# Johnson Site Stream Restoration
## Project No. 197
## 2008 Monitoring Report (Final): Year 1 of 5

**June 2009**


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# EXECUTIVE SUMMARY

# Executive Summary

The unnamed tributary to Little Hunting Creek (UTLHC) Stream Restoration Project (Site) is located in Iredell County, North Carolina within the 197 acre parcel owned by Mrs. Lottie V. Johnson. The following goals and objectives were established for the Site.

*Restoration Goals*

1. Restore a stable channel that is capable of moving the flows and sediment provided by its watershed.
2. Improve water quality and reduce land and riparian vegetation loss resulting from lateral erosion and bed degradation.
3. Enhance aquatic and terrestrial habitat.

*Restoration Objectives*

1. Build an appropriate B4c type channel with stable dimensions.
2. Plant a riparian buffer of native trees and shrubs.
3. Install in-stream structures that will promote bed feature diversity and prevent vertical instability.
4. Exclude livestock from the riparian buffer.

The stream was restored by establishing appropriate dimension and profile to 2,209 linear feet (lf) of UTLHC (Restoration, Priority 3) and stabilizing in-place approximately 417 lf of UTLHC's tributaries (Stabilization, Priority 4). UTLHC's main channel was designed and constructed as a B4c type channel. The restoration reach was restored using native vegetation and in-stream structures, such as cross-vanes and rock sill grade controls. Riparian areas were planted with native bare root seedlings and herbaceous cover to enhance the riparian areas and stabilize streambanks. This report serves as the 1st year of the 5 year monitoring plan for the Site.

The CVS protocol (Level 2) was not conducted to assess the vegetation plots for the 2008 monitoring year (MY-1). Land access issues resulted in the monitoring activities to be postponed during the 2008 calendar year. The first survey opportunity occurred in the month of January 2009 during the vegetative dormant season. Therefore, the 2008 vegetation monitoring was conducted using a visual assessment. From the visual assessment, the vegetation growth on the site appears to be good-fair. The seed mix growth has been successful and has helped establish temporary bank stability on the majority of the streambanks. There were some barren areas that may need to be re-planted/seeded again. JJG also assessed planted woody stems that were present within the vegetation plots and along the channel. JJG found that there were some planted woody stems that appear to be living, but were dormant at the time of the survey. It was also noted that there were planted woody stems in each vegetation plot that were flagged and dead. The planted stems that appeared dead may not actually be completely dead and have the potential to re-spout in the spring of 2009. Overall, it appears there are few planted woody stems within the vegetation plots and along the channel. However there was a lot of seed mix growth that had folded over along the banks, which made it difficult to determine where all planted woody stems were located during the dormant season.

Results from the 2008 stream monitoring effort indicate that UTLHC and the two unnamed tributaries are maintaining vertical and lateral stability. The pattern, profile, and dimension of the restored main channel and tributaries appear stable. A few problem areas were observed, such as bare banks and in-stream vegetation. Although some areas are illustrating bare banks and in-stream vegetation, visual assessments along the channel indicated that there are no major advancements towards instability within the reach. Areas with in-stream vegetation growth could potentially result in localized areas of aggradation, and lead to lateral and/or vertical shifts in the stream. These areas will continue to be monitored closely for significant adjustments in the bed features and the channel thalweg.

High sedimentation is evident at the upper and lower sections of the main channel, immediately upstream of the confluence with Little Hunting Creek and downstream from the cattle crossing and the gravel road crossing at the culvert. The stream was classified as a B4C in the as-built report and is classified as a B5c for the 2008 monitoring year (MY-1). This change is due to the upstream sediment sources, such as the cattle housing facilities in the upstream reach and the gravel road crossing at the culvert. The downstream reach appears to have heavier deposition occurring than in the upstream reach. This is most likely due to the backwater effects from the main channel of Little Hunting Creek.

Overall, the Site appears to be stable and has met stream mitigation goals for monitoring year 1.

# SECTION 1
# PROJECT BACKGROUND

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## PROJECT BACKGROUND

The background information provided in this report is referenced from the mitigation plan prepared by KCI and Associates (2008).

## 1.1 Location and Setting

The Site is located west of Harmony Highway (NC 21) and north of Hunting Creek Road (SR 1111) in Iredell County, North Carolina (Figure 1.1). UTLHC is a first order perennial stream that drains south-southwest across the Johnson property. The Site is located in the Northern Inner Piedmont ecoregion in the Yadkin River Basin (USGS HUC 03040102).

To access the site from Interstate 77, take Exit 65 (Highway 901) and turn east onto Highway 901 at the end of the ramp. Next, turn left onto Eagle Mills Road, and continue until the intersection with West Houstonville Road and turn right. Continue to Highway 21 (Harmony Highway) and then turn left onto NC 21. Follow to Hunting Creek Road and turn left. The restoration project is located before the bridge, where the UTLHC joins the main channel of Little Hunting Creek.

## 1.2 Mitigation Structure and Objectives

UTLHC is an active dairy farm with several structures located on the property for housing livestock and storing farm machinery. The primary land uses on the site are dairy operation, rangeland, agriculture (small grain), and forest. A private residence is located on the northeastern section of the property. The following goals and objectives were established for the Site.

*Restoration Goals*

1. Restore a stable channel that is capable of moving the flows and sediment provided by its watershed.
2. Improve water quality and reduce land and riparian vegetation loss resulting from lateral erosion and bed degradation.
3. Enhance aquatic and terrestrial habitat.

*Restoration Objectives*

1. Build an appropriate B4c type channel with stable dimensions.
2. Plant a riparian buffer of native trees and shrubs.
3. Install in-stream structures that will promote bed feature diversity and prevent vertical instability.
4. Exclude livestock from the riparian buffer.

The stream was restored by establishing appropriate dimension and profile to 2,209 lf of UTLHC (Restoration, Priority 3) and stabilize in-place approximately 417 lf of UTLHC's tributaries (Stabilization, Priority 4) (Table 1.1). UTLHC's main channel was designed and constructed as a B4c type channel. The restoration reach was restored using native vegetation and in-stream structures, such as cross-vanes and rock sill grade controls. Riparian areas were planted with native bare root seedlings and herbaceous cover to enhance the riparian areas and stabilize streambanks. Construction of the restoration project was completed in the fall of 2007.

**Table 1.1**
**Project Mitigation Structure and Objectives**
**Johnson Site/Project No. 197**

| Segment/Reach | Mitigation Type | Approach | Linear Footage or Acres | Stationing (ft) | Comments |
|---|---|---|---|---|---|
| UTLHC | Restoration | P3 | 2,209 lf | 10+00-32+09 | Channel restoration, established dimension and profile with use of grade control and bank protection structures. Project length includes a 27-foot wide easement exception |
| UT1 | Stabilization | P4 | 117 lf | | Channel stabilization |
| UT2 | Stabilization | P4 | 300 lf | | Channel stabilization |

| Component Summations | | | | | | |
|---|---|---|---|---|---|---|
| Restoration Level | Stream (lf) | Wetland (ac) | | Upland (ac) | Buffer (ac) | BMP |
| | | Riparian | Non-Riparian | | | |
| Restoration (R) | 2,209 | N/A | N/A | N/A | N/A | N/A |
| Enhancement (E) | N/A | N/A | N/A | N/A | N/A | N/A |
| Enahncement I (E) | N/A | N/A | N/A | N/A | N/A | N/A |
| Enhancement II (E) | N/A | N/A | N/A | N/A | N/A | N/A |
| Creation (C) | N/A | N/A | N/A | N/A | N/A | N/A |
| Preservation (P) | N/A | N/A | N/A | N/A | N/A | N/A |
| HQ Preservation (P) | N/A | N/A | N/A | N/A | N/A | N/A |
| **Totals** | **2,209** | **N/A** | **N/A** | **N/A** | **N/A** | **N/A** |

## 1.3 Project History and Background

The stream restoration plan was designed by KCI Associates of North Carolina. Construction and seeding activities were completed in the fall of 2007. This report serves as the 1st year of the 5 year monitoring plan for the Site. Tables 1.2 and 1.3 provide detailed project activity, history and contact information for this project. Table 1.4 provides more in-depth watershed/site background for the project.

**Table 1.2**
**Project Activity and Reporting History**
**Johnson Site/Project No. 197**

| Activity or Report | Data Collection Completed | Actual Completion or Delivery |
|---|---|---|
| Restoration Plan | November 2005 | February 2006 |
| Final Design-90% | November 2005 | February 2006 |
| Construction | N/A | November 2005 |
| Temporary S&E mix applied to entire project area* | N/A | November 2007 |
| Permanent seed mix applied to reach | N/A | November 2007 |
| Containerized and B&B plantings for reach | N/A | December 2007 |
| Mitigation Plan/ As-Built (Year 0 Monitoring) | December 2007 | June 2008 |
| Year 1 Monitoring | January 2009 | February 2009 |
| Year 2 Monitoring | 2009 | 2009 |
| Year 3 Monitoring | 2010 | 2010 |
| Year 4 Monitoring | 2011 | 2011 |
| Year 5 Monitoring | 2012 | 2012 |

*Seed and mulch is added as each section of construction is completed.

**Table 1.3**
**Project Contacts**
**Johnson Site/Project No. 197**

| | |
|---|---|
| **Designer** | KCI Associates of North Carolina, P.A.<br>Landmark Center II, Suite 220<br>4601 Six Forks Road<br>Raleigh, NC 27609 |
| **Construction** | Quartermaster Environmental Inc.<br>P.O. Drawer 400<br>Shelby, NC 28150 |
| **Planting Contractor** | Carolina Wetland Services<br>550 E. Westinghouse Blvd.<br>Charlotte, NC 28273 |
| **Seeding Contractor** | Quartermaster Environmental Inc.<br>P.O. Drawer 400<br>Shelby, NC 28150 |
| **Monitoring Performers** | Jordan, Jones, and Goulding<br>9101 Southern Pine Blvd., Suite 160<br>Charlotte, NC 28273 |
| **Stream Monitoring, POC** | Kirsten Young, 704-527-4106 ext.246 |
| **Vegetation Monitoring, POC** | |

**Table 1.4**
**Project Background**
**Johnson Site/Project No. 197**

| | |
|---|---|
| Project County | Iredell County, North Carolina |
| Drainage Area – UTLHC | 0.17 sq. mi |
| UT1 | >0.016 sq. mi |
| UT2 | >0.016 sq. mi |
| Drainage impervious cover estimate | 3% |
| Stream Order – UTLHC | 1st |
| UT1 | Intermittent-1st |
| UT2 | Pond Overflow Swale-1st |
| Physiographic Region | Piedmont |
| Ecoregion | Northern Inner Piedmont |
| Rosgen Classification of As-built – UTLHC | B4c |
| UT1 | N/A |
| UT2 | N/A |
| Dominant soil types | Chewalca, Colfax Sandy Loam, Various Cecil Series |
| Reference site ID | UT to Fisher River |
| USGS HUC | 03040102 |
| NCDWQ Sub-basin for Project and Reference | 03-07-06 |
| NCDWQ classification for Project and Reference | WS-III |
| Any portion of any project segment 303d list? | No |
| Any portion of any project segment upstream of a 303d listed segment? | Yes, South Yadkin River |
| Reason for 303d listing or stressor? | Turbidity |
| % of project easement fenced? | 100% |

## 1.4 Monitoring Plan View

The monitoring plan view map (Figure 1.2) illustrates the location of the longitudinal profile stations, cross-section stations, vegetation plots, and photo points. A total of five cross-sections and 2,156 linear feet of longitudinal profile were monitored within the main reach of UTLHC. Vegetative plots in the riparian zone adjacent to UTLHC were not monitored in the 2008 monitoring year. Photographs were taken upstream and downstream at each cross-section and photo points for the 2008 monitoring year.

# SECTION 2

# PROJECT CONDITIONS AND MONITORING RESULTS

# SECTION 2

## PROJECT CONDITIONS AND MONITORING RESULTS

The following monitoring results are from the 2008 (year 1 of 5) survey.

## 2.1 Vegetative Assessment

### 2.1.1 Soil Data

UTLHC is situated within an agricultural valley in the Northern Inner Piedmont belt of the North Carolina Piedmont Physiographic Province. Local geology consists of intrusive and metamorphic rocks, including metamorphosed granitic rock with biotite, gneiss, and schist. Predominant soil types located within the project watershed include Chewacala soils (Cw), Colfax sandy loam (CxB), and various soils from the Cecil Series (CcC, CcE, CfB, CfC, CfD, CgC, and CsE). Lesser areas of Lloyd loam (LmE) and Hiwassee loam (HwC) were indicated in the south west portion of the watershed. Researchable data indicates that the soils within the project area are those found in alluvial landforms in this physiographic region; however, grading and filling activities during construction have likely disturbed the parent soil material.

### 2.1.2 Vegetative Current Condition

Herbaceous seeding appears to provide adequate soil cover along the streambanks; however, isolated areas along the streambanks have barren areas of little to no vegetative cover. Please refer to Appendix 1.1 and 1.2 for more details on vegetative current condition areas and photos.

### 2.1.3 Vegetative Current Condition Plan View

Please refer to Appendix 3 for the location of vegetative current conditions onsite and Appendix 1.2 for representative vegetation current condition photos.

### 2.1.4 Stem Counts

The CVS protocol (Level 2) was not conducted to assess the vegetation plots for the 2008 monitoring year (MY-1). Land access issues resulted in the monitoring activities to be postponed during the 2008 calendar year. The first survey opportunity occurred in the month of January 2009 during the vegetative dormant season. Therefore, the 2008 vegetation monitoring was conducted using a visual assessment. From the visual assessment, the vegetation growth on the site appears to be good-fair. The seed mix growth has been successful and has helped established temporary bank stability on the majority of the streambanks. There were some barren areas that may need to be re-planted/seeded again. JJG also assessed planted woody stems that were present within the vegetation plots and along the channel. JJG found that there were some planted woody stems that appear to be living, but were dormant at the time of the survey. It was also noted that there were planted woody stems in each vegetation plot that were flagged and dead. The planted stems that appeared dead may not actually be completely dead and have the potential to re-spout in the spring of 2009. Overall, it appears there are few planted

woody stems within the vegetation plots and along the channel. However there was a lot of seed mix growth that had folded over along the banks, which made it difficult to determine where all planted woody stems were located during the dormant season.

### 2.1.5 Vegetation Plot Photos

Vegetation plot photos were not taken in the 2008 monitoring year.

## 2.2 Stream Assessment

Stream dimension, pattern, profile, and substrate were evaluated within 2,156 linear feet of the Site. Please refer to Table 2.1 for a summary of the visual stability assessment, Table 2.2 for the as-built morphology and hydraulic summary, Table 2.3 for the 2008 monitoring year morphology and hydraulic summary, Table 2.4 for hydrologic criteria, and Appendix 2 for more detailed stream data tables and plots.

### 2.2.1 Stream Current Condition Plan View

Please refer to Appendix 3 for the location of the stream current conditions onsite.

### 2.2.2 Stream Current Condition Table

Please refer to Appendix 2.1 for the stream current condition table.

### 2.2.3 Numbered Issues Photo Section

Please refer to Appendix 2.2 for representative stream current condition photos.

### 2.2.4 Fixed Photo Station Photos

Please refer to Appendix 2.3 for stream photo station photos and Appendix 2.4 for stream cross-section photos.

### 2.2.5 Stability Assessment

The restored stream length was assessed from the beginning of the project at the tributary confluence with the main channel to the downstream end of the restoration project where the UTLHC joins Little Hunting Creek. The majority of the project conditions reflected the as-built drawings. The following general observations were noted.

- Aggradation is evident within the upper and lower sections of the restored channel. However, the downstream reach appears to have heavier deposition occurring than in the upstream reach. This is most likely due to the backwater effects from the main channel of Little Hunting Creek.
- The pattern, profile, and dimension of the restored channel appear stable.
- The tributaries in the upstream portion of the project appear stable.

- All structures appear to be in good condition.

Overall, the present stream dimensions in UTLHC appear to be stable. The average bankfull width (9.12 ft) of the surveyed cross-sections is slightly higher than the proposed 8.4 ft, and the average surveyed mean bankfull depth is 1.07 ft compared to the proposed 0.8 ft. The surveyed bankfull widths and depths lead to an average Width/Depth ratio of 8.90. The average riffle entrenchment ratio is 2.12, which is typical of a B-type stream. The substrate analysis illustrates a shift in bed materials. This change is due to the upstream sediment sources, such as the livestock housing facilities in the upstream reach and the gravel road stream crossing at the culvert. The stream was classified as a B4c in the as-built and a B5c for the 2008 monitoring year (MY-1). This change in classification is a result of sedimentation occurring within isolated sections along the channel.

JJG conducted a longitudinal profile along 2,156 linear feet of UTLHC. The thalweg profile appears to be stable, and was characterized by well-defined riffle and pool features. The average water surface slope and the average bankfull slope were very similar for the surveyed reach, 0.0193 and 0.0190, respectively. The surveyed water surface slope was within the proposed range of 0.0100 ft/ft to 0.0220 ft/ft. The profile appears stable and is not showing significant shifting in the bed features; however, increased amounts of fine sediment deposition is occurring within the upper and lower sections of the Site.

Overall, the reach appears to be maintaining vertical and lateral stability with stable structures and moderate in-stream sedimentation.

**Table 2.1**
**Categorical Stream Feature Visual Stability Assessment**
**Johnson Site/Project No. 197**

| Feature | Initial-2007 | MY1-2008 | MY2-2009 | MY3-2010 | MY4-2011 | MY5-2012 |
|---|---|---|---|---|---|---|
| A. Riffles | * | 93% | | | | |
| B. Pools | * | 100% | | | | |
| C. Thalweg | * | 100% | | | | |
| D. Meanders | * | 100% | | | | |
| E. Bed General | * | 100% | | | | |
| F. Bank | * | 100% | | | | |
| G. Vanes | * | 100% | | | | |
| H. Wads/ Boulders | * | 100% | | | | |

*Data was not provided in previous reports.

### 2.2.6 Quantitative Measures Tables

Tables 2.2 and 2.3 display morphological summary data for baseline as-built conditions and from the 2008 monitoring year. Please refer to Appendix 2 for morphological plots and raw data tables.

**Table 2.2**
**Baseline Morphology and Hydraulic As-Built Summary**
**Johnson Site/Project No. 197**

| Parameter | Pre-Existing Condition | | | | | Reference Reach Data | | | | | Design | | As-built | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimension - Riffle** | Min | Mean | Med | Max | n | Min | Mean | Med | Max | n | Min | Max | Min | Mean | Med | Max | n |
| Bankfull Width (ft) | 4.0 | 9.4 | 8.4 | 15.0 | 6 | 9.0 | 9.5 | ** | 10.0 | 2 | 8.4 | ** | 8.2 | 8.5 | 8.7 | 8.7 | 3 |
| Floodprone Width (ft) | 7 | 13 | 12 | 21 | 6 | 13 | 17 | ** | 21 | 2 | 10 | 11 | 15 | 17 | 18 | 18 | 3 |
| Bankfull Mean Depth (ft) | 0.5 | 0.8 | 0.8 | 1.0 | 6 | 1.1 | 1.2 | ** | 1.2 | 2 | 0.8 | ** | 0.9 | 1.0 | 0.9 | 1.1 | 3 |
| Bankfull Max Depth (ft) | 0.7 | 1.2 | 1.2 | 1.7 | 6 | 1.3 | 1.4 | ** | 1.5 | 2 | 0.9 | 1.0 | 1.1 | 1.2 | 1.1 | 1.4 | 3 |
| Bankfull Cross-Sectional Area ($ft^2$) | 3.5 | 6.7 | 6.5 | 7.4 | 6 | 10.4 | 10.6 | ** | 10.7 | 2 | 7.0 | ** | 7.2 | 8.2 | 7.6 | 9.7 | 3 |
| Width/Depth Ratio | 4.2 | 14.3 | 10.7 | 30.1 | 6 | 8.0 | 10.0 | ** | 12.0 | 2 | 10.0 | ** | 7.7 | 9.0 | 9.4 | 10.0 | 3 |
| Entrenchment Ratio | 1.1 | 1.4 | 1.3 | 5.4 | 6 | 1.3 | 1.8 | ** | 2.3 | 2 | 1.3 | 2.3 | 2.0 | 2.0 | 2.0 | 2.1 | 3 |
| Bank Height Ratio | 2.6 | 5.2 | 5.1 | 9.1 | 6 | 0.9 | 1.5 | ** | 2.1 | 2 | 1.0 | ** | 1.0 | 1.0 | 1.0 | 1.0 | 3 |
| Bankfull Velocity (fps) | 1.9 | 3.1 | 3.2 | 5.2 | 6 | 4.1 | 4.3 | ** | 4.5 | 2 | 3.1 | 3.6 | ** | ** | ** | ** | ** |
| **Pattern** | | | | | | | | | | | | | | | | | |
| Channel Beltwidth (ft) | ** | 30 | ** | ** | ** | ** | 45 | ** | ** | ** | 38 | 42 | 16 | 26 | 23 | 39 | 9 |
| Radius of Curvature (ft) | 11 | ** | ** | 20 | ** | 13 | ** | ** | 42 | ** | 11 | 37 | 16 | 27 | 28 | 41 | 14 |
| Rc:Bankfull width (ft/ft) | 0.7 | ** | ** | 5 | ** | 1.3 | ** | ** | 4.4 | ** | 1.3 | 4.4 | 1.9 | 3.2 | 3.3 | 4.8 | 14 |
| Meander Wavelength (ft) | 40 | ** | ** | 140 | ** | 93 | ** | ** | 136 | ** | 76 | 126 | 47 | 69 | 70 | 97 | 10 |
| Meander Width Ratio | 2 | ** | ** | 7.5 | ** | 4.5 | ** | ** | 5 | ** | 4.5 | 5.0 | 1.9 | 3.1 | 2.7 | 4.6 | 9 |
| **Profile** | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | ** | ** | ** | | ** | ** | ** | ** | ** | ** | ** | ** | 16 | 44 | 43 | 86 | 32 |
| Riffle Slope (ft/ft) | 0.0070 | ** | ** | 0.0860* | ** | 0.0130 | ** | ** | 0.0280 | ** | 0.0100 | 0.0220 | 0.0025 | 0.0198 | 0.0170 | 0.0888* | 32 |
| Pool Length (ft) | 2 | ** | ** | 15 | ** | 3 | ** | ** | 25 | ** | 3 | 21 | 3 | 9 | 8 | 36 | 22 |
| Pool Spacing (ft) | 15 | ** | ** | 132 | ** | 30 | ** | ** | 59 | ** | 28 | 50 | 18 | 102 | 68 | 364 | 22 |
| **Substrate and Transport Parameters** | | | | | | | | | | | | | | | | | |
| SC% / Sa% / G% / C% / B% / Be% | 26% / 39% / 30% / 2% / - / 3% | | | | | 0.5% / 18.5% / 77% / 4% / - / - | | | | | ** | | 13.7% / 46.3% / 37.7% / 0.7% / - / 1.7% | | | | |
| d16 / d35 / d50 / d84 / d95 / $di^p$ / $di^{sp}$ (mm) | <0.062 / 0.15 / 0.31 / 12.1 / 48 / - /- | | | | | 1.6 / 4.0 / 6.7 / 34 / 60 / - / - | | | | | ** | | 0.1 / 0.2 / 1.3 / 20 / 37 / - / - | | | | |
| Reach Shear Stress (competency) $lb/ft^2$ | ** | | | | | ** | | | | | 0.95 | | 1.01 | | | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | |
| Channel length (ft) | 2,260 | | | | | ** | | | | | 2,156 | | 2,209 | | | | |
| Drainage Area ($mi^2$) | 0.17 | | | | | 0.37 | | | | | 0.17 | | 0.17 | | | | |
| Rosgen Classification | F5/B5c/G5c | | | | | B4c | | | | | B4c | | B4c | | | | |
| Bankfull Discharge (cfs) | 22 | | | | | 44 | | | | | 22 | | 22 | | | | |
| Sinuosity | 1.1 | | | | | 1.2 | | | | | 1.1 | | 1.1 | | | | |
| Water Surface Slope (ft/ft) | 0.018 | | | | | 0.013 | | | | | 0.019 | | 0.018 | | | | |
| BF slope (ft/ft) | 0.019 | | | | | 0.016 | | | | | 0.019 | | 0.019 | | | | |

*Maximum value includes bedrock steps
**Data was not provided in previous reports

**Table 2.3**
**Morphology and Hydraulic Monitoring Summary**
**Johnson Site/Project No. 197**

| PARAMETER | Cross-Section 1-Riffle | | | | | | Cross-Section 2-Pool | | | | | | Cross-Section 3-Pool | | | | | | Cross-Section 4-Riffle | | | | | | Cross-Section 5-Riffle | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DIMENSION** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** |
| **Bankfull Width (ft)** | 8.70 | 9.15 | | | | | 11.00 | 11.04 | | | | | 8.20 | 8.86 | | | | | 8.70 | 8.23 | | | | | 9.00 | 8.32 | | | | |
| **Floodprone Width (ft)** | 18.00 | 19.36 | | | | | 25.70 | 28.58 | | | | | 14.70 | 17.00 | | | | | 17.60 | 16.73 | | | | | 21.00 | 18.40 | | | | |
| **Bankfull Cross-sectional Area** | 7.60 | 7.72 | | | | | 13.70 | 15.67 | | | | | 7.20 | 7.18 | | | | | 9.70 | 7.63 | | | | | 11.90 | 11.39 | | | | |
| **Bankfull Mean Depth** | 0.90 | 0.84 | | | | | 1.20 | 1.42 | | | | | 0.90 | 0.81 | | | | | 1.10 | 0.93 | | | | | 1.30 | 1.37 | | | | |
| **Bankfull Max Depth** | 1.10 | 1.26 | | | | | 2.00 | 2.44 | | | | | 1.10 | 1.24 | | | | | 1.40 | 1.27 | | | | | 2.20 | 2.08 | | | | |
| **Width/Depth Ratio** | 10.00 | 10.89 | | | | | 8.90 | 7.77 | | | | | 9.40 | 10.94 | | | | | 7.70 | 8.85 | | | | | 6.80 | 6.07 | | | | |
| **Entrenchment Ratio** | 2.10 | 2.11 | | | | | 2.30 | 2.59 | | | | | 2.00 | 1.92 | | | | | 2.00 | 2.03 | | | | | 2.30 | 2.21 | | | | |
| **Wetted Perimeter (ft)** | * | 9.66 | | | | | * | 12.51 | | | | | * | 9.50 | | | | | * | 9.04 | | | | | * | 9.66 | | | | |
| **Hydraulic Radius (ft)** | * | 0.80 | | | | | * | 1.25 | | | | | * | 0.76 | | | | | * | 0.84 | | | | | * | 1.18 | | | | |
| **Bank Height Ratio** | 1.00 | 1.00 | | | | | 1.00 | 1.00 | | | | | 1.00 | 1.00 | | | | | 1.00 | 1.00 | | | | | 1.00 | 1.00 | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **SUBSTRATE** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** | **MY0-2007** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** |
| **D50 (mm)** | 0.10 | 0.05 | | | | | 0.44 | 0.49 | | | | | 3.20 | 0.75 | | | | | 1.30 | 0.31 | | | | | 0.26 | 0.13 | | | | |
| **D84 (mm)** | 8.80 | 0.50 | | | | | 10.00 | 18.20 | | | | | 26.00 | 37.57 | | | | | 20.00 | 7.42 | | | | | 0.45 | 0.92 | | | | |
| **PROFILE** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | MY0-2007 | | | MY1-2008 | | | MY2-2009 | | | MY3-2010 | | | MY4-2011 | | | MY5-2012 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Channel** | **Min** | **Max** | **Med** | **Min** | **Max** | **Med** | **Min** | **Max** | **Med** | **Min** | **Max** | **Med** | **Min** | **Max** | **Med** | **Min** | **Max** | **Med** |
| **Riffle Length (ft)** | 15.52 | 86.44 | 42.78 | 6.97 | 74.22 | 22.44 | | | | | | | | | | | | |
| **Riffle Slope (ft/ft)** | 0.0025 | 0.0888 | 0.0170 | 0.0024 | 0.0867 | 0.0226 | | | | | | | | | | | | |
| **Pool Length (ft)** | 2.77 | 35.64 | 7.80 | 9.06 | 33.77 | 16.71 | | | | | | | | | | | | |
| **Pool to Pool Spacing (ft)** | 18.20 | 364.40 | 67.75 | 19.99 | 156.17 | 73.45 | | | | | | | | | | | | |

| **ADDITIONAL REACH PARAMETERS** | **MY1-2008** | **MY2-2009** | **MY3-2010** | **MY4-2011** | **MY5-2012** |
|---|---|---|---|---|---|
| **Valley Length (ft)** | * | 1,939 | | | |
| **Channel Length (ft)** | 2,209 | 2,158 | | | |
| **Sinuosity** | 1.10 | 1.11 | | | |
| **Water Surface Slope (ft/ft)** | 0.0180 | 0.0193 | | | |
| **Bankfull Slope (ft/ft)** | 0.0180 | 0.0190 | | | |
| **Rosgen Classification** | B4c | B5c | | | |

*Data was not provided in previous reports

### 2.2.7 Hydrologic Criteria

Table 2.4a below, verifies that one bankfull or greater event occurred within the Site in the 2008 monitoring year. Since a gauge is not located on-site to record bankfull events, JJG verbally confirmed with Mr. Alan Johnson (relative to land owner) that he observed a bankfull or greater event within the restoration site. The local USGS gauge number 02118500 located on the main channel of Hunting Creek near Harmony, NC recorded significant rainfall events that could have resulted in a bankfull or greater event within the Site (Table 2.4b)

**Table 2.4a**
**Verification of Bankfull Events**
**Johnson Site/Project No. 197**

| Date of Collection | Date of Occurrence | Method | Photo # (if available) |
|---|---|---|---|
| Unknown | Unknown | Land Owner Confirmation | N/A |

**Table 2.4b**
**Verification of Bankfull Events**
**Johnson Site/Project No. 197**

| Date of Rainfall | Amount (inches) | USGS Approved (A) or Provisional (P) Data |
|---|---|---|
| 8/26/2008 | 1.60 | A |
| 8/27/2008 | 2.96 | A |
| 12/10/2008 | 1.06 | P |
| 12/11/2008 | 2.04 | P |

# SECTION 3
# METHODOLOGY

# SECTION 3
## METHODOLOGY

### 3.1 Methodology

Methods employed for the Site were a combination of those established by standard regulatory guidance and procedures documents and as well as previous monitoring reports completed by KCI. Geomorphic and stream assessments were performed following guidelines outlined in the Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (Harrelson et al., 1994) and in the Stream Restoration a Natural Channel Design Handbook (Doll et al, 2003). Precipitation data for the bankfull verification was obtained from an off-site resource. Off-site daily precipitation was obtained from the USGS gauge station number 02118500 on Hunting Creek near Harmony, NC (the closest location offering daily precipitation data) through the following URL.

http://waterdata.usgs.gov/nwis/dv?cb_00060=on&cb_00065=on&cb_00045=on&format=html&begin_date=2008-01-01&end_date=2009-12-31&site_no=02118500&referred_module=sw.

# SECTION 4
# REFERENCES

# SECTION 4
## REFERENCES

Doll, B.A., Grabow, G.L., Hall, K.A., Halley, J., Harman, W.A., Jennings, G.D., and Wise, D.E., 2003. Stream Restoration A Natural Channel Design Handbook.

Harrelson, Cheryl C; Rawlins, C.L.; Potyondy, John P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

KCI Associates of NC. 2008. Johnson Site Stream Restoration Mitigation Plan and As-Built Report (2008). Raleigh, NC.

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

# SECTION 5
# FIGURES

# SECTION 6
# APPENDICES

**Appendix 1 - Vegetation Raw Data**

**Appendix 2 - Geomorphic and Stream Stability Data**

**Appendix 3 - Current Condition Plan View (Integrated)**

# APPENDIX 1
# VEGETATION RAW DATA

**1. Vegetation Survey Data Tables***

**2. Representative Vegetation Problem Area Photos**

*Raw data tables have been provided electronically.

**UT Little Hunting Creek (2,209 linear feet)**

| Feature Issue | Station Numbers | Suspected Cause | Photo ID # |
|---|---|---|---|
| Bare Bank | 3+66-3+90 | Banks lacking vegetation protections-RB | 1 |
| | 8+43-9+07 | Banks lacking vegetation protections-RB | |

1. Bare Banks (1/2009)

| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 1.2 Representative Vegetation Current Condition Photos** | |

# APPENDIX 2
# GEOMORPHIC AND STREAM STABILITY DATA

1. **Stream Problem Areas Table**
2. **Representative Stream Problem Area Photos**
3. **Stream Photo Station Photos**
4. **Stream Cross-Section Photos**
5. **Qualitative Visual Stability Assessment**
6. **Cross-Section Plots and Raw Data Tables***
7. **Longitudinal Plots and Raw Data Tables***
8. **Pebble Count Plots and Raw Data Tables***

*Raw data tables have been provided electronically.

**UT Little Hunting Creek (2,209 linear feet)**

| Feature Issue | Station Numbers | Suspected Cause | Photo ID # |
|---|---|---|---|
| In-Stream Vegetation | 0+36-1+20 | Vegetation growing in middle of channel | 1 |
| | 1+92-2+39 | | |
| | 2+90-3+29 | | |
| | 4+40-4+47 | | |

1. In-Stream Vegetation (1/2009)

| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.2 Representative Stream Current Condition Photos** | |

Photo Point 1-View Downstream
Main Channel (1/2009)

Photo Point 2-View Upstream
Tributary (1/2009)

Photo Point 2-View Upstream
Main Channel (1/2009)

Photo Point 2-View Downstream
Main Channel (1/2009)

| | | |
|---|---|---|
| Prepared For: Ecosystem Enhancement Program | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.3 Stream Photo Station Photos** | JJG |

Photo Point 3-View Upstream
Main Channel (1/2009)

Photo Point 4-View Upstream
Tributary (1/2009)

Photo Point 4-View Downstream
Tributary (1/2009)

| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.3 Stream Photo Station Photos** | |

Photo Point 5-View Upstream
Main Channel (1/2009)

Photo Point 5-View Downstream
Main Channel (1/2009)

Photo Point 6-View Upstream
Main Channel (1/2009)

Photo Point 6-View Downstream
Main Channel (1/2009)

| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.3 Stream Photo Station Photos** | |

Photo Point 7-View Upstream
Main Channel (1/2009)

Photo Point 7-View Downstream
Main Channel (1/2009)

Photo Point 8-View Upstream
Main Channel (1/2009)

Photo Point 8-View Downstream
Main Channel (1/2009)

| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.3 Stream Photo Station Photos** | |

Photo Point 9-View Upstream
Main Channel (1/2009)

Photo Point 9-View Downstream
Main Channel (1/2009)

Photo Point 10-View Upstream
Main Channel (1/2009)

Photo Point 10-View Downstream
Main Channel (1/2009)

| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.3 Stream Photo Station Photos** | |

Photo Point 11-View Upstream
Main Channel (1/2009)

Photo Point 11-View Downstream
Main Channel (1/2009)

Photo Point 12-View Upstream
Main Channel (1/2009)

Photo Point 12-View Downstream
Main Channel (1/2009)

| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.3 Stream Photo Station Photos** | |

Cross-Section 1-View Upstream (1/2009)

Cross-Section 1-View Downstream (1/2009)

Cross-Section 2-View Upstream (1/2009)

Cross-Section 2-View Downstream (1/2009)

| | | |
|---|---|---|
| Prepared For: Ecosystem Enhancement Program | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.4 Stream Cross-Section Photos** | JJG |

Cross-Section 3-View Upstream (1/2009)

Cross-Section 3-View Downstream (1/2009)

Cross-Section 4-View Upstream (1/2009)

Cross-Section 4-View Downstream (1/2009)

| | | |
|---|---|---|
| Prepared For: Ecosystem Enhancement Program | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.4 Stream Cross-Section Photos** | JJG |

Cross-Section 5-View Upstream (1/2009)

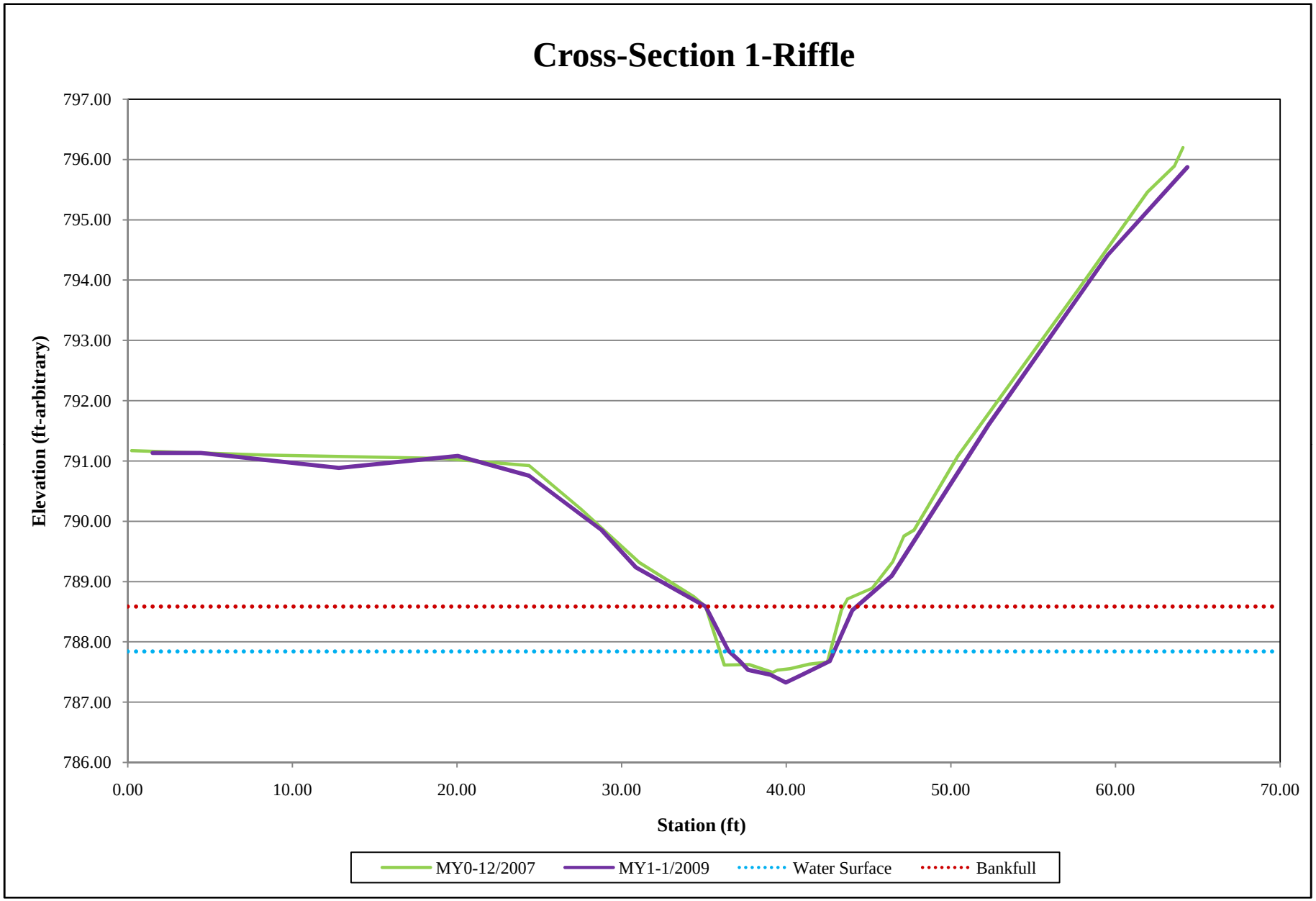
Cross-Section 5-View Downstream (1/2009)

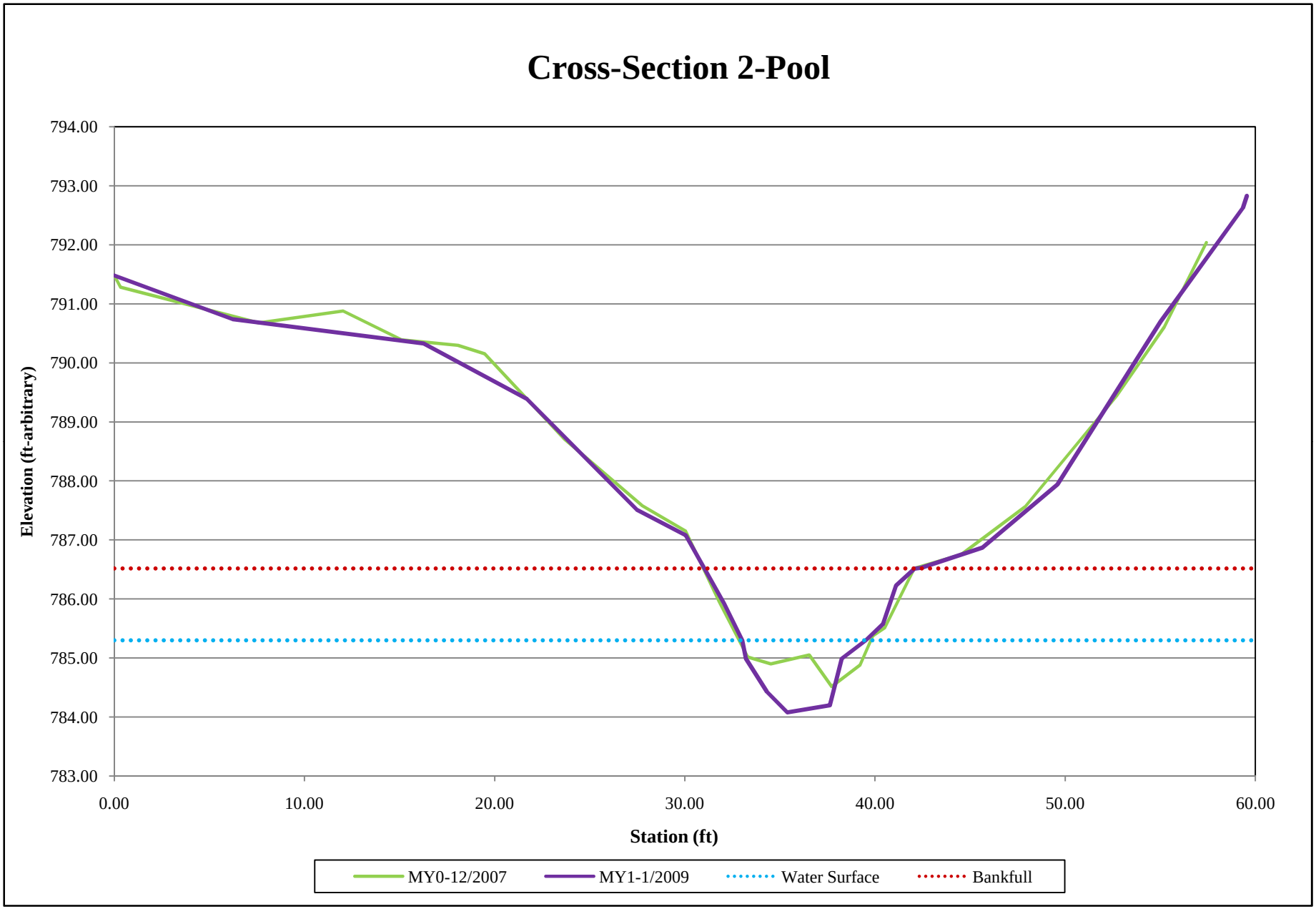
| | | |
|---|---|---|
| Prepared For: | Johnson Site Stream Restoration<br>Year 1 of 5 | Date: February 2009<br>Project No.: 197 |
| | **Appendix 2.4 Stream Cross-Section Photos** | |

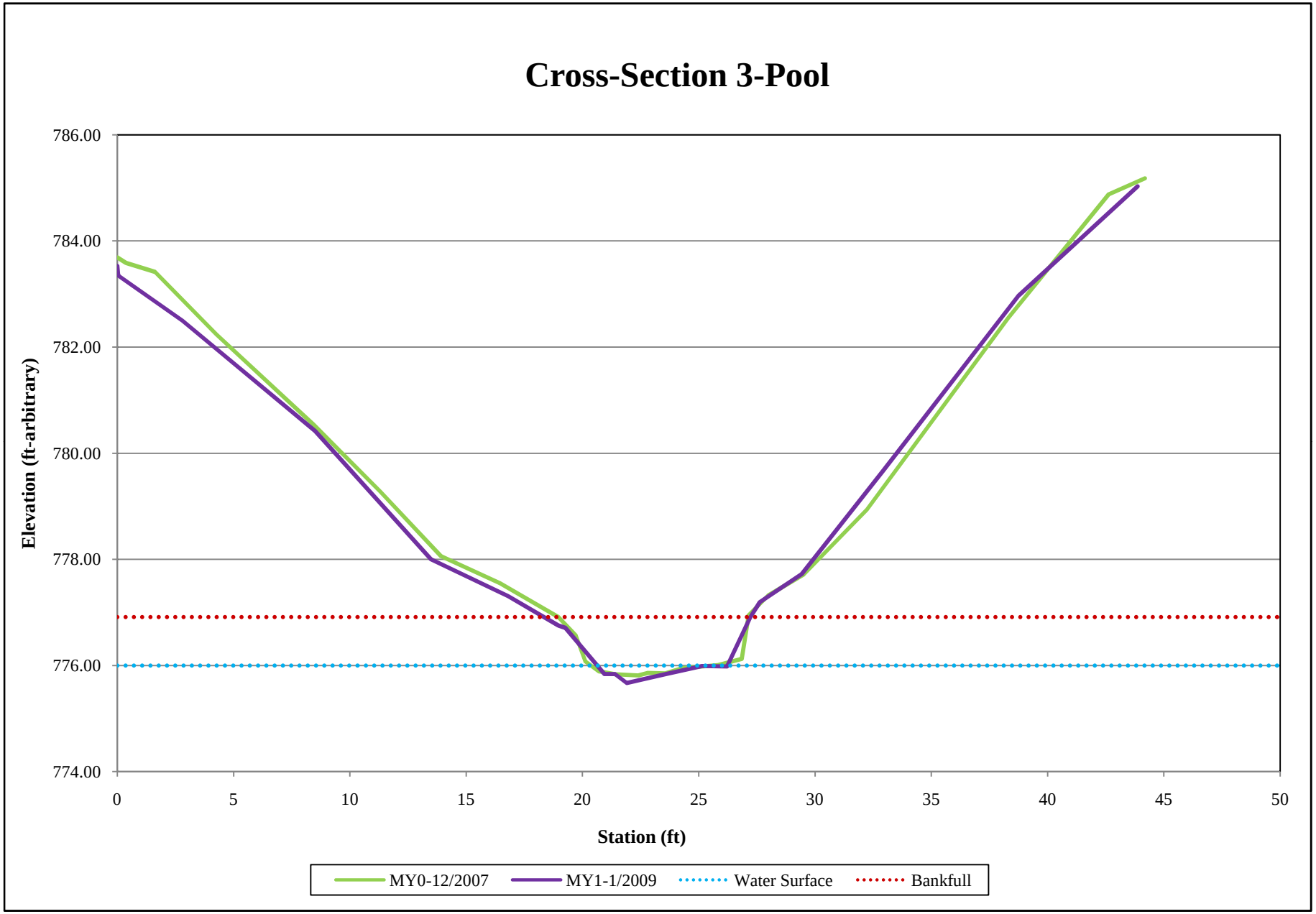
UT Little Hunting Creek-2,209 linear feet

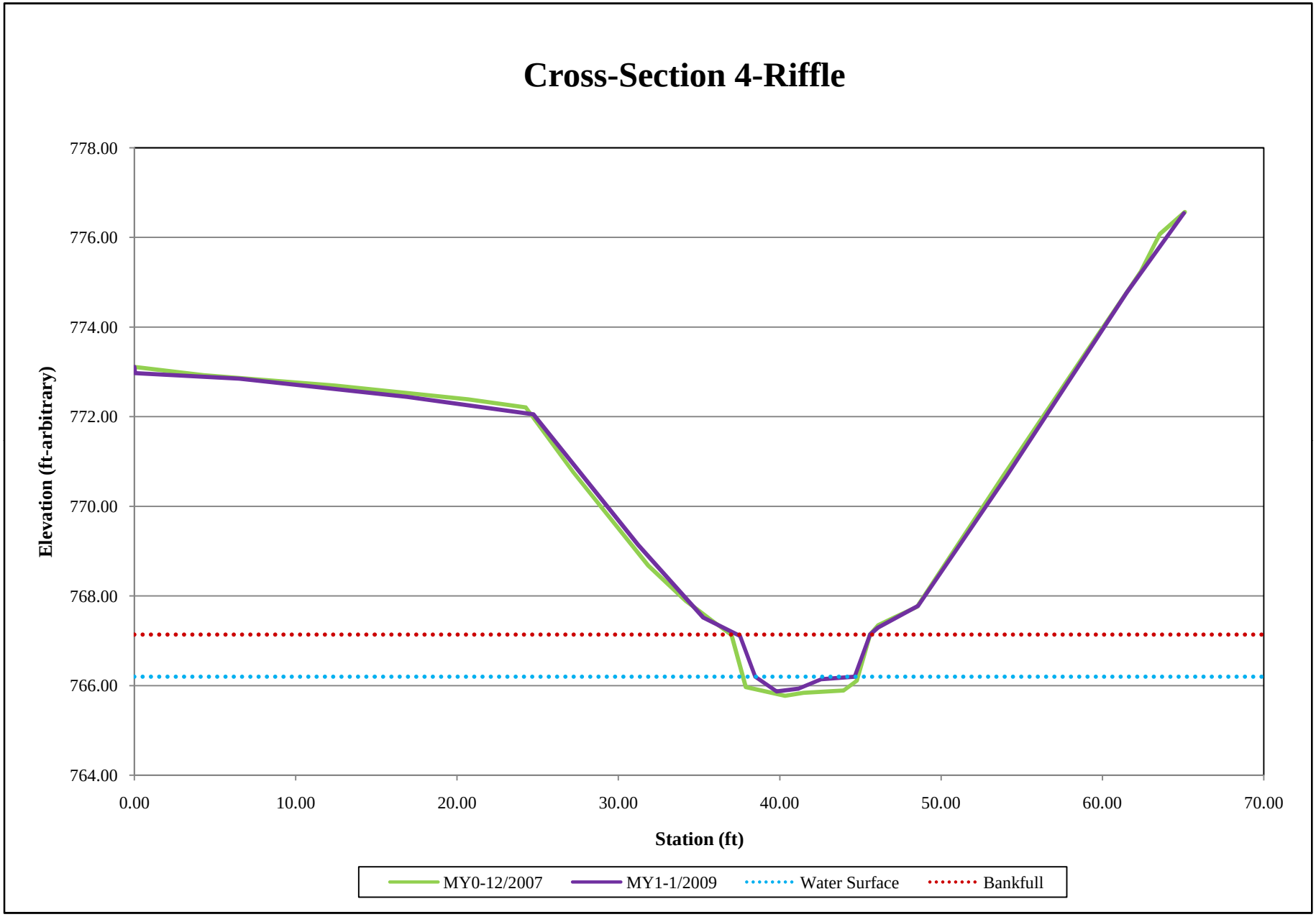
| **Feature Category** | | (# Stable) Number Performing as Intended | Total Number assessed per As-built survey | Total Number/ feet in unstable state | % Perform in Stable Condition | Feature Perform Mean or Total |
|---|---|---|---|---|---|---|
| A. Riffles | 1. Present? | 32 | 32 | N/A | 100% | **93%** |
| | 2. Armor Stable? | 32 | | | 100% | |
| | 3. Facet grade appears stable? | 32 | | | 100% | |
| | 4. Minimal evidence of embedding/fining? | 20 | | | 63% | |
| | 5. Length appropriate? | 32 | | | 100% | |
| B. Pools | 1. Present? | 22 | 22 | N/A | 100% | **100%** |
| | 2. Sufficiently deep? | 22 | | | 100% | |
| | 3. Length Appropriate? | 22 | | | 100% | |
| C. Thalweg | 1. Upstream of meander bend centering? | 22 | 22 | N/A | 100% | **100%** |
| | 2. Downstream of meander centering? | 22 | | | 100% | |
| D. Meanders | 1. Outer bend in state of limited/controlled erosion? | 22 | 22 | N/A | 100% | **100%** |
| | 2. Of those eroding, # w/concomitant point bar formation? | 22 | | | 100% | |
| | 3. Apparent Rc within spec? | 22 | | | 100% | |
| | 4. Sufficient floodplain access and relief? | 22 | | | 100% | |
| E. Bed General | 1. General channel bed aggradation areas (bar formation)? | N/A | | 0* | 70% | **85%** |
| | 2. Channel bed degradation - areas of increasing down-cutting or head cutting? | | | 0 | 100% | |
| F. Bank | 1. Actively eroding, wasting, or slumping bank | N/A | | 0 | 100% | **100%** |
| G. Vanes | 1. Free of back or arm scour? | 11 | 11 | N/A | 100% | **100%** |
| | 2. Height appropriate? | 11 | | | 100% | |
| | 3. Angle and geometry appear appropriate? | 11 | | | 100% | |
| | 4. Free of piping or other structural failures? | 11 | | | 100% | |
| H. Wads/ Boulders | 1. Free of scour? | 2 | 2 | N/A | 100% | **100%** |
| | 2. Footing stable? | 2 | | | 100% | |

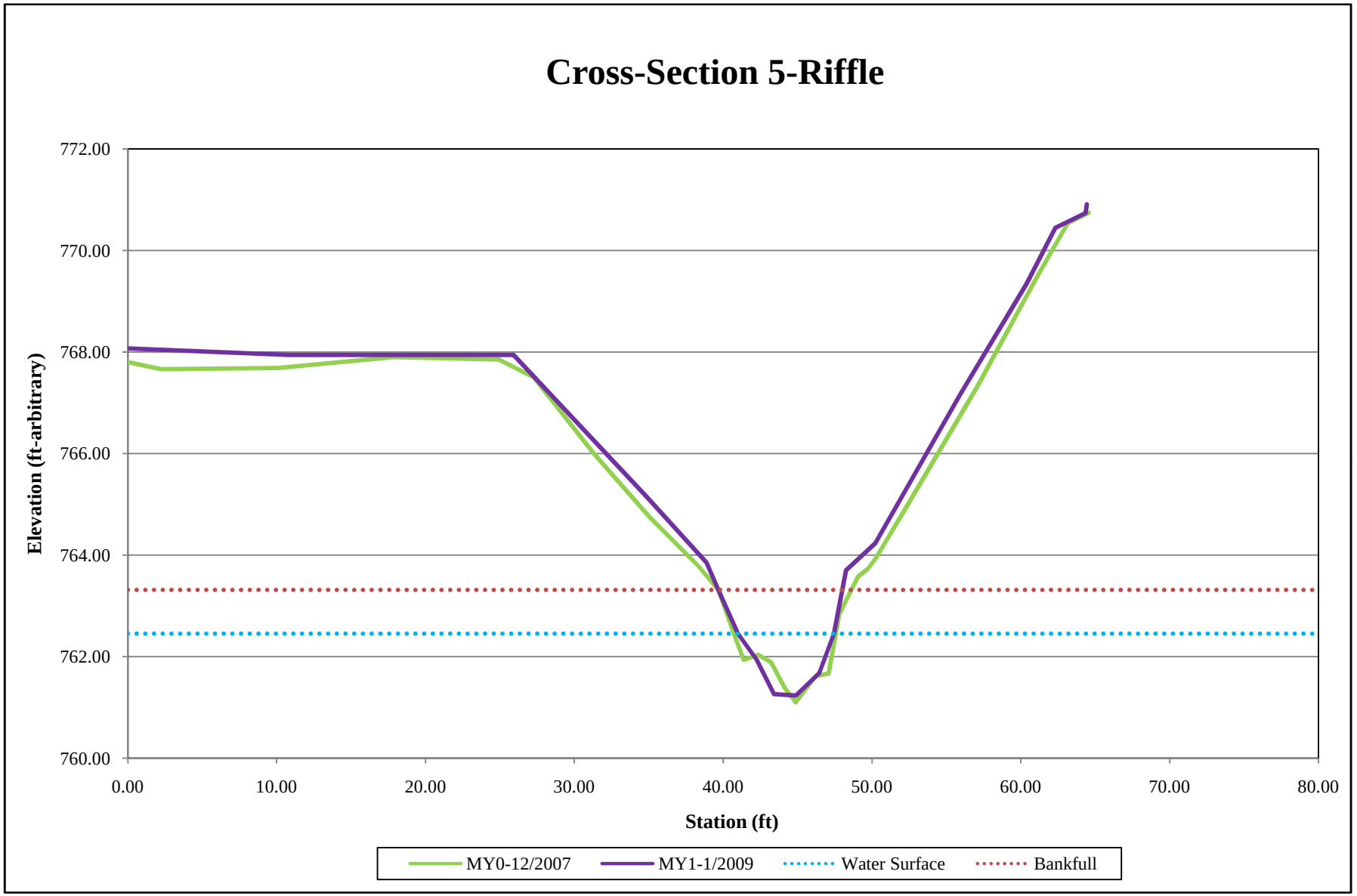
*Aggradation is occurring in isolated reaches along the channel, JJG has estimated through visual assessments that approximately 70% of the site is affected by in-stream sedimentation.

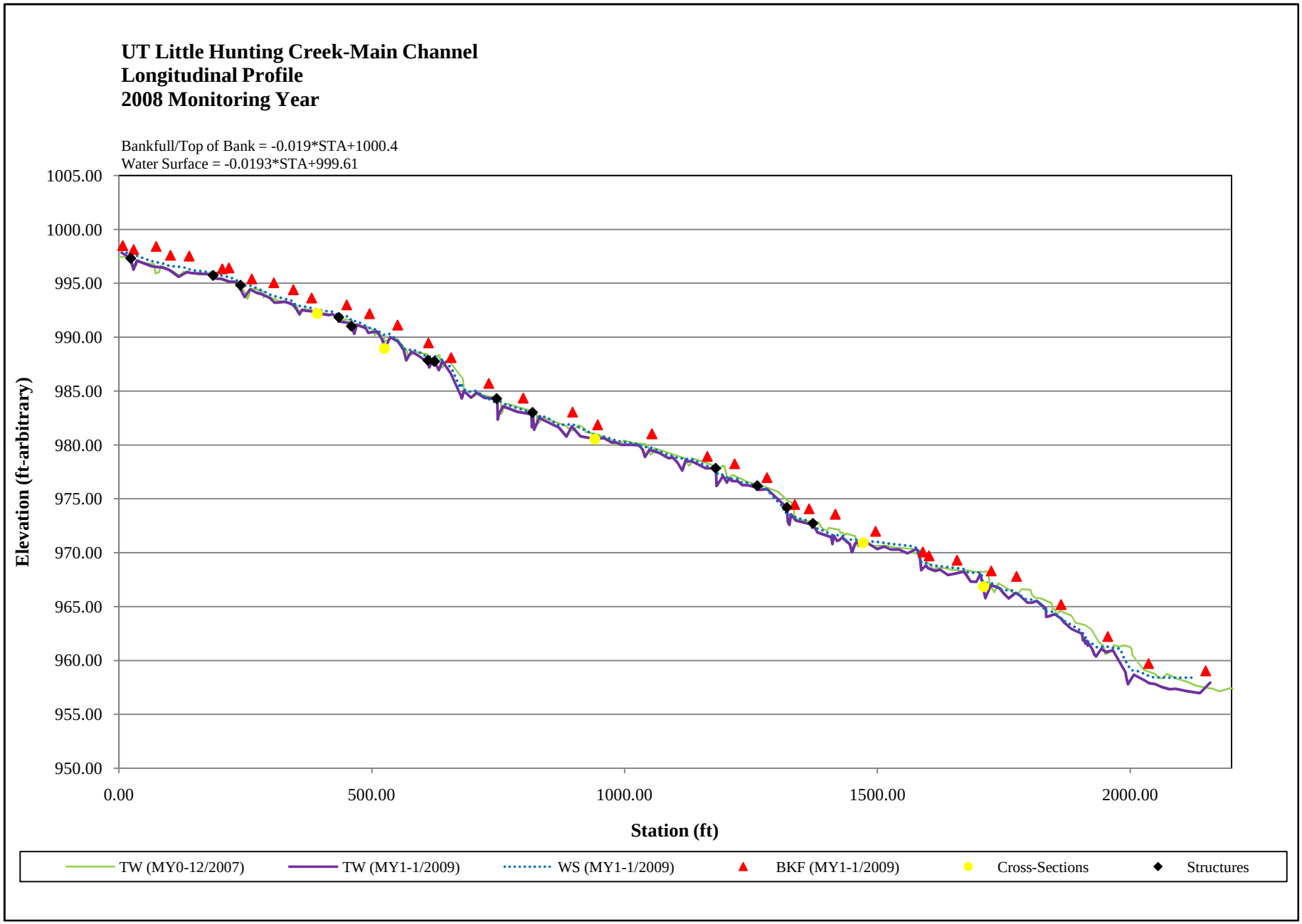

Cross-Section 1-Riffle
797.00
796.00
795.00
794.00
793.00
792.00
791.00
790.00
789.00
788.00
787.00
786.00
Elevation (ft-arbitrary)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Station (ft)
MY0-12/2007
MY1-1/2009
Water Surface
Bankfull


Cross-Section 2-Pool
794.00
793.00
792.00
791.00
790.00
789.00
788.00
787.00
786.00
785.00
784.00
783.00
Elevation (ft-arbitrary)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
Station (ft)
MY0-12/2007
MY1-1/2009
Water Surface
Bankfull

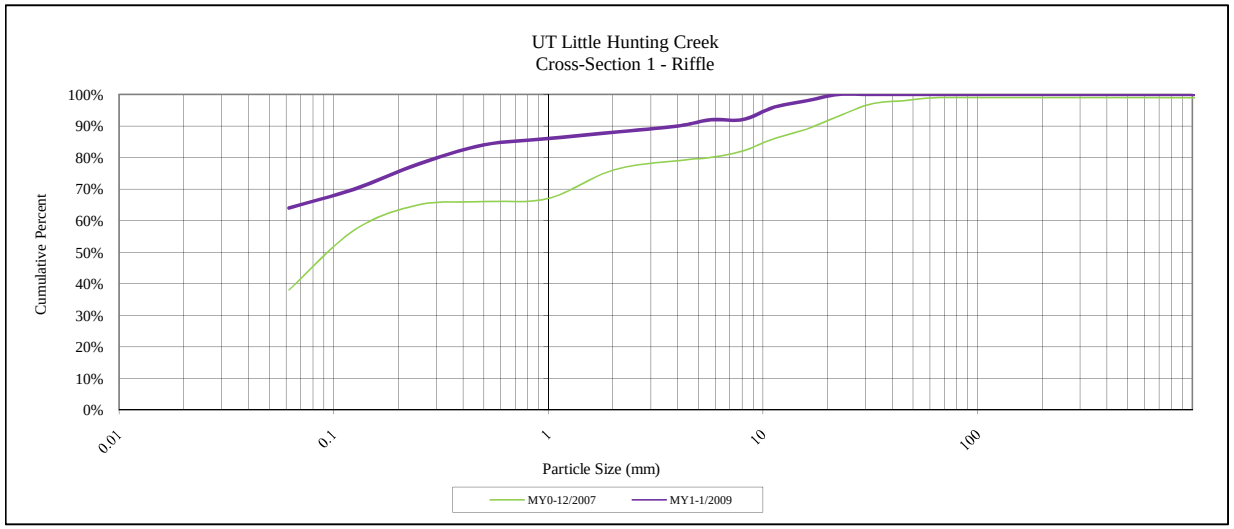

Cross-Section 3-Pool
786.00
784.00
782.00
780.00
778.00
776.00
774.00
Elevation (ft-arbitrary)
0
5
10
15
20
25
30
35
40
45
50
Station (ft)
MY0-12/2007
MY1-1/2009
Water Surface
Bankfull

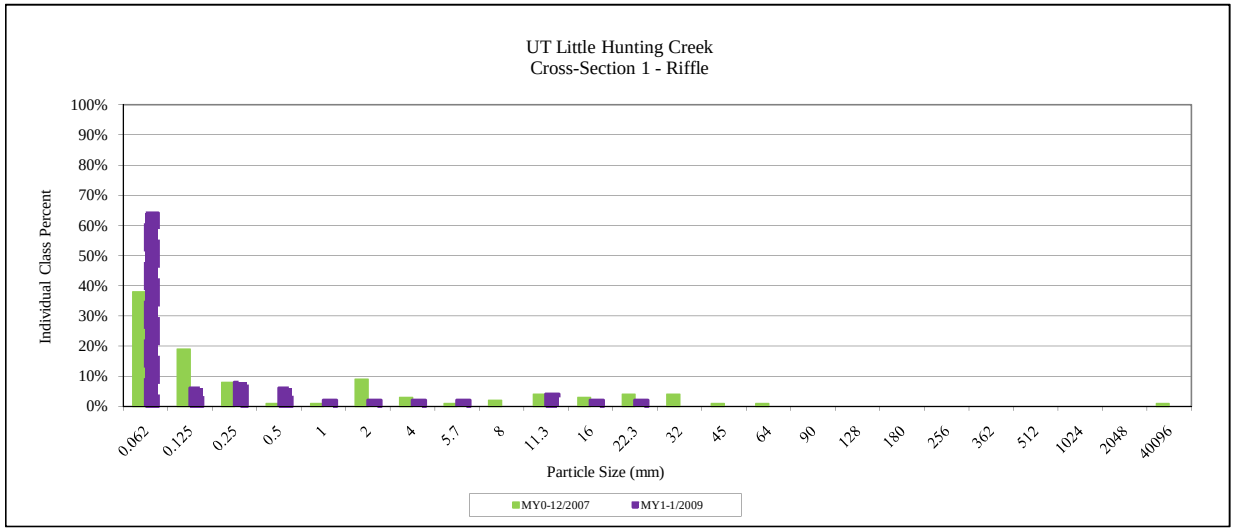

Cross-Section 4-Riffle
778.00
776.00
774.00
772.00
770.00
768.00
766.00
764.00
Elevation (ft-arbitrary)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Station (ft)
MY0-12/2007
MY1-1/2009
Water Surface
Bankfull


Cross-Section 5-Riffle
772.00
770.00
768.00
766.00
764.00
762.00
760.00
Elevation (ft-arbitrary)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Station (ft)
MY0-12/2007
MY1-1/2009
Water Surface
Bankfull

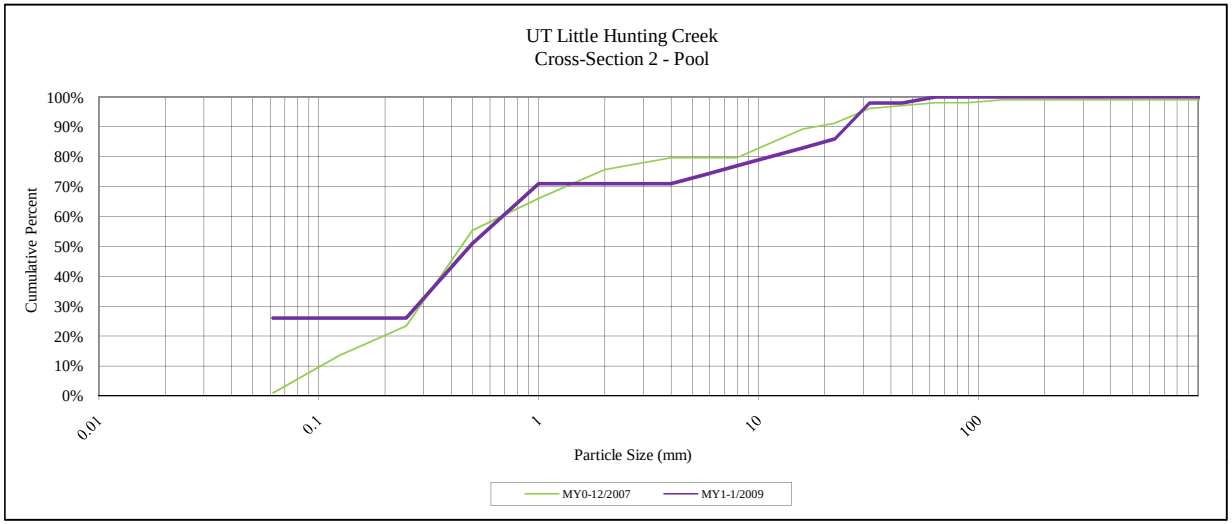

UT Little Hunting Creek-Main Channel
Longitudinal Profile
2008 Monitoring Year
Bankfull/Top of Bank = -0.019*STA+1000.4
Water Surface = -0.0193*STA+999.61
1005.00
1000.00
995.00
990.00
985.00
980.00
975.00
970.00
965.00
960.00
955.00
950.00
Elevation (ft-arbitrary)
0.00
500.00
1000.00
1500.00
2000.00
Station (ft)
TW (MY0-12/2007)
TW (MY1-1/2009)
WS (MY1-1/2009)
BKF (MY1-1/2009)
Cross-Sections
Structures

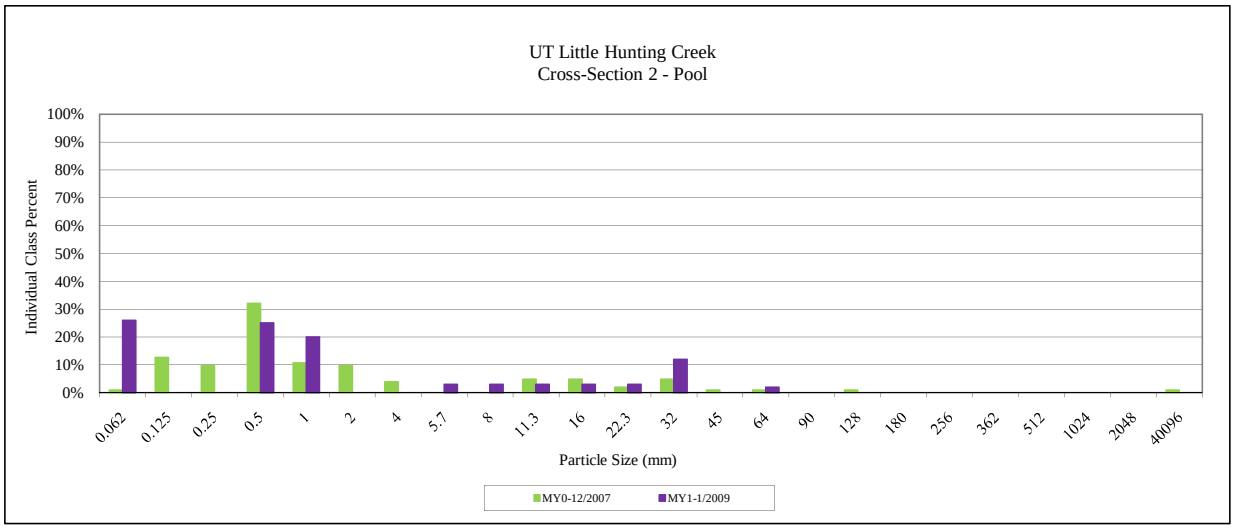
Project Name: UT Little Hunting Creek
Cross-Section: 1
Feature: Riffle



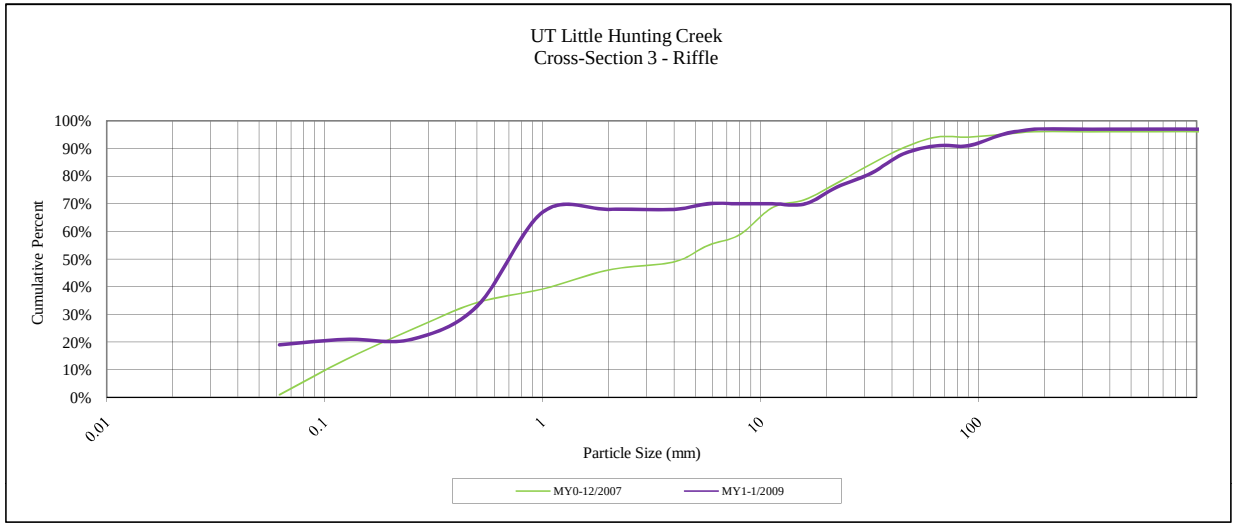



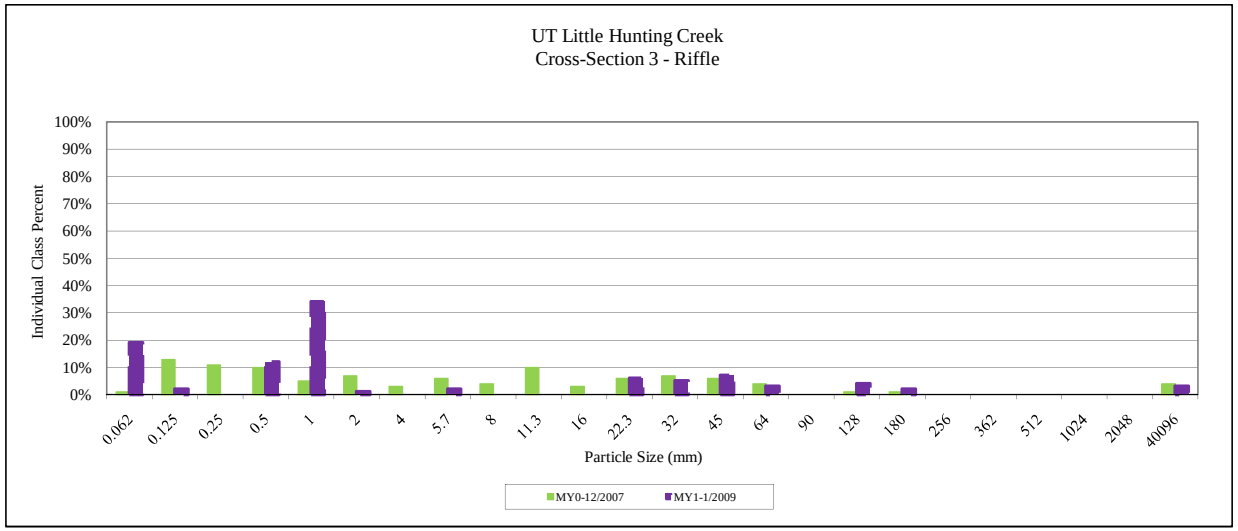
Project Name: UT Little Hunting Creek
Cross-Section: 2
Feature: Pool



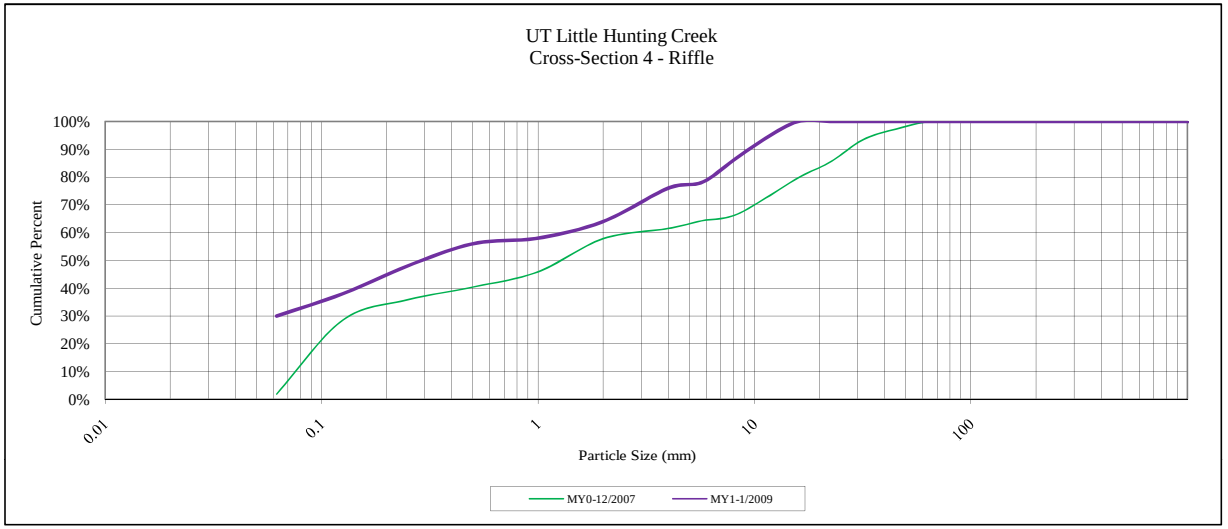



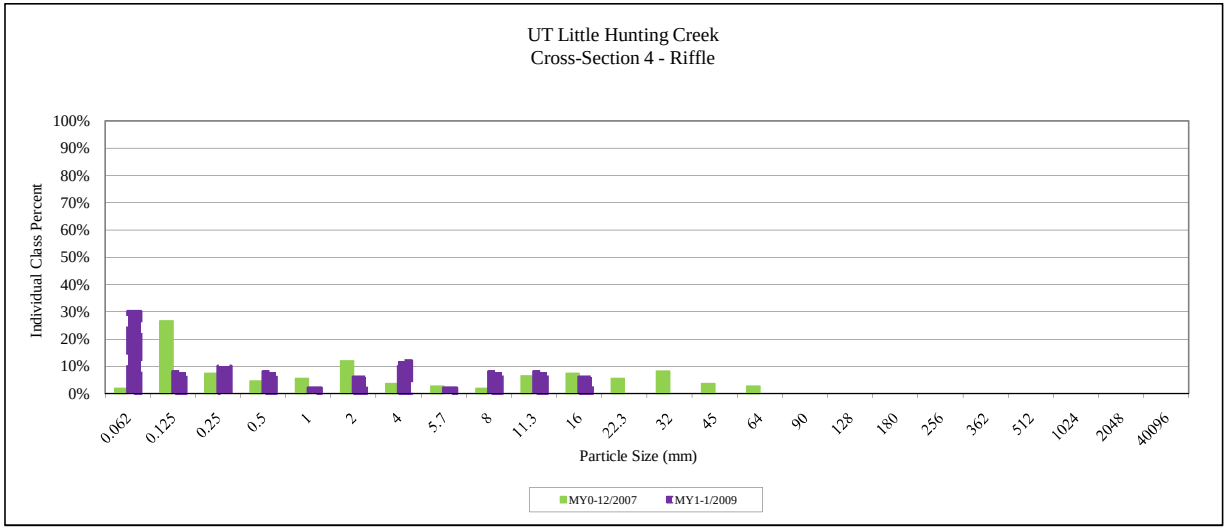
Project Name: UT Little Hunting Creek
Cross-Section: 3
Feature: Riffle



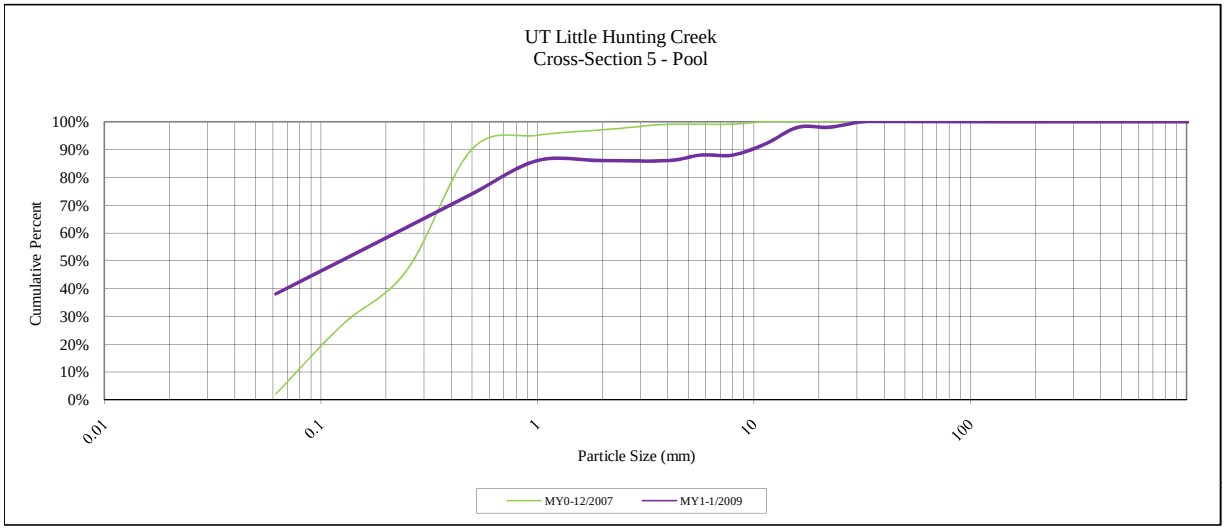



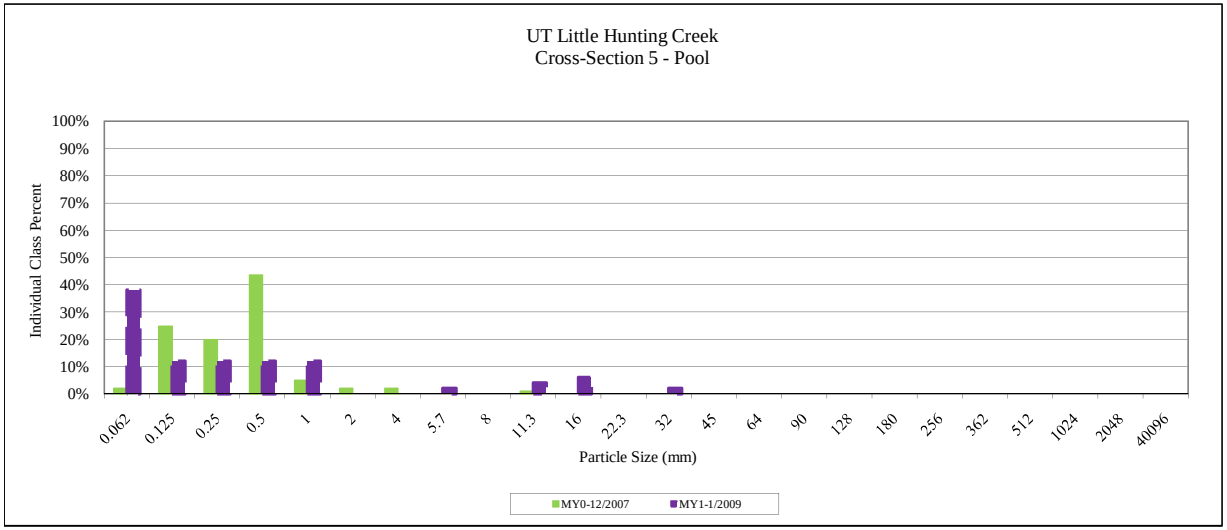
Project Name: UT Little Hunting Creek
Cross-Section: 4
Feature: Riffle



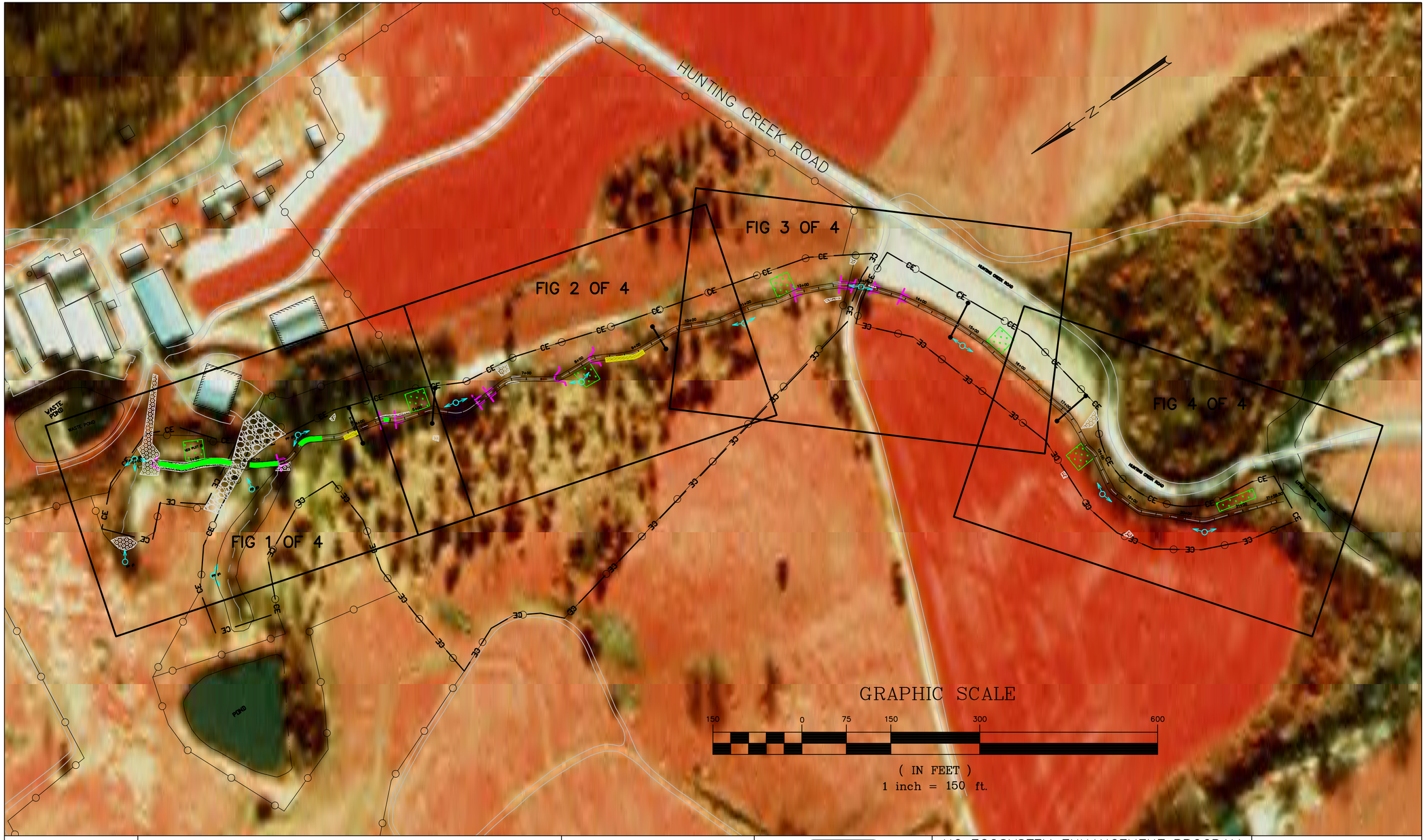
Project Name: UT Little Hunting Creek
Cross-Section: 5
Feature: Pool



# APPENDIX 3
# CURRENT CONDITION PLAN VIEW (INTEGRATED)

**1. Current Condition Plan View (Integrated)**




Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 197
IREDELL COUNTY
NORTH CAROLINA
MONITORING
YEAR 2 of 5

JJG

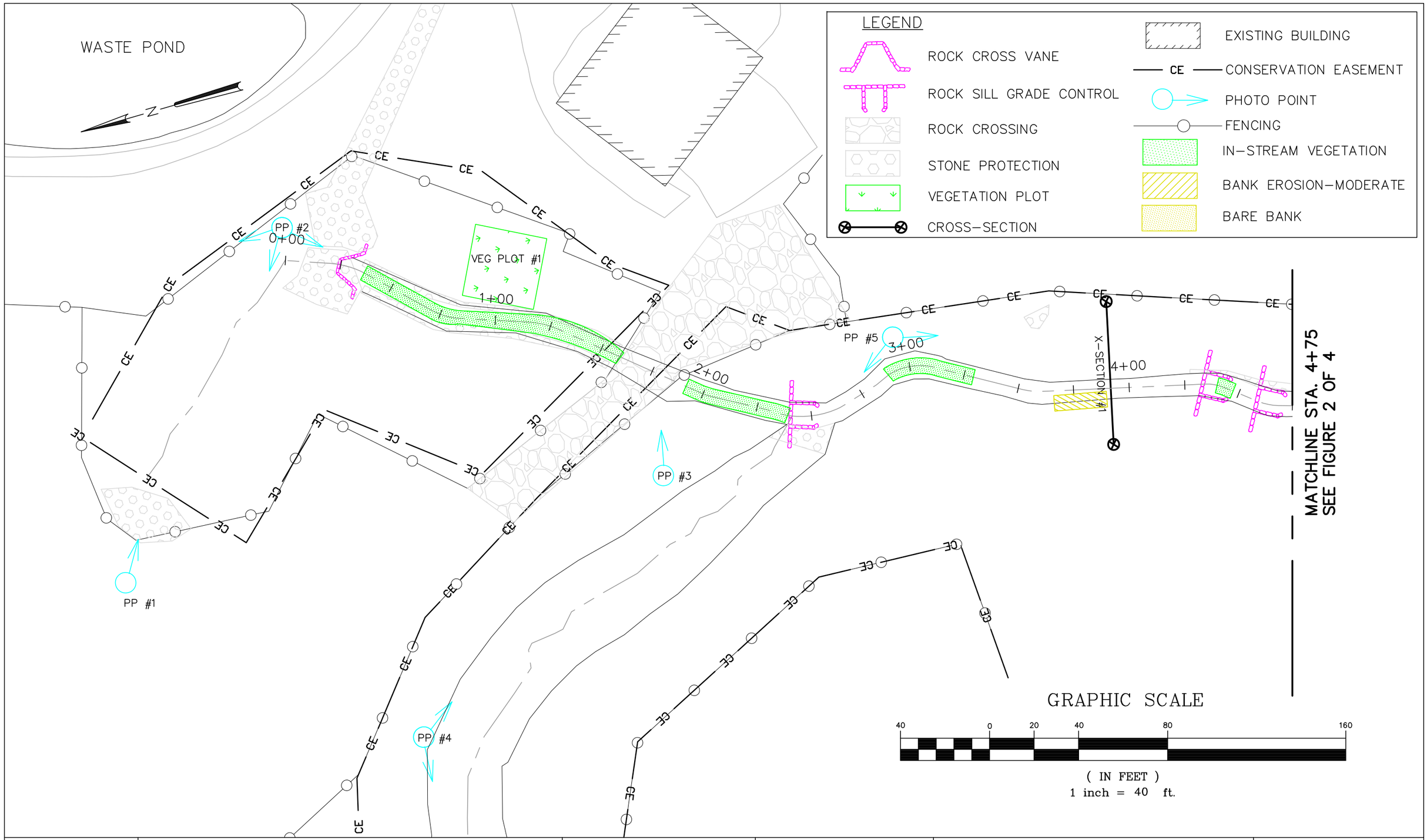
NC ECOSYSTEM ENHANCEMENT PROGRAM
JOHNSON SITE

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009

JOB NO.: 03060005

FIGURE KEY




Ecosystem Enhancement PROGRAM

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 197
IREDELL COUNTY
NORTH CAROLINA
MONITORING
YEAR 2 of 5

JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
JOHNSON SITE

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009

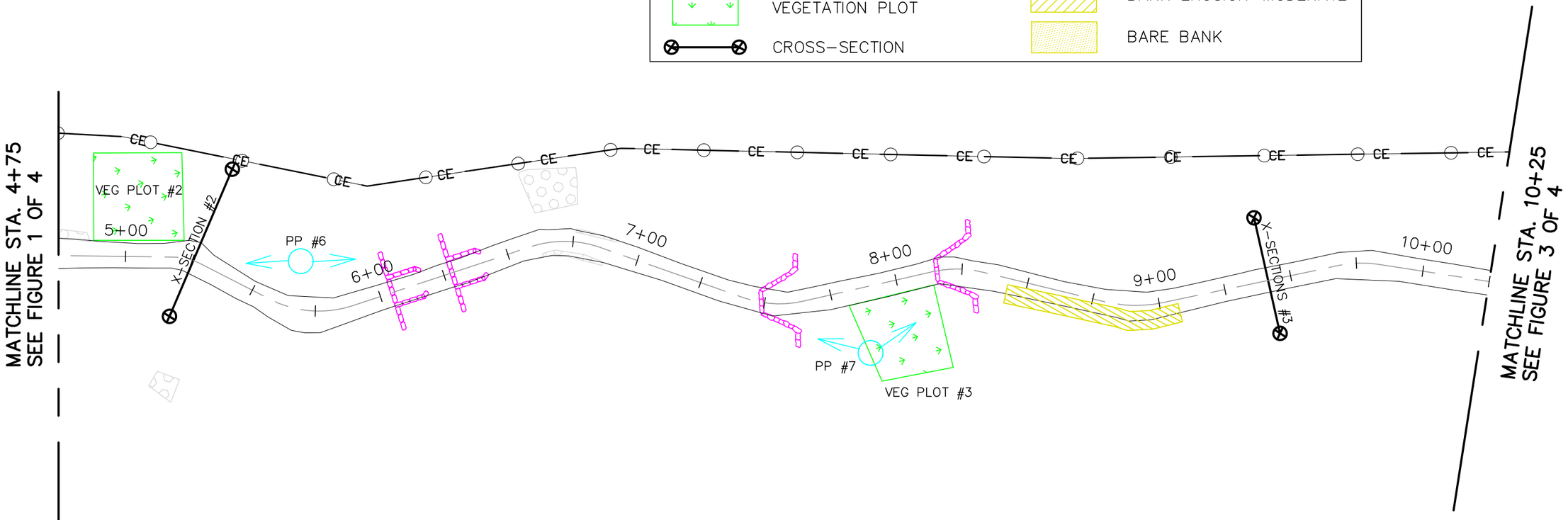
JOB NO.: 03060005

FIGURE 1 OF 4

LEGEND

- ROCK CROSS VANE
- ROCK SILL GRADE CONTROL
- ROCK CROSSING
- STONE PROTECTION
- VEGETATION PLOT
- CROSS-SECTION
- EXISTING BUILDING
- CE — CONSERVATION EASEMENT
- PHOTO POINT
- FENCING
- IN-STREAM VEGETATION
- BANK EROSION-MODERATE
- BARE BANK

N




GRAPHIC SCALE

40 0 20 40 80 160

( IN FEET )
1 inch = 40 ft.

NOTES:
1. GENERAL SITE DATA PROVIDED BY NCEEP.
2. ALL LOCATIONS ARE APPROXIMATE.

PROJECT NO. 197
IREDELL COUNTY
NORTH CAROLINA
MONITORING
YEAR 2 of 5

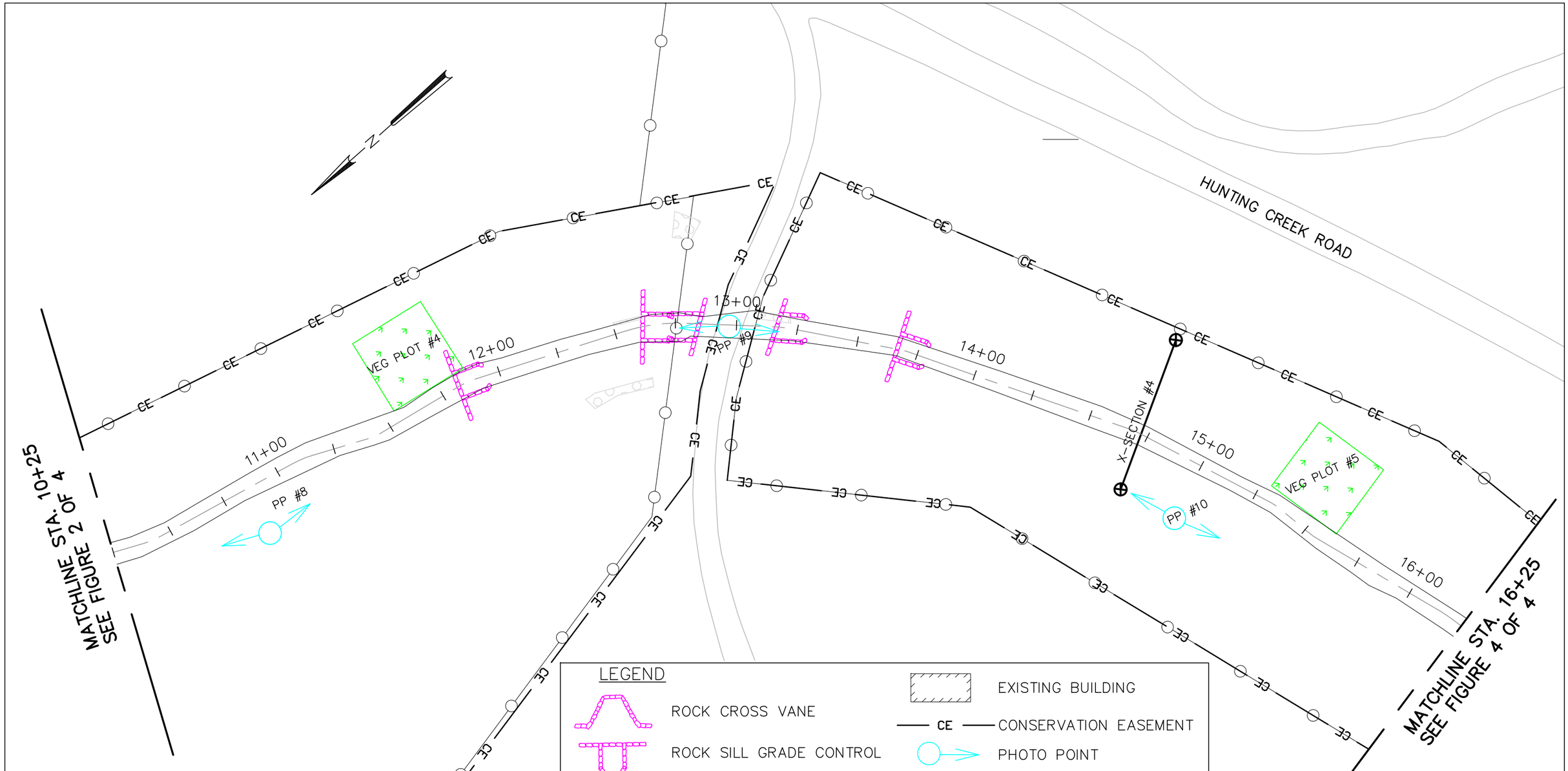
NC ECOSYSTEM ENHANCEMENT PROGRAM
JOHNSON SITE

APPENDIX 3
CURRENT CONDITION PLAN VIEW

DATE : FEBRUARY 2009

JOB NO.: 03060005

FIGURE 2 OF 4




LEGEND

- ROCK CROSS VANE
- ROCK SILL GRADE CONTROL
- ROCK CROSSING
- STONE PROTECTION
- VEGETATION PLOT
- CROSS-SECTION
- EXISTING BUILDING
- CE — CONSERVATION EASEMENT
- PHOTO POINT
- FENCING
- IN-STREAM VEGETATION
- BANK EROSION-MODERATE
- BARE BANK

GRAPHIC SCALE

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FIGURE 3 OF 4

MATCHLINE STA. 16+25
SEE FIGURE 3 OF 4

N

HUNTING CREEK ROAD

LITTLE HUNTING CREEK

17+00

18+00

19+00

20+00

21+00

21+58.50

X-SECTIONS #5

VEG PLOT #6

VEG PLOT #7

PP #11

PP #12

CE

LEGEND

- ROCK CROSS VANE
- ROCK SILL GRADE CONTROL
- ROCK CROSSING
- STONE PROTECTION
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GRAPHIC SCALE

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Ecosystem Enhancement PROGRAM

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PROJECT NO. 197
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JJG

NC ECOSYSTEM ENHANCEMENT PROGRAM
JOHNSON SITE

APPENDIX 3
CURRENT CONDITION PLAN VIEW

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FIGURE 4 OF 4