0		196.5									229.0	342.0	
Pattern																			
Channel Belt Width (ft)					NA												60.0	94.0	
Radius of Curvature (ft)					NA												60.0	82.0	
Rc:Bankfull Width (ft/ft)					NA												1.8	2.4	
Meander Wavelength (ft)					NA												250.0	370.0	
Meander Width Ratio					NA												1.8	2.8	

[a]Pre-existing and design data extracted from Phillips-Willis construction plan (NCWRC 2003).
[b]Reference reach data were unavailable for inclusion into monitoring report.

Table B.4.1 Continued.

Phillips-Willis Site (EEP project number 92703) Middle Fork Creek (1,888 ft)																		
Parameter (Riffles Only)	**As-built/Baseline**						**MY1**						**MY2**					
Dimension and Substrate	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n
Bankfull Width (ft)	27.2	36.0	33.6	32.5	3.3	5	27.2	35.9	31.1	31.4	3.1	5	27.0	34.0	31.2	30.7	2.6	5
Floodprone Width (ft)	379.0	514.0	413.0	443.4	60.2	5	379.0	514.0	413.0	443.4	60.2	5	379.0	514.0	413.0	443.4	60.2	5
Bankfull Cross-Sectional Area (ft^2)	57.7	78.6	71.2	69.1	9.8	5	41.1	59.9	57.9	53.2	8.5	5	41.8	65.8	49.1	51.9	10.4	5
Bankfull Mean Depth (ft)	1.7	2.3	2.2	2.1	0.3	5	1.3	2.2	1.6	1.7	0.4	5	1.3	2.2	1.5	1.7	0.4	5
Bankfull Max Depth (ft)	3.0	4.2	3.6	3.6	0.5	5	3.1	3.9	3.5	3.4	0.3	5	3.1	3.9	3.3	3.4	0.4	5
Width/Depth Ratio	12.8	21.6	14.4	15.6	3.4	5	12.4	24.7	20.3	19.1	4.9	5	12.3	24.0	20.1	18.9	5.3	5
Entrenchment Ratio	10.5	16.1	14.8	13.7	2.3	5	10.6	16.6	15.2	14.3	2.5	5	11.2	17.0	15.3	14.6	2.5	5
Bank Height Ratio	1.2	2.0	1.4	1.6	0.4	5	1.5	1.9	1.6	1.7	0.2	5	1.4	2.0	1.7	1.7	0.2	5
Bankfull Wetted Perimeter (ft)	28.9	37.6	35.9	34.9	3.4	5	30.0	38.4	33.4	33.8	3.1	5	23.5	36.5	31.1	30.7	4.8	5
Hydraulic Radius (ft)	1.6	2.2	2.0	2.0	0.2	5	1.2	2.0	1.5	1.6	0.3	5	1.3	2.0	1.4	1.6	0.3	5
D50 (mm)	NO DATA					0	0.3	64.0	32.0	34.0	24.9	5	11.5	18.2	15.7	14.7	2.8	5
Profile																		
Riffle Length (ft)	38.0	93.0	66.0	64.2	20.4	5	30.6	82.1	36.0	51.0	24.9	5	36.4	96.3	65.8	66.8	23.2	5
Riffle Slope (ft/ft)	0.005	0.019	0.008	0.011	0.006	5	0.006	0.026	0.014	0.015	0.007	5	0.009	0.017	0.009	0.011	0.003	5
Pool Length (ft)	39.0	91.0	60.0	66.2	20.9	5	26.9	60.3	32.6	40.0	15.1	5	31.0	101.9	66.7	63.8	26.4	5
Pool Max Depth (ft)	3.3	5.2	4.2	4.2	0.9	5	3.8	4.4	4.0	4.1	0.3	5	3.9	5.0	4.2	4.3	0.5	5
Pool-to-Pool Spacing (ft)	234.0	327.0	279.5	280.0	40.3	4	223.5	499.2	285.7	323.5	120.9	4	195.1	447.5	317.6	310.4	126.6	4
Pattern																		
Channel Belt Width (ft)													36.7	112.5	95.4	87.5	27.2	6
Radius of Curvature (ft)													110.6	302.5	152.8	179.5	71.9	7
Rc:Bankfull Width (ft/ft)													3.6	9.9	5.0	5.8	2.3	7
Meander Wavelength (ft)													251.4	344.4	302.8	297.9	35.6	7
Meander Width Ratio													1.2	3.7	3.1	2.8	0.9	6

Table B.4.1 Continued.

Phillips-Willis Site (EEP project number 92703) Middle Fork Creek (1,888 ft)																		
Parameter (Riffles Only)	**MY3**						**MY4**						**MY5**					
Dimension and Substrate	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n	Min	Max	Med	Mean	SD	n
Bankfull Width (ft)																		
Floodprone Width (ft)																		
Bankfull Cross-Sectional Area (ft^2)																		
Bankfull Mean Depth (ft)																		
Bankfull Max Depth (ft)																		
Width/Depth Ratio																		
Entrenchment Ratio																		
Bank Height Ratio																		
Bankfull Wetted Perimeter (ft)																		
Hydraulic Radius (ft)																		
D50 (mm)																		
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)																		
Pool Length (ft)																		
Pool Max Depth (ft)																		
Pool to Pool Spacing (ft)																		
Pattern																		
Channel Belt Width (ft)																		
Radius of Curvature (ft)																		
Rc:Bankfull Width (ft/ft)																		
Meander Wavelength (ft)																		
Meander Width Ratio																		

Table B.4.1 Continued.

Phillips-Willis Site (EEP project number 92703) Middle Fork Creek (1,888 ft)														
Substrate, bed and transport parameters	**Gauge**	**Regional Curve Interval**			**Pre-Existing Condition[c]**							**Reference Reach(es) Data[d]**	**Design[c]**	
[a]Ri % / Ru % / P % / G % / S %						25		25	25	25	0			
[a]SC % / Sa % / G % / C % / B % / Be %						6.2	20.4	39.8	26.6	0.9	6.2			
[a]D_{16} / D_{35} / D_{50} / D_{84} / D_{95} / Di^p / Di^{sp}					0.2	12.2	31.3	127.6	bedrock	125.0	105.0			
Reach Shear Stress (competency) lb/ft[b]					0.025								NA	
Max part size (mm) mobilized at bankfull					150.0								NA	
Stream Power (transport capacity) W/m[b]					NA								NA	
Additional Reach Parameters														
Drainage Area (mi^2)					14									
Impervious cover estimate (%)					<10									
Rosgen Classification					C4								C4	
Bankfull Velocity (fps)					6.4								NA	
Bankfull Discharge (cfs)					500									
Valley Length (ft)					1,175									
Channel Thalweg Length (ft)					1,483								1,600	
Sinuosity					1.3								1.2	
Water Surface Slope (Channel) (ft/ft)					0.006								0.006	
Bankfull Slope (ft/ft)					0.006								0.006	
Bankfull Floodplain Area (acres)					NA								NA	
Proportion Over Wide (%)					<5									
Entrenchment Class (ER Range)						2.9								
Incision Class (BHR)						NA								
BEHI VL% / L% /M% / H% / VH% / E %						NA								
Channel Stability or Habitat Metric					NA									
Biological or Other					NA									

[a]Riffle, Run, Pool, Glide, Step; Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock, Di^p = max pavement, Di^{sp} = max sub-pavement. Shaded cells indicate that these will typically not be filled in

[b] Methodology should be cited and described either here or in text

[c]Pre-existing condition and design data extracted from the construction plan (NCWRC 2003).

[d]Reference reach data was unavailable for inclusion into monitoring report.

= Non-Applicable; NA = Not Available

Table B.4.1 Continued.

Phillips-Willis Site (EEP project number 92703) Middle Fork Creek (1,888 ft)																				
Substrate, bed and transport parameters	**As-built / Baseline**						**MY1**							**MY2**						
[a]Ri % / Ru % / P % / G % / S %	25	25		25	25	0	25		25		25	25	0	25		25		25	25	0
[a]SC % / Sa % / G % / C % / B % / Be %	NO DATA						9.0		26.0	44.0	21.0	NA	NA	4.8		18.8	58.9	16.8	0.1	0.8
[a]D_{16} / D_{35} / D_{50} / D_{84} / D_{95} / Di^{p} / Di^{sp}	NO DATA						0.2	19.8	99.5	154.0	265.0	NA	NA	0.6	7.3	13.0	69.3	118.9	NA	NA
Reach Shear Stress (competency) lb/ft[b]	NA																			
Max part size (mm) mobilized at bankfull	NA																			
Stream Power (transport capacity) W/m[b]	NA																			
Additional Reach Parameters																				
Drainage Area (mi^2)	14						14							14						
Impervious cover estimate (%)	<10						<10							<10						
Rosgen Classification	C4						C4							C4						
Bankfull Velocity (fps)	8.3						8.6							10.2						
Bankfull Discharge (cfs)	500						500							500						
Valley Length (ft)	1,175						1,595							1,595						
Channel Thalweg Length (ft)	1,710						1,888							1,888						
Sinuosity	1.5						1.2							1.2						
Water Surface Slope (Channel) (ft/ft)	0.008						0.006							0.006						
Bankfull Slope (ft/ft)	0.008						0.006							0.006						
Bankfull Floodplain Area (acres)	NA						NA							<1.0						
Proportion Over Wide (%)																				
Entrenchment Class (ER Range)																				
Incision Class (BHR)																				
BEHI VL% / L% /M% / H% / VH% / E %																				
Channel Stability or Habitat Metric																				
Biological or Other																				

[a]Riffle, Run, Pool, Glide, Step; Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock, Di^{p} = max pavement, Di^{sp} = max sub-pavement. Shaded cells indicate that these will typically not be filled in

[b]Methodology should be cited and described either here or in text

= Non-Applicable; NA = Not Available

Table B.4.1 Continued.

Phillips-Willis Site (EEP project number 92703) Middle Fork Creek (1,888 ft)			
Substrate, bed and transport parameters	**MY3**	**MY4**	**MY5**
[a]Ri % / Ru % / P % / G % / S %			
[a]SC % / Sa % / G % / C % / B % / Be %			
[a]D_{16} / D_{35} / D_{50} / D_{84} / D_{95} / Di^p / Di^{sp}			
Reach Shear Stress (competency) lb/ft[b]			
Max part size (mm) mobilized at bankfull			
Stream Power (transport capacity) W/m[b]			
Additional Reach Parameters			
Drainage Area (mi^2)			
Impervious cover estimate (%)			
Rosgen Classification			
Bankfull Velocity (fps)			
Bankfull Discharge (cfs)			
Valley Length (ft)			
Channel Thalweg Length (ft)			
Sinuosity			
Water Surface Slope (Channel) (ft/ft)			
Bankfull Slope (ft/ft)			
Bankfull Floodplain Area (acres)			
Proportion Over Wide (%)			
Entrenchment Class (ER Range)			
Incision Class (BHR)			
BEHI VL% / L% /M% / H% / VH% / E %			
Channel Stability or Habitat Metric			
Biological or Other			

[a]Riffle, Run, Pool, Glide, Step; Silt/Clay, Sand, Gravel, Cobble, Boulder, Bedrock, Di^p = max pavement, Di^{sp} = max sub-pavement. Shaded cells indicate that these will typically not be filled in

[b]Methodology should be cited and described either here or in text

= Non-Applicable; NA = Not Available

Table B.4.2 Morphology and Hydraulic Summary (Dimensional Parameters - Cross Section).

Phillips–Willis Site (EEP project number 92703)																		
	MFC Cross-Section 1 (Riffle)						**MFC Cross-Section 2 (Riffle)**						**MFC Cross-Section 3 (Pool)**					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	36.0	35.9	34.0				27.2	27.2	27.0				34.3	33.1	32.5			
Floodprone Width (ft)	379.0	379.0	379.0				413.0	413.0	413.0				271.9	271.9	271.9			
Bankfull Cross-sectional Area (ft^2)	60.0	57.9	49.1				57.7	59.9	59.3				79.5	55.8	62.7			
Bankfull Mean Depth (ft)	1.7	1.6	1.4				2.1	2.2	2.2				2.3	1.7	1.9			
Bankfull Max Depth (ft)	3.0	3.5	3.2				3.1	3.2	3.1				4.1	3.6	4.0			
Bankfull Width/Depth Ratio	21.6	22.3	23.6				12.8	12.4	12.3				14.8	19.6	16.8			
Bankfull Entrenchment Ratio	10.5	10.6	11.2				15.2	15.2	15.3				7.9	8.2	8.4			
Bankfull Bank Height Ratio	1.9	1.7	1.9				2.0	1.9	2.0				1.9	2.0	1.9			
Based on current/developing bankfull feature																		
Bankfull Width (ft)																		
Floodprone Width (ft)																		
Bankfull Cross-sectional Area (ft^2)																		
Bankfull Mean Depth (ft)																		
Bankfull Max Depth (ft)																		
Bankfull Width/Depth Ratio																		
Bankfull Entrenchment Ratio																		
Bankfull Bank Height Ratio																		
Cross-sectional Area between end pins (ft^2)																		
D50(mm)		22.6	15.7					32.0	12.1					0.7	9.1			
	MFC Cross-Section 4 (Pool)						**MFC Cross-Section 5 (Pool)**						**MFC Cross-Section 6 (Riffle)**					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	33.7	36.5	37.6				34.4	30.3	31.0				33.6	31.8	31.7			
Floodprone Width (ft)	311.5	311.5	311.5				320.0	320.0	320.0				410.0	410.0	410.0			
Bankfull Cross-sectional Area (ft^2)	45.5	58.2	60.8				64.9	54.4	55.0				78.1	41.1	41.8			
Bankfull Mean Depth (ft)	1.4	1.6	1.6				1.9	1.8	1.8				2.3	1.3	1.3			
Bankfull Max Depth (ft)	3.0	3.4	3.7				3.4	3.7	3.6				3.6	3.1	3.5			
Bankfull Width/Depth Ratio	24.9	22.8	23.2				18.2	16.9	17.4				14.4	24.7	24.0			
Bankfull Entrenchment Ratio	9.3	8.5	8.3				9.3	10.6	10.3				12.2	12.9	12.9			
Bankfull Bank Height Ratio	2.1	1.7	1.6				1.5	1.4	1.4				1.2	1.6	1.5			
Based on current/developing bankfull feature																		
Bankfull Width (ft)																		
Floodprone Width (ft)																		
Bankfull Cross-sectional Area (ft^2)																		
Bankfull Mean Depth (ft)																		
Bankfull Max Depth (ft)																		
Bankfull Width/Depth Ratio																		
Bankfull Entrenchment Ratio																		
Bankfull Bank Height Ratio																		
Cross-sectional Area between end pins (ft^2)																		
D50(mm)		8.0	11.6					38.5	8.8					51.3	15.9			

Table B.4.2 Continued.

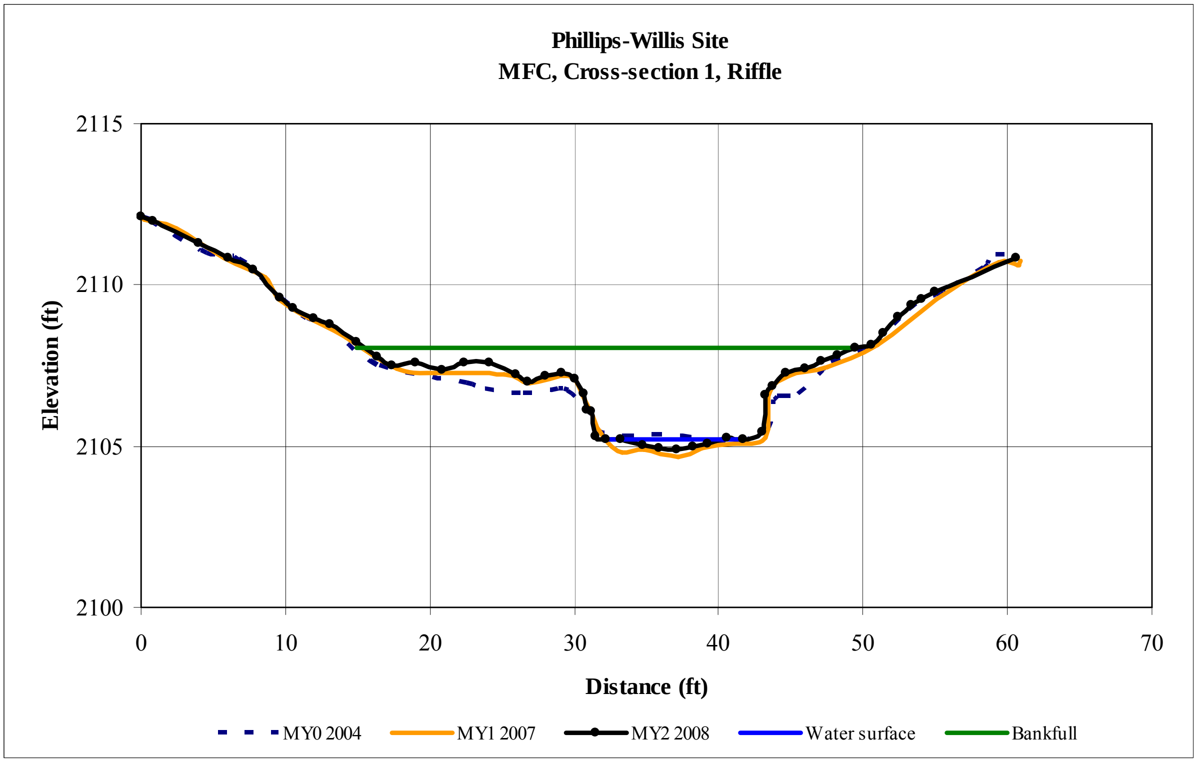
Phillips–Willis Site (EEP project number 92703)																		
	MFC Cross-Section 7 (Pool)						MFC Cross-Section 8 (Pool)						MFC Cross-Section 9 (Riffle)					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	31.5	33.1	33.3				28.7	36.3	33.8				33.8	31.1	29.5			
Floodprone Width (ft)	448.5	448.5	448.5				605.4	605.4	605.4				501.0	501.0	501.0			
Bankfull Cross-sectional Area (ft^2)	76.2	84.3	84.6				74.6	77.8	92.2				78.6	47.5	43.3			
Bankfull Mean Depth (ft)	2.4	2.6	2.5				2.6	2.1	2.7				2.3	1.5	1.5			
Bankfull Max Depth (ft)	4.6	3.5	3.5				4.6	5.2	5.3				4.2	3.5	3.3			
Bankfull Width/Depth Ratio	13.1	13.0	13.1				11.1	17.0	12.4				14.6	20.3	20.1			
Bankfull Entrenchment Ratio	14.2	13.6	13.5				11.1	16.7	17.9				14.8	16.1	17.0			
Bankfull Bank Height Ratio	1.4	1.4	1.4				1.3	1.2	1.1				1.4	1.6	1.7			
Based on current/developing bankfull feature																		
Bankfull Width (ft)																		
Floodprone Width (ft)																		
Bankfull Cross-sectional Area (ft^2)																		
Bankfull Mean Depth (ft)																		
Bankfull Max Depth (ft)																		
Bankfull Width/Depth Ratio																		
Bankfull Entrenchment Ratio																		
Bankfull Bank Height Ratio																		
Cross-sectional Area between end pins (ft^2)																		
D50(mm)		16.0	11.3					0.8	11.8					64.0	18.2			
	MFC Cross-Section 10 (Riffle)						MB Cross-Section 1						MB Cross-Section 2					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	32.0	31.0	31.2				7.8	6.3	6.4				5.9	6.4	5.6			
Floodprone Width (ft)	514.0	514.0	514.0				19.0	19.4	19.8				20.4	15.0	15			
Bankfull Cross-sectional Area (ft^2)	71.2	59.8	65.8				5.6	6.5	5.4				4.7	2.7	2.8			
Bankfull Mean Depth (ft)	2.2	1.9	2.1				0.7	1.0	0.9				0.8	0.4	0.5			
Bankfull Max Depth (ft)	4.1	3.9	3.9				1.2	1.7	1.7				1.3	1.1	0.9			
Bankfull Width/Depth Ratio	14.4	16.1	14.8				10.9	6.1	7.5				7.5	15.2	11.5			
Bankfull Entrenchment Ratio	16.1	16.6	16.5				2.4	3.1	3.1				3.4	2.4	2.7			
Bankfull Bank Height Ratio	1.4	1.5	1.4				2.9	2.4	2.4				1.4	1.8	1.6			
Based on current/developing bankfull feature																		
Bankfull Width (ft)																		
Floodprone Width (ft)																		
Bankfull Cross-sectional Area (ft^2)																		
Bankfull Mean Depth (ft)																		
Bankfull Max Depth (ft)																		
Bankfull Width/Depth Ratio																		
Bankfull Entrenchment Ratio																		
Bankfull Bank Height Ratio																		
Cross-sectional Area between end pins (ft^2)																		
D50(mm)		0.3	11.5					7.0	0.9					7.2	11.4			

Table B.4.2 Continued.

Phillips–Willis Site (EEP project number 92703)																		
	MB Cross-Section 3						MB Cross-Section 4						MB Cross-Section 5					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	5.1	5.5	4.6				5.8	4.3	4.2				5.6	6.7	5.9			
Floodprone Width (ft)	14.4	22.2	13.9				29.0	22.5	20.4				21.0	16.7	16.3			
Bankfull Cross-sectional Area (ft^2)	2.9	3.5	2.6				2.4	1.9	1.6				3.7	2.4	2.4			
Bankfull Mean Depth (ft)	0.6	0.6	0.6				0.4	0.4	0.4				0.7	0.4	0.4			
Bankfull Max Depth (ft)	0.9	1.3	1.1				0.9	0.9	0.8				1.3	1.1	1.1			
Bankfull Width/Depth Ratio	9.0	8.7	8.1				14.1	10.0	11.0				8.6	19.1	14.6			
Bankfull Entrenchment Ratio	2.8	4.1	3.0				5.0	5.3	4.9				3.7	2.5	2.8			
Bankfull Bank Height Ratio	2.3	1.7	2.3				1.9	1.8	2.2				1.9	2.5	2.1			
Based on current/developing bankfull feature																		
Bankfull Width (ft)																		
Floodprone Width (ft)																		
Bankfull Cross-sectional Area (ft^2)																		
Bankfull Mean Depth (ft)																		
Bankfull Max Depth (ft)																		
Bankfull Width/Depth Ratio																		
Bankfull Entrenchment Ratio																		
Bankfull Bank Height Ratio																		
Cross-sectional Area between end pins (ft^2)																		
D50(mm)		6.5	8.1					5.7	3.7					6.4	4.4			

	WB Cross-Section 1						Cross-Section ()						Cross-Section ()					
Dimension and Substrate	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Based on fixed baseline bankfull elevation																		
Bankfull Width (ft)	6.7	6.4	6.2															
Floodprone Width (ft)	10.8	10.9	9.8															
Bankfull Cross-sectional Area (ft^2)	6.6	5.9	4.9															
Bankfull Mean Depth (ft)	1.0	0.9	0.8															
Bankfull Max Depth (ft)	1.4	1.3	1.0															
Bankfull Width/Depth Ratio	6.9	7.0	7.8															
Bankfull Entrenchment Ratio	1.6	1.7	1.6															
Bankfull Bank Height Ratio	2.8	3.2	3.2															
Based on current/developing bankfull feature																		
Bankfull Width (ft)																		
Floodprone Width (ft)																		
Bankfull Cross-sectional Area (ft^2)																		
Bankfull Mean Depth (ft)																		
Bankfull Max Depth (ft)																		
Bankfull Width/Depth Ratio																		
Bankfull Entrenchment Ratio																		
Bankfull Bank Height Ratio																		
Cross-sectional Area between end pins (ft^2)																		
D50(mm)			8.0															

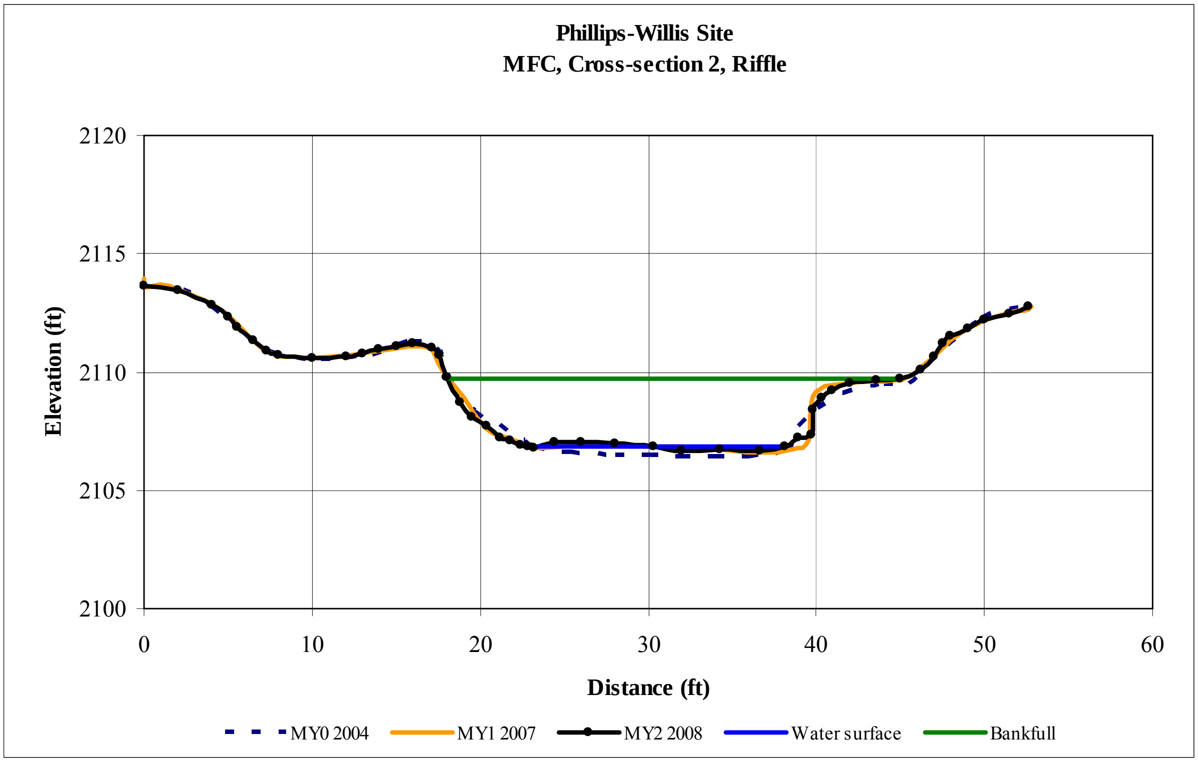
B.5 Annual Overlays of Cross-Section Plots (orange line represents cross-section location).




MFC cross-section 1, facing downstream, 4 Dec 2007.


MFC cross-section 1, facing downstream, 14 Oct 2008.

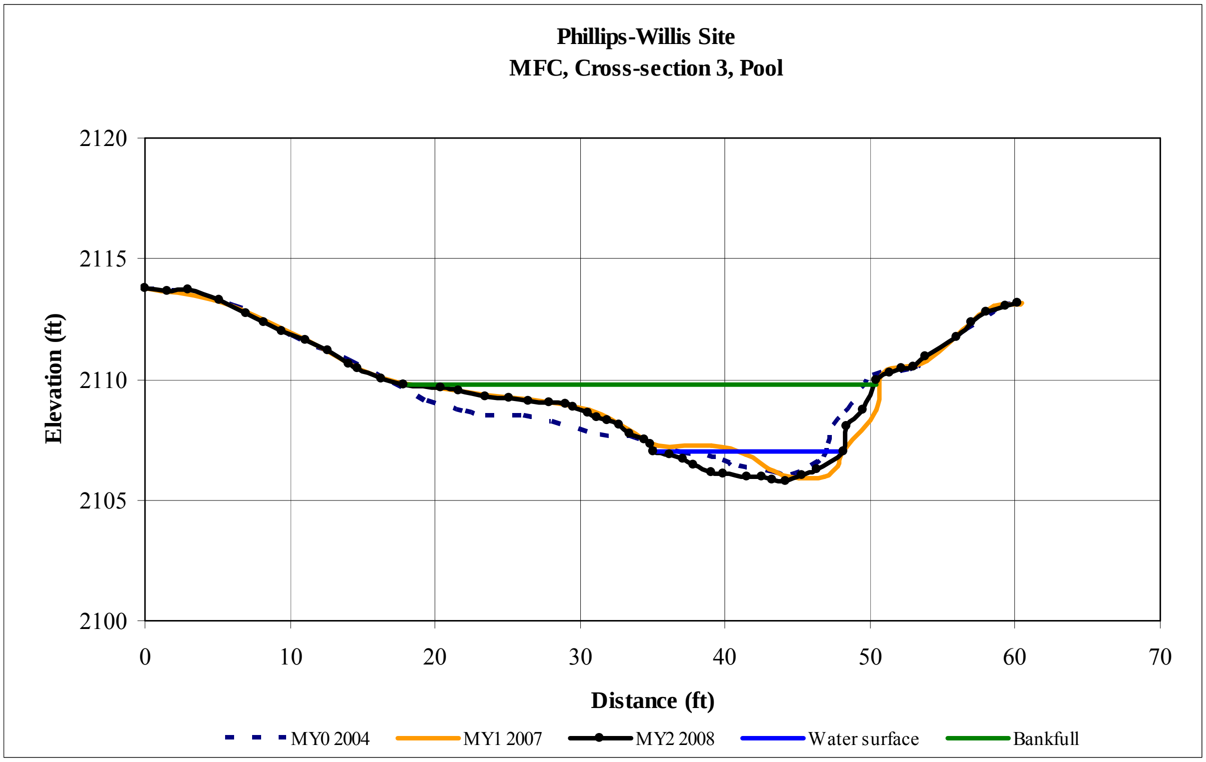
B.5 Continued.




MFC cross-section 2, facing downstream, 4 Dec 2007.


MFC cross-section 2, facing downstream, 14 Oct 2008.

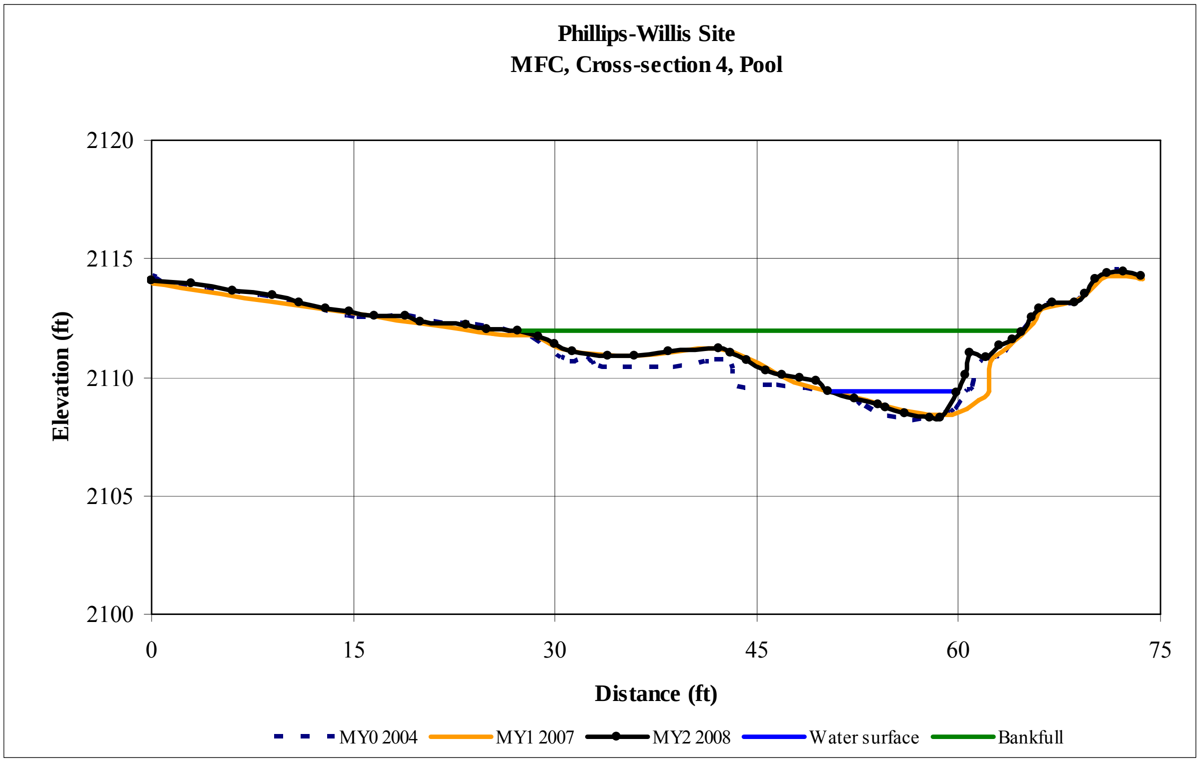
B.5 Continued.



MFC cross-section 3, facing downstream, 4 Dec 2007.

MFC cross-section 3, facing downstream, 14 Oct 2008.

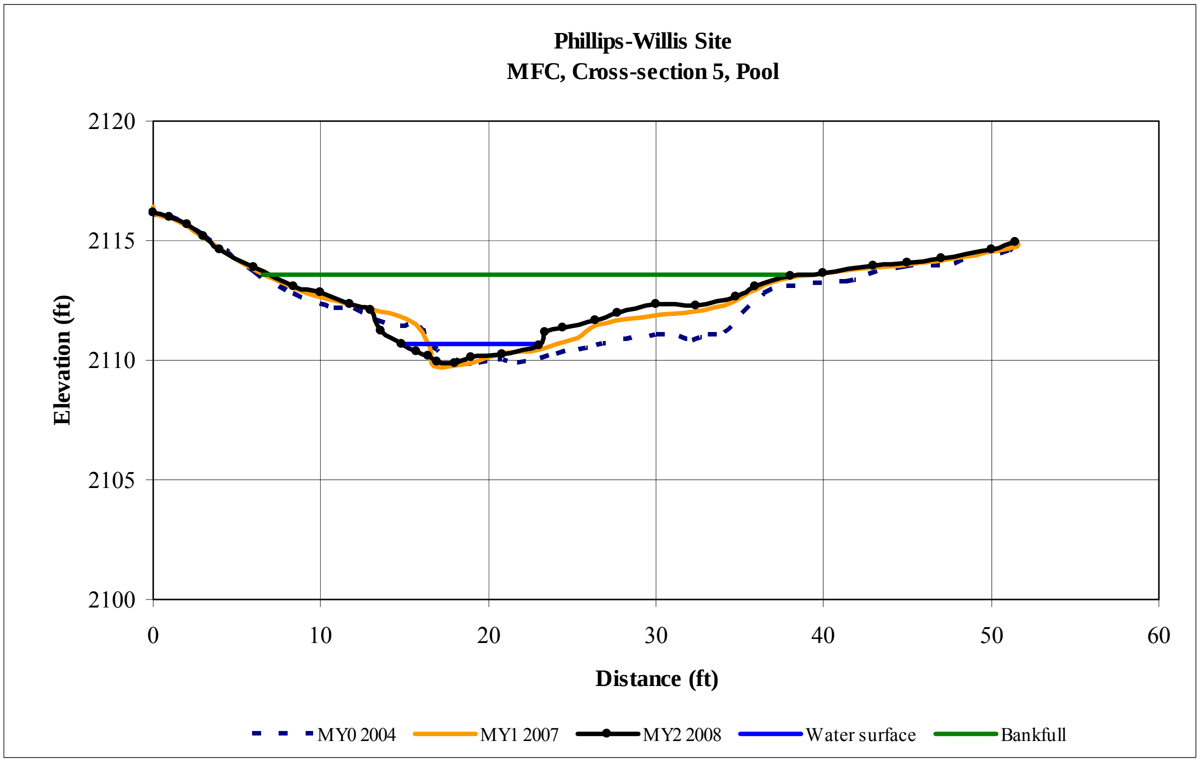
B.5 Continued.



MFC cross-section 4, facing downstream, 4 Dec 2007.

MFC cross-section 4, facing downstream, 14 Oct 2008.

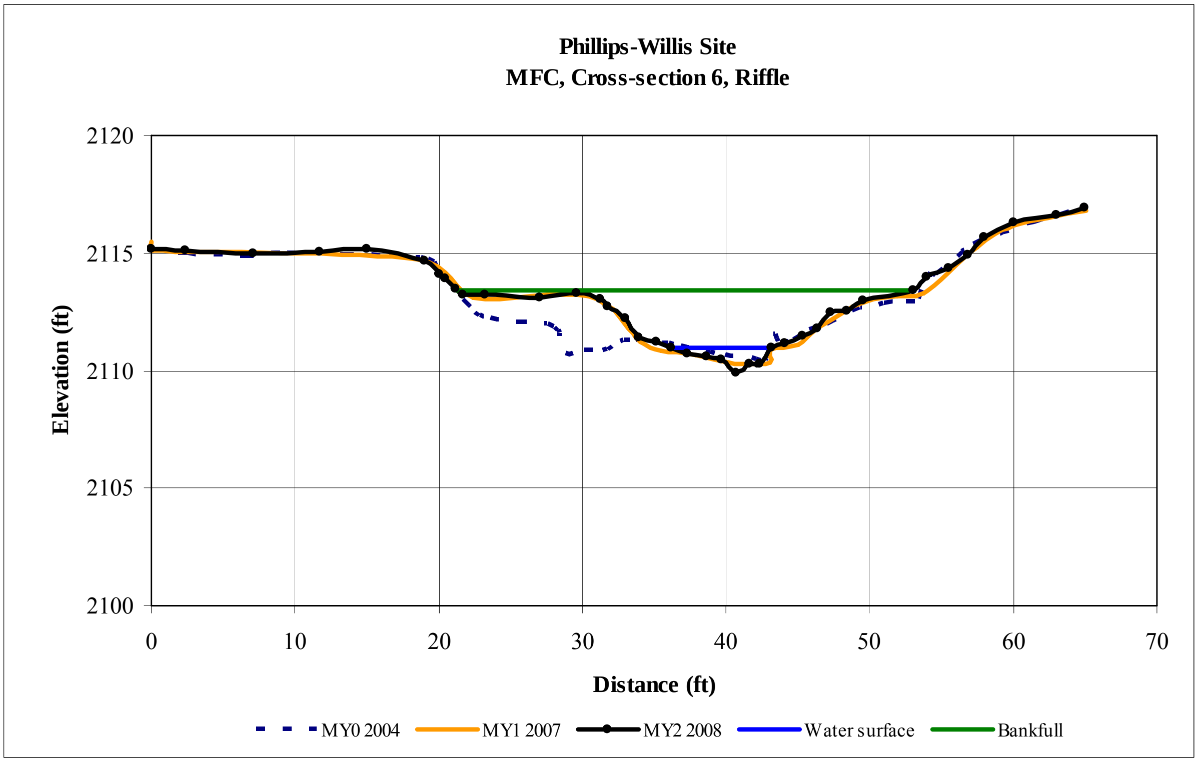
B.5 Continued.



MFC cross-section 5, facing downstream, 4 Dec 2007.

MFC cross-section 5, facing downstream, 14 Oct 2008.

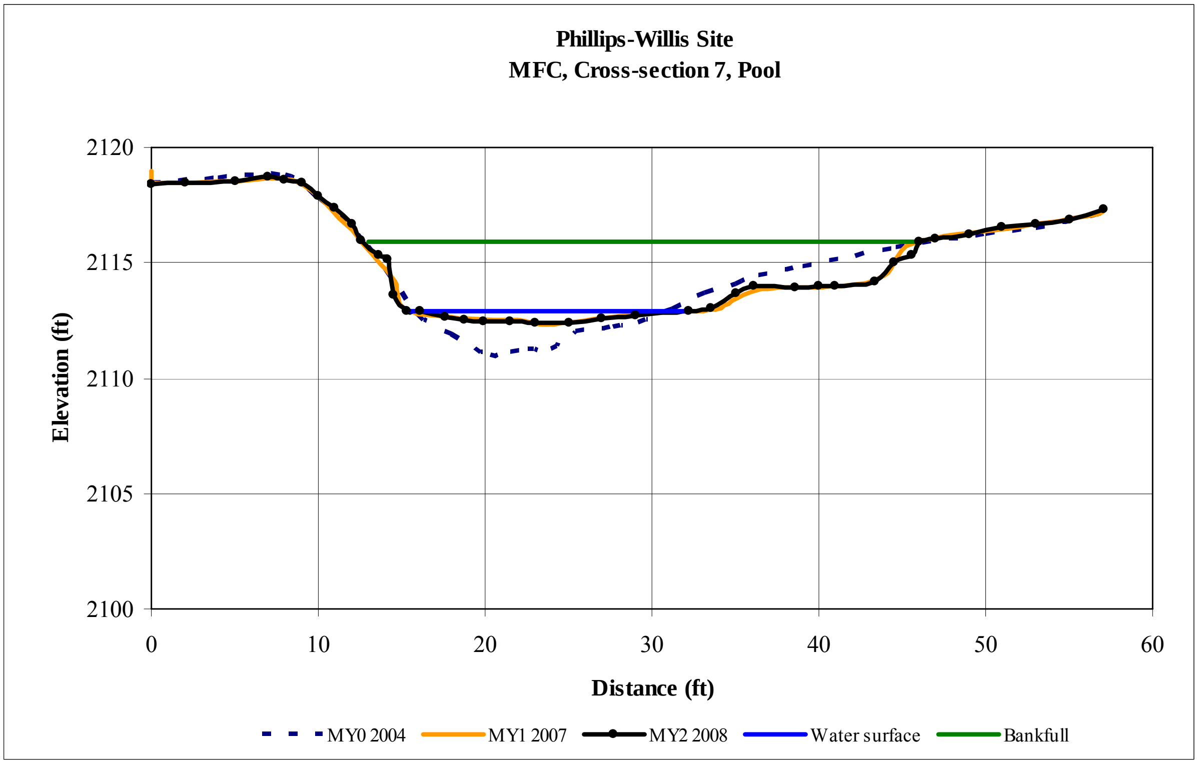
B.5 Continued.



MFC cross-section 6, facing downstream, 4 Dec 2007.

MFC cross-section 6, facing downstream, 14 Oct 2008.

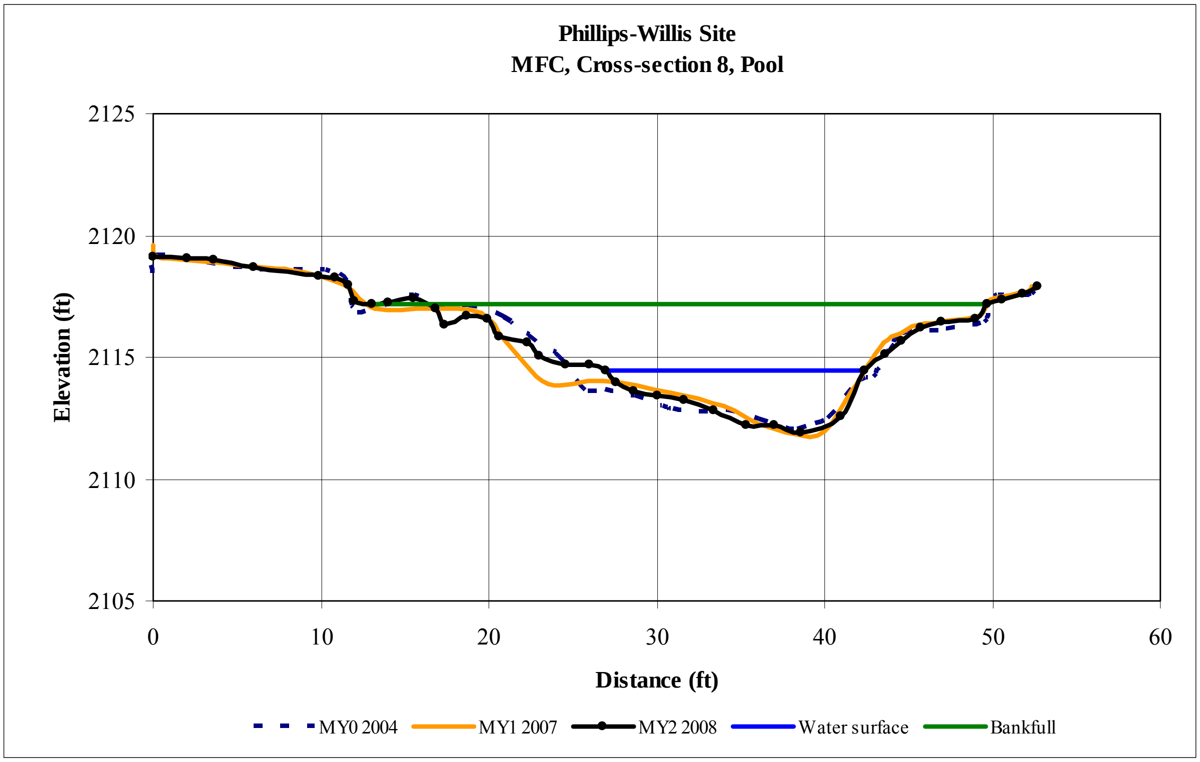
B.5 Continued.



MFC cross-section 7, facing downstream, 4 Dec 2007.

MFC cross-section 7, facing downstream, 14 Oct 2008.

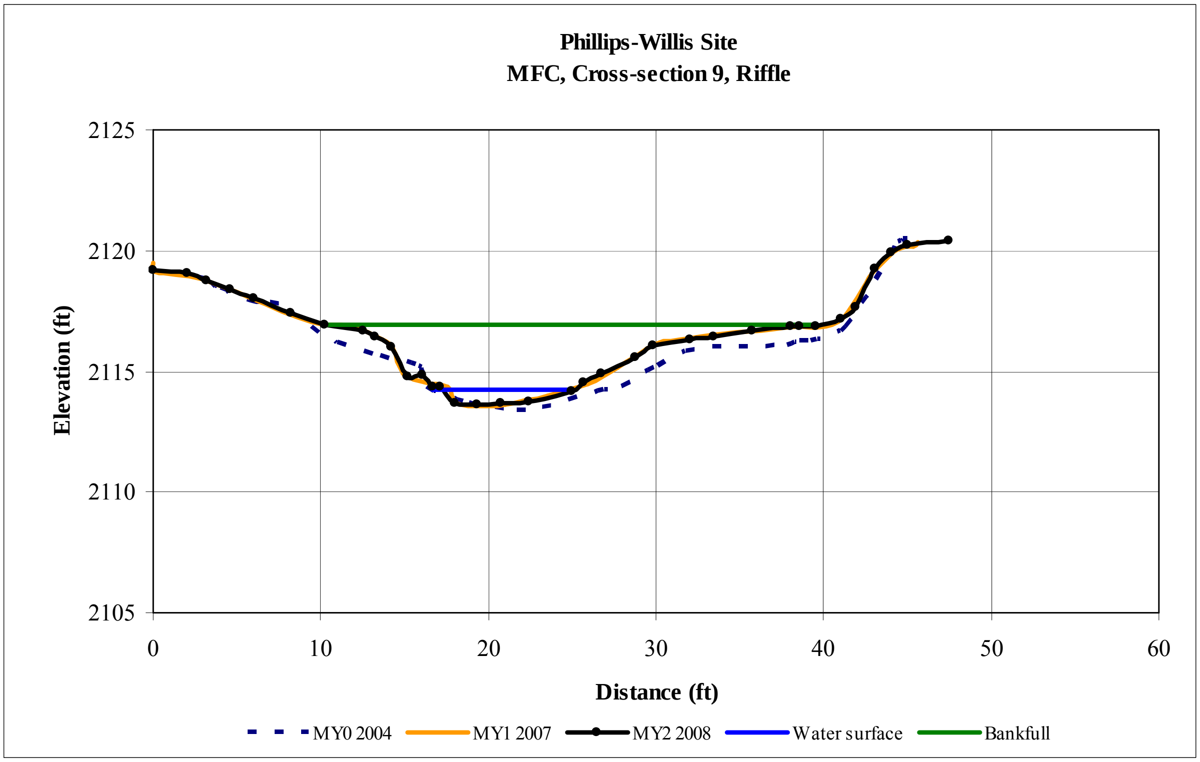
B.5 Continued.



MFC cross-section 8, facing downstream, 4 Dec 2007.

MFC cross-section 8, facing downstream, 14 Oct 2008.

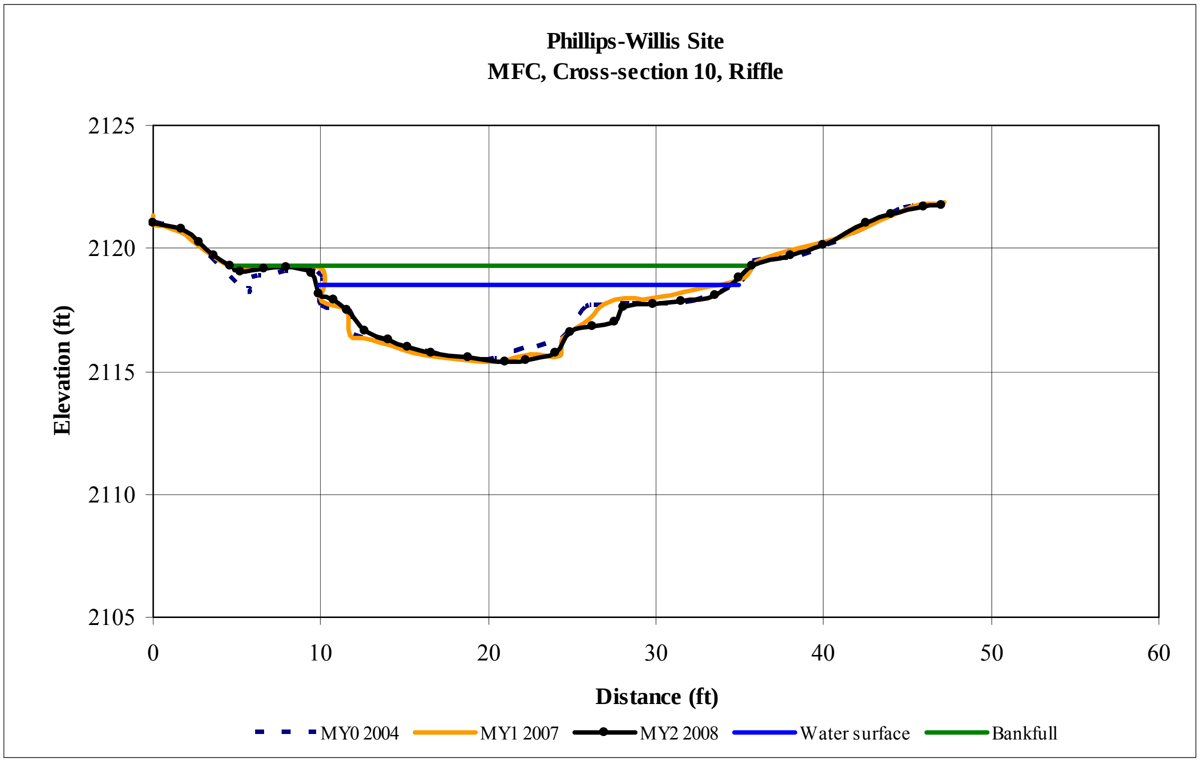
B.5 Continued.



MFC cross-section 9, facing downstream, 4 Dec 2007.

MFC cross-section 9, facing downstream, 14 Oct 2008.

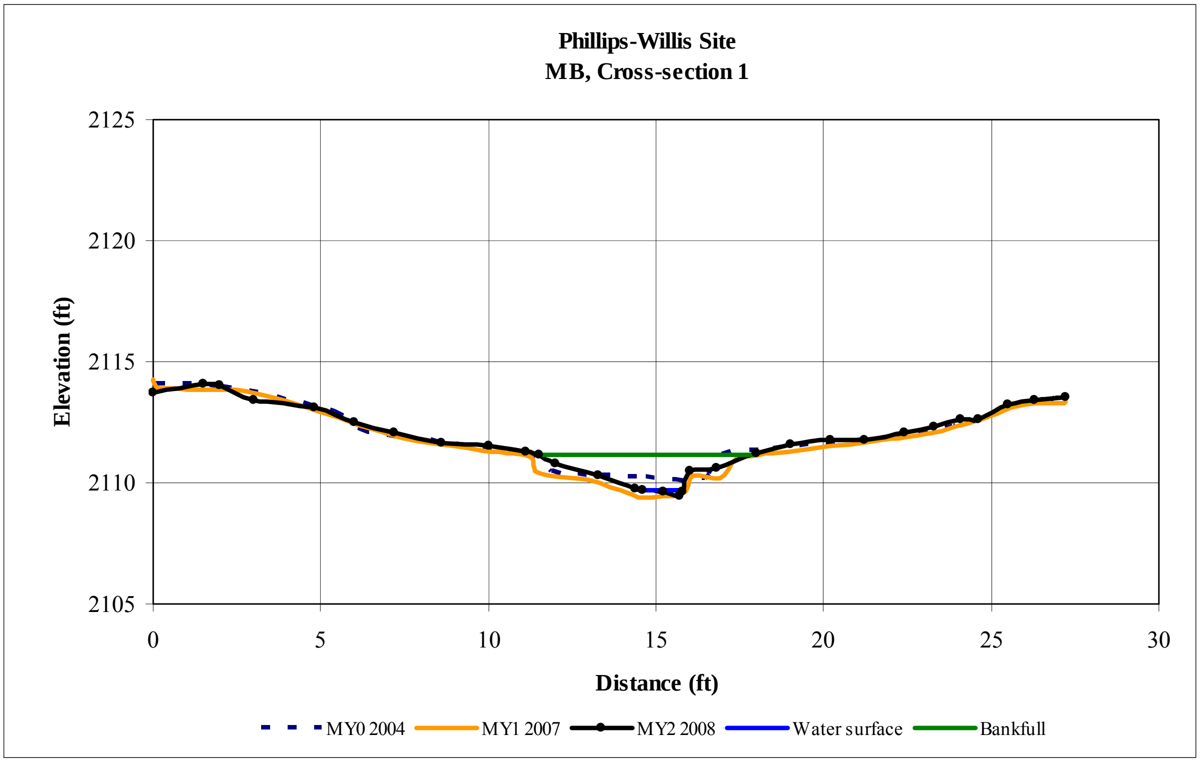
B.5 Continued.



MFC cross-section 10, facing downstream, 4 Dec 2007.

MFC cross-section 10, facing downstream, 14 Oct 2008.

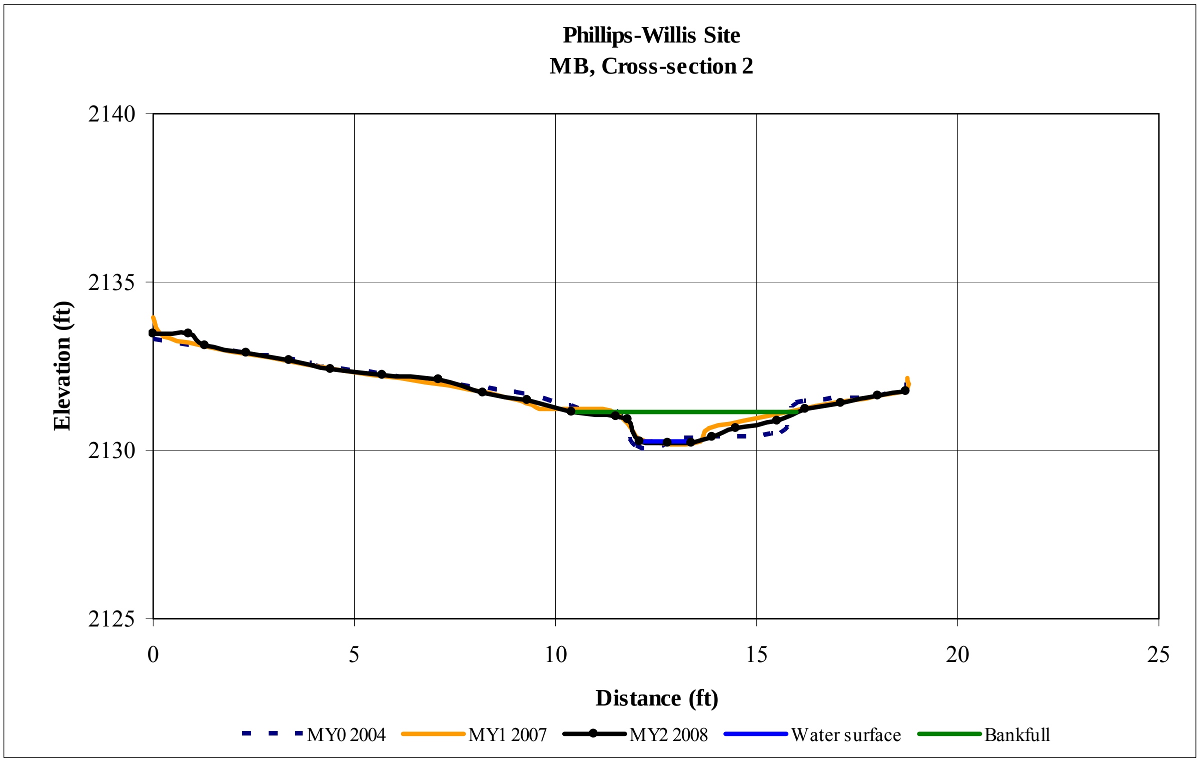
B.5 Continued.



MB cross-section 1, facing downstream, 4 Dec 2007.

MB cross-section 1, facing downstream, 14 Oct 2008.

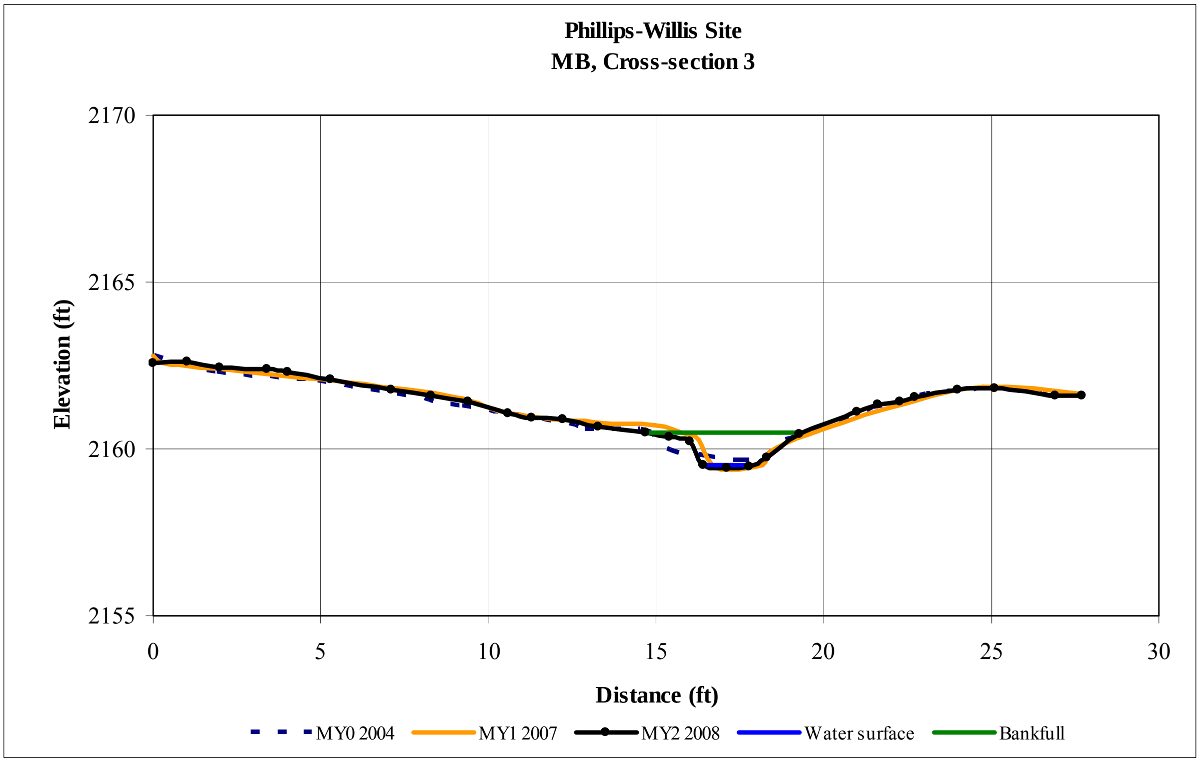
B.5 Continued.



MB cross-section 2, facing downstream, 4 Dec 2007.

MB cross-section 2, facing downstream, 14 Oct 2008.

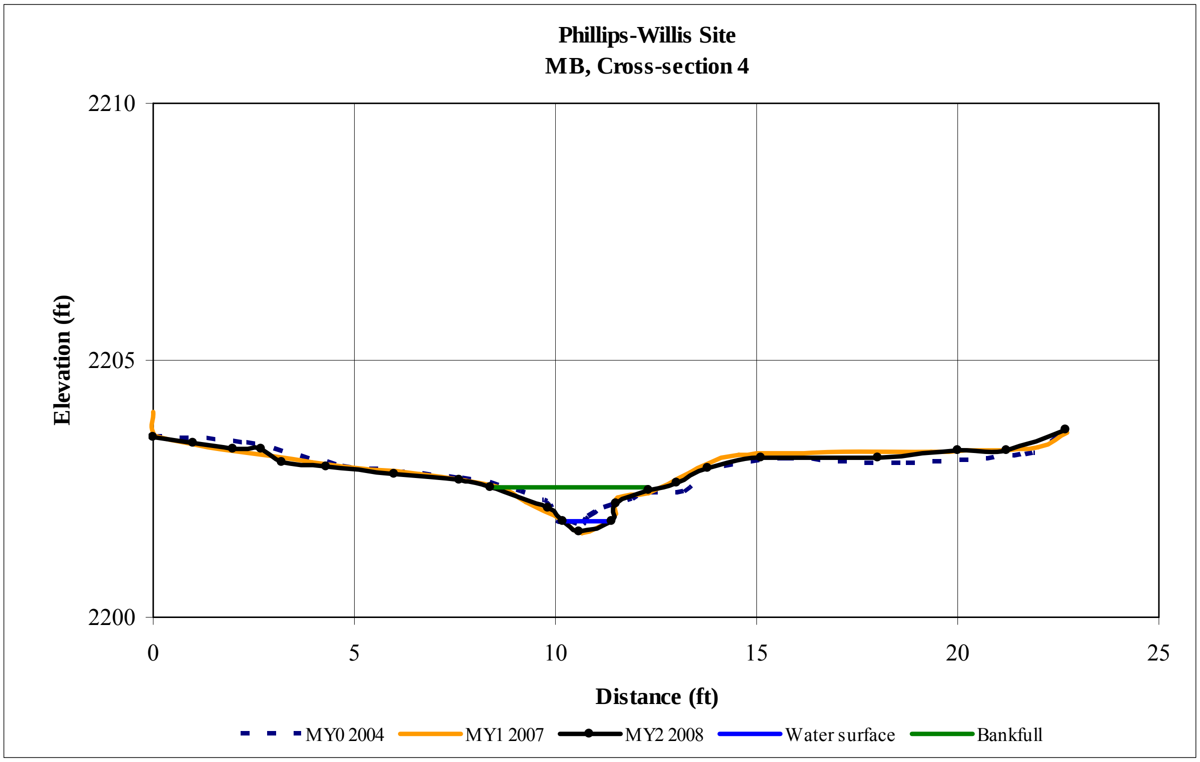
B.5 Continued.




MB cross-section 3, facing downstream, 4 Dec 2007.


MB cross-section 3, facing downstream, 14 Oct 2008.

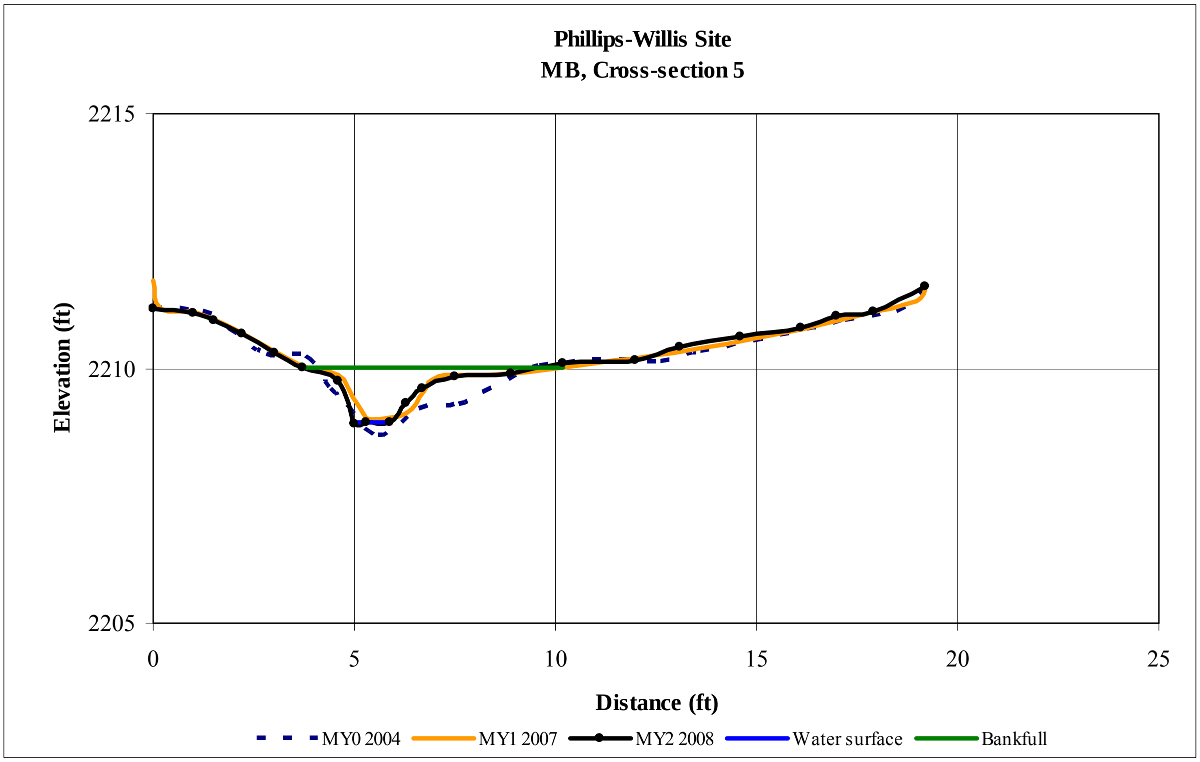
B.5 Continued.



MB cross-section 4, facing downstream, 4 Dec 2007.

MB cross-section 4, facing downstream, 14 Oct 2008.

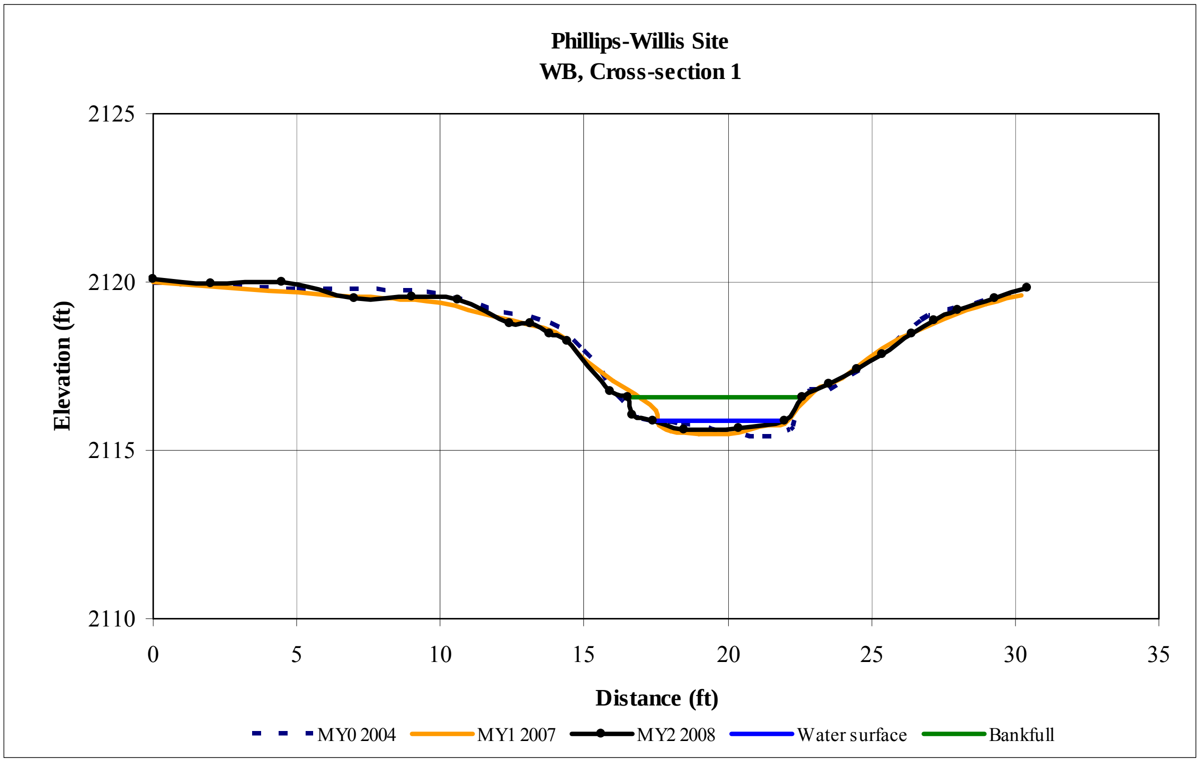
B.5 Continued.



MB cross-section 5, facing downstream, 4 Dec 2007.

MB cross-section 5, facing downstream, 14 Oct 2008.

B.5 Continued.



WB cross-section 1, facing downstream, 4 Dec 2007.

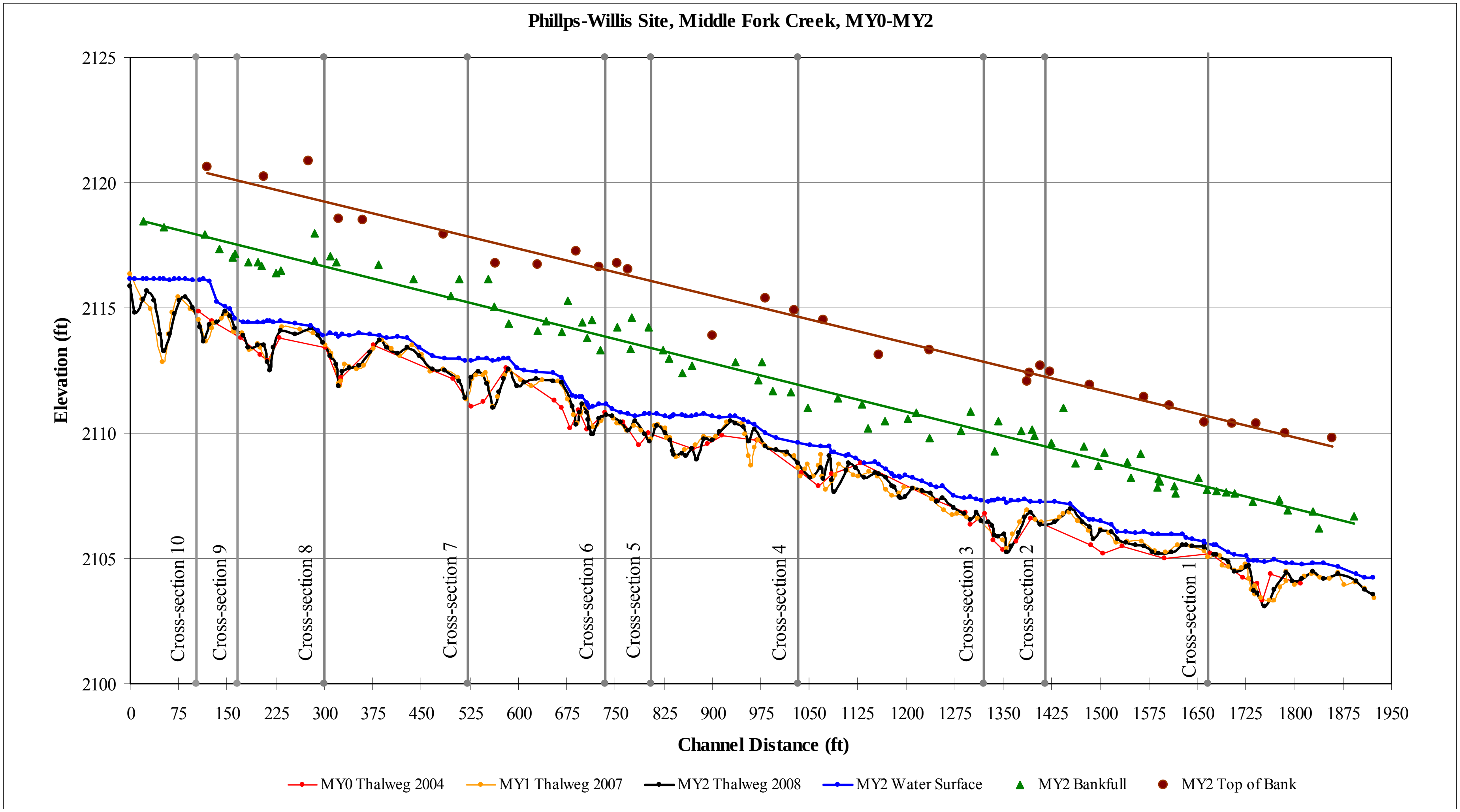
WB cross-section 1, facing downstream, 14 Oct 2008.

B.6 Channel Pattern Geometry

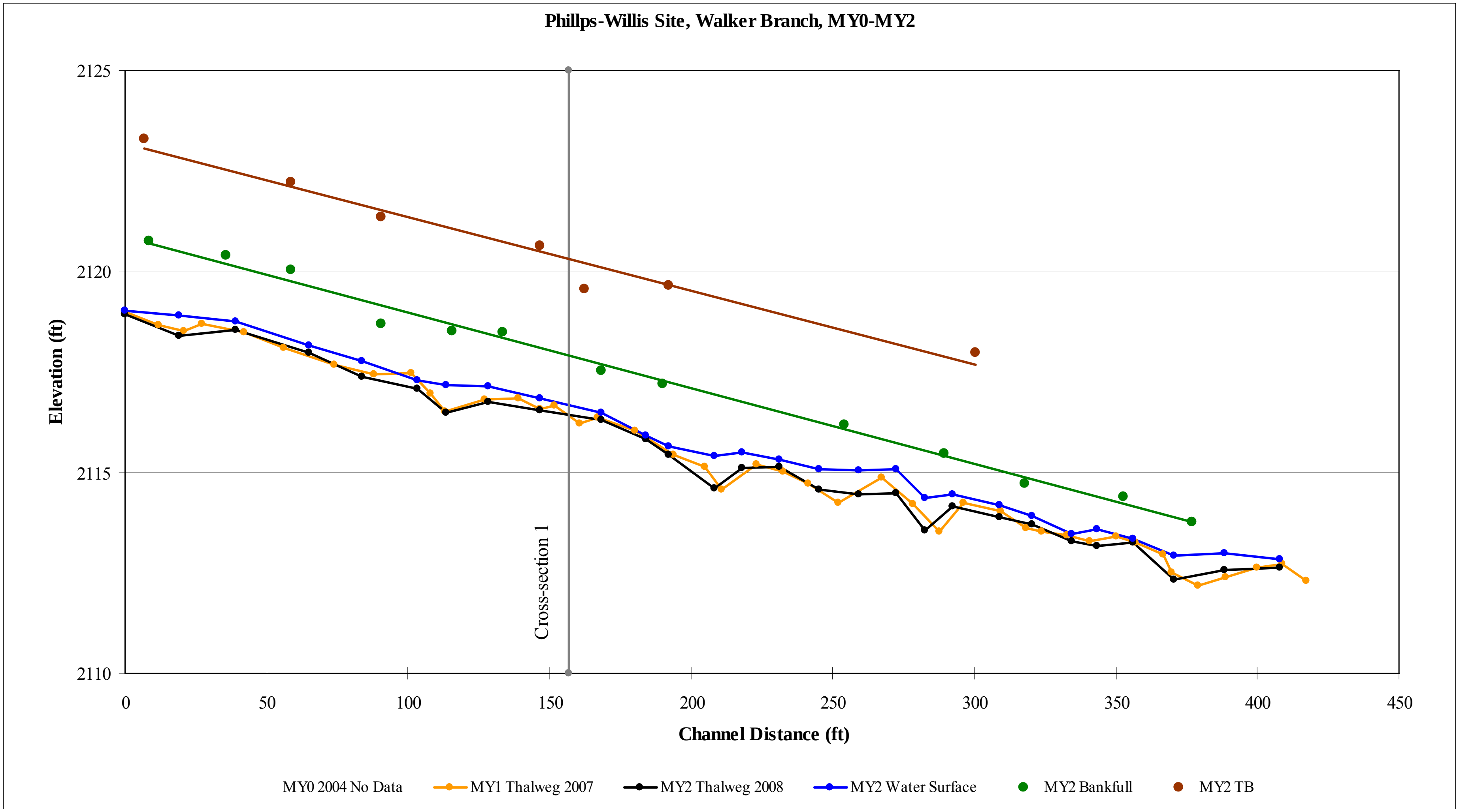
Table B.6.1 Belt Width, Meander Wavelength, and Radius of Curvature Pattern Measurements.

Phillips-Willis Site (EEP project number 92703) MY2, Middle Fork Creek (1,888 ft)													
Parameter	**Measurements**							**Min**	**Max**	**Med**	**Mean**	**SD**	**n**
Channel Belt Width	92.7	104.6	112.5	36.7	98.0	80.3		36.7	112.5	95.4	87.5	27.2	6
Radius of Curvature	147.8	114.2	152.8	110.6	251.3	177.4	302.5	110.6	302.5	152.8	179.5	71.9	7
Meander Wavelength	257.6	318.9	328.4	302.8	251.4	282.0	344.4	251.4	344.4	302.8	297.9	35.6	7
Radius of Curvature:WidthBKF	4.8	3.7	5.0	3.6	8.2	5.8	9.9	3.6	9.9	5.0	5.8	2.3	7
Meander Width Ratio	3.0	3.4	3.7	1.2	3.2	2.6		1.2	3.7	3.1	2.8	0.9	6
Phillips-Willis Site (EEP project number 92703) MY1, McKinney Branch (2,851 ft)													
Parameter	**Measurements**							**Min**	**Max**	**Med**	**Mean**	**SD**	**n**
Channel Belt Width	16.2	20.4	24.7	50.4	14.9	24.8		14.9	50.4	22.6	25.2	13.0	6
Radius of Curvature	195.7	32.3	18.5	23.7	42.2	142.7		18.5	195.7	37.3	75.9	74.7	6
Meander Wavelength	99.6	56.4	101.8	144.0	59.4	63.7		56.4	144.0	81.7	87.5	34.3	6
Radius of Curvature:WidthBKF	36.9	6.1	3.5	4.5	8.0	26.9		3.5	36.9	7.0	14.3	14.1	6
Meander Width Ratio	3.1	3.8	4.7	9.5	2.8	4.7		2.8	9.5	4.3	4.8	2.5	6
Phillips-Willis Site (EEP project number 92703) MY2, Walker Branch (375 ft)													
Parameter	**Measurements**							**Min**	**Max**	**Med**	**Mean**	**SD**	**n**
Channel Belt Width	24.9	23.4						23.4	24.9	24.2	24.2	1.1	2
Radius of Curvature	45.6	25.0						25.0	45.6	35.3	35.3	14.6	2
Meander Wavelength	87.9	103.8						87.9	103.8	95.9	95.9	11.2	2
Radius of Curvature:WidthBKF	7.4	4.0						4.0	7.4	5.7	5.7	2.3	2
Meander Width Ratio	4.0	3.8						3.8	4.0	3.9	3.9	0.2	2

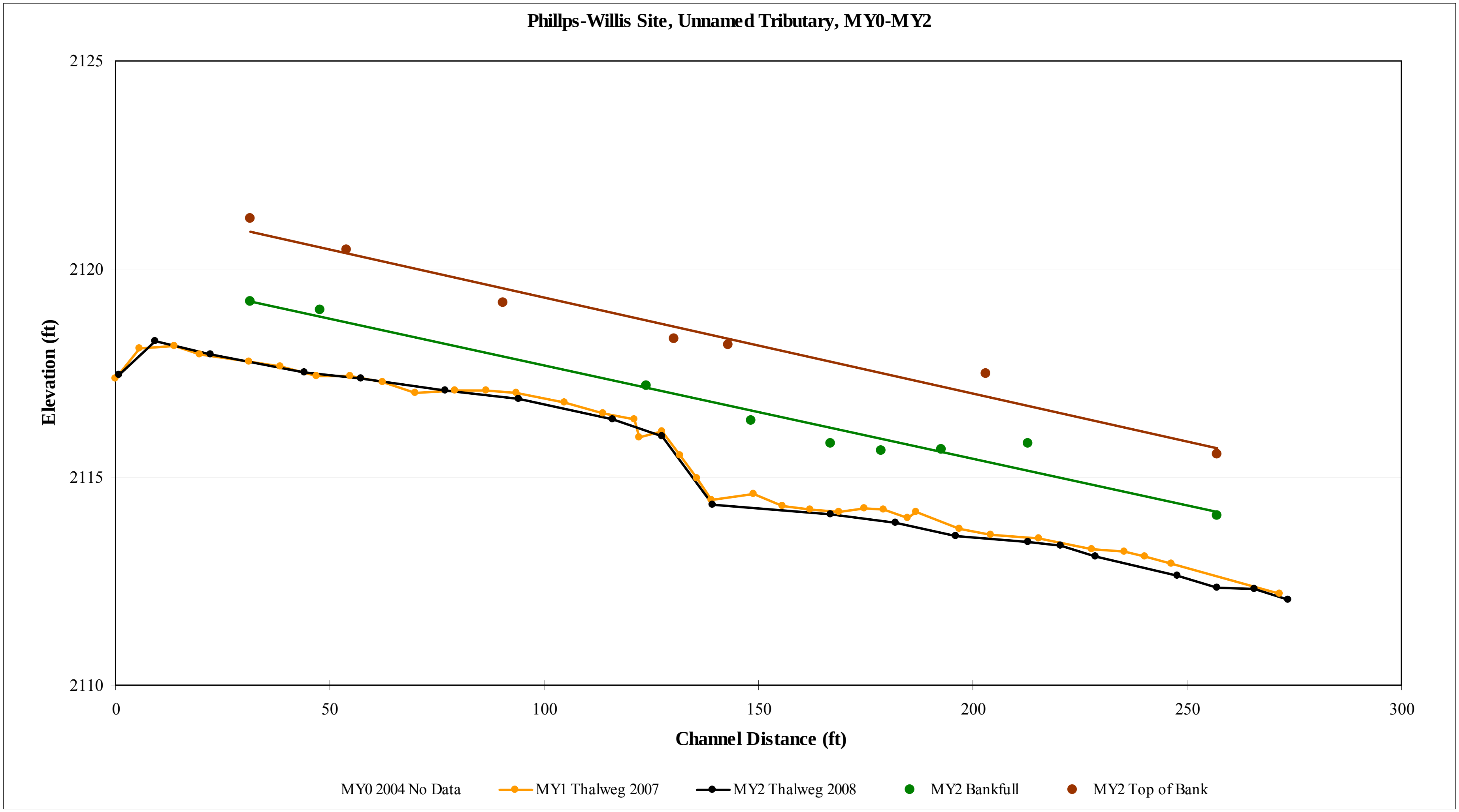
B.7 Annual Overlays of Longitudinal Profile Plots.



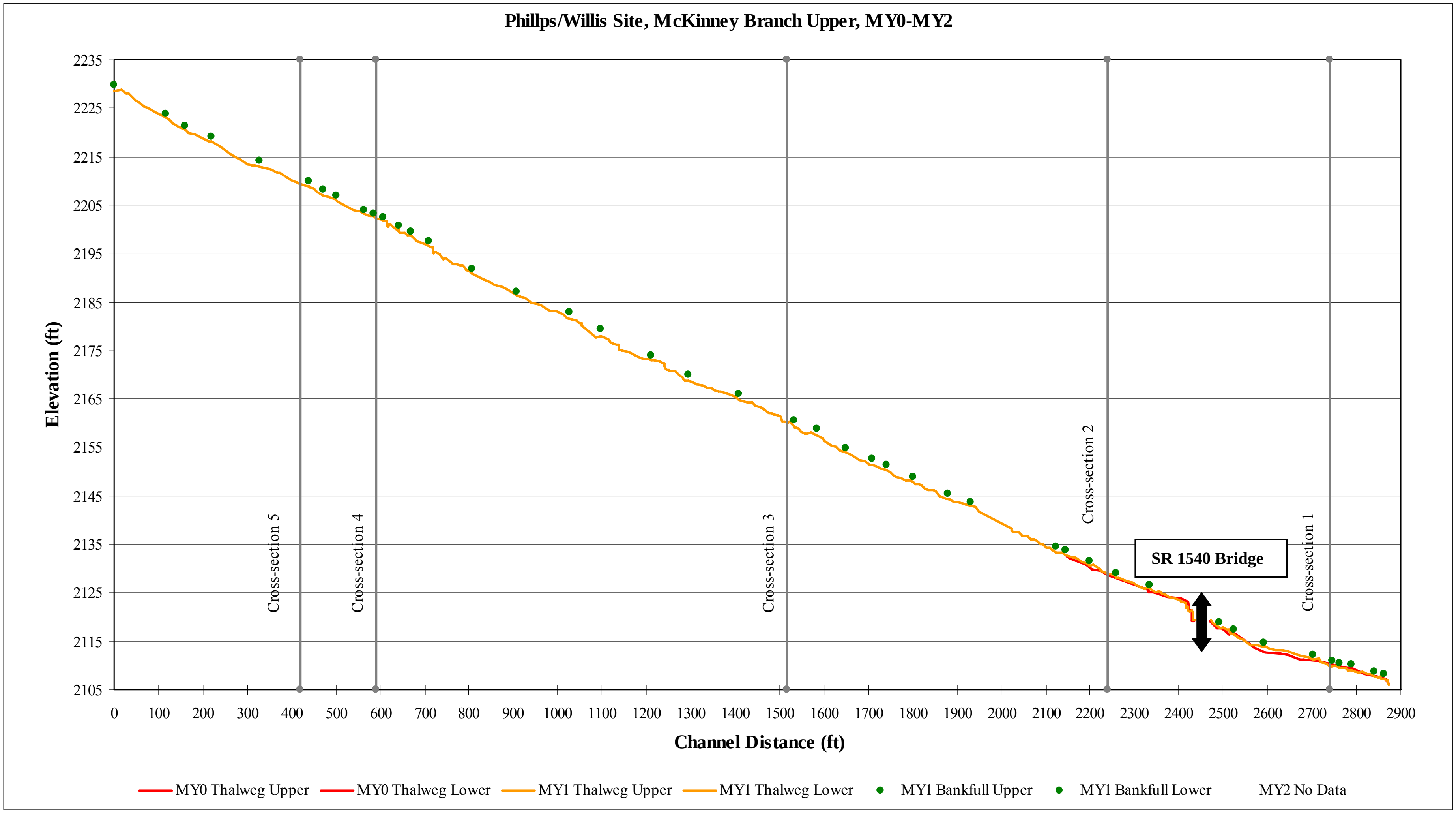
B.7 Continued.



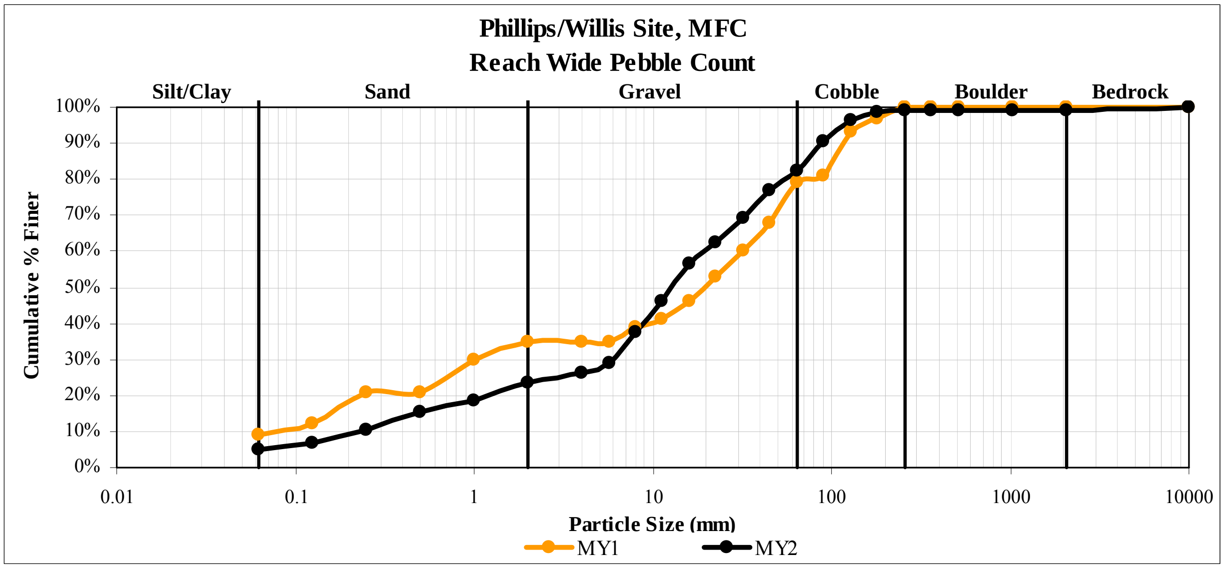
B.7 Continued.



B.7 Continued.

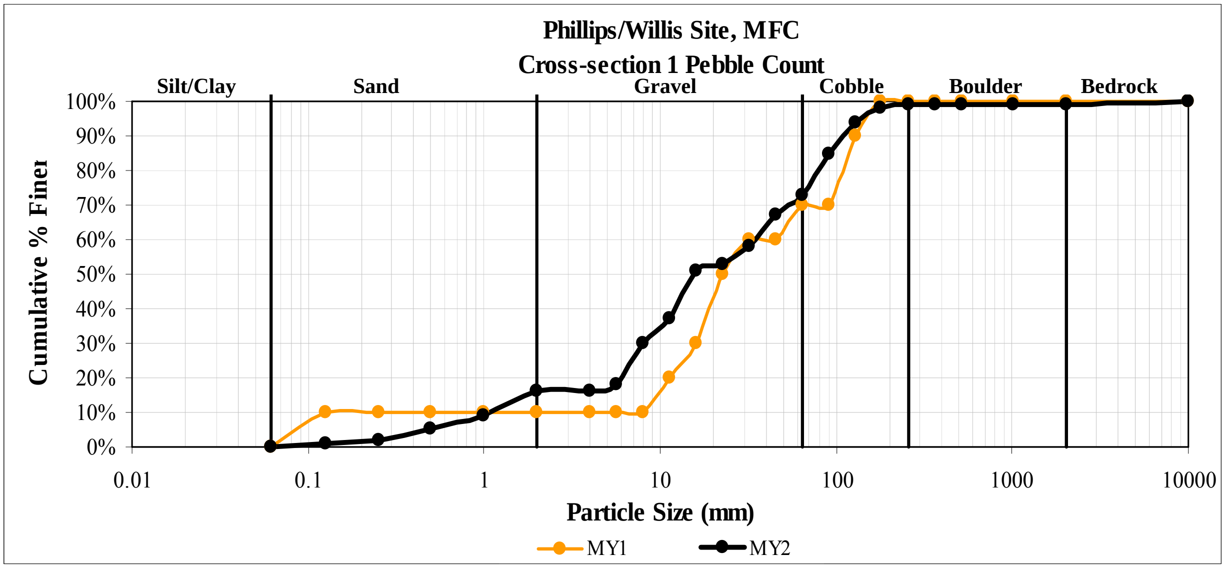


B.8 Pebble Count Cumulative Frequency Distribution Plots



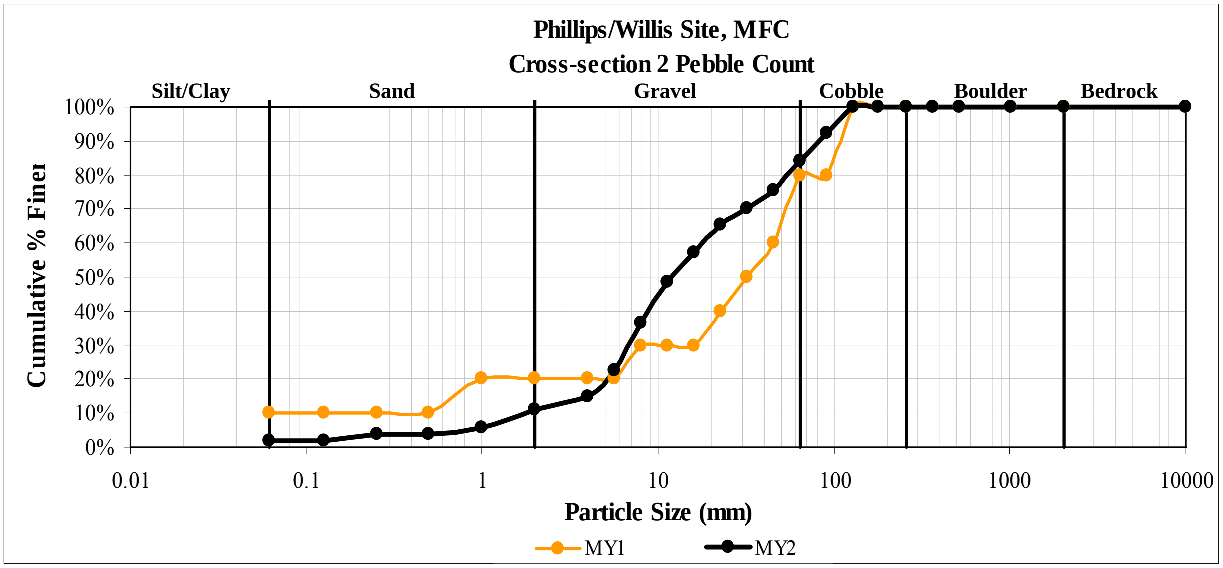
MFC Reach-wide Pebble Count			
	Particle Size by Category		
Category	MY0	MY1	MY2
D16 (mm)	No Data	0.2	0.6
D35 (mm)		2.0	7.3
D50 (mm)		19.8	13.0
D84 (mm)		99.5	69.3
D95 (mm)		154.0	118.9
	Percent Bed Material by Category		
Category	MY0	MY1	MY2
Silt/Clay	No Data	9.0%	4.8%
Sand		26.0%	18.7%
Gravel		44.0%	58.9%
Cobble		21.0%	16.8%
Boulder		0.0%	0.1%
Bedrock		0.0%	0.8%

B.8 Continued.



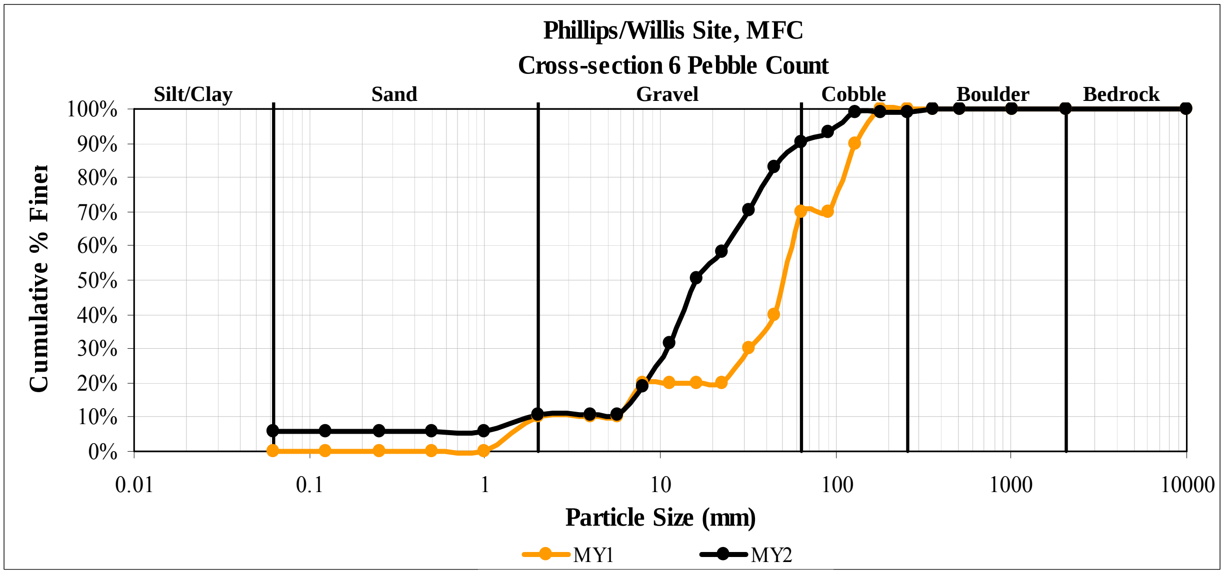
MFC Cross-section 1 Pebble Count			
	Particle Size by Category		
Category	**MY0**	**MY1**	**MY2**
D16 (mm)	No Data	10.0	2.0
D35 (mm)		17.7	10.3
D50 (mm)		22.6	15.7
D84 (mm)		116.6	88.8
D95 (mm)		154.0	143.6
	Percent Bed Material by Category		
Category	**MY0**	**MY1**	**MY2**
Silt/Clay	No Data	0.0%	0.0%
Sand		10.0%	16.4%
Gravel		60.0%	56.4%
Cobble		30.0%	26.4%
Boulder		0.0%	0.0%
Bedrock		0.0%	0.9%

B.8 Continued.



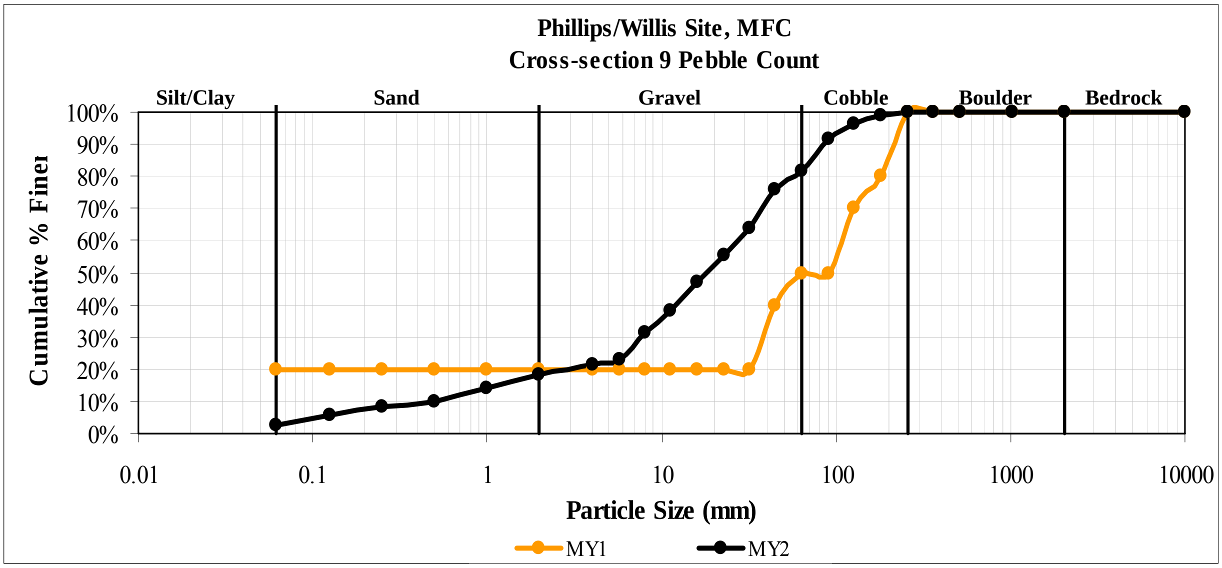
MFC Cross-section 2 Pebble Count			
	Particle Size by Category		
Category	MY0	MY1	MY2
D16 (mm)	No Data	0.8	4.3
D35 (mm)		19.3	7.7
D50 (mm)		32.0	12.1
D84 (mm)		97.6	63.7
D95 (mm)		118.5	104.0
	Percent Bed Material by Category		
Category	MY0	MY1	MY2
Silt/Clay	No Data	10.0%	2.0%
Sand		10.0%	8.9%
Gravel		60.0%	73.3%
Cobble		20.0%	15.8%
Boulder		0.0%	0.0%
Bedrock		0.0%	0.0%

B.8 Continued.



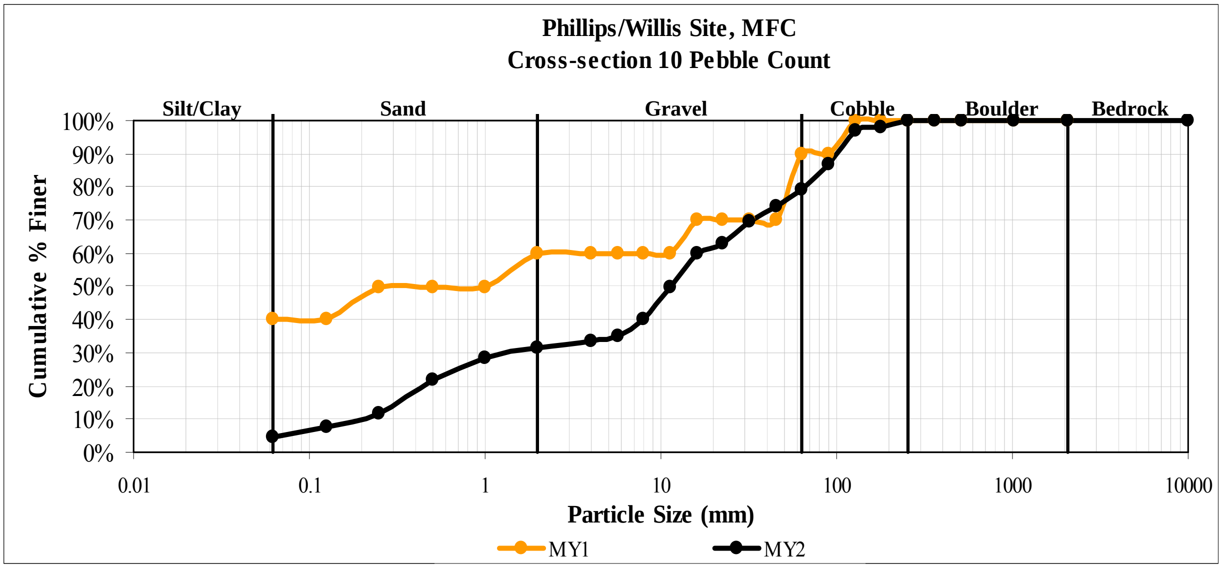
MFC Cross-section 6 Pebble Count			
	Particle Size by Category		
Category	**MY0**	**MY1**	**MY2**
D16 (mm)	No Data	7.1	7.2
D35 (mm)		38.5	12.2
D50 (mm)		51.3	15.9
D84 (mm)		116.6	47.8
D95 (mm)		154.0	101.1
	Percent Bed Material by Category		
Category	**MY0**	**MY1**	**MY2**
Silt/Clay	No Data	0.0%	5.7%
Sand		10.0%	4.8%
Gravel		60.0%	80.0%
Cobble		30.0%	8.6%
Boulder		0.0%	1.0%
Bedrock		0.0%	0.0%

B.8 Continued.



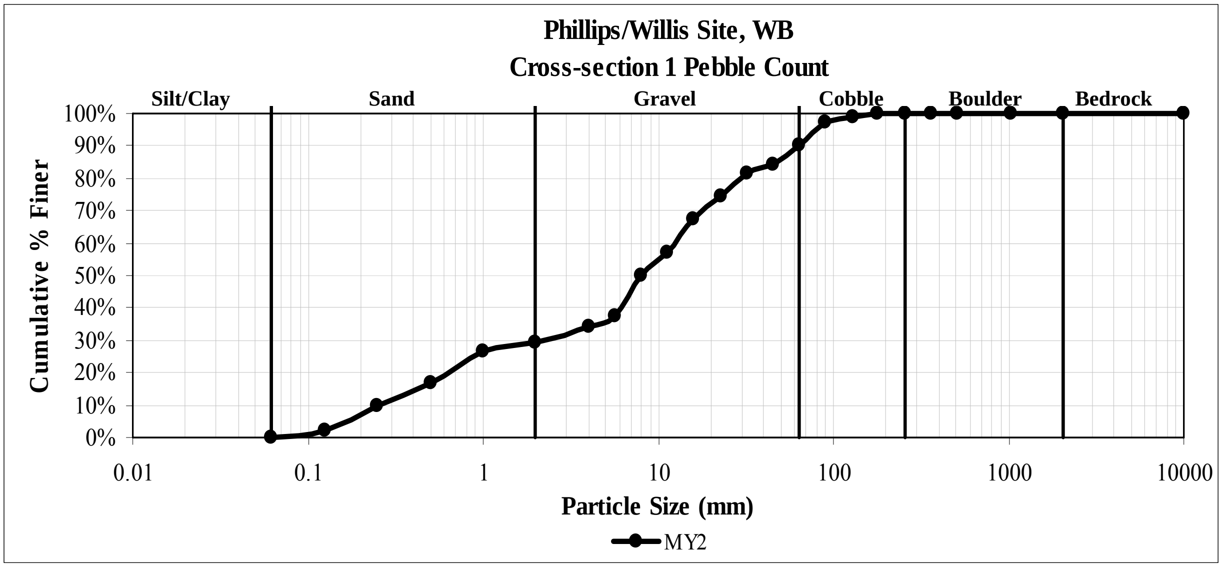
MFC Cross-section 9 Pebble Count			
	Particle Size by Category		
Category	**MY0**	**MY1**	**MY2**
D16 (mm)	No Data	0.1	1.5
D35 (mm)		41.8	9.8
D50 (mm)		64.0	18.2
D84 (mm)		195.2	70.4
D95 (mm)		237.0	117.3
	Percent Bed Material by Category		
Category	**MY0**	**MY1**	**MY2**
Silt/Clay	No Data	20.0%	2.8%
Sand		0.0%	15.7%
Gravel		30.0%	63.0%
Cobble		50.0%	18.5%
Boulder		0.0%	0.0%
Bedrock		0.0%	0.0%

B.8 Continued.



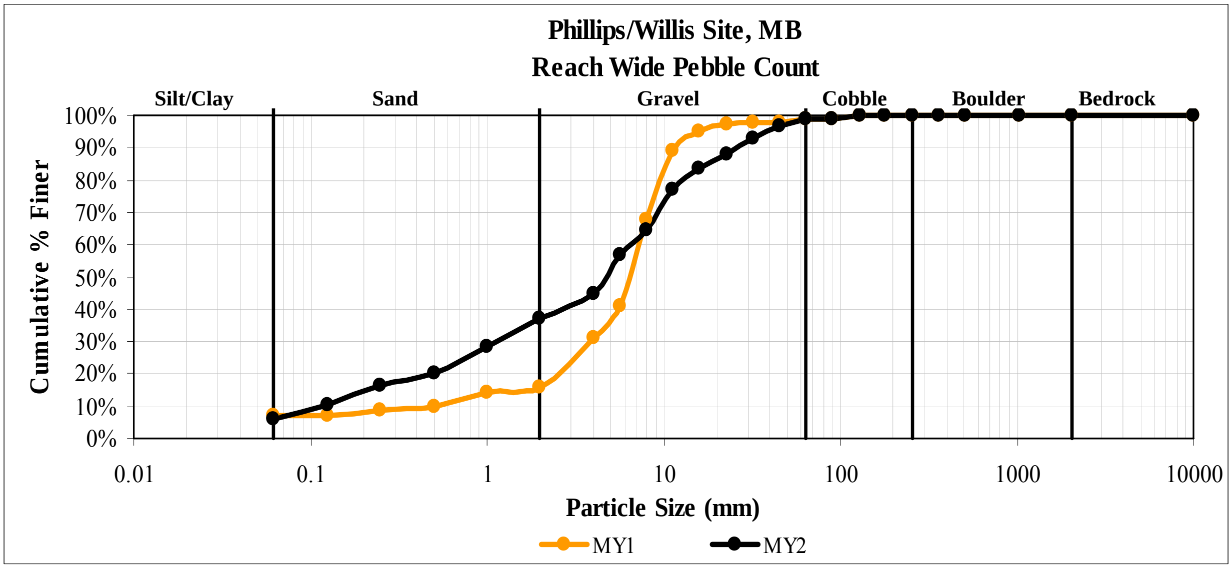
MFC Cross-section 10 Pebble Count			
	Particle Size by Category		
Category	MY0	MY1	MY2
D16 (mm)	No Data	0.0	0.4
D35 (mm)		0.1	5.5
D50 (mm)		0.3	11.5
D84 (mm)		58.3	80.9
D95 (mm)		109.0	120.2
	Percent Bed Material by Category		
Category	MY0	MY1	MY2
Silt/Clay	No Data	40.0%	4.8%
Sand		20.0%	26.7%
Gravel		30.0%	47.6%
Cobble		10.0%	21.0%
Boulder		0.0%	0.0%
Bedrock		0.0%	0.0%

B.8 Continued.



WB Cross-section 1 Pebble Count			
	Particle Size by Category		
Category	**MY0**	**MY1**	**MY2**
D16 (mm)	No Data	No Data	0.5
D35 (mm)			4.4
D50 (mm)			8.0
D84 (mm)			43.6
D95 (mm)			82.2
	Percent Bed Material by Category		
Category	**MY0**	**MY1**	**MY2**
Silt/Clay	No Data	No Data	0.0
Sand			29.4
Gravel			60.8
Cobble			9.8
Boulder			0.0
Bedrock			0.0

B.8 Continued.



	Particle Size by Category		
Category	**MY0**	**MY1**	**MY2**
D16 (mm)	No Data	2.0	0.3
D35 (mm)		4.7	1.8
D50 (mm)		6.5	4.8
D84 (mm)		10.5	16.2
D95 (mm)		16.0	39.7

	Percent Bed Material by Category		
Category	**MY0**	**MY1**	**MY2**
Silt/Clay	No Data	7.0%	6.1%
Sand		9.0%	30.9%
Gravel		83.0%	61.8%
Cobble		1.0%	1.2%
Boulder		0.0%	0.0%
Bedrock		0.0%	0.0%

B.9 Fixed Point Photographs

Photo point 1, facing upstream, 29 July 2004.

Photo point 1 facing upstream, 4 Dec 2007.

Photo point 1, facing upstream, 14 Oct 2008.

B.9 Continued.

Photo point 2, facing upstream, 13 Jan 2004.

Photo point 2, facing upstream, 4 Dec 2007.

Photo point 2, facing upstream, 14 Oct 2008.

B.9 Continued.

Photo point 3, facing upstream, 27 April 2004.

Photo point 3, facing upstream, 4 Dec 2007.

Photo point 3, facing upstream, 14 Oct 2008.

B.9 Continued.

Photo point 4, facing upstream, 29 July 2004.

Photo point 4, facing upstream, 4 Dec 2007.

Photo point 4, facing upstream, 14 Oct 2008.

B.9 Continued.

Photo point 5, facing downstream, 12 Jan 2004.

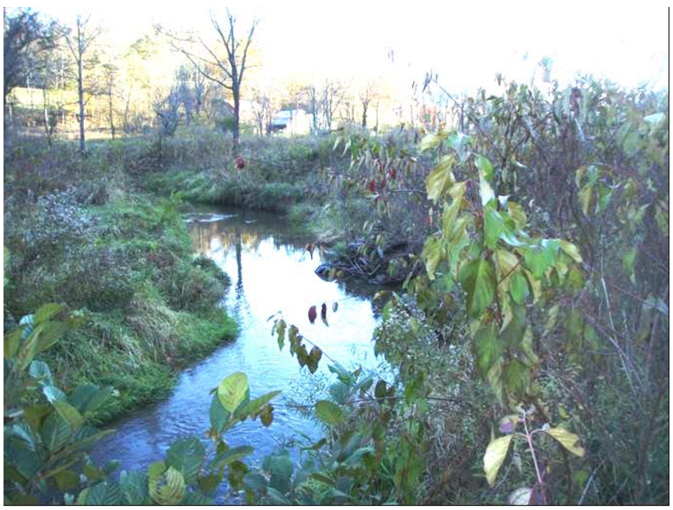


Photo point 5, facing downstream, 4 Dec 2007.

Photo point 5, facing downstream, 14 Oct 2008.

B.9 Continued.

Photo point 6, facing upstream, 29 July 2004.

Photo point 6, facing upstream, 4 Dec 2007.

Photo point 6, facing upstream, 14 Oct 2008.

B.9 Continued.

Photo point 7, facing upstream, 29 July 2004.

Photo point 7, facing upstream, 4 Dec 2007.

Photo point 7, facing upstream, 14 Oct 2008.

B.9 Continued.

Photo point 8, facing upstream, 27 April 2004.

Photo point 8, facing upstream, 4 Dec 2007.

Photo point 8, facing upstream, 14 Oct 2008.

B.9 Continued.


Photo point 9, pre-existing facing upstream, 15 April 2002.


Photo point 9, facing upstream, 29 Jan 2004.


Photo point 9, facing upstream, 4 Dec 2007.


Photo point 9, facing upstream, 14 Oct 2008.

B.9 Continued.

Photo point 10, pre-existing facing downstream, 15 April 2002.

Photo point 10, facing downstream, 29 Jan 2004.

Photo point 10, facing downstream, 4 Dec 2007.

Photo point 10, facing downstream, 14 Oct 2007.

B.10 Bankfull Verification Data and Photographs

Table B.10.1 Verification of Bankfull Events.

Phillips-Willis Site, MFC (EEP project number 92703)			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo Number (if available)**

B.11 Hydrologic Data

Figure B.11.1 USGS Hydrograph.

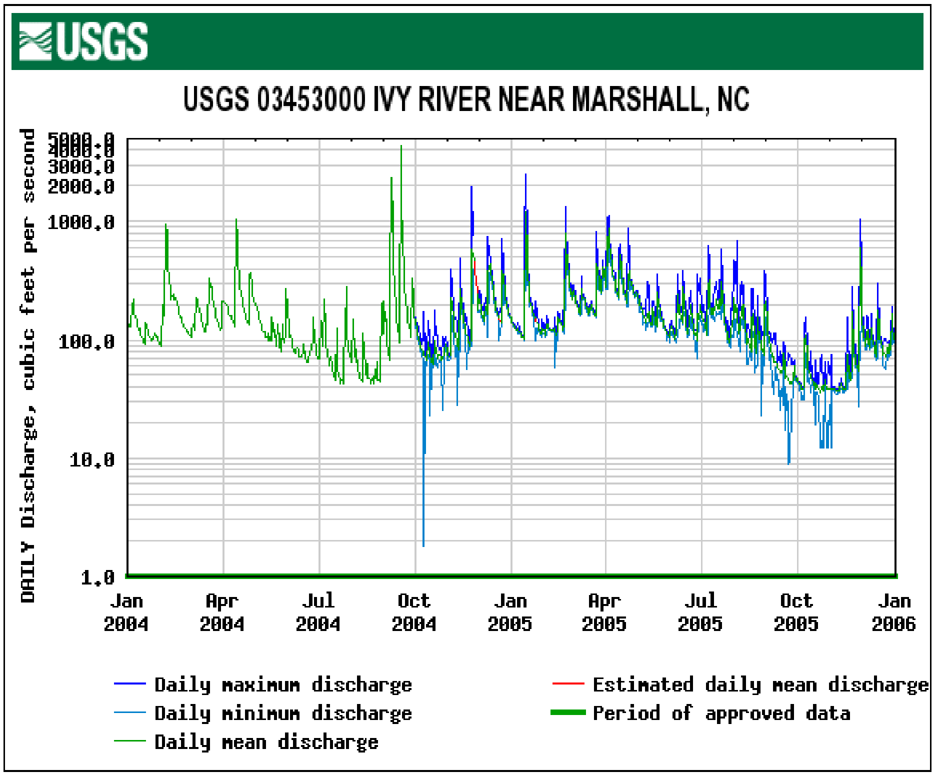
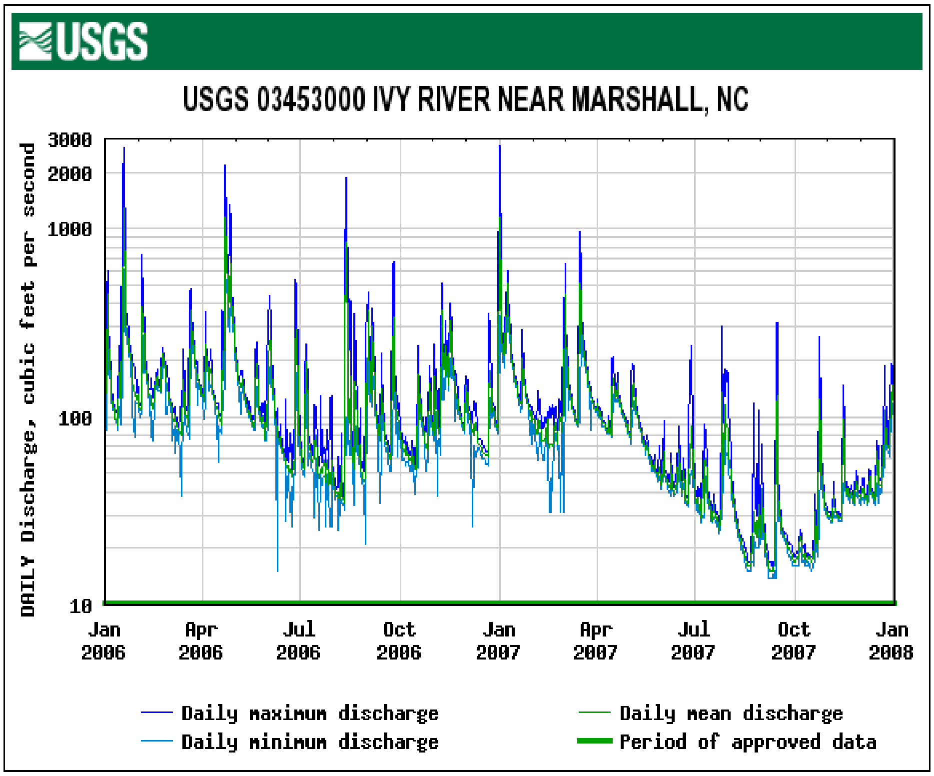
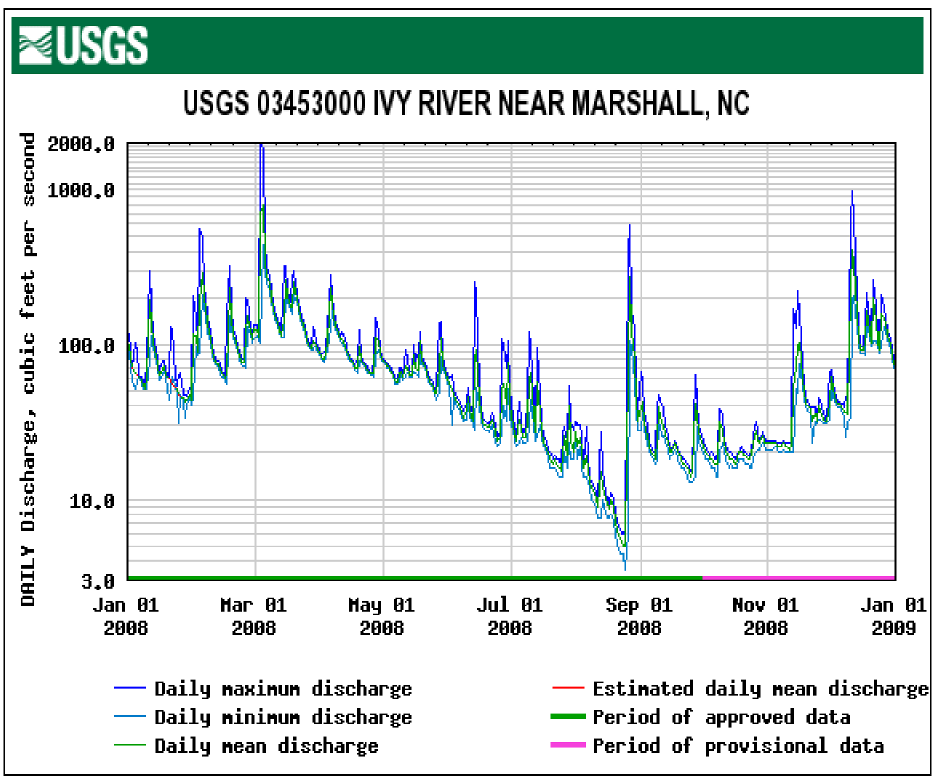


Figure B.11.1 Continued.





Appendix C Vegetation Data

C.1 Vegetation Data Summary Tables

Table C.1.1 Vegetation Plot Attribute Data.

Phillips-Willis Site (EEP project number 92703)						
Plot Identification	**Community Type**	**Planting Zone Identification**	**Reach Identification**	**Associated Gauge(s)**	**Method[a]**	**CVS Level**
MFC VP1	Riparian		I	N/A		1 and 2
MFC VP2	Riparian		I	N/A		1 and 2
MFC VP3	Riparian		I	N/A		1 and 2
MFC VP4	Riparian		I	N/A		1 and 2
MFC VP5	Riparian		I	N/A		1 and 2
MB VP1	Riparian		II	N/A		1 and 2
MB VP2	Riparian		II	N/A		1 and 2
MB VP3	Riparian		II	N/A		1 and 2
WB VP1	Riparian		IV	N/A		1 and 2

N/A = Not applicable

[a]Denote method if other than CVS method

Table C.1.2 Vegetation Metadata.

Phillips-Willis Site (EEP project number 92703)	
Report Prepared By	C. Scott Loftis, A. Brent Burgess
Date Prepared	30 Oct 08, 13:19
Database Name	NCWRCBalsam P-W site MY2 2008.mdb
Database Location	C:\Documents and Settings\Micky Clemmons\My Documents\My Data\Restoration Projects\CVS-EEP veg data
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.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY	
Project Code/Number	92703
Project Name	Phillips-Willis Site, Middle Fork Creek
Description	Bruce Phillips and Neal Willis properties, Madison County, N.C.
Length (ft)	MFC 1,888
Stream-to-Edge Width (ft)	
Area (m^2/acres)	
Required Plots (calculated)	9
Sampled Plots	9

Table C.1.3 Vegetation Vigor by Species.

MY1 Vegetation Vigor by Species Phillips-Willis (EEP project number 92703)						
Species	**4**	**3**	**2**	**1**	**0**	**Missing**
Alnus serrulata	2					
Carya cordiformis						
Cornus amomum	42	20				
Fraxinus pennsylvanica		3				
Juglans nigra						
Liriodendron tulipifera						
Malus angustifolia						
Nyssa sylvatica						
Ostrya virginiana						
Oxydendrum arboreum						
Pinus strobus						
Platanus occidentalis	2	4				
Prunus americana						
Prunus armeniaca						
Prunus serotina						
Quercus alba						
Rhus typhina						
Robinia pseudoacacia						
Salix nigra	1					
Tilia americana var. heterophylla						
Viburnum dentatum						
TOT: 21	**47**	**27**				

MY2 Vegetation Vigor by Species Phillips-Willis (EEP project number 92703)							
Species	**4**	**3**	**2**	**1**	**0**	**Missing**	**Unknown**
Alnus serrulata	2						
Cornus amomum	62						
Fraxinus pennsylvanica	3						
Platanus occidentalis	5	1					
Salix nigra	1						
TOT: 5	**73**	**1**					

Table C.1.4 Vegetation Damage by Species.

MY1 Vegetation Damage by Species Phillips-Willis Site (EEP project number 92703)						
Species	**All Damage Categories**[a]	**No Damage**	**Enter other damage**	**Human Trampled**	**Storm**	**Unknown**
Alnus serrulata	2	2				
Carya cordiformis	4	4				
Cornus amomum	64	64				
Fraxinus pennsylvanica	3	3				
Juglans nigra	5	5				
Liriodendron tulipifera	3	3				
Malus angustifolia	2	2				
Nyssa sylvatica	2	2				
Ostrya virginiana	1	1				
Oxydendrum arboreum	2	2				
Pinus strobus	1	1				
Platanus occidentalis	6	6				
Prunus americana	1	1				
Prunus armeniaca	1	1				
Prunus serotina	4	4				
Quercus alba	1	1				
Rhus typhina	1	1				
Robinia pseudoacacia	2	2				
Salix nigra	3	3				
Tilia americana var. heterophylla	2	2				
Viburnum dentatum	6	6				
TOT: 21	**116**	**116**				
[a]Total includes 42 non-planted stems						

MY2 Vegetation Damage by Species Phillips-Willis Site (EEP project number 92703)						
Species	**All Damage Categories**	**No Damage**	**Enter other damage**	**Human Trampled**	**Storm**	**Unknown**
Alnus serrulata	2	2				
Cornus amomum	62	62				
Fraxinus pennsylvanica	3	3				
Platanus occidentalis	6	6				
Salix nigra	1	1				
TOT: 5	**74**	**74**				

Table C.1.5 Vegetation Damage by Plot.

MY1 Vegetation Damage by Plot Phillips-Willis Site (EEP project number 92703)						
Plot	**All Damage Categories**[a]	**No Damage**	**Other Damage**	**Human Trampled**	**Storm**	**Unknown**
92703-TE/ABB-MB1	13	13				
92703-TE/ABB-MB2	13	13				
92703-TE/ABB-MB3	39	39				
92703-TE/ABB-MF1	7	7				
92703-TE/ABB-MF2	7	7				
92703-TE/ABB-MF3	21	21				
92703-TE/ABB-MF4	6	6				
92703-TE/ABB-MF5	7	7				
92703-TE/ABB-WB1	3	3				
TOT: 3	**116**	**116**				

[a]Total includes 42 non-planted stems

MY2 Vegetation Damage by Plot Phillips-Willis Site (EEP project number 92703)						
Plot	**All Damage Categories**	**No Damage**	**Other Damage**	**Human Trampled**	**Storm**	**Unknown**
92703-TE/ABB-MB1	8	8				
92703-TE/ABB-MB2	9	9				
92703-TE/ABB-MB3	32	32				
92703-TE/ABB-MF1	3	3				
92703-TE/ABB-MF2	5	5				
92703-TE/ABB-MF3	15	15				
92703-TE/ABB-MF4	1	1				
92703-TE/ABB-MF5	1	1				
TOT: 3	**74**	**74**				

Table C.1.6 Planted Stems Counted by Plot and Species.

MY1 Planted Stems Counted by Plot and Species Phillips-Willis Site (EEP project number 92703)												
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**MB Plot 92703 VP1**	**MB Plot 92703 VP2**	**MB Plot 92703 VP3**	**MFC Plot 92703 VP1**	**MFC Plot 92703 VP2**	**MFC Plot 92703 VP3**	**MFC Plot 92703 VP4**	**MFC Plot 92703 VP5**	**WB Plot 92703 VP1**
Alnus serrulata	2	1	2						2			
Cornus amomum	62	8	7.75	6	5	30	4	4	11	1	1	
Fraxinus pennsylvanica	3	1	3		3							
Platanus occidentalis	6	4	1.5		1	2		1	2			
Salix nigra	1	1	1						1			
TOT: 5	**74**	**5**		**6**	**9**	**32**	**4**	**5**	**16**	**1**	**1**	**0**
Density (stems/acre)	**374.4**			**242.8**	**364.2**	**1295.0**	**161.9**	**202.4**	**647.5**	**40.5**	**40.5**	**0**

MY2 Planted Stems Counted by Plot and Species Phillips-Willis Site (EEP project number 92703)												
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**MB Plot 92703 VP1**	**MB Plot 92703 VP2**	**MB Plot 92703 VP3**	**MFC Plot 92703 VP1**	**MFC Plot 92703 VP2**	**MFC Plot 92703 VP3**	**MFC Plot 92703 VP4**	**MFC Plot 92703 VP5**	**WB Plot 92703 VP1**
Alnus serrulata	2	1	2						2			
Cornus amomum	62	8	7.75	8	5	30	3	4	10	1	1	
Fraxinus pennsylvanica	3	1	3		3							
Platanus occidentalis	6	4	1.5		1	2		1	2			
Salix nigra	1	1	1						1			
TOT: 5	**74**	**5**		**8**	**9**	**32**	**3**	**5**	**15**	**1**	**1**	**0**
Density (stems/acre)	**374.4**			**323.8**	**364.2**	**1295.0**	**121.4**	**202.4**	**607.0**	**40.5**	**40.5**	**0**

Table C.1.7 All Stems Counted by Plot and Species.

MY2 All Stems Counted by Plot and Species Phillips-Willis Site (EEP project number 92703)												
Species	**Total Stems**	**Number of Plots**	**Average Number of Stems**	**MB Plot 92703 VP1**	**MB Plot 92703 VP2**	**MB Plot 92703 VP3**	**MFC Plot 92703 VP1**	**MFC Plot 92703 VP2**	**MFC Plot 92703 VP3**	**MFC Plot 92703 VP4**	**MFC Plot 92703 VP5**	**WB Plot 92703 VP1**
Acer negundo	3	2	1.5	2	1							
Alnus serrulata	2	1	2						2			
Carya cordiformis	14	5	2.8	2		2		1	3		6	
Cornus amomum	78	8	9.75	14	9	30	3	8	12	1	1	
Fraxinus pennsylvanica	3	1	3		3							
Juglans nigra	26	6	4.33	2		1		2		4	4	13
Liriodendron tulipifera	9	3	3		4	4			1			
Malus angustifolia	4	3	1.33					2	1	1		
Morus rubra	1	1	1					1				
Nyssa sylvatica	7	2	3.5						5	2		
Ostrya virginiana	6	1	6			6						
Oxydendrum arboreum	2	2	1			1					1	
Pinus strobus	1	1	1	1								
Platanus occidentalis	6	4	1.5		1	2		1	2			
Prunus americana	50	2	25	12			38					
Prunus serotina	7	4	1.75	1	1				4		1	
Quercus alba	1	1	1			1						
Rhus typhina	3	1	3				3					
Robinia pseudoacacia	3	2	1.5				1				2	
Salix nigra	4	3	1.33						1	2		1
Tilia americana var. heterophylla	126	2	63								23	103
Viburnum dentatum	30	6	5	11	2	2		1	11	3		
TOT: 22	**386**	**22**		**45**	**21**	**49**	**45**	**16**	**42**	**13**	**38**	**117**
Density (stems/acre)	**1735.7**			**1821.1**	**849.9**	**1983.0**	**1821.1**	**647.5**	**1700.0**	**526.1**	**1537.8**	**4734.9**

C.2 Vegetation Problem Area Photographs

Table C.2.1 Vegetation Problem Areas.

MY1 Vegetation Problem Areas Phillips-Willis Site (EEP project number 92703)			
Feature/Issue	**Station Number/Range**	**Probable Cause**	**Photo Number**
Conservation easement encroachment	MB 0+00, left bank	Long arm mower	1

MY2 Vegetation Problem Areas Phillips-Willis Site (EEP project number 92703)			
Feature/Issue	**Station Number/Range**	**Probable Cause**	**Photo Number**
Chinese privet, multiflora rose present	MFC 17+50, left bank	Parent stock	1

Vegetation problem area 1 MB, facing downstream, 15 Oct 2007.

Vegetation problem area 1 MFC, left bank, 14 Aug 2008.

C.3 Vegetation Monitoring Plot Photographs

Table C.3.1 Permanent Vegetation Photograph Points.

Phillips-Willis Site (EEP project number 92703)			
Stream	**Location[a]**	**Plot Dimensions (m)**	**Bearing (Degrees from North)**
Middle Fork Creek (MFC)	Plot 1 left bank sta. 16+00	20 X 5	Plot origin (0,0) 7^o
Middle Fork Creek	Plot 2 right bank sta. 14+00	20 X 5	Plot origin (0,0) 324
Middle Fork Creek	Plot 3 right bank sta. 10+00	20 X 5	Plot origin (0,0) 31^o
Middle Fork Creek	Plot 4 left bank sta. 7+00	10 X 10	Plot origin (0,0) 332^o
Middle Fork Creek	Plot 5 right bank sta. 4+50	10 X 10	Plot origin (0,0) 340^o
McKinney Branch (MB)	Plot 1 left bank sta. 27+00	20 X 5	Plot origin (0,0) 82^o
McKinney Branch	Plot 2 left bank sta. 14+50	20 X 5	Plot origin (0,0) 66^o
McKinney Branch	Plot 3 both banks sta. 6+00	20 X 5	Plot origin (0,0) 270^o
Walker Branch (WB)	Plot 1 left bank sta. 3+00	20 X 5	Plot origin (0,0) 14^o

[a]GPS coordinates for plot origin are provided on the plan view drawing.

Vegetation plot 1 MFC, facing upstream (0,0), 15 Oct 07.

Vegetation plot 1 MFC, facing upstream (0,0), 14 Aug 08.

Vegetation plot 2 MFC, facing upstream (0,0), 15 Oct 07.

Vegetation plot 2 MFC, facing upstream (0,0), 14 Aug 08.

Table C. 3.1 Continued.

Vegetation plot 3 MFC, facing upstream (0,0), 15 Oct 07.

Vegetation plot 3 MFC, facing upstream (0,0), 14 Aug 08.

Vegetation plot 4 MFC, facing upstream (0,0), 15 Oct 07.

Vegetation plot 4 MFC, facing upstream (0,0), 14 Aug 08.

Vegetation plot 5 MFC, facing upstream (0,0), 15 Oct 07.

Vegetation plot 5 MFC, facing upstream (0,0), 14 Aug 08.

Table C. 3.1 Continued.

Vegetation plot 1 MB, facing upstream (0,0), 15 Oct 07.

Vegetation plot 1 MB, facing upstream (0,0), 14 Aug 08.

Vegetation plot 2 MB, facing upstream (0,3), 15 Oct 07.

Vegetation plot 2 MB, facing upstream (0,3), 14 Aug 08.

Vegetation plot 3 MB, facing downstream (0,0), 15 Oct 07.

Vegetation plot 3 MB, facing upstream (0,0), 14 Aug 08.

Table C. 3.1 Continued.


Vegetation plot 1 WB, facing upstream (0,0), 15 Oct 07.


Vegetation plot 1 WB, facing upstream (0,0), 14 Aug 08.