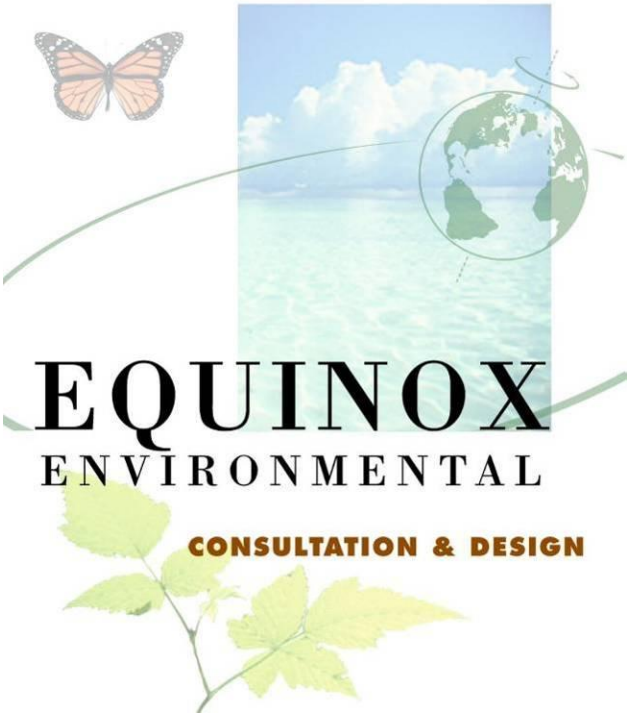
# Kings Creek
# Stream Restoration
## NCEEP Project Number: 208
## Contract Number: D09082S
## Monitoring Year 5
## 2013 Final Report

**Submitted to**
**North Carolina Ecosystem Enhancement Program**
**North Carolina Department of Environment and Natural Resources**
**November 2013**

**1619 Mail Service Center**
**Raleigh, NC 27699**

# Monitoring Firm

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**Asheville, North Carolina 28801**
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# Kings Creek Stream Restoration
# 2013 Monitoring Report (MY 5)

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## Appendices

# 1.0 EXECUTIVE SUMMARY / PROJECT ABSTRACT

The goals and objectives stated in the Kings Creek Mitigation Report (NCEEP 2006) are as follows:

- Restore 2,119 linear feet of channel dimension, pattern, and profile to the extent possible;
- Improve floodplain functionality by matching floodplain elevation with bankfull stage, thereby increasing watershed attenuation and reducing peak flows;
- Establish native floodplain vegetation, which will allow treatment of diffuse storm flow and nutrient uptake while establishing part of a wildlife corridor in the watershed;
- Remove invasive exotic vegetation species from the stream corridor;
- Improve the natural aesthetics of the stream corridor; and
- Improve the water quality in the Kings Creek watershed by reducing bank erosion, increasing nutrient storage and uptake, and increasing dissolved oxygen of the system.

The monitoring year five (MY5) vegetation plot data indicate that the project is meeting the final established criterion for planted stem density, which is a minimum survival of 260 planted stems per acre at the end of the year five monitoring period. Average stem density for planted stems in MY5 is approximately 648 stems per acre. Additionally, when planted and natural stems are combined, the average stem density is 2,536 stems per acre, which is well above the minimum established criterion. Of the 48 planted stems recorded within the monitoring plots, 94% had vigor codes of good or excellent. The site includes a diverse assemblage of 18 planted and volunteers species of native trees and shrubs. Planted species range from 5 to 6 per plot with 10 to 13 species observed when volunteers are included. Past problems with vegetation consist of areas of low stem densities adjacent to the stream reach as well as approximately 16 currently isolated patches of high threat invasive plant species that span the project area. A supplemental live stake planting occurred on March 16, 2011 in those areas noted with low stem densities and eroding banks. A total of four treatments of invasive plant populations occurred on February 6$^{th}$, April 24$^{th}$, June 24$^{th}$, and September 30$^{th}$ of 2013. Treatments targeted Bittersweet, Kudzu, Multiflora Rose, Privet, Japanese Honeysuckle, Japanese Spirea, and Bamboo. A walk-through was performed to evaluate efficacy of prior treatments during the September 30$^{th}$ treatment; some resiliency was observed on privet and rose, but other species were affected greatly by initial treatments. Additionally, follow up treatments will be completed during 2014 growing season, prior to project closeout.

Stream longitudinal profiles have remained relatively stable among monitoring years. The primary stream issue observed during MY5 was bank erosion resulting from thalweg migration and low woody stem densities. In particular, thalweg migration has continued at station 2+00 (83 feet) and 5+25 (38 feet) causing further bank erosion. These two areas of concern have continued to actively erode between monitoring years. Including these two areas, 16% of the project area is currently actively eroding. All other morphological metrics indicated performance percentages averaging between 88 and 100%. Two bankfull events, one event on January 31$^{st}$ and one event on July 3$^{rd}$, were documented during MY5. The former was documented using wrack lines as well as the crest gauge. High rainfall in the area and anecdotal evidence of overbank flows confirmed the second bankfull event.

Summary information/data related to the occurrence of items such as beaver or easement encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEP's website. All raw data supporting tables and figures in the appendices is available from EEP upon request.

# 2.0 Methodology

The stream monitoring methodologies utilized in 2013 replicate those employed during previous monitoring years and are based on standard guidance and procedures documents (Rosgen 1996 and USACE 2003). Vegetation monitoring data were collected following the standard CVS-EEP Protocol for Recording Vegetation, Level II (Lee et al. 2008).

# 3.0 References

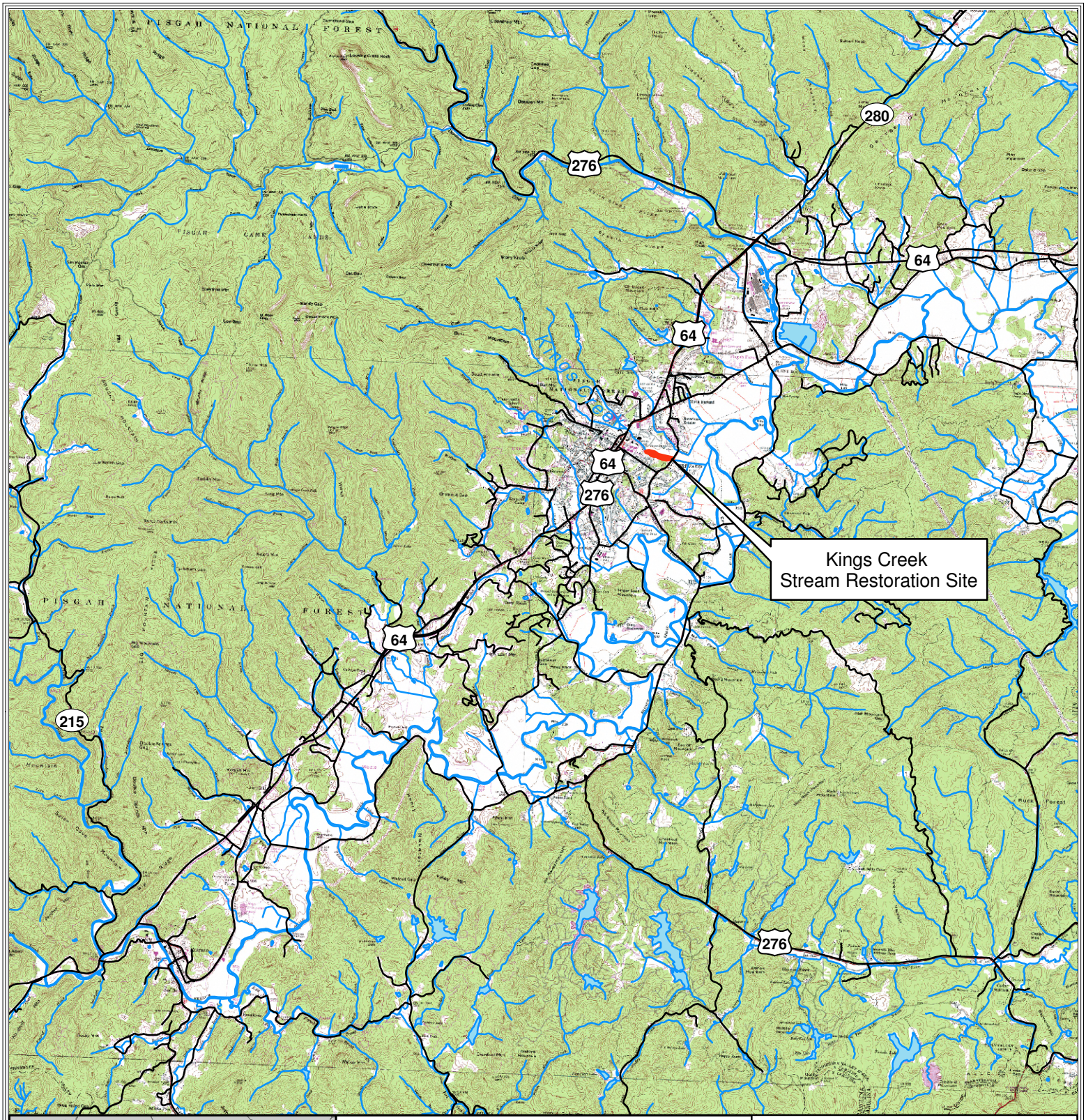
Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation. Version 4.2. The University of North Carolina at Chapel Hill, Department of Biology.

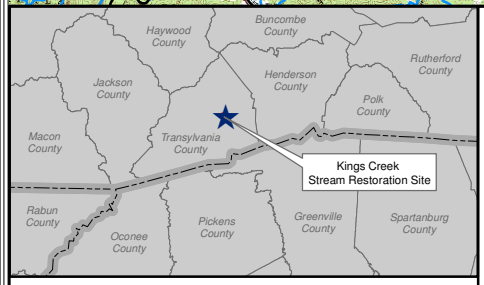
NCEEP (North Carolina Ecosystem Enhancement Program). 2006. Mitigation Report Kings Creek Restoration Project. Raleigh.

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

USACE (U.S. Army Corps of Engineers). 2003. Stream Mitigation Guidelines. USACOE, USEPA, NCWRC, NCDENR-DWQ. Wilmington District.

# Appendix A
# Project Vicinity Map and Background Tables




Directions: From Raleigh, proceed west on I-40 W to Asheville. Take the Sweeten Creek Rd/US-25 A exit (Exit 51). Proceed south on US-25-Alt to NC-280 S in Fletcher. Continue on NC-280 S towards Brevard. NC-280 S becomes US-276 S/US-64 in Brevard. After passing Brevard College turn left on E French Broad St and continue to Park Ave. Turn left on Park Ave for approximately 1/4 mile and project site is on the left.

# Figure 1 - Vicinity Map

Kings Creek
Stream Restoration Site
Project No. 208

Transylvania County, North Carolina

N

EQUINOX ENVIRONMENTAL CONSULTATION & DESIGN

Ecosystem Enhancement PROGRAM

0 0.5 1 2 3 Miles

7.5 Minute Series Brevard Quadrangle

**Table 1a. Project Components**
**Kings Creek / Project No. 208**

| Project Component or Reach ID | Existing Feet | Restoration Level | Approach | Footage | Credible Footage | Stationing | Mitigation Ratio | *Anticipated Mitigation Units | BMP Elements | Comment |
|---|---|---|---|---|---|---|---|---|---|---|
| Reach I | 824 | R | P2 | 990 | 840 | 1+00 - 10+90 | 1 : 1 | 840 | N/A | Excavated new off-line bankfull channel and constructed floodplain at lower elevation. |
| Reach II | 191 | EI | - | 191 | 0 | 10+90 - 12+81 | 2.5 : 1 | 0 | N/A | Excavated floodplain on left bank and stabilized left bank slopes. No work on right bank. |
| Reach III | 800 | R | P2 | 936 | 791 | 12+81 - 22+17 | 1 : 1 | 791 | N/A | Excavated new off-line bankfull channel and constructed floodplain at lower elevation. |

*The anticipated mitigation units are based on the expected yields due to the lack of a full 30-foot riparian buffer on portions of the stream
- Information unavailable

**Table 1b. Component Summations**
**Kings Creek / Project No. 208**

| Restoration Level | Stream (lf) | Riparian Wetland (Ac) | | Non-Ripar (Ac) | Upland (Ac) | Buffer (Ac) | BMP |
|---|---|---|---|---|---|---|---|
| | | Riverine | Non-Riverine | | | | |
| Restoration | 1,928 | | | | | | |
| Enhancement | | | | | | | |
| Enhancement I | | | | | | | |
| Enhancement II | 191 | | | | | | |
| Creation | | | | | | | |
| Preservation | | | | | | | |
| HQ Preservation | | | | | | | |
| | | 0 | 0 | | | | |
| **Totals** | **2,119** | **0.0** | | **0.0** | **0.0** | **0.0** | **BMP Count** |
| ***Anticipated SMU Totals** | **1,631** | **0.0** | | **0.0** | **0.0** | **0.0** | **0** |

=Non-Applicable

*The anticipated mitigation units are based on the expected yields due to the lack of a full 30-foot riparian buffer on portions of the stream

| Table 2. Project Activity and Reporting History<br>Kings Creek / Project No. 208<br>Elapsed Time Since Grading Complete: 7 Years<br>Elapsed Time Since Planting Complete: 7 Years<br>Number of Reporting Years: 5 | | |
|---|---|---|
| **Activity or Deliverable** | **Data Collection Complete** | **Completion or Delivery** |
| Restoration Plan | - | - |
| Final Design - Construction Plans | - | Sep-04 |
| Construction | N/A | 2006 |
| Live Stakes and Bare Root Trees Planted | N/A | 2006 |
| Mitigation Plan / As-built (Year 0 Monitoring - Baseline) | Nov-05/Dec-05 | May-06 |
| Year 1 Monitoring | 2008 | 2008 |
| Year 2 Monitoring | Nov-10 | Nov-10 |
| Supplemental Live Stake Planting Effort | Mar-11 | Mar-11 |
| Year 3 Monitoring | Nov-11 | Nov-11 |
| Beaver and Beaver Dam Removal | Oct-12 | Oct-12 |
| Year 4 Monitoring | Nov-12 | Dec-12 |
| Year 5 Monitoring | Nov-13 | Nov-13 |

- Information unavailable

N/A - Item does not apply

| Table 3. Project Contacts<br>Kings Creek / Project No. 208 | |
|---|---|
| **Designer**<br><br>Primary Project Design POC | Buck Engineering / Michael Baker Corp.<br>797 Haywood Road, Suite 201<br>Asheville, North Carolina 28806<br>Andrew Bick (828) 350-1408 |
| **Construction Contractor**<br><br>Construction Contractor POC | L-J, Inc.<br>220 Stoneridge Drive, Suite 405<br>Columbia, SC 29210<br>Richard Goodwin (803) 929-1181 |
| **Survey Contractor**<br><br>Survey Contractor POC | Joel Johnson Land Surveying<br><br>Joel Johnson (828) 586-6488 |
| **Planting Contractor**<br><br>Planting Contractor POC | Unknown<br><br>Unknown |
| **Seeding Contractor**<br><br>Planting Contractor POC | Unknown<br><br>Unknown |
| Seed Mix Sources | Unknown |
| Nursery Stock Suppliers | Unknown |
| **Monitoring Performers (Y0) - 2006** | Buck Engineering / Michael Baker Corp.<br>797 Haywood Road, Suite 201<br>Asheville, North Carolina 28806 |
| Stream Monitoring POC | Unknown |
| Vegetation Monitoring POC | Unknown |
| **Monitoring Performers (Y1) - 2008** | North Carolina Wildlife Resources Commission<br>171 Southern Cross Road<br>Weaverville, North Carolina 28787 |
| Stream Monitoring POC | Jeff Ferguson (828) 231-3517 |
| Vegetation Monitoring POC | Jeff Ferguson (828) 231-3517 |
| **Monitoring Performers (Y2) - 2010** | Equinox Environmental Consultation & Design, Inc.<br>37 Haywood Street, Suite 100<br>Asheville, North Carolina 28801 |
| Stream Monitoring POC | Steve Melton (828) 253-6856 |
| Vegetation Monitoring POC | Sarah Marcinko (828) 253-6856 |
| **Monitoring Performers (Y3) - 2011** | Equinox Environmental Consultation & Design, Inc.<br>37 Haywood Street, Suite 100<br>Asheville, North Carolina 28801 |
| Stream Monitoring POC | Win Taylor (828) 253-6856 |
| Vegetation Monitoring POC | Kevin Mitchell (828) 253-6856 |
| **Monitoring Performers (Y4) - 2012** | Equinox Environmental Consultation & Design, Inc.<br>37 Haywood Street, Suite 100<br>Asheville, North Carolina 28801 |
| Stream Monitoring POC | Kevin Mitchell (828) 253-6856 |
| Vegetation Monitoring POC | Kevin Mitchell (828) 253-6856 |
| **Monitoring Performers (Y5) - 2013** | Equinox Environmental Consultation & Design, Inc.<br>37 Haywood Street, Suite 100<br>Asheville, North Carolina 28801 |
| Stream Monitoring POC | Hunter Terrell (828) 253-6856 |
| Vegetation Monitoring POC | Hunter Terrell(828) 253-6856 |

Unknown - Information was unknown at time of report submittal

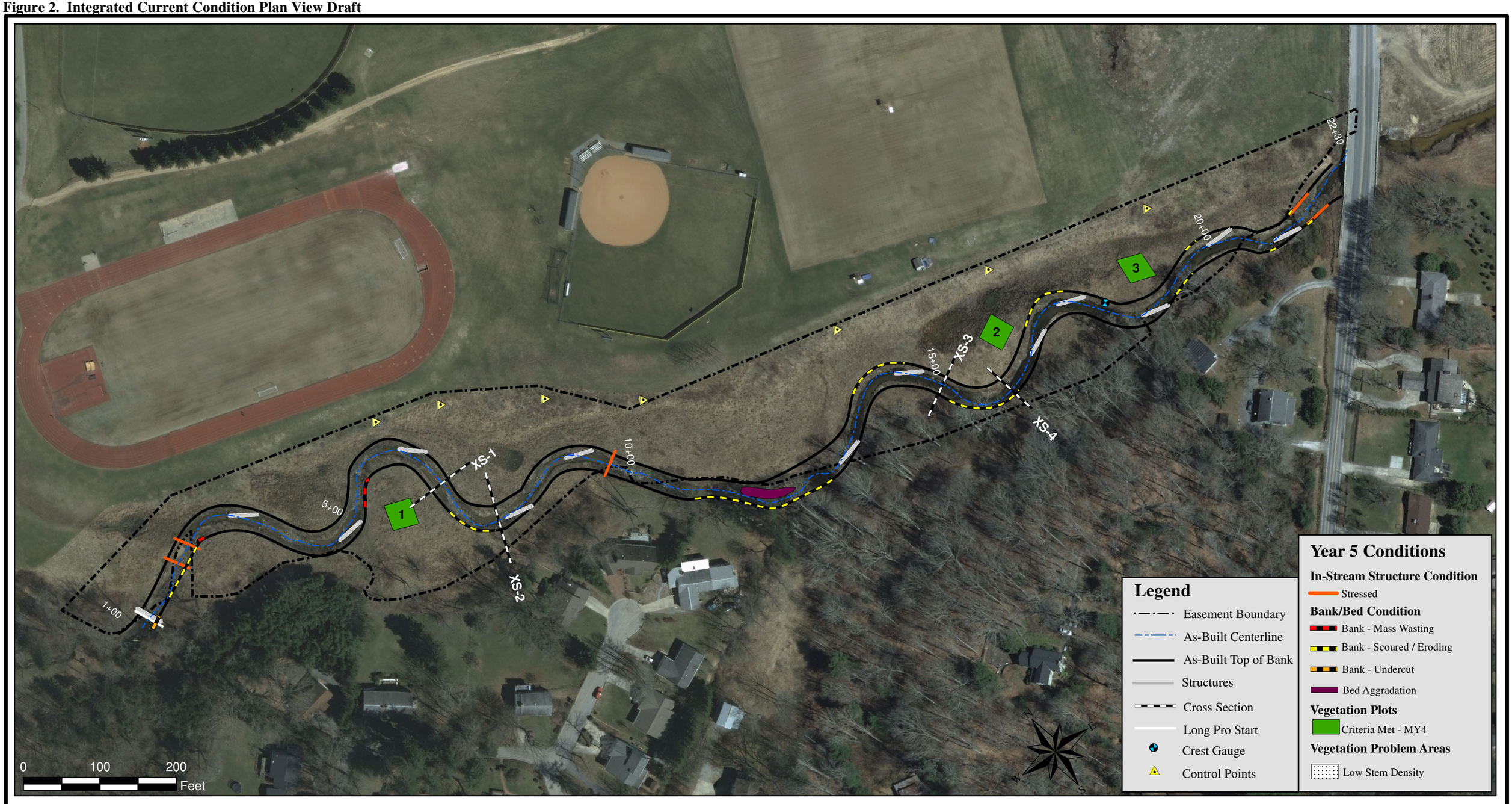
| Table 4. Project Attributes<br>Kings Creek / Project No. 208 | |
|---|---|
| Project County | Transylvania |
| Physiographic Region | Blue Ridge |
| Ecoregion | Broad Basins |
| Project River Basin | French Broad |
| USGS HUC for Project (14 digit) | 06010105010050 |
| NCDWQ Sub-Basin for Project | 04-03-01 |
| Within Extent of EEP Watershed Plan | No |
| WRC Class (Warm, Cool, Cold) | Cool |
| % of Project Easement Fenced or Demarcated | 100% |
| Beaver Activity Observed During Design Phase | Unknown |
| | |
| **Restoration Component Attributes** | |
| | Kings Creek |
| Drainage Area (sq.mi.) | 4.2 |
| Stream Order | Second |
| Restored Length (feet) | 2,119 |
| Perennial or Intermittent | Perennial |
| Watershed Type | Urban |
| Watershed LULC Distribution | - |
| Watershed Impervious Cover | - |
| NCDWQ AU / Index Number | 6-30 |
| NCDWQ Classification | C / Tr |
| 303d Listed | No |
| Upstream of 303d Listed Segment | No |
| Reasons for 303d Listing or Stressor | N/A |
| Total Acreage of Easement | 6.11 |
| Total Vegetated Acreage within Easement | 5.66 |
| Total Planted Acreage as Part of Restoration | 5.56 |
| Rosgen Classification of Pre-Existing | - |
| Rosgen Classification of As-Built | C4 |
| Valley Type | - |
| Valley Slope | - |
| Valley Side Slope Range | - |
| Valley Toe Slope Range | - |
| Cowardin Classification | N/A |
| Trout Waters Designation | Yes |
| Species of Concern, Endangered, Etc. | - |
| Dominant Soil Series and Characteristics | |
| Series | - |
| Depth | - |
| Clay% | - |
| K | - |
| T | - |

- Information unavailable

N/A - Item does not apply

# Appendix B
# Visual Assessment Data

**Figure 2. Integrated Current Condition Plan View Draft**




| | | | |
|---|---|---|---|
| Prepared for<br>Ecosystem Enhancement Program | **Project:**<br>Kings Creek<br>Year 5 Monitoring<br>Transylvania County, North Carolina | Notes: 1) Base Map Data Provided by NCEEP<br>2) 2010 Aerial Photo | Prepared by<br>EQUINOX ENVIRONMENTAL CONSULTATION & DESIGN |
| | Sheet 1 of 1 | | |
| | Date | Project Number | |
| | November 2013 | NCEEP # 208 | |

**Table 5. Visual Stream Morphology Stability Assessment**
**Kings Creek / Project No. 208**
**Assessed Length 2,119 feet**

| Major Channel Category | Channel Sub-Category | Metric | Number Stable, Performing as Intended | Total Number in As-built | Number of Unstable Segments | Amount of Unstable Footage | % Stable, Performing as Intended | Number with Stabilizing Woody Vegetation | Footage with Stabilizing Woody Vegetation | Adjusted % for Stabilizing Woody Vegetation |
|---|---|---|---|---|---|---|---|---|---|---|
| **1. Bed** | **1. Vertical Stability** (Riffle and Run Units) | 1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars). | | | 1 | 74 | 96% | | | |
| | | 2. Degradation - Evidence of downcutting. | | | 0 | 0 | 100% | | | |
| | **2. Riffle Condition** | 1. Texture/Substrate - Riffle maintains coarser substrate. | 13 | 13 | | | 100% | | | |
| | **3. Meander Pool Condition** | 1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ? 1.6). | 12 | 12 | | | 100% | | | |
| | | 2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle). | 12 | 12 | | | 100% | | | |
| | **4. Thalweg Position** | 1. Thalweg centering at upstream of meander bend (Run). | 7 | 12 | | | 58% | | | |
| | | 2. Thalweg centering at downstream of meander bend (Glide). | 10 | 11 | | | 91% | | | |
| **2. Bank** | **1. Scoured / Eroding** | Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion. | | | 11 | 611 | 86% | 11 | 284 | 92% |
| | **2. Undercut** | Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat. | | | 1 | 18 | 100% | 1 | 18 | 100% |
| | **3. Mass Wasting** | Bank slumping, calving, or collapse. | | | 2 | 49 | 99% | 0 | 49 | 100% |
| | | | | **Totals** | 14 | 678 | 84% | 12 | 351 | 92% |
| **3. Engineered Structures** | **1. Overall Integrity** | Structures physically intact with no dislodged boulders or logs. | 14 | 16 | | | 88% | | | |
| | **2. Grade Control** | Grade control structures exhibiting maintenance of grade across the sill. | 21 | 24 | | | 88% | | | |
| | **2a. Piping** | Structures lacking any substantial flow underneath sills or arms. | 24 | 24 | | | 100% | | | |
| | **3. Bank Protection** | Bank erosion within the structures extent of influence does NOT exceed 15%. | 29 | 30 | | | 97% | | | |
| | **4. Habitat** | Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth Ratio ? 1.6. Rootwads/logs providing some cover at base-flow. | 12 | 12 | | | 100% | | | |

| Table 6. Vegetation Condition Assessment<br>Kings Creek / Project No. 208<br>Planted Acreage 5.56 | | | | | |
|---|---|---|---|---|---|
| **Vegetation Category** | **Definitions** | **CCPV Depiction** | **Number of Polygons** | **Combined Acreage** | **% of Planted Acreage** |
| **1. Bare Areas** | Very limited cover of both woody and herbaceous material. | N/A | 0 | 0.00 | 0% |
| **2. Low Stem Density Areas** | Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria. | Stipple<br>Black Dots White Background | 7 | 0.05 | 1% |
| | | **Totals** | 7 | 0.05 | 1% |
| **3. Areas of Poor Growth Rates or Vigor** | Areas with woody stems of a size class that are obviously small given the monitoring year. | N/A | 0 | 0.00 | 0% |
| | | **Cumulative Totals** | 7 | 0.05 | 1% |
| **Easement Acreage 6.11** | | | | | |
| **Vegetation Category** | **Definitions** | **CCPV Depiction** | **Number of Polygons** | **Combined Acreage** | **% of Easement Acreage** |
| **4. Invasive Areas of Concern** | Areas or points (if too small to render as polygons at map scale). | Cross Hatch<br>(Red - Dense/Yellow - Present) | 0 | 0.00 | 0% |
| **5. Easement Encroachment Areas** | Areas or points (if too small to render as polygons at map scale). | N/A | 0 | 0.00 | 0% |

# Appendix C
# Vegetation Plot Data

| Table 7. Vegetation Plot Criteria Attainment<br>Kings Creek / Project No. 208 | | |
|---|---|---|
| **Vegetation Plot ID** | **Vegetation Survival Threshold Met?** | **Tract Mean** |
| 1 | Yes | 100% |
| 2 | Yes | |
| 3 | Yes | |


Vegetation Monitoring Plot 1
Monitoring Year 5 – June 3, 2013


Vegetation Monitoring Plot 2
Monitoring Year 5 – June 3, 2013


Vegetation Monitoring Plot 3
Monitoring Year 5 – June 3, 2013

| Table 8. CVS Vegetation Plot Metadata<br>Kings Creek / Project No. 208 | |
|---|---|
| **Report Prepared By** | Owen Carson |
| **Date Prepared** | 7/15/2013 10:49 |
| **Database Name** | Equinox-2013-A-KingsCreek-MY5.mdb |
| **Database Location** | Z:\ES\NRI&M\EEP Monitoring\Kings Creek\KC-MY5-2013\Data\Veg |
| **Computer Name** | SENIORSCIENTIST |
| **File Size** | 48234496 |
| **DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------** | |
| **Metadata** | Description of database file, the report worksheets, and a summary of project(s) and project data. |
| **Proj, Planted** | Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes. |
| **Proj, Total Stems** | Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems. |
| **Plots** | List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.). |
| **Vigor** | Frequency distribution of vigor classes for stems for all plots. |
| **Vigor by Spp** | Frequency distribution of vigor classes listed by species. |
| **Damage** | List of most frequent damage classes with number of occurrences and percent of total stems impacted by each. |
| **Damage by Spp** | Damage values tallied by type for each species. |
| **Damage by Plot** | Damage values tallied by type for each plot. |
| **Planted Stems by Plot and Spp** | A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded. |
| **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** | 208 |
| **project Name** | Kings Creek |
| **Description** | On the campus of Brevard College |
| **River Basin** | French Broad |
| **Length(ft)** | |
| **Stream-to-Edge Width (ft)** | |
| **Area (sq m)** | |
| **Required Plots (calculated)** | |
| **Sampled Plots** | 3 |

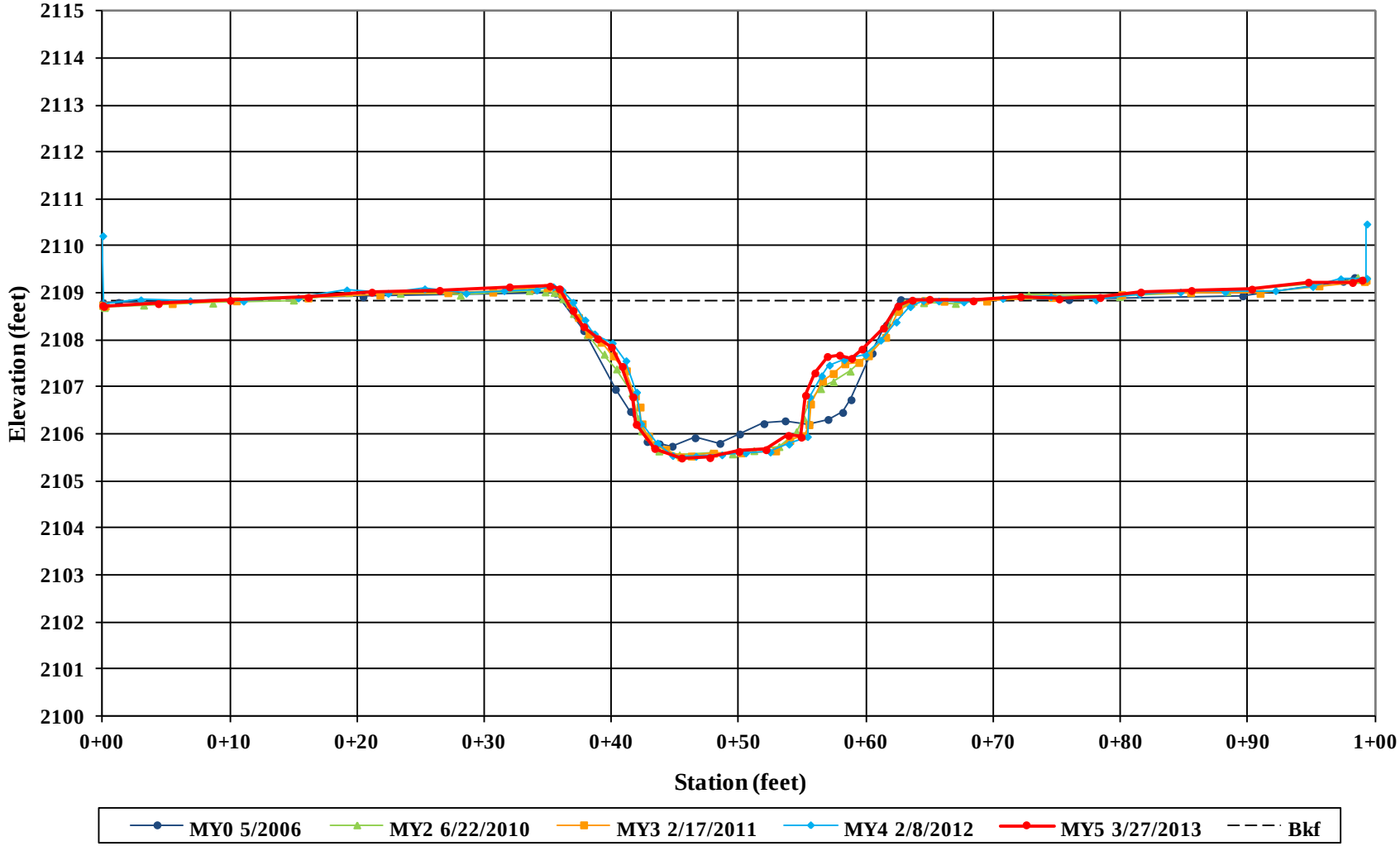
**Table 9. Planted and Total Stem Counts (Species by Plot with Annual Means)**
**Kings Creek / Project No. 208**

| | | | Current Plot Data (MY5 2013) | | | | | | | | | Annual Means | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | E208-01-0001 | | | E208-01-0002 | | | E208-01-0003 | | | MY5 (2013) | | | MY4 (2012) | | | MY3 (2011) | | | MY2 (2010) | | |
| Scientific Name | Common Name | Species Type | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T | PnoLS | P-all | T |
| Acer | maple | Tree | | | | | | | | | | | | | | | | | | 3 | | | |
| Acer rubrum | red maple | Tree | | | | | | | | | | | | | | | 48 | | | 113 | | | |
| Acer rubrum var. rubrum | red maple | Tree | | | 16 | | | 10 | | | 49 | | | 75 | | | | | | | | | 113 |
| Acer saccharinum | silver maple | Tree | | | 2 | | | | | | | | | 2 | | | | | | | | | |
| Alnus serrulata | hazel alder | Shrub | 6 | 6 | 6 | 1 | 1 | 1 | 1 | 1 | 4 | 8 | 8 | 11 | 8 | 8 | 16 | 8 | 8 | 13 | 10 | 10 | 10 |
| Aronia arbutifolia | Red Chokeberry | Shrub | | | 1 | | | | 2 | 2 | 3 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |
| Betula nigra | river birch | Tree | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 8 | 8 | 8 | 8 | 8 | 8 | 7 | 7 | 7 | 8 | 8 | 8 |
| Cornus amomum | silky dogwood | Shrub | 3 | 3 | 9 | | | 8 | | | 3 | 3 | 3 | 20 | 3 | 3 | 21 | 3 | 3 | 8 | 3 | 3 | 5 |
| Corylus americana | American hazelnut | Shrub | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Fraxinus pennsylvanica | green ash | Tree | | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hamamelis virginiana var | American witchhazel | Tree | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 1 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 5 | 5 | 5 |
| Juglans nigra | black walnut | Tree | | | 2 | | | | | | | | | 2 | | | | | | | | | 2 |
| Liquidambar styraciflua | sweetgum | Tree | | | 1 | | | | | | | | | 1 | | | 7 | | | 1 | | | 2 |
| Liriodendron tulipifera | tuliptree | Tree | | | | | | | | | | | | | | | | | | 13 | | | |
| Liriodendron tulipifera va | Tulip-tree, Yellow Po | Tree | | | 2 | | | 1 | | | 6 | | | 9 | | | 6 | | | | | | 12 |
| Nyssa sylvatica | blackgum | Tree | 2 | 2 | 3 | | | | | | | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Pinus strobus | eastern white pine | Tree | | | | | | 1 | | | 1 | | | 2 | | | | | | | | | 1 |
| Platanus occidentalis var. | Sycamore, Plane-tree | Tree | 6 | 6 | 11 | 3 | 3 | 3 | 7 | 7 | 9 | 16 | 16 | 23 | 12 | 12 | 28 | 16 | 16 | 27 | 15 | 15 | 39 |
| Prunus serotina | black cherry | Tree | | | | | | | | | | | | | | | 2 | | | | | | |
| Prunus serotina var. serot | black cherry | Tree | | | 2 | | | | | | | | | 2 | | | | | | | | | 1 |
| Quercus phellos | willow oak | Tree | | | | | | | | | | | | | | | | | | | | | 1 |
| Salix nigra | black willow | Tree | | | | | | | | | 3 | | | 3 | | | | | | 4 | | | 3 |
| Sambucus canadensis | Common Elderberry | Shrub | | | | | | 12 | | | 2 | | | 14 | | 1 | 2 | | 1 | 1 | | 1 | 1 |
| | | Stem count | 23 | 23 | 61 | 10 | 10 | 42 | 15 | 15 | 85 | 48 | 48 | 188 | 44 | 45 | 151 | 47 | 48 | 204 | 47 | 48 | 209 |
| | | size (ares) | 1 | | | 1 | | | 1 | | | 3 | | | 3 | | | 3 | | | 3 | | |
| | | size (ACRES) | 0.02 | | | 0.02 | | | 0.02 | | | 0.07 | | | 0.07 | | | 0.07 | | | 0.07 | | |
| | | Species count | 6 | 6 | 13 | 5 | 5 | 10 | 6 | 6 | 12 | 9 | 9 | 18 | 9 | 10 | 14 | 9 | 10 | 15 | 9 | 10 | 18 |
| | | Stems per ACRE | 930.8 | 930.8 | 2469 | 404.7 | 404.7 | 1700 | 607 | 607 | 3440 | 647.5 | 647.5 | 2536 | 593.5 | 607 | 2037 | 634 | 647.5 | 2752 | 634 | 647.5 | 2819 |

Exceeds requirements by 10%

# Appendix D
# Stream Survey Data

**Kings Creek / Project No. 208**
**Cross-Section 1 - Riffle**
**Station 6+84**



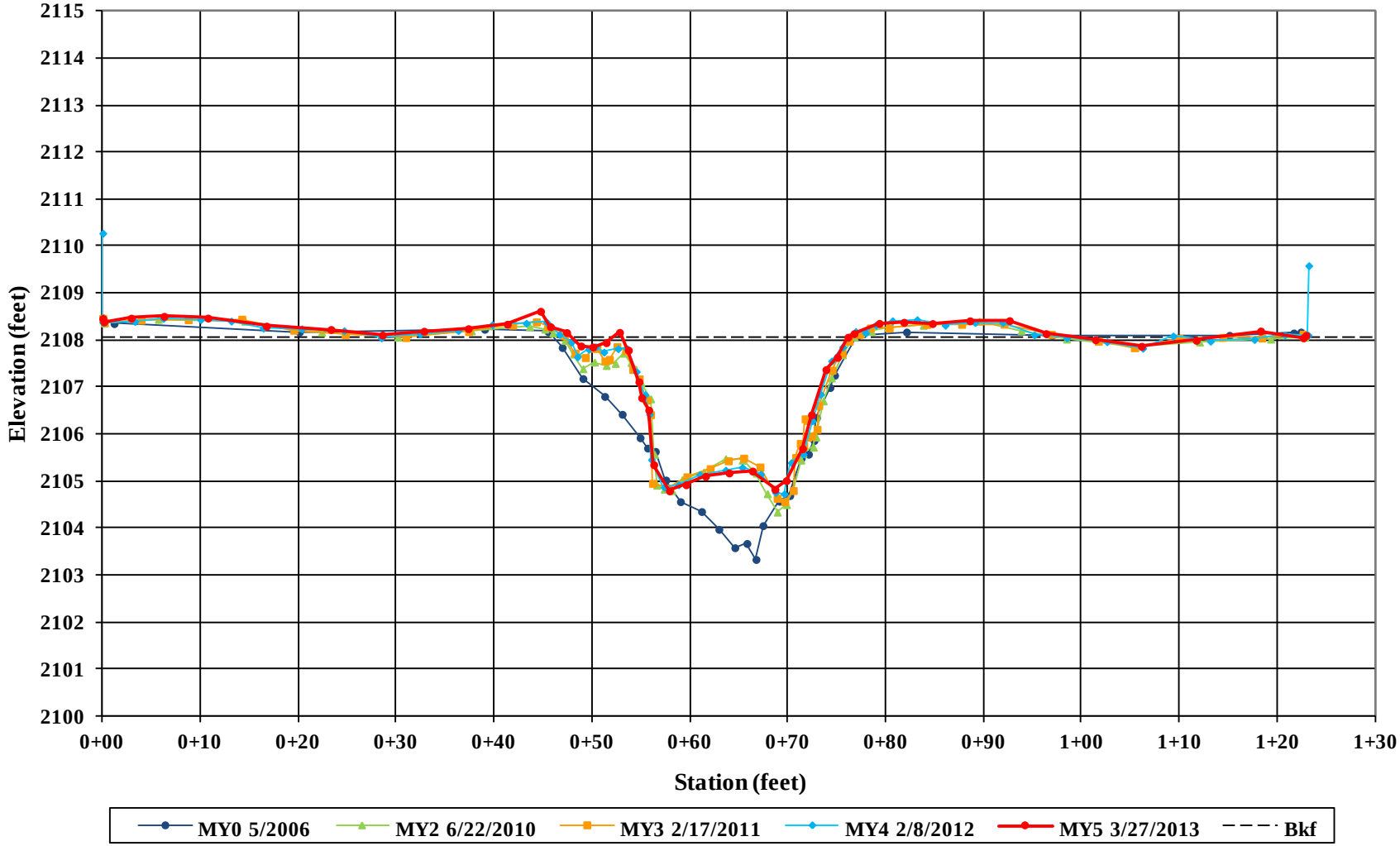

Cross-Section 1 – Riffle
Left Bank Descending
Monitoring Year 5 – March 27, 2013


Cross-Section 1 – Riffle
Right Bank Descending
Monitoring Year 5 – March 27, 2013


Cross-Section 1 – Riffle
Downstream
Monitoring Year 5 – March 27, 2013


Cross-Section 1 – Riffle
Upstream
Monitoring Year 5 – March 27, 2013

**Kings Creek / Project No. 208**
**Cross-Section 2 - Pool**
**Station 7+85**



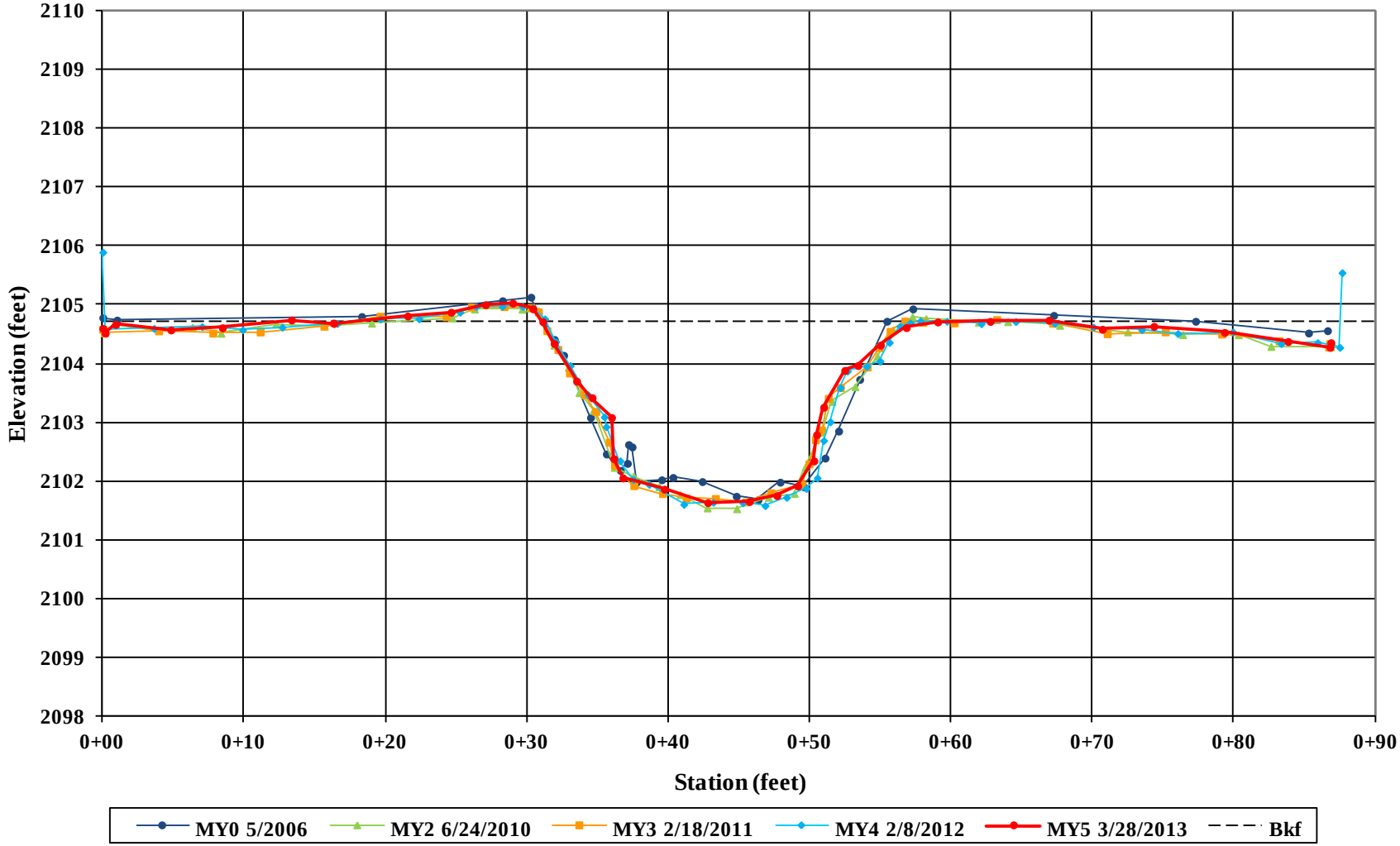

Cross-Section 2 – Pool
Left Bank Descending
Monitoring Year 5 – March 27, 2013


Cross-Section 2 – Pool
Right Bank Descending
Monitoring Year 5 – March 27, 2013


Cross-Section 2 – Pool
Downstream
Monitoring Year 5 – March 27, 2013


Cross-Section 2 – Pool
Upstream
Monitoring Year 5 – March 27, 2013

**Kings Creek / Project No. 208**
**Cross-Section 3 - Riffle**
**Station 15+13**



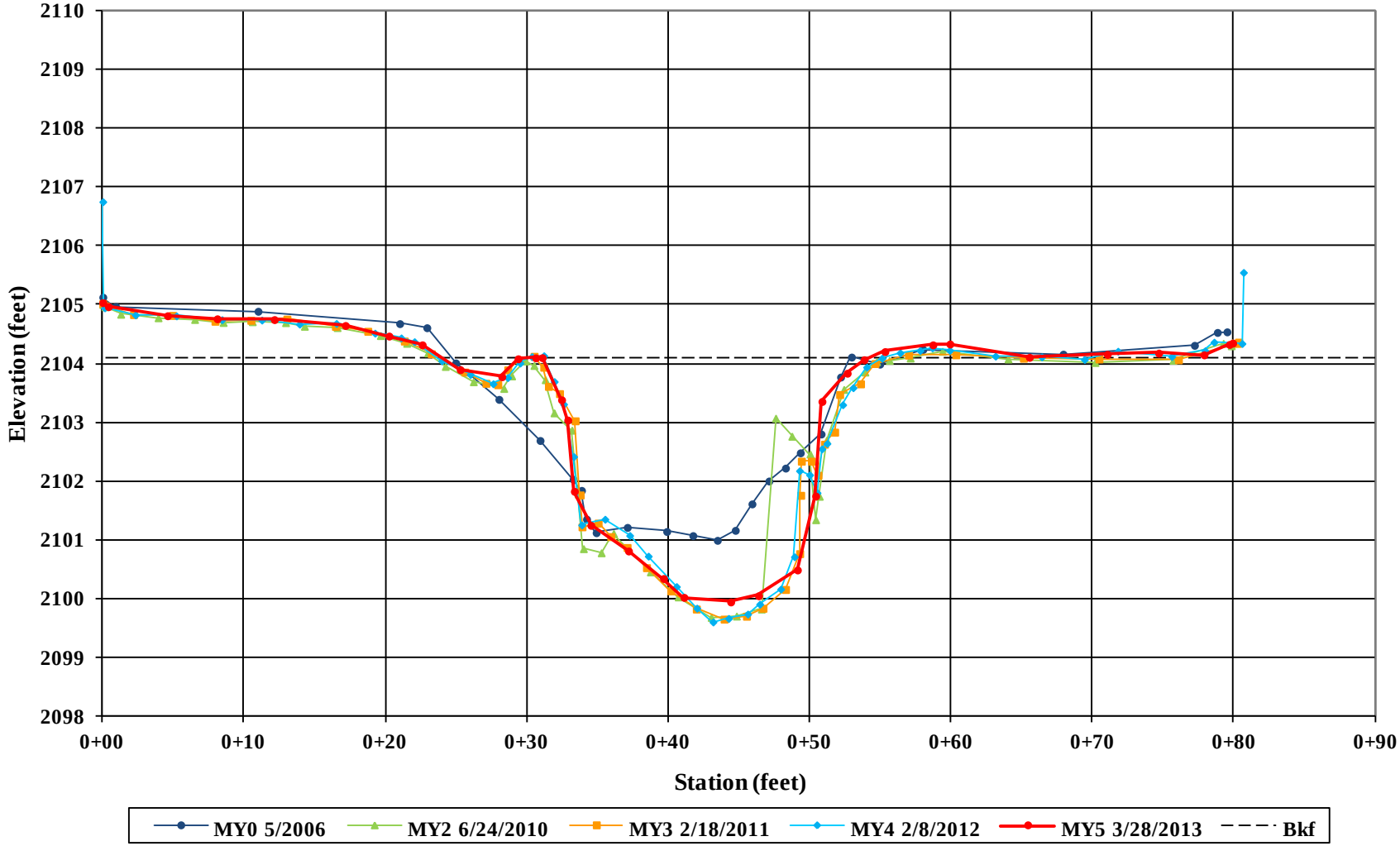

Cross-Section 3 – Riffle
Left Bank Descending
Monitoring Year 5 – March 28, 2013


Cross-Section 3 – Riffle
Right Bank Descending
Monitoring Year 5 – March 28, 2013


Cross-Section 3 – Riffle
Downstream
Monitoring Year 5 – March 28, 2013


Cross-Section 3 – Riffle
Upstream
Monitoring Year 5 – March 28, 2013

**Kings Creek / Project No. 208**
**Cross-Section 4 - Pool**
**Station 16+17**



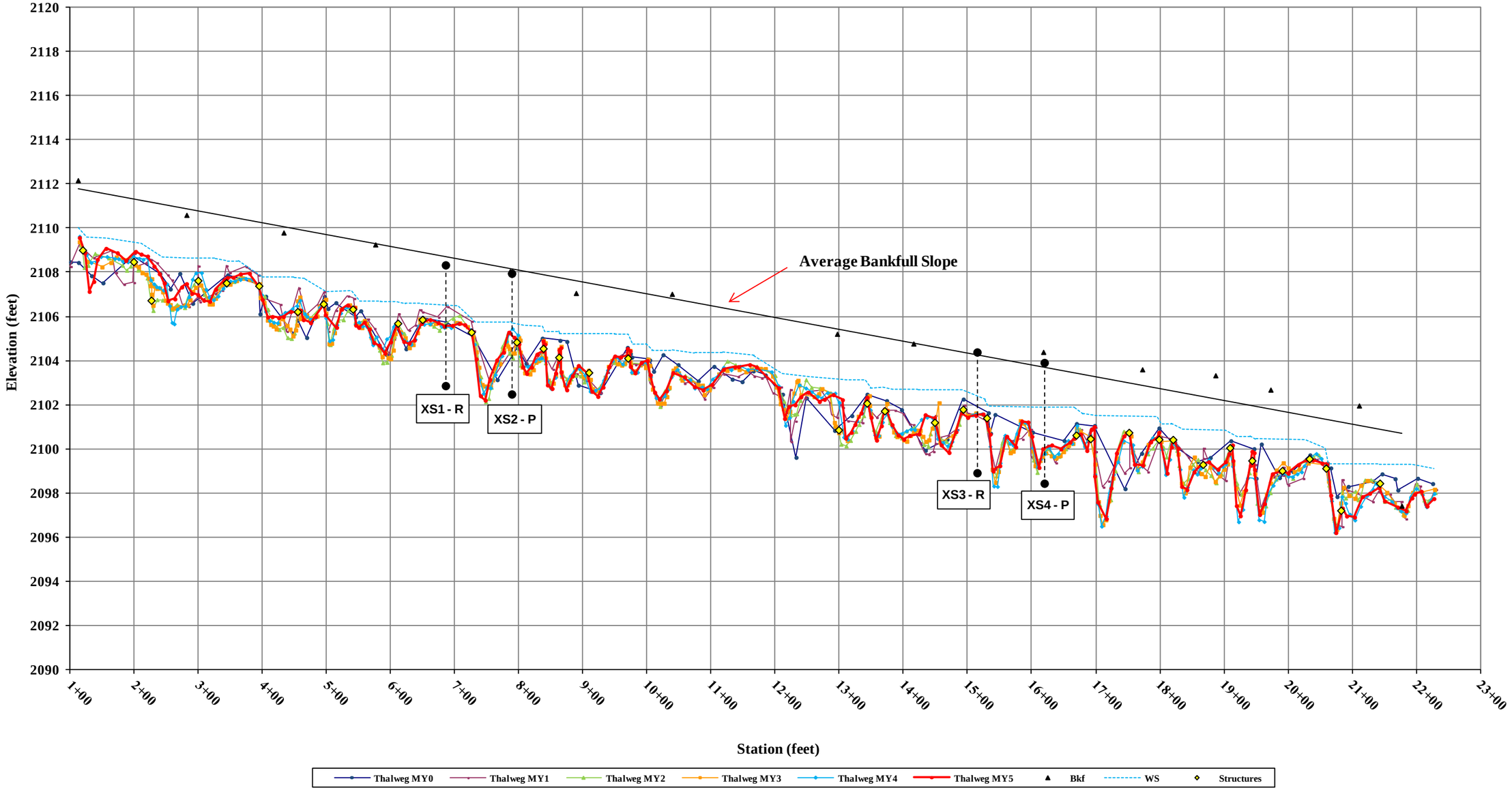

Cross-Section 4 – Pool
Left Bank Descending
Monitoring Year 5 – March 28, 2013


Cross-Section 4 – Pool
Right Bank Descending
Monitoring Year 5 – March 28, 2013


Cross-Section 4 – Pool
Downstream
Monitoring Year 5 – March 28, 2013

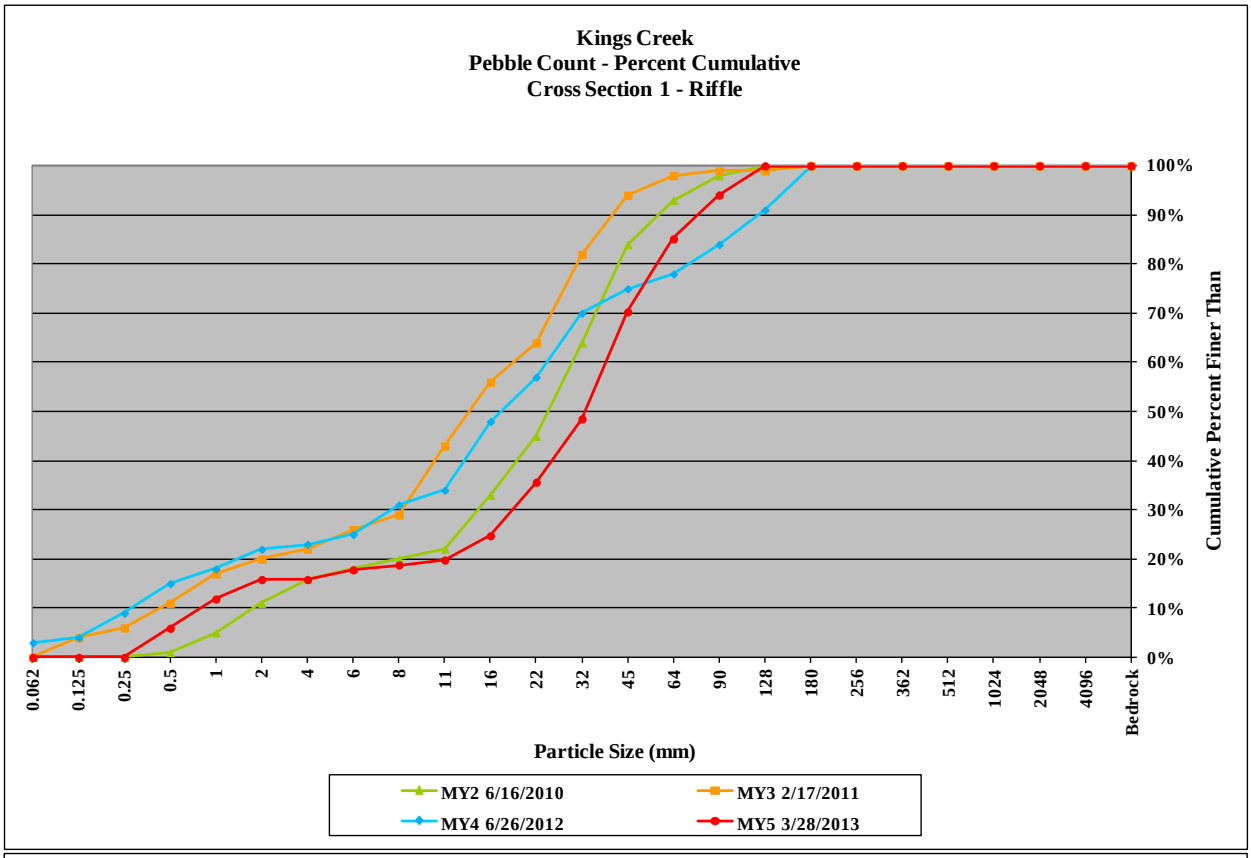

Cross-Section 4 – Pool
Upstream
Monitoring Year 5 – March 28, 2013

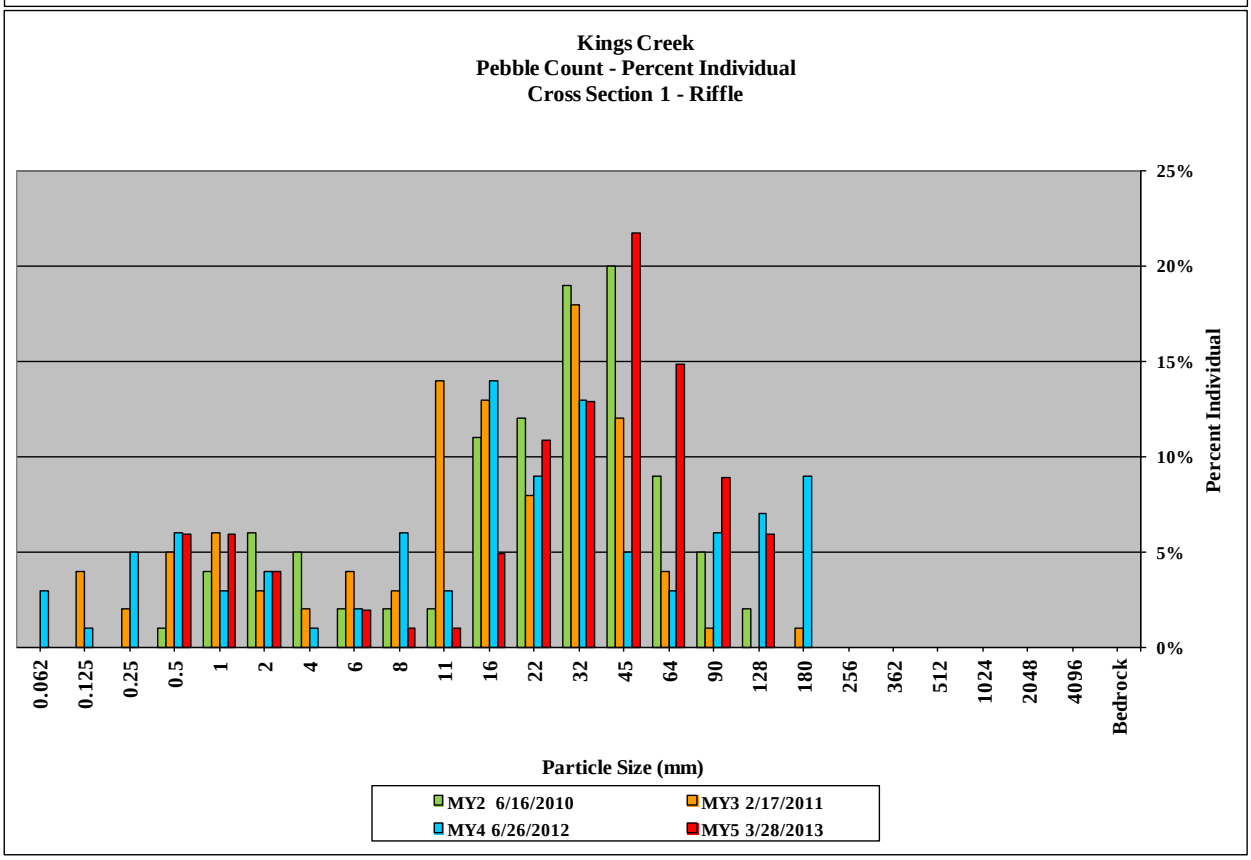
**Kings Creek**
**Longitudinal Profile**
**Stationing 1+14 - 22+28**



| Kings Creek / Project No. 208<br>Cross Section 1 - Pebble Count Summary<br>Riffle | | | | | |
|---|---|---|---|---|---|
| | | | Monitoring Year 5 | | |
| **Description** | **Material** | **Size (mm)** | **Total #** | **Item %** | **Cum %** |
| **Silt/Clay** | silt/clay | 0.062 | | 0% | 0% |
| **Sand** | very fine sand | 0.125 | | 0% | 0% |
| | fine sand | 0.25 | | 0% | 0% |
| | medium sand | 0.50 | 6 | 6% | 6% |
| | coarse sand | 1.00 | 6 | 6% | 12% |
| | very coarse sand | 2.00 | 4 | 4% | 16% |
| **Gravel** | very fine gravel | 4.0 | | 0% | 16% |
| | fine gravel | 5.7 | 2 | 2% | 18% |
| | fine gravel | 8.0 | 1 | 1% | 19% |
| | medium gravel | 11.3 | 1 | 1% | 20% |
| | medium gravel | 16.0 | 5 | 5% | 25% |
| | coarse gravel | 22.3 | 11 | 11% | 36% |
| | coarse gravel | 32 | 13 | 13% | 49% |
| | very coarse gravel | 45 | 22 | 22% | 70% |
| | very coarse gravel | 64 | 15 | 15% | 85% |
| **Cobble** | small cobble | 90 | 9 | 9% | 94% |
| | medium cobble | 128 | 6 | 6% | 100% |
| | large cobble | 180 | | 0% | 100% |
| | very large cobble | 256 | | 0% | 100% |
| **Boulder** | small boulder | 362 | | 0% | 100% |
| | small boulder | 512 | | 0% | 100% |
| | medium boulder | 1024 | | 0% | 100% |
| | large boulder | 2048 | | 0% | 100% |
| | very large boulder | 4096 | | 0% | 100% |
| **Bedrock** | bedrock | >4096 | | 0% | 100% |
| **TOTALS** | | | 101 | 100% | 100% |

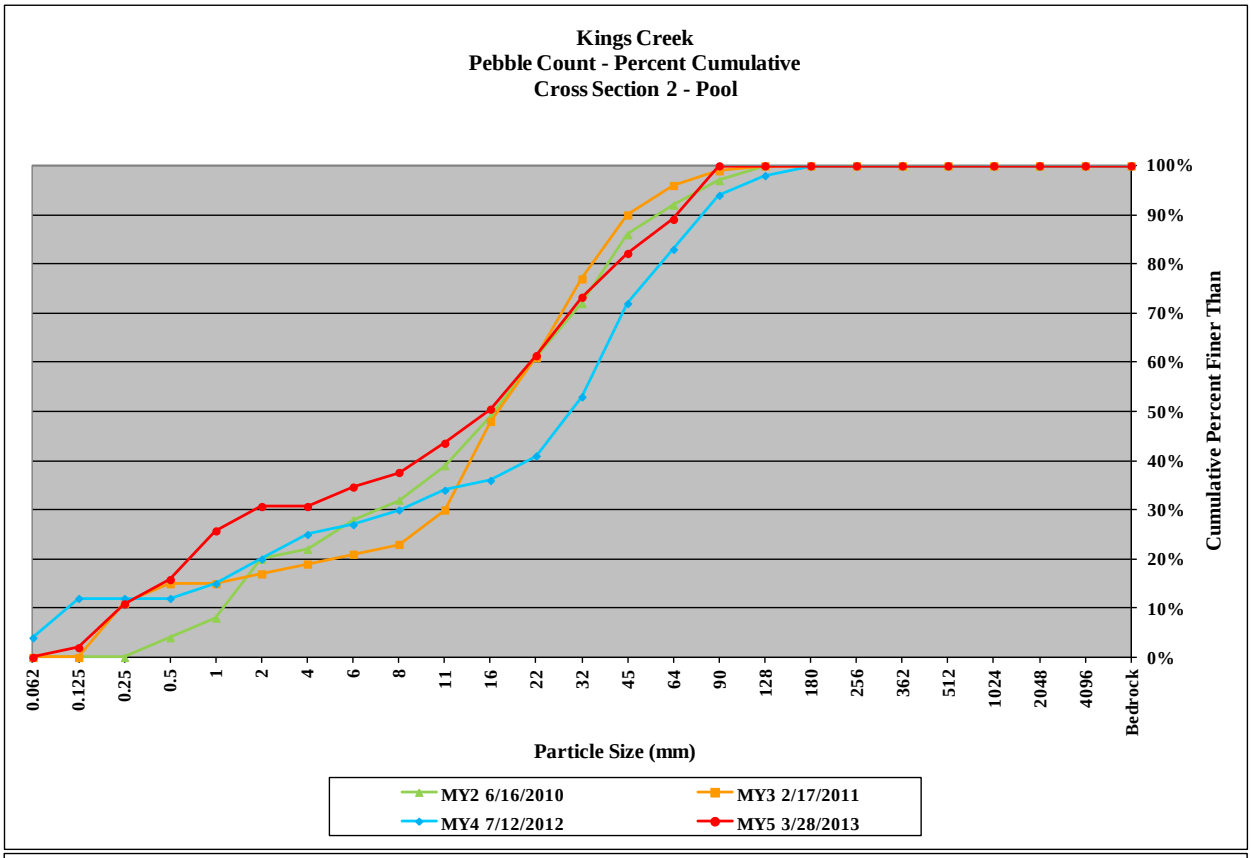
| Summary Data | |
|---|---|
| D50 | 33 |
| D84 | 62 |
| D95 | 95 |

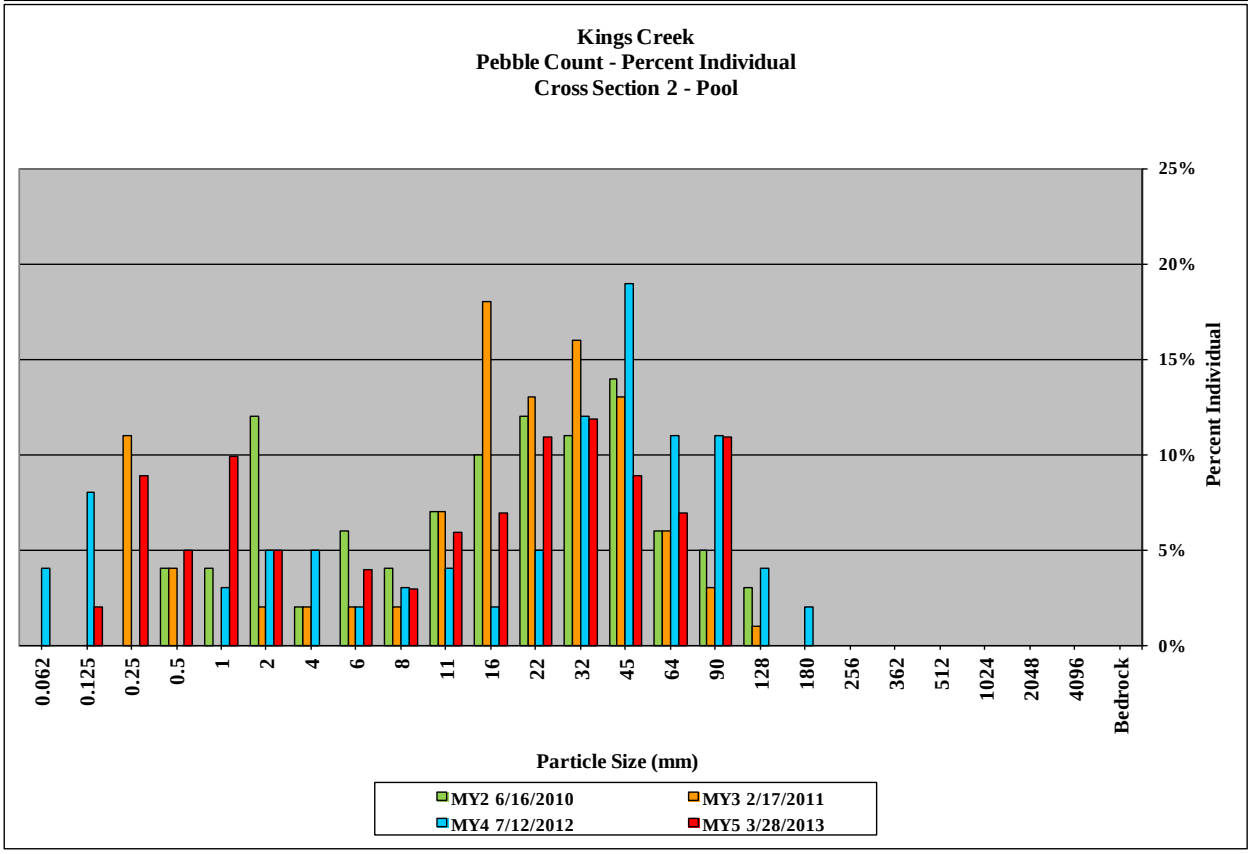

Kings Creek
Pebble Count - Percent Cumulative
Cross Section 1 - Riffle
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Percent Finer Than
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/17/2011
MY4 6/26/2012
MY5 3/28/2013


Kings Creek
Pebble Count - Percent Individual
Cross Section 1 - Riffle
25%
20%
15%
10%
5%
0%
Percent Individual
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/17/2011
MY4 6/26/2012
MY5 3/28/2013

| Kings Creek / Project No. 208<br>Cross Section 2 - Pebble Count Summary<br>Pool | | | | | |
|---|---|---|---|---|---|
| | | | Monitoring Year 5 | | |
| **Description** | **Material** | **Size (mm)** | **Total #** | **Item %** | **Cum %** |
| **Silt/Clay** | silt/clay | 0.062 | | 0% | 0% |
| **Sand** | very fine sand | 0.125 | 2 | 2% | 2% |
| | fine sand | 0.25 | 9 | 9% | 11% |
| | medium sand | 0.50 | 5 | 5% | 16% |
| | coarse sand | 1.00 | 10 | 10% | 26% |
| | very coarse sand | 2.00 | 5 | 5% | 31% |
| **Gravel** | very fine gravel | 4.0 | | 0% | 31% |
| | fine gravel | 5.7 | 4 | 4% | 35% |
| | fine gravel | 8.0 | 3 | 3% | 38% |
| | medium gravel | 11.3 | 6 | 6% | 44% |
| | medium gravel | 16.0 | 7 | 7% | 50% |
| | coarse gravel | 22.3 | 11 | 11% | 61% |
| | coarse gravel | 32 | 12 | 12% | 73% |
| | very coarse gravel | 45 | 9 | 9% | 82% |
| | very coarse gravel | 64 | 7 | 7% | 89% |
| **Cobble** | small cobble | 90 | 11 | 11% | 100% |
| | medium cobble | 128 | | 0% | 100% |
| | large cobble | 180 | | 0% | 100% |
| | very large cobble | 256 | | 0% | 100% |
| **Boulder** | small boulder | 362 | | 0% | 100% |
| | small boulder | 512 | | 0% | 100% |
| | medium boulder | 1024 | | 0% | 100% |
| | large boulder | 2048 | | 0% | 100% |
| | very large boulder | 4096 | | 0% | 100% |
| **Bedrock** | bedrock | >4096 | | 0% | 100% |
| **TOTALS** | | | 101 | 100% | 100% |

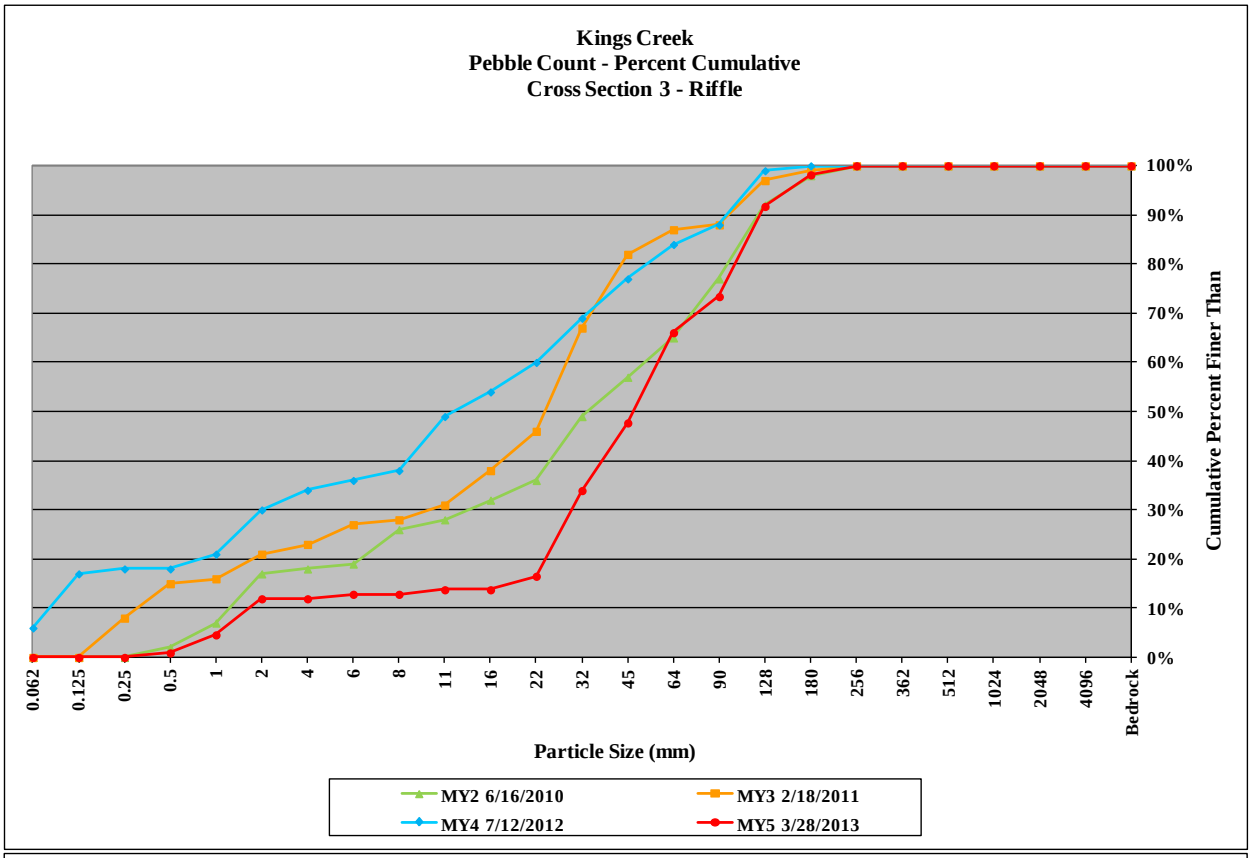
| Summary Data | |
|---|---|
| D50 | 16 |
| D84 | 49 |
| D95 | 77 |

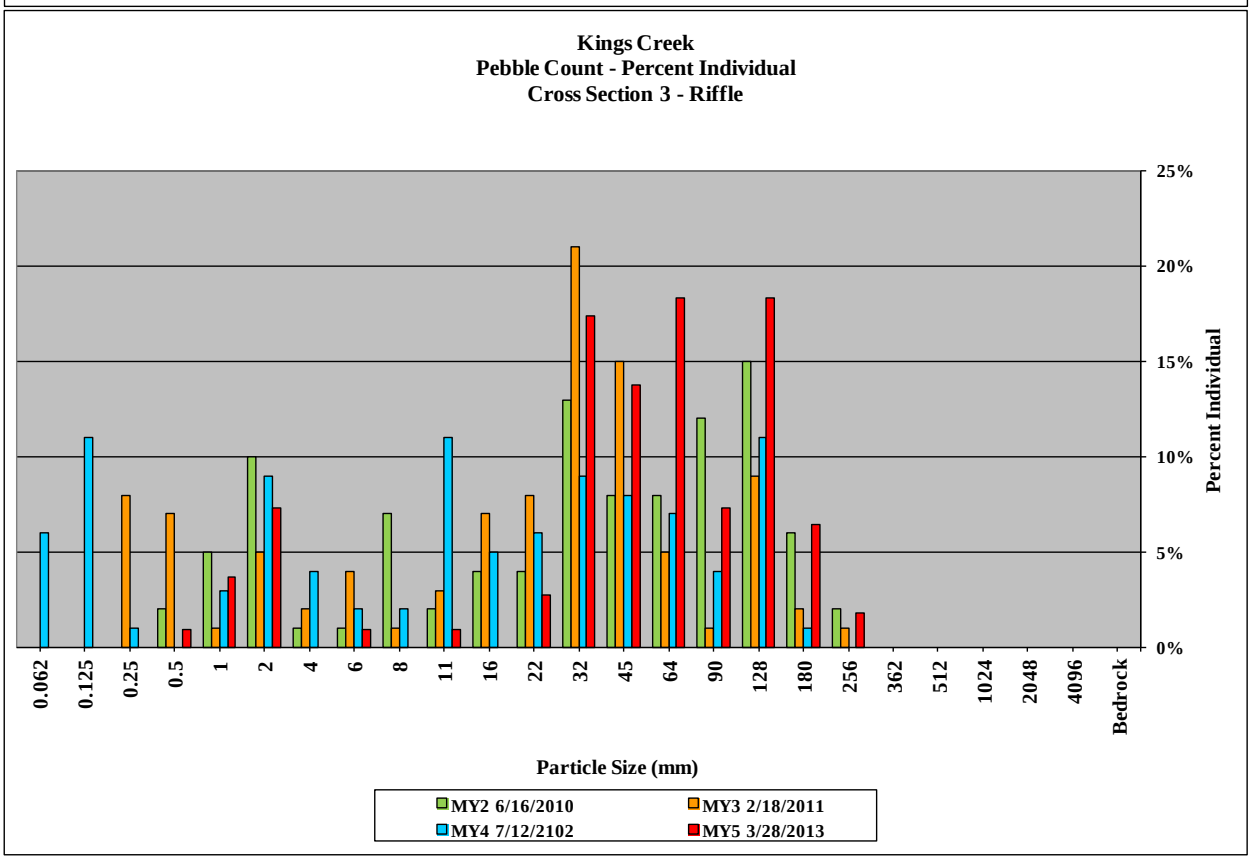

Kings Creek
Pebble Count - Percent Cumulative
Cross Section 2 - Pool
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Percent Finer Than
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/17/2011
MY4 7/12/2012
MY5 3/28/2013


Kings Creek
Pebble Count - Percent Individual
Cross Section 2 - Pool
25%
20%
15%
10%
5%
0%
Percent Individual
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/17/2011
MY4 7/12/2012
MY5 3/28/2013

| Kings Creek / Project No. 208<br>Cross Section 3 - Pebble Count Summary<br>Riffle | | | | | |
|---|---|---|---|---|---|
| | | | Monitoring Year 5 | | |
| **Description** | **Material** | **Size (mm)** | **Total #** | **Item %** | **Cum %** |
| **Silt/Clay** | silt/clay | 0.062 | | 0% | 0% |
| **Sand** | very fine sand | 0.125 | | 0% | 0% |
| | fine sand | 0.25 | | 0% | 0% |
| | medium sand | 0.50 | 1 | 1% | 1% |
| | coarse sand | 1.00 | 4 | 4% | 5% |
| | very coarse sand | 2.00 | 8 | 7% | 12% |
| **Gravel** | very fine gravel | 4.0 | | 0% | 12% |
| | fine gravel | 5.7 | 1 | 1% | 13% |
| | fine gravel | 8.0 | | 0% | 13% |
| | medium gravel | 11.3 | 1 | 1% | 14% |
| | medium gravel | 16.0 | | 0% | 14% |
| | coarse gravel | 22.3 | 3 | 3% | 17% |
| | coarse gravel | 32 | 19 | 17% | 34% |
| | very coarse gravel | 45 | 15 | 14% | 48% |
| | very coarse gravel | 64 | 20 | 18% | 66% |
| **Cobble** | small cobble | 90 | 8 | 7% | 73% |
| | medium cobble | 128 | 20 | 18% | 92% |
| | large cobble | 180 | 7 | 6% | 98% |
| | very large cobble | 256 | 2 | 2% | 100% |
| **Boulder** | small boulder | 362 | | 0% | 100% |
| | small boulder | 512 | | 0% | 100% |
| | medium boulder | 1024 | | 0% | 100% |
| | large boulder | 2048 | | 0% | 100% |
| | very large boulder | 4096 | | 0% | 100% |
| **Bedrock** | bedrock | >4096 | | 0% | 100% |
| **TOTALS** | | | 109 | 100% | 100% |

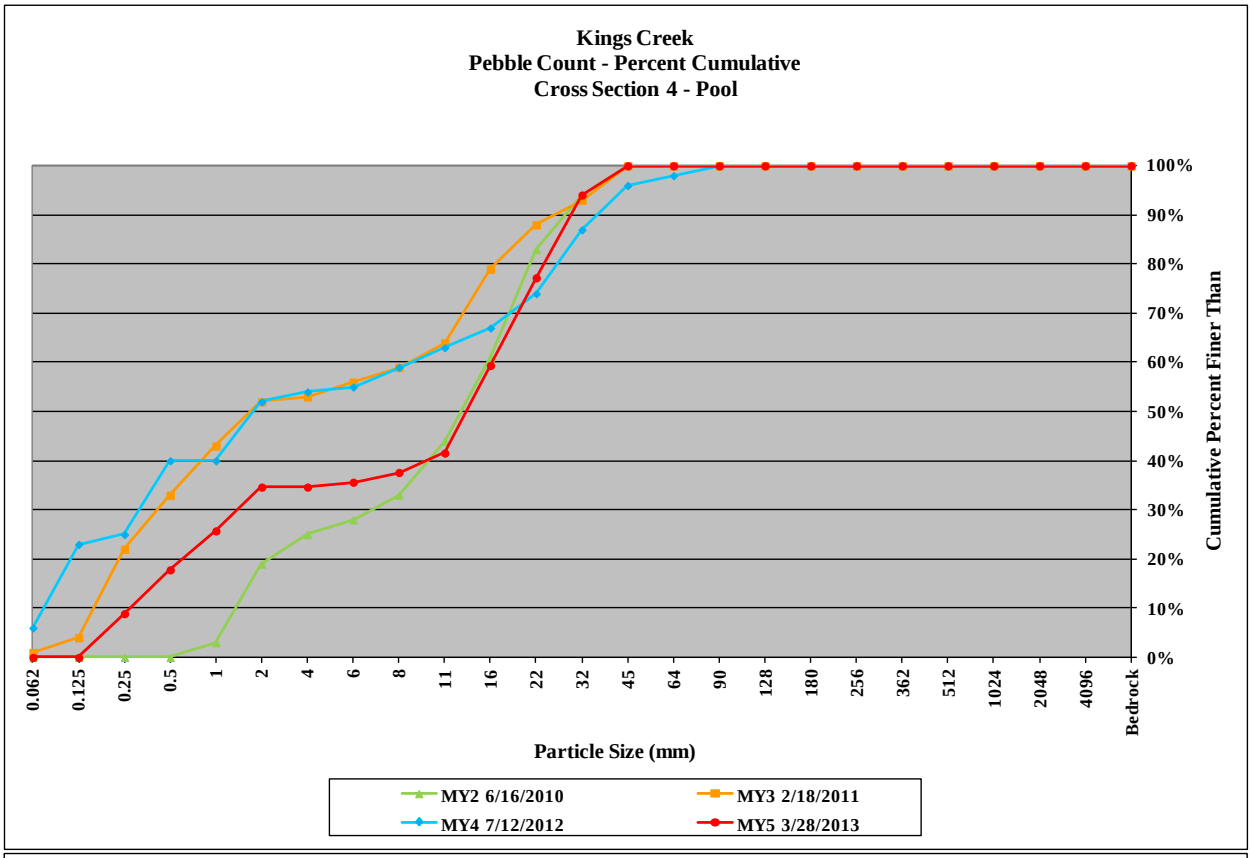
| Summary Data | |
|---|---|
| D50 | 47 |
| D84 | 110 |
| D95 | 150 |


Kings Creek
Pebble Count - Percent Cumulative
Cross Section 3 - Riffle
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Percent Finer Than
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/18/2011
MY4 7/12/2012
MY5 3/28/2013


Kings Creek
Pebble Count - Percent Individual
Cross Section 3 - Riffle
25%
20%
15%
10%
5%
0%
Percent Individual
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/18/2011
MY4 7/12/2102
MY5 3/28/2013

| Kings Creek / Project No. 208<br>Cross Section 4 - Pebble Count Summary<br>Pool | | | | | |
|---|---|---|---|---|---|
| | | | Monitoring Year 5 | | |
| **Description** | **Material** | **Size (mm)** | **Total #** | **Item %** | **Cum %** |
| **Silt/Clay** | silt/clay | 0.062 | | 0% | 0% |
| **Sand** | very fine sand | 0.125 | | 0% | 0% |
| | fine sand | 0.25 | 9 | 9% | 9% |
| | medium sand | 0.50 | 9 | 9% | 18% |
| | coarse sand | 1.00 | 8 | 8% | 26% |
| | very coarse sand | 2.00 | 9 | 9% | 35% |
| **Gravel** | very fine gravel | 4.0 | | 0% | 35% |
| | fine gravel | 5.7 | 1 | 1% | 36% |
| | fine gravel | 8.0 | 2 | 2% | 38% |
| | medium gravel | 11.3 | 4 | 4% | 42% |
| | medium gravel | 16.0 | 18 | 18% | 59% |
| | coarse gravel | 22.3 | 18 | 18% | 77% |
| | coarse gravel | 32 | 17 | 17% | 94% |
| | very coarse gravel | 45 | 6 | 6% | 100% |
| | very coarse gravel | 64 | | 0% | 100% |
| **Cobble** | small cobble | 90 | | 0% | 100% |
| | medium cobble | 128 | | 0% | 100% |
| | large cobble | 180 | | 0% | 100% |
| | very large cobble | 256 | | 0% | 100% |
| **Boulder** | small boulder | 362 | | 0% | 100% |
| | small boulder | 512 | | 0% | 100% |
| | medium boulder | 1024 | | 0% | 100% |
| | large boulder | 2048 | | 0% | 100% |
| | very large boulder | 4096 | | 0% | 100% |
| **Bedrock** | bedrock | >4096 | | 0% | 100% |
| **TOTALS** | | | 101 | 100% | 100% |

| Summary Data | |
|---|---|
| D50 | 13 |
| D84 | 26 |
| D95 | 34 |


Kings Creek
Pebble Count - Percent Cumulative
Cross Section 4 - Pool
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Cumulative Percent Finer Than
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/18/2011
MY4 7/12/2012
MY5 3/28/2013

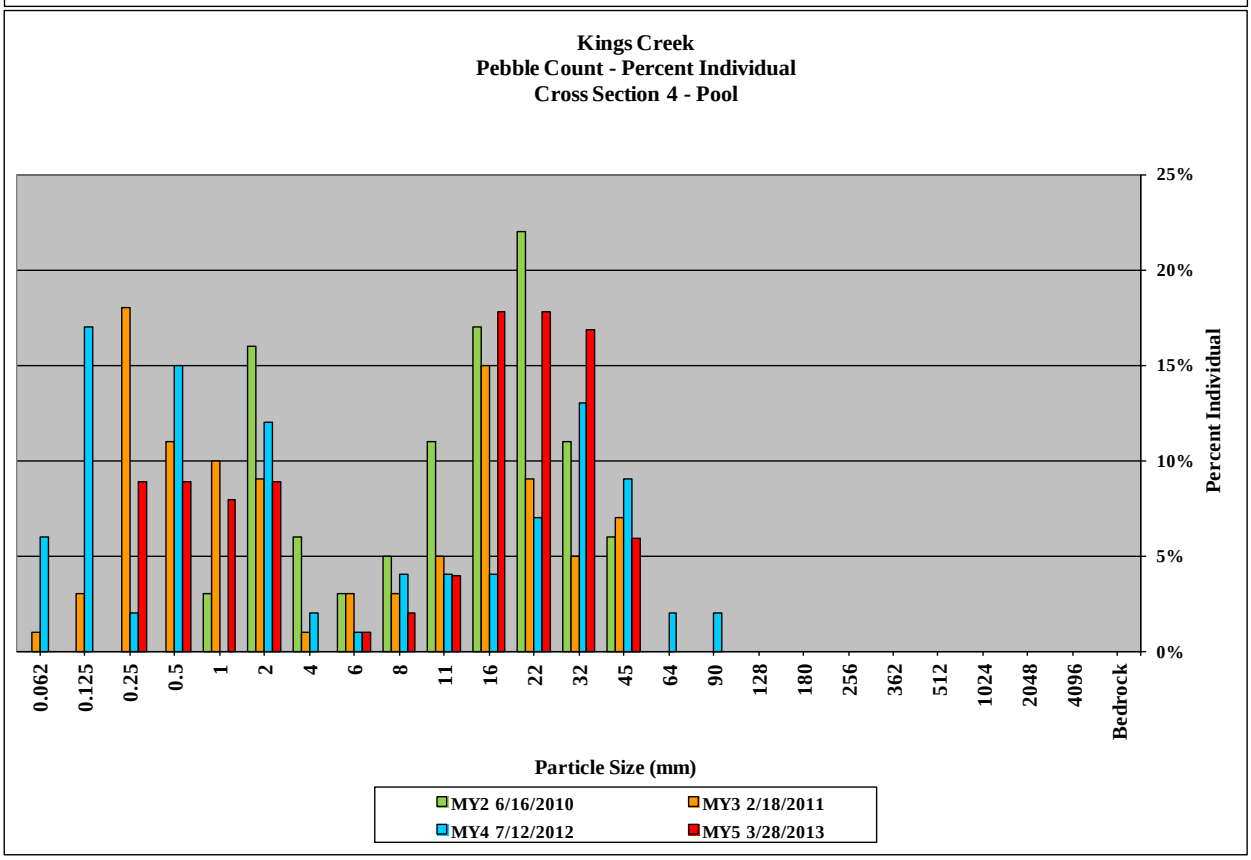

Kings Creek
Pebble Count - Percent Individual
Cross Section 4 - Pool
25%
20%
15%
10%
5%
0%
Percent Individual
0.062
0.125
0.25
0.5
1
2
4
6
8
11
16
22
32
45
64
90
128
180
256
362
512
1024
2048
4096
Bedrock
Particle Size (mm)
MY2 6/16/2010
MY3 2/18/2011
MY4 7/12/2012
MY5 3/28/2013

**Table 10a. Baseline Stream Data Summary**
**Kings Creek / Project No. 208**

| Parameter | Gauge | Regional Curve | | | Pre-Existing Condition | | | | | | Reference Reach(es) Data | | | | | | Design | | | Monitoring Baseline | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimension & Substrate - Riffle** | | LL | UL | Eq. | Min | Mean | Med | Max | SD | n | Min | Mean | Med | Max | SD | n | Min | Med | Max | Min | Mean | Med | Max | SD | n |
| Bankfull Width (ft) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 24.2 | 25.5 | 25.5 | 26.7 | N/A | 2 |
| Floodprone Width (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | >150 | >150 | >150 | >150 | N/A | 2 |
| Bankfull Mean Depth (ft) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2.1 | 2.2 | 2.2 | 2.2 | N/A | 2 |
| Bankfull Max Depth (ft) | - | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3.0 | 3.1 | 3.1 | 3.1 | N/A | 2 |
| Bankfull Cross-Sectional Area ($ft^2$) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 51.9 | 55.2 | 55.2 | 58.5 | N/A | 2 |
| Width/Depth Ratio | - | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 11.3 | 11.8 | 11.8 | 12.2 | N/A | 2 |
| Entrenchment Ratio | - | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | >3.60 | >3.65 | >3.65 | >3.70 | N/A | 2 |
| Bank Height Ratio | - | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.0 | 1.0 | 1.0 | 1.0 | N/A | 2 |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 29.3 | 46.0 | 44.4 | 68.2 | 13.2 | 10 |
| Riffle Slope (ft/ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.0026 | 0.0069 | 0.0059 | 0.0153 | 0.0039 | 10 |
| Pool Length (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 28.1 | 52.4 | 58.6 | 69.8 | 15.6 | 11 |
| Pool Max Depth (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.4 | 2.2 | 2.3 | 3.4 | 0.5 | 11 |
| Pool Spacing (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 98.5 | 150.6 | 143.2 | 220.9 | 40.9 | 8 |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channel Beltwidth (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 61.0 | 110.8 | 107.5 | 173.0 | 35.2 | 12 |
| Radius of Curvature (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 41.0 | 62.0 | 56.0 | 139.0 | 26.7 | 11 |
| Rc: Bankfull Width (ft/ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Meander Wavelength (ft) | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 231.0 | 276.8 | 240.0 | 414.0 | 77.6 | 5 |
| Meander Width Ratio | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4.0 | 4.2 | 4.2 | 4.4 | N/A | 2 |
| **Transport Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Reach Shear Stress (competency) ($lb/ft^2$) | | | | | | | - | | | | | | | | | | | - | | | | - | | |
| Max part size (mm) mobilized at bankfull | | | | | | | - | | | | | | | | | | | - | | | | - | | |
| Stream Power (transport capacity) ($W/m^2$) | | | | | | | - | | | | | | | | | | | - | | | | - | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rosgen Classification | - | | | | | | - | | | | | | - | | | | | - | | | | C4 | | |
| Bankfull Velocity (fps) | - | - | - | - | | | - | | | | | | | | | | | - | | | | - | | |
| Bankfull Discharge (cfs) | - | - | - | - | | | - | | | | | | | | | | | | | | | | | |
| Valley Length (ft) | | | | | | | 1,694 | | | | | | - | | | | | | | | | | | |
| Channel Thalweg Length (ft) | | | | | | | 1,815 | | | | | | - | | | | | - | | | | 2,135 | | |
| Sinuosity (ft) | | | | | | | 1.07 | | | | | | - | | | | | - | | | | 1.28 | | |
| Water Surface Slope (Channel) (ft/ft) | - | | | | | | - | | | | | | - | | | | | - | | | | 0.0049 | | |
| Bankfull Slope (ft/ft) | - | | | | | | - | | | | | | - | | | | | - | | | | 0.0044 | | |
| Bankfull Floodplain Area (acres) | | | | | | | - | | | | | | - | | | | | - | | | | - | | |
| % of Reach with Eroding Banks | | | | | | | - | | | | | | - | | | | | | | | | | | |
| Channel Stability or Habitat Metric | | | | | | | - | | | | | | - | | | | | | | | | | | |
| Biological or Other | | | | | | | - | | | | | | - | | | | | | | | | | | |

- Information unavailable
N/A - Information does not apply

**Table 10b. Baseline Stream Data Summary**
**(Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)**
**Kings Creek / Project No. 208 - Reaches: I & III**

| Parameter | Pre-Existing Condition | | | | | | | Reference Reach(es) Data | | | | | | | Design | | | | | | | Monitoring Baseline | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ri% / Ru% / P% / G% / S% | - | - | - | - | - | | | - | - | - | - | - | | | - | - | - | - | - | - | - | 33% | 10% | 41% | 16% | 0% | | |
| SC% / SA% / G% / C% / B% / Be% | - | - | - | - | - | - | | - | - | - | - | - | - | | | | | | | | | | | | | | | |
| d16 / d35 / d50 / d84 / d95 / $di^p$ / $di^{sp}$ (mm) | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | | | | | | | | | | | |
| Entrenchment Class<br><1.5 / 1.5 - 1.99 / 2 - 4.9 / 5.0 - 9.9 / >10 | - | - | - | - | - | | | - | - | - | - | - | | | | | | | | | | - | - | - | - | - | | |
| Incision Class<br><1.2 / 1.2 - 1.49 / 1.5 - 1.99 / >2.0 | - | - | - | - | | | | - | - | - | - | | | | | | | | | | | - | - | - | - | | | |

Ri = Riffle / Ru = Run / P = Pool / G = Glide / S = Step
SC = Silt-Clay / SA = Sand / G = Gravel / C = Cobble / B = Boulder / Be = Bedrock
$di^p$ = max pave / $di^{sp}$ = max sub pave
- Information unavailable

**Table 11a. Monitoring Data - Dimensional Morphology Summary**
**(Dimensional Parameters - Cross-Sections)**
**Kings Creek / Project No. 208**

| | Cross-Section 1 Riffle | | | | | | Cross-Section 2 Pool | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimension** | **Base** | **MY1** | **MY2** | **MY3** | **MY4** | **MY5** | **Base** | **MY1** | **MY2** | **MY3** | **MY4** | **MY5** |
| Record elevation (datum) used | - | - | 2108.9 | 2108.9 | 2108.9 | 2108.9 | - | - | 2108.1 | 2108.1 | 2108.1 | 2108.1 |
| Bankfull Width (ft) | 26.7 | - | 26.8 | 26.8 | 27.5 | 27.2 | 31.1 | - | 30.3 | 29.8 | 29.6 | 27.6 |
| Floodprone Width (ft) | >150 | - | >150 | >150 | >150 | >150 | >150 | - | >150 | >150 | >150 | >150 |
| Bankfull Mean Depth (ft) | 2.2 | - | 2.2 | 2.1 | 2.0 | 2.0 | 2.5 | - | 1.9 | 1.9 | 1.9 | 2.0 |
| Bankfull Max Depth (ft) | 3.1 | - | 3.3 | 3.3 | 3.3 | 3.4 | 4.7 | - | 3.7 | 3.5 | 3.4 | 3.3 |
| Bankfull Cross-Sectional Area ($ft^2$) | 58.5 | - | 58.0 | 57.3 | 56.1 | 55.2 | 76.6 | - | 58.5 | 55.6 | 55.0 | 54.1 |
| Bankfull Width/Depth Ratio | 12.2 | - | 12.4 | 12.5 | 13.5 | 13.4 | 12.7 | - | 15.7 | 16.0 | 15.9 | 14.1 |
| Bankfull Entrenchment Ratio | >3.7 | - | >5.6 | >5.6 | >5.4 | >5.5 | >3.9 | - | >4.9 | >5.0 | >5.1 | >5.4 |
| Bankfull Bank Height Ratio | 1.0 | - | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | - | 1.1 | 1.1 | 1.1 | 1.1 |
| Cross-Sectional Area Between End Pins ($ft^2$) | - | - | 59.6 | 58.4 | 56.6 | 56.1 | - | - | 61.6 | 57.4 | 57.1 | 55.9 |
| d50 (mm) | - | - | 24 | 13 | 17 | 33 | - | - | 16 | 17 | 29 | 16 |
| | **Cross-Section 3 Riffle** | | | | | | **Cross-Section 4 Pool** | | | | | |
| **Dimension** | **Base** | **MY1** | **MY2** | **MY3** | **MY4** | **MY5** | **Base** | **MY1** | **MY2** | **MY3** | **MY4** | **MY5** |
| Record elevation (datum) used | - | - | 2104.7 | 2104.7 | 2104.7 | 2104.7 | - | - | 2104.1 | 2104.1 | 2104.1 | 2104.1 |
| Bankfull Width (ft) | 24.2 | - | 25.7 | 25.6 | 25.8 | 27.9 | 28.3 | - | 25.8 | 25.9 | 24.1 | 22.8 |
| Floodprone Width (ft) | >150 | - | >150 | >150 | >150 | >150 | >150 | - | >150 | >150 | >150 | >150 |
| Bankfull Mean Depth (ft) | 2.1 | - | 2.1 | 2.0 | 2.1 | 1.8 | 2.0 | - | 2.5 | 2.6 | 2.7 | 2.9 |
| Bankfull Max Depth (ft) | 3.0 | - | 3.2 | 3.1 | 3.1 | 3.1 | 3.1 | - | 4.4 | 4.5 | 4.5 | 4.2 |
| Bankfull Cross-Sectional Area ($ft^2$) | 51.9 | - | 53.1 | 52.0 | 53.0 | 51.1 | 55.5 | - | 63.1 | 67.4 | 65.9 | 65.3 |
| Bankfull Width/Depth Ratio | 11.3 | - | 12.4 | 12.6 | 12.5 | 15.3 | 14.4 | - | 10.5 | 9.9 | 8.8 | 7.9 |
| Bankfull Entrenchment Ratio | >3.6 | - | >5.8 | >5.9 | >5.8 | >5.4 | >3.2 | - | >5.8 | >5.8 | >6.2 | >6.6 |
| Bankfull Bank Height Ratio | 1.0 | - | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | - | 1.0 | 1.0 | 1.0 | 1.0 |
| Cross-Sectional Area Between End Pins ($ft^2$) | - | - | 60.2 | 59.3 | 59.4 | 56.1 | - | - | 66.1 | 69.3 | 67.6 | 66.5 |
| d50 (mm) | - | - | 33 | 24 | 12 | 47 | - | - | 13 | 2 | 2 | 13 |

- Information unavailable

**Table 11b. Monitoring Data - Stream Reach Data Summary**
**Kings Creek / Project No. 208 - Reach I & III**

| Parameter | Baseline | | | | | | MY - 1 | | | | | | MY - 2 | | | | | | MY - 3 | | | | | | MY - 4 | | | | | | MY - 5 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dimension & Substrate - Riffle** | **Min** | **Mean** | **Med** | **Max** | **SD** | **n** | **Min** | **Mean** | **Med** | **Max** | **SD** | **n** | **Min** | **Mean** | **Med** | **Max** | **SD** | **n** | **Min** | **Mean** | **Med** | **Max** | **SD** | **n** | **Min** | **Mean** | **Med** | **Max** | **SD** | **n** | **Min** | **Mean** | **Med** | **Max** | **SD** | **n** |
| Bankfull Width (ft) | 24.2 | 25.5 | 25.5 | 26.7 | N/A | 2 | - | - | - | - | - | - | 25.7 | 26.3 | 26.3 | 26.8 | N/A | 2 | 25.6 | 26.2 | 26.2 | 26.8 | N/A | 2 | 25.8 | 26.7 | 26.7 | 27.5 | N/A | 2 | 27.2 | 27.6 | 27.6 | 27.9 | N/A | 2 |
| Floodprone Width (ft) | >150 | >150 | >150 | >150 | N/A | 2 | - | - | - | - | - | - | >150 | >150 | >150 | >150 | N/A | 2 | >150 | >150 | >150 | >150 | N/A | 2 | >150 | >150 | >150 | >150 | N/A | 2 | >150 | >150 | >150 | >150 | N/A | 2 |
| Bankfull Mean Depth (ft) | 2.1 | 2.2 | 2.2 | 2.2 | N/A | 2 | - | - | - | - | - | - | 2.1 | 2.2 | 2.2 | 2.2 | N/A | 2 | 2.0 | 2.1 | 2.1 | 2.1 | N/A | 2 | 2.0 | 2.1 | 2.1 | 2.1 | N/A | 2 | 1.8 | 1.9 | 1.9 | 2.0 | N/A | 2 |
| Bankfull Max Depth (ft) | 3.0 | 3.1 | 3.1 | 3.1 | N/A | 2 | - | - | - | - | - | - | 3.2 | 3.3 | 3.3 | 3.3 | N/A | 2 | 3.1 | 3.2 | 3.2 | 3.3 | N/A | 2 | 3.1 | 3.2 | 3.2 | 3.3 | N/A | 2 | 3.1 | 3.3 | 3.3 | 3.4 | N/A | 2 |
| Bankfull Cross-Sectional Area ($ft^2$) | 51.9 | 55.2 | 55.2 | 58.5 | N/A | 2 | - | - | - | - | - | - | 53.1 | 55.6 | 55.6 | 58.0 | N/A | 2 | 52.0 | 54.7 | 54.7 | 57.3 | N/A | 2 | 53.0 | 54.6 | 54.6 | 56.1 | N/A | 2 | 51.1 | 53.2 | 53.2 | 55.2 | N/A | 2 |
| Width/Depth Ratio | 11.3 | 11.8 | 11.8 | 12.2 | N/A | 2 | - | - | - | - | - | - | 12.4 | 12.4 | 12.4 | 12.4 | N/A | 2 | 12.5 | 12.6 | 12.6 | 12.6 | N/A | 2 | 12.5 | 13.0 | 13.0 | 13.5 | N/A | 2 | 13.4 | 14.4 | 14.4 | 15.3 | N/A | 2 |
| Entrenchment Ratio | >3.6 | >3.7 | >3.7 | >3.7 | N/A | 2 | - | - | - | - | - | - | >5.6 | >5.7 | >5.7 | >5.8 | N/A | 2 | >5.6 | >5.8 | >5.8 | >5.9 | N/A | 2 | >5.4 | >5.6 | >5.6 | >5.8 | N/A | 2 | >5.4 | >5.5 | >5.5 | >5.5 | N/A | 2 |
| Bank Height Ratio | 1.0 | 1.0 | 1.0 | 1.0 | N/A | 2 | - | - | - | - | - | - | 1.0 | 1.0 | 1.0 | 1.0 | N/A | 2 | 1.0 | 1.0 | 1.0 | 1.0 | N/A | 2 | 1.0 | 1.0 | 1.0 | 1.0 | N/A | 2 | 1.0 | 1.0 | 1.0 | 1.0 | N/A | 2 |
| **Profile** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Riffle Length (ft) | 29.3 | 46.0 | 44.4 | 68.2 | 13.2 | 10 | 9.5 | 34.7 | 33.3 | 58.8 | 16.6 | 10 | 10.8 | 25.7 | 25.6 | 63.0 | 15.5 | 10 | 11.9 | 33.4 | 30.5 | 60.9 | 15.6 | 9 | 13.5 | 35.2 | 31.2 | 58.2 | 14.3 | 9 | 13.0 | 34.8 | 36.2 | 59.0 | 12.8 | 9 |
| Riffle Slope (ft/ft) | 0.003 | 0.007 | 0.006 | 0.015 | 0.004 | 10 | 0.005 | 0.013 | 0.010 | 0.027 | 0.008 | 10 | 0.003 | 0.017 | 0.020 | 0.025 | 0.009 | 10 | 0.004 | 0.013 | 0.012 | 0.029 | 0.007 | 9 | 0.004 | 0.013 | 0.012 | 0.027 | 0.008 | 9 | 0.002 | 0.015 | 0.013 | 0.034 | 0.010 | 9 |
| Pool Length (ft) | 28.1 | 52.4 | 58.6 | 69.8 | 15.6 | 11 | 12.9 | 35.7 | 32.2 | 87.9 | 18.9 | 22 | 14.4 | 41.4 | 38.1 | 99.8 | 21.7 | 22 | 14.7 | 38.3 | 33.9 | 100.7 | 21.4 | 21 | 15.1 | 38.2 | 37.4 | 96.7 | 21.1 | 21 | 14.8 | 40.3 | 38.5 | 97.8 | 22.4 | 23 |
| Pool Max Depth (ft) | 3.1 | 3.9 | 3.9 | 4.7 | N/A | 2 | - | - | - | - | - | - | 3.7 | 4.1 | 4.1 | 4.4 | N/A | 2 | 3.5 | 4.0 | 4.0 | 4.5 | N/A | 2 | 4.0 | 5.1 | 5.0 | 7.2 | 0.8 | 21 | 3.9 | 4.8 | 4.7 | 6.4 | 0.6 | 22 |
| Pool Spacing (ft) | 98.5 | 150.6 | 143.2 | 220.9 | 40.9 | 8 | 22.9 | 94.6 | 101.2 | 170.5 | 40.9 | 21 | 32.0 | 79.8 | 71.1 | 214.1 | 41.4 | 21 | 30.5 | 88.6 | 93.3 | 183.3 | 38.3 | 19 | 38.2 | 89.7 | 84.8 | 161.5 | 35.4 | 19 | 31.1 | 86.9 | 83.4 | 172.8 | 35.7 | 21 |
| **Pattern** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Channel Belt Width (ft) | 61.0 | 110.8 | 107.5 | 173.0 | 35.2 | 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Radius of Curvature (ft) | 41.0 | 62.0 | 56.0 | 139.0 | 26.7 | 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rc: Bankfull Width (ft/ft) | - | - | - | - | - | - | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Meander Wavelength (ft) | 231.0 | 276.8 | 240.0 | 414.0 | 77.6 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Meander Width Ratio | 4.0 | 4.2 | 4.2 | 4.4 | N/A | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Additional Reach Parameters** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rosgen Classification | C4 | | | | | | - | | | | | | C4 | | | | | | C4 | | | | | | C4 | | | | | | C4 | | | | | |
| Channel Thalweg Length (ft) | 2,119 | | | | | | 2,189 | | | | | | 2,135 | | | | | | 2,138 | | | | | | 2,101 | | | | | | 2,092 | | | | | |
| Sinuosity (ft) | 1.25 | | | | | | 1.29 | | | | | | 1.28 | | | | | | 1.28 | | | | | | 1.26 | | | | | | 1.25 | | | | | |
| Water Surface Slope (Channel) (ft/ft) | 0.0049 | | | | | | 0.0050 | | | | | | 0.0048 | | | | | | 0.0048 | | | | | | 0.0048 | | | | | | 0.0049 | | | | | |
| Bankfull Slope (ft/ft) | 0.0044 | | | | | | 0.0051 | | | | | | 0.0052 | | | | | | 0.0049 | | | | | | 0.0048 | | | | | | 0.0051 | | | | | |
| Ri% / Ru% / P% / G% / S%* | 33% | 10% | 41% | 16% | 0% | | 22% | 11% | 51% | 16% | 0% | | 16% | 6% | 57% | 21% | 0% | | 17% | 9% | 45% | 28% | 0% | | 17% | 12% | 44% | 26% | 0% | | 16% | 14% | 47% | 23% | 0% | |
| SC% / SA% / G% / C% / B% / Be% | | | | | | | | | | | | | 0% | 17% | 71% | 13% | 0% | 0% | 0% | 27% | 68% | 5% | 0% | 0% | 5% | 26% | 59% | 10% | 0% | 0% | 0% | 23% | 62% | 15% | 0% | 0% |
| d16 / d35 / d50 / d84 / d95 (mm) | | | | | | | | | | | | | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| % of Reach with Eroding Banks | 0% | | | | | | 11% | | | | | | 15% | | | | | | 15% | | | | | | 15% | | | | | | 16% | | | | | |
| Channel Stability or Habitat Metric | N/A | | | | | | N/A | | | | | | N/A | | | | | | N/A | | | | | | N/A | | | | | | N/A | | | | | |
| Biological or Other | N/A | | | | | | N/A | | | | | | N/A | | | | | | N/A | | | | | | N/A | | | | | | N/A | | | | | |

- Information unavailable

N/A - Information does not apply.

Ri = Riffle / Ru = Run / P = Pool / G = Glide / S = Step

SC = Silt-Clay / SA = Sand / G = Gravel / C = Cobble / B = Boulder / Be = Bedrock

*Percentages based on riffle and pool pebble counts

# Appendix E
# Hydrologic Data

| Table 12. Verification of Bankfull Events<br>Kings Creek / Project No. 208 | | | |
|---|---|---|---|
| **Date of Data Collection** | **Date of Occurrence** | **Method** | **Photo # (if available)** |
| 6/15/2010 | Unknown | Crest gauge & wrack lines | |
| 11/9/2010 | Unknown | Crest gauge & wrack lines | |
| 1/20/2011 | Unknown | Crest gauge & wrack lines | |
| 10/26/2011 | 9/6/2011 | Crest gauge & wrack lines | |
| 1/18/2012 | 11/29/2011 | Crest gauge & wrack lines | |
| 10/15/2012 | 9/19/2012 | Crest gauge & wrack lines | |
| 3/28/2013 | 1/31/2013 | Crest gauge & wrack lines | |
| 7/25/2013 | 07/03/13 | Precipitation data & anecdotal evidence | |