YEAR 4 (2012)
ANNUAL MONITORING REPORT
THREE MILE CREEK RESTORATION SITE (EEP Project# 92664)
AVERY COUNTY, NORTH CAROLINA
(Contract #16-D06125-A)

FULL DELIVERY PROJECT
TO PROVIDE STREAM AND WETLAND MITIGATION
IN THE FRENCH BROAD RIVER BASIN
CATALOGING UNIT 06010108

Prepared for:

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EXECUTIVE SUMMARY

Restoration Systems, L.L.C. has completed restoration of streams and wetlands at the Three Mile Creek Restoration Site (hereafter referred to as the "Site") to assist the North Carolina Ecosystem Enhancement Program in fulfilling stream and wetland mitigation goals. The Site, located in southwestern Avery County approximately 5.2 miles northeast of Spruce Pine, North Carolina, provides 8103 stream mitigation units and 3.7 riparian wetland mitigation units as described in the As-Built Mitigation Plan dated April 2009. The Site is located in United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 06010108010020 (North Carolina Division of Water Quality Subbasin 04-03-06) of the French Broad River Basin. This report serves as the Year 4 (2012) annual monitoring report.

Primary activities at the Site included 1) stream restoration, 2) stream enhancement, 3) stream preservation, 4) wetland restoration and enhancement, 5) soil scarification, and 6) plant community restoration. Project restoration efforts provide 8103 Stream Mitigation Units and 3.7 riverine Wetland Mitigation Units.

Eight vegetation plots (10-meter by 10-meter in size) were established and permanently monumented. These plots were surveyed in July 2012 for the Year 4 (2012) monitoring season. Vegetation sampling across the Site was above the required average density with 622 planted stems per acre surviving. In addition, each individual plot was above success criteria. During early 2012, ball and burlap trees were planted in the vicinity of vegetation plots 3 and 4. These trees are doing well.

Eleven cross-sections and 3600 linear feet of longitudinal profiles were measured for the Year 4 (2012) monitoring. As a whole, monitoring measurements indicate that there have been minimal changes in both the longitudinal profile and cross-sections as compared to as-built data. The as-built channel geometry compares favorably with the emulated, stable E/C type stream reach as set forth in the detailed mitigation plan and construction plans. Current monitoring has demonstrated dimension, pattern, and profile were stable over the course of the monitoring period. During a heavy, flashy rain event in April 2011, an outer bend near Cross-section 6 was compromised; however, up- and downstream of the outerbend remained stable. The outer bend was repaired and replanted in September 2011, and is doing well through Year 4 (2012) monitoring. The outerbend will continue to be monitored closely. The only remaining stream problem area noted within the Site includes aggradation within a portion of Tributary 1, which resulted from the installation of a dirt driveway on the neighboring property in 2010. Aggradation of sediment in this reach has altered stream flow, which is currently bypassing a portion of the constructed channel. A walkthrough of the reach with NCEEP representatives is being scheduled to determine the appropriate course of action for this reach.

All three of the monitored gauges within restoration areas were inundated/saturated within 12 inches of the surface for greater than 12.5 percent of the growing season, which extends from May 1 to October 11 (163 days).

Marsh treatment areas, located at agricultural ditches entering the Site, were constructed as shallow depressions to attenuate flood flows and treat runoff entering Threemile Creek. Marsh treatment areas appear to be functioning properly. Marsh treatment area locations are depicted on Figure 2 (Appendix A).

In summary, Site vegetation, streams, and wetland hydrology met success criteria for Year 4 (2012) monitoring.

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1.0 PROJECT BACKGROUND

1.1 Location and Setting

Restoration Systems, L.L.C. (Restoration Systems) has completed restoration of streams and wetlands at the Three Mile Creek Restoration Site (hereafter referred to as the "Site") to assist the North Carolina Ecosystem Enhancement Program (NCEEP) in fulfilling stream and wetland mitigation goals. The Site, located in southwestern Avery County approximately 5.2 miles northeast of Spruce Pine, North Carolina, provides 8103 stream mitigation units and 3.7 riparian wetland mitigation units as described in the April 2009 As-Built Mitigation Plan (Figures 1 and 2, Appendix A). The Site is located in United States Geological Survey (USGS) Hydrologic Unit and Targeted Local Watershed 06010108010020 (North Carolina Division of Water Quality Subbasin 04-03-06) of the French Broad River Basin.

Directions to the Site:

- From Asheville or Raleigh, take I-40 to Marion; take NC 226 north through Linville Falls; go left on NC 194; site is ~4.5 miles on left
- Or, from Asheville take 19/23 North to 19E through Spruce Pine to NC 194
- Take a right on NC 194 and travel approximately 1.5 miles
- The Site is on the right
- Latitude, Longitude of Site: 35.9827°N, 81.9843°W (NAD83/WGS84)

1.2 Project Objectives

The primary components of the restoration project included 1) construction of a stable, riffle-pool stream channel; 2) enhancement of water quality functions within and downstream of the Site; 3) creation of a natural vegetated buffer along restored stream channels; 4) restoration of jurisdictional riverine wetlands in the Site; 5) improvement of aquatic habitat and species diversity by enhancing stream bed variability; and 6) restoration of wildlife functions associated with a riparian corridor/stable stream.

1.3 Project Structure, Restoration Type, and Approach

A 26.68-acre conservation easement was placed on the Site to incorporate all restoration activities. The Site contains 4.8 acres of hydric soil, Three Mile Creek, 12 unnamed tributaries (UTs) to Three Mile Creek, Fork Creek, and adjacent floodplains, which represent the primary hydrologic features of the Site. Prior to construction, the project was characterized by agricultural land utilized for Christmas tree and ornamental landscape nursery plant production, timber harvest, and livestock grazing. Agricultural practices included the maintenance and removal of riparian vegetation and relocation, dredging, and straightening of onsite streams. In addition, hydric soils were disturbed due to regular plowing and vegetation maintenance, hoof shear from livestock, and the removal of groundwater hydrology inputs from the rerouting and straightening of Site tributaries.

Restoration of Site streams and wetlands will result in positive benefits for water quality and biological diversity in the Three Mile Creek watershed. Targeted mitigation efforts at the Site were accomplished by:

1. Removing nonpoint and point sources of pollution associated with agricultural practices including a) cessation of broadcasting fertilizer, pesticides, and other agricultural chemicals into and adjacent to the Site and b) provide a forested riparian buffer to treat surface runoff.
2. Reducing sedimentation within onsite and downstream receiving waters by a) reducing bank erosion associated with vegetation maintenance and plowing adjacent to Site streams and wetlands and b) planting a forested riparian buffer adjacent to Site streams and wetlands.
3. Reestablishing stream stability and the capacity to transport watershed flows and sediment loads by restoring a stable dimension, pattern, and profile supported by natural in-stream habitat and grade/bank stabilization structures.

4. Promoting floodwater attenuation by a) reconnecting bankfull stream flows to the abandoned floodplain terrace; b) restoring secondary, dredged, straightened, and entrenched tributaries, thereby reducing floodwater velocities within smaller catchment basins; c) restoration of depressional floodplain wetlands and floodwater storage capacity within the Site, and d) revegetating Site floodplains to increase frictional resistance on floodwaters.
5. Improving aquatic habitat with bed variability and the use of in-stream structures upstream of a reach identified by the North Carolina Wildlife Resources Commission as supporting naturally reproducing rainbow trout populations.
6. Providing a terrestrial wildlife corridor and refuge in an area that is developed for agricultural production.

As constructed, the Site restored historic stream and wetland functions, which existed onsite prior to channel straightening and dredging, agricultural impacts, and vegetation removal. Stream construction of meandering, E/C stream channel resulted in 6057 linear feet of stream restoration, 618 linear feet of stream enhancement (Level I), 875 linear feet of stream enhancement (Level II), 6421 linear feet of stream preservation, 2.5 acres of riverine wetland restoration, and 2.3 acres of riverine wetland enhancement (Table 1).

Table 1. Site Restoration Structures and Objectives

Restoration Segment/ Reach ID*	Station Range	Mitigation Type	Priority Approach	Existing Linear Footage/ Acreage	Designed Linear Footage/ Acreage**	SMU/ WMU	Comment
Three Mile Creek	1+25-37+30	Restoration	1	3552	3495	3495	Restoration of a straightened channel on new location.
	37+30-42+15	Enhancement I	2	485	485	323.3	Restoration of dimension and profile in place.
Fork Creek	0+00-1+58	Enhancement II	NA	158	158	63.2	Removal of invasive species and supplemental planting.
Tributary 1	0+00-3+84	Restoration	1	172	384	384	Restoration of a straightened channel on new location.
Tributary 2	0+00-1+33	Enhancement I	2	133	133	88.7	Restoration of dimension and profile in place.
	NA	Enhancement II	NA	351	351	140.4	Removal of invasive species and supplemental planting.
Tributary 3	0+00-3+40	Restoration	1	252	340	340	Restoration of a ditched and disturbed channel on new location.
	NA	Preservation	NA	1808	1808	361.6	Preservation of existing reach
Tributary 4	0+00-2+28	Restoration	1	136	198	198	Restoration of a ditched and disturbed channel on new location.
	NA	Enhancement II	NA	366	366	146.4	Removal of invasive species and supplemental planting.
Tributary 5	0+00-2+44	Restoration	1	150	214	214	Restoration of a ditched and disturbed channel on new location.
	NA	Preservation	NA	931	931	186.2	Preservation of stable, forested stream reaches.
Tributary 6a	0+00-2+44	Restoration	1	124	214	214	Restoration of a ditched and disturbed channel on new location.
	NA	Preservation	NA	681	681	136.2	Preservation of stable, forested stream reaches.

Table 1. Site Restoration Structures and Objectives (continued)

Restoration Segment/ Reach ID*	Station Range	Mitigation Type	Priority Approach	Existing Linear Footage/ Acreage	Designed Linear Footage/ Acreage**	SMU/ WMU	Comment
Tributary 7	0+00-2+75	Restoration	1	146	245	245	Restoration of a ditched and disturbed channel on new location.
Tributary 8	0+00-3+43	Restoration	1	519	343	343	Restoration of a ditched and disturbed channel on new location.
	242	Restoration	1	242	242	242	Filling a ditched springhead systems and braiding restoration channel.
Tributary 9	0+00-0+43	NA	NA	0	43	0	Tie spring head to design channel.
Tributary 11a	0+00-0+92	Restoration	1	72	92	92	Restoration of a ditched and disturbed channel on new location.
	228	Restoration	1	228	228	228	Braiding surface flow of restoration channel.
	NA	Preservation	NA	49	49	9.8	Preservation of stable, forested stream reaches.
Tributary 11b	0+00-0+62	Restoration	1	51	62	62	Restoration of a ditched and disturbed channel on new location.
Preservation Tributaries	NA	Preservation	NA	2952	2952	590.4	Preservation of stable, forested stream reaches.
					TOTAL SMUs	**8103**	
Riparian/ Riverine Wetlands	--	Restoration	--	--	2.5	2.5	Reconstructing site tributaries, filling ditched channels and ditches, rehydrating floodplain soils, and planting with native forest vegetation.
	--	Enhancement	--	--	2.3	1.2	Planting with native forest vegetation.
					TOTAL WMUs	**3.7**	

* Locations of each tributary and restoration type are depicted on Sheets 1-23 in Appendix A (As-built Survey)

** Constructed linear footage excludes crossings or areas outside of easement; therefore, is slightly shorter than stationing depicts.

Priority Approach 1 – Convert incised stream to stable stream at historic floodplain elevation.

Priority Approach 2 – Convert incised stream to stable stream and reestablish floodplain at present location.

1.4 Project History and Background

Completed project activities, reporting history, completion dates, project contacts, and background information are summarized in Tables 2-4.

Table 2. Project Activity and Reporting History

Activity or Report	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	August 2007	September 2007
Construction Completion	NA	January 2009
Site Planting	NA	February 2009
Mitigation Plan/As-builts	March 2009	April 2009
Year 1 Monitoring (2009)	October 2009	September 2009
Year 2 Monitoring (2010)	October 2010	September 2010
Year 3 Monitoring (2011)	October 2011	October 2011
Year 4 Monitoring (2012)	October 2012	July 2012

Table 3. Project Contacts

Full Delivery Provider	Restoration Systems 1101 Haynes Street, Suite 211 Raleigh, North Carolina 27604 George Howard and John Preyer (919) 755-9490
Designer and Monitoring Performer	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis (919) 215-1693
Construction Contractor	Land Mechanics Designs, Inc. 126 Circle G Lane Willow Spring, North Carolina 27592 Lloyd Glover (919) 422-3392
Planting Contractor	Carolina Silvics 908 Indian Trail Road Edenton, North Carolina 27932 Dwight McKinney (252) 482-8491
Surveying Contractor	K2 Design Group, PA 5758 US Highway 70 East Goldsboro, North Carolina 27534 John Rudolph (919) 751-0075

Table 4. Project Background

Project County	Avery County, North Carolina
Drainage Area	Three Mile Creek: 5.1 square miles Fork Creek: 1.8 square miles Tributaries: 0.02-0.2 square mile
Drainage impervious cover estimate (%)	< 1
Stream Order	Three Mile Creek: Second and Third Fork Creek: Second Tributaries: First and Second
Physiographic Region	Blue Ridge
Ecoregion	Southern Crystalline Ridges and Mountains
Rosgen Classification of As-built	C/E-type
Dominant Soil Types	Chandler, Cullowhee, Nikwasi, Micaville, Saunook, Thunder
Reference Site ID	Stone Mountain and Cranberry Creek
USGS HUC	06010108010020
NCDWQ Subbasin	04-03-06
NCDWQ Classification	WS-IV Tr (Stream Index # 7-2-25-(0.7))
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes, the receiving water of the North Toe River (Stream Index Number 7-2-[27.7]b) is listed for impaired biological integrity and turbidity
Reasons for 303d listing or stressor	Not Applicable
% of project easement fenced	+/- 8%

1.5 Monitoring Plan View

Monitoring activities for the Site, including relevant structures and utilities, project features, specific project structures, and monitoring features are detailed in the monitoring plan view in Figure 2 of Appendix A. Site features including vegetation, stream dimension (cross-sections), stream profile and pattern, wetland hydrology, and photographic documentation were monitored in Year 4 (2012).

2.0 PROJECT CONDITION AND MONITORING RESULTS

2.1 Vegetation Assessment

Following Site construction, eight plots (10-meter by 10-meter in size) were established and monumented with metal fence posts at all plot corners and PVC at each plot origin. Sampling was conducted as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) (http://cvs.bio.unc.edu/methods.htm); results are included in Appendix B. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas* (Weakley 2007). The locations of vegetation monitoring plots were placed to accurately represent the entire Site and are depicted on the monitoring plan view in AppendixA.

2.1.1 Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for forest development. Success criteria are dependent upon density and growth of "Characteristic Tree Species." Characteristic Tree Species include planted species, species identified through inventory of a reference (relatively undisturbed) forest community used to orient the planting plan,

and appropriate Schafale and Weakley (1990) community descriptions. All species planted and identified in the reference forest will be utilized to define "Characteristic Tree Species" as termed in the success criteria (Table 5).

Table 5. Characteristic Tree Species

Planted Species	**Reference Species**
Pawpaw (*Asimina triloba*)	Red maple (*Acer rubrum*)
Sugarberry (*Celtis laevigata*)	Ironwood (*Carpinus caroliniana*)
Redbud (*Cercis canadensis*)	Dogwood (*Cornus florida*)
Buttonbush (*Cephalanthus occidentalis*)	Strawberry bush (*Euonymous americana*)
Silky dogwood (*Cornus amomum*)	Spice bush (*Lindera benzoin*)
Persimmon (*Diospyros virginiana*)	Tulip poplar (*Liriodendron tulipifera*)
Green ash (*Fraxinus pennsylvanica*)	Sycamore (*Platanus occidentalis*)
Sycamore (*Platanus occidentalis*)	White pine (*Pinus strobes*)
Black cherry (*Prunus serotina*)	Black cherry (*Prunus serotina*)
White oak (*Quercus alba*)	White oak (*Quercus alba*)
Swamp chestnut oak (*Quercus michauxii*)	Red oak (*Quercus* sp.)
Cherrybark oak (*Quercus pagoda*)	Rhododendron (*Rhododendron* sp.)
Northern red oak (*Quercus rubra*)	Wild azalea (*Rhododendron periclymenoides*)
Elderberry (*Sambucus canadensis*)	Black locust (*Robinia pseudoacacia*)
	Hemlock (*Tsuga* sp.)

An average density of 320 stems per acre of Characteristic Tree Species must be surviving at the end of the third monitoring year. Subsequently, 290 Characteristic Tree Species per acre must be surviving at the end of year 4 and 260 Characteristic Tree Species per acre at the end of year 5.

If vegetation success criteria are not achieved, based on average density calculations from combined plots over the entire restoration area, supplemental planting may be performed with tree species approved by regulatory agencies. Supplemental planting will be performed as needed until achievement of vegetation success criteria.

2.1.2 Vegetative Problem Areas

No vegetation problem areas were identified within the Site during Year 4 (2012) Monitoring.

2.2 Stream Assessment

Eleven permanent cross-sections were established after construction was completed. Measurements of each cross-section include points at all breaks in slope including top of bank, bankfull, and thalweg. Riffle cross-sections are classified using the Rosgen stream classification system. Longitudinal profile measurements of 3600 linear feet of stream include thalweg, water surface, and bankfull; with each measurement taken at the head of facets (i.e. riffle, run, pool, and glide) in addition to the maximum pool depth.

2.2.1 Stream Success Criteria

Success criteria for stream restoration will include 1) successful classification of the reach as a functioning stream system (Rosgen 1996) and 2) channel variables indicative of a stable stream system. Annual monitoring will continue until success criteria are met and no less than two bankfull events have occurred,

as determined by in situ crest gauge, otherwise monitoring will continue until the second bankfull event has occurred.

Visual assessment of in-stream structures will be conducted to determine if failure has occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure.

2.2.2 Bankfull Events

One bankfull event was documented during the Year 4 (2012) monitoring period for a total of three bankfull events in two years.

Table 6. Verification of Bankfull Events

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
April 2011	March 5-6, 2011	Total of 2.5 inches* of rain documented between March 5-6, 2011	Photo 1-2
May 2011	April 15-16, 2011	Total of 4.09 inches* of rain documented between April 15-16, 2011	Photo 3-4
July 23, 2012	May 29, 2012	Total of 1.81 inches* of rain documented on May 29, 2012 after a total of 3.85 inches occurring during the previous 3 week period	--

*Weather Underground 2012 (weather station 2.7 miles southwest of site)

2.2.3 Stream Problem Areas

During a heavy, flashy rain event in April 2011, an outer bend near Cross-section 6 was compromised; however, up- and downstream of the outerbend remained stable. The outer bend was repaired and replanted in September 2011, and is doing well (see photos). The outerbend will continue to be monitored closely. The only remaining stream problem area noted within the Site includes aggradation within a portion of Tributary 1, which has resulted from the installation of a dirt driveway on the neighboring property in 2010. Aggradation of sediment in this reach has altered stream flow, which is currently bypassing a portion of the constructed channel. A walkthrough of the reach with NCEEP representatives is being scheduled to determine the appropriate course of action.

2.2.4 Categorical Stream Feature Visual Stability Assessment

The stream was visually inspected during the Year 4 (2012) monitoring period using eight feature categories and various metrics within each category. Assessment features included riffles, pools, thalweg, meanders, channel bed, structures, and root wads/boulders. A table for semi-quantitative assessments of the stream is included in Appendix C (Table C1). The mean percentage of performance for features is summarized in the table below.

Table 7. Categorical Stream Feature Visual Stability Assessment

Feature	Year 1 (2009)	Year 2 (2010)	Year 3 (2011)	Year 4 (2012)	Year 5 (2013)
A. Riffles	99%	99%	99%	99%	
B. Pools	100%	100%	100%	100%	
C. Thalweg	100%	100%	100%	100%	
D. Meanders	100%	100%	100%	100%	
E. Bed General	100%	100%	100%	100%	
F. Banks	100%	100%	100%	100%	
G. Vanes / J. Hooks, Etc.	100%	100%	100%	100%	
H. Wads and Boulders	NA	NA	NA	NA	

2.2.5 Quantitative Stream Measurements

During the Year 4 (2012) monitoring period 11 cross-sections and 3600 linear feet of longitudinal profile were measured. Permanent cross-sections and longitudinal profiles are included in Appendix C; each is graphically depicted for as-built through Year 4 (2012) for analysis. As a whole, monitoring measurements

indicate minimal changes in both the longitudinal profile and cross-sections as compared to as-built data. The channel geometry compares favorably with the emulated, stable E/C type stream reach as set forth in the detailed mitigation plan and as constructed. Current monitoring has demonstrated dimension, pattern, and profile were stable over the course of the monitoring period. Tables for baseline data and annual quantitative assessments are included below.

2.3 Wetland Assessment

Three groundwater gauges were installed in wetland restoration and enhancement areas to provide representative coverage of the Site. One additional gauge was placed in a reference wetland area. Graphs of groundwater hydrology and precipitation from a nearby rain station are included in Appendix D.

2.3.1 Wetland Success Criteria

Target hydrological characteristics include saturation or inundation for 5 to 12.5 percent of the growing season, during average climatic conditions. During growing seasons with atypical climatic conditions, groundwater gauges in reference wetlands may dictate threshold hydrology success criteria (75 percent of reference). These areas are expected to support hydrophytic vegetation. If wetland parameters are marginal as indicated by vegetation and/or hydrology monitoring, a jurisdictional determination will be performed.

2.3.2 Wetland Problem Areas

No wetland problem areas were identified within the Site during Year 4 (2012) monitoring.

2.3.3 Wetland Criteria Attainment

All three of the monitored gauges within restoration areas were inundated/saturated within 12 inches of the surface for greater than 12.5 percent of the growing season, which extends from May 1 to October 11 (163 days). Groundwater data presented in this document was collected through July 16 and 18, 2012; data will continue to be collected throughout the growing season and will be available upon request. Hydrographs containing groundwater and precipitation data for each gauge can be found in Appendix D.

Table 8. Baseline Morphology and Hydraulic Summary
Threemile Creek

Parameter	USGS Gage Data			Pre-Existing Condition			Project Reference Stream			Design			As-built		
Dimension	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
BF Width (ft)	USGS gage data is unavailable for this project			17.4	23	20.7	27.2	33	30.1	21	29	25	23.1	27.8	26.1
Floodprone Width (ft)				32	250	100			100	50	350	250			250
BF Cross Sectional Area (ft2)				36.5	53	43			46	36	53	45	46.5	55.3	53.1
BF Mean Depth (ft)				1.5	2.8	2.2	1.4	1.7	1.6	1.5	2.1	1.8	1.8	2.2	2.1
BF Max Depth (ft)				1.9	3.3	2.8	2.2	2.6	2.4	2	2.7	2.3	2.2	2.7	2.5
Width/Depth Ratio				6.6	14.5	10	16.1	23.8	20	12	16	14	12	15	12
Entrenchment Ratio				1.5	8	6.5	3	3.7	3.4	2.2	7.4	4.4	9	11	10
Bank Height Ratio				1.9	2.5	1.8	1	1.6	1.3	1	1.3	1.1			1
Wetted Perimeter(ft)						===			===			===	25	29	28
Hydraulic radius (ft)						===			===			===	1.8	2	2
Pattern															
Channel Beltwidth (ft)				No pattern of riffles and pools due to straightening activties			40	55	46.8	27	76	47	27	76	47
Radius of Curvature (ft)							62.4	312.1	94.5	45	252	52	45	252	52
Meander Wavelength (ft)							101.7	273.2	199.4	136	252	200	136	252	200
Meander Width ratio							1.3	1.8	1.6	1.2	3	2	1.2	3	2
Profile															
Riffle length (ft)				No pattern of riffles and pools due to straightening activties					===			===	17	111	51
Riffle slope (ft/ft)							0.26%	1.83%	1.18%	1.94%	2.91%	2.43%	0.43%	4.80%	1.54%
Pool length (ft)									===			===	26	78	46
Pool spacing (ft)							65.2	166.7	104.3	67	176	115	76	176	126
Substrate															
d50 (mm)						===			===			===			===
d84 (mm)						===			===			===			===
Additional Reach Parameters															
Valley Length (ft)						===			===			===			4057
Channel Length (ft)						===			===			===			3528
Sinuosity						1.1			1.2			1.15			1.15
Water Surface Slope (ft/ft)						1.03%			1.21%			0.97%			0.98%
BF slope (ft/ft)						===			===			===			===
Rosgen Classification						C/E4			Cb3			Ce4			C/E 3/4

Table 9A. Morphology and Hydraulic Monitoring Summary
Threemile Creek - Stream and Wetland Restoration Site

Parameter	Cross Section 1 Riffle (UT 8)						Cross Section 2 Pool (UT 8)						Cross Section 3 Riffle						Cross Section 4 Pool					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	4.8	4.8	4.4	5.2	4.6		6.3	7.5	7.6	7.7	7.3		27.8	30.3	28.5	28.5	28.2		27.9	27.8	27.9	27.3	28	
Floodprone Width (ft)	250	250	250	250	250		----	----	----	----	----		250	250	250	250	250		----	----	----	----	----	
BF Cross Sectional Area (ft2)	1.8	2.3	1.7	2.2	1.6		4.8	5.4	5.9	5.5	5.6		51.1	51.9	49.9	48.1	47		63.4	62.8	58.9	57.4	56.9	
BF Mean Depth (ft)	0.4	0.5	0.4	0.4	0.4		0.8	0.7	0.8	0.7	0.8		1.8	1.7	1.7	1.7	1.7		2.3	2.3	2.1	2.1	2	
BF Max Depth (ft)	0.6	0.8	0.7	0.7	0.6		1.3	1.2	1.3	1.2	1.3		2.2	2.3	2.2	2.9	2.9		3.7	3.6	3.4	3.4	3.5	
Width/Depth Ratio	12.8	10.2	11.3	12.3	12.9		----	----	----	----	----		15.124	17.7	16.3	16.9	16.9		----	----	----	----	----	
Entrenchment Ratio	52.1	51.6	56.6	48.1	54.1		----	----	----	----	----		9.0	8.2	8.8	8.8	8.9		----	----	----	----	----	
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0		----	----	----	----	----		1.0	1.0	1.0	1.0	1.0		----	----	----	----	----	
Wetted Perimeter (ft)	5.1	5.1	4.7	5.6	4.8		6.9	8.0	8.2	8.2	7.9		29.0	31.2	29.3	30.0	29.4		29.6	29.6	29.9	29.3	29.5	
Hydraulic Radius (ft)	0.4	0.4	0.4	0.4	0.3		0.7	0.7	0.7	0.7	0.7		1.8	1.7	1.7	1.6	1.6		2.1	2.1	2	2	1.9	
Substrate																								
d50 (mm)	----	12.9	17.5	15	16		----	NA	0.2	0.3	N/A		----	23.4	35.4	35.4	68.2		----	2.4	1.3	2.2	1.1	
d84 (mm)	----	22	25	33	24		----	12	14	4	0		----	54	70	70	104		----	16	25	12	8	

Parameter	MY-00 (2008)			MY-01 (2009)			MY-02 (2010)			MY-03 (2011)			MY-04 (2012)			MY-05 (2013)		
	Min	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Pattern																		
Channel Beltwidth (ft)	30	76	50	30	76	50	30	76	50	30	76	50	30	76	50			
Radius of Curvature (ft)	50	252	101	50	252	101	50	252	101	50	252	101	50	252	101			
Meander Wavelength (ft)	151	252	214	151	252	214	151	252	214	151	252	214	151	252	214			
Meander Width Ratio	1.2	3	2	1.2	3	2	1.2	3	2	1.2	3	2	1.2	3	2			
Profile																		
Riffle Length (ft)	17	111	51	21	121	53	23	117	51	11	141	50	19	112	39			
Riffle Slope (ft/ft)	0.43%	4.80%	1.54%	0.15%	3.08%	1.43%	0.65%	2.74%	1.42%	0.00%	7.11%	1.73%	0.53%	4.07%	1.37%			
Pool Length (ft)	26	78	46	24	69	39	27	95	44	14	82	46	26	97	47			
Pool Spacing (ft)	76	176	126	76	176	126	76	176	126	76	176	126	76	176	126			
Additonal Reach Parameters																		
Valley Length (ft)	3068			3085			3084			3111			3111					
Channel Length (ft)	3,528			3,548			3547			3578			3576					
Sinuosity	1.15			1.15			1.15			1.15			1.15					
Water Surface Slope (ft/ft)	0.0098			0.0097			0.0098			0.0097			0.0098					
BF Slope (ft/ft)	------			------			------			------			------					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 9B. Morphology and Hydraulic Monitoring Summary
Threemile Creek - Stream and Wetland Restoration Site

Parameter	Cross Section 5 Riffle						Cross Section 6 Pool						Cross Section 7 Riffle						Cross Section 8 Pool					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	26.4	28.6	29.6	29	25.9		21.6	21.2	21.5	19.5	21.6		23.1	23.6	23.6	24.2	22.7		25.7	27.2	26.7	27.1	30.6	
Floodprone Width (ft)	250	250	250	250	250		----	----	----	----	----		250	250	250	250	250		----	----	----	----	----	
BF Cross Sectional Area (ft2)	55	60.6	61.3	59.4	43.4		49.9	48.1	54.6	44.1	47.2		46.5	49.9	48.7	47.1	40.4		52.1	52.4	51.2	51.4	52.3	
BF Mean Depth (ft)	2.1	2.1	2.1	2	1.7		2.3	2.3	2.5	2.3	2.2		2.0	2.1	2.1	1.9	1.8		2.0	1.9	1.9	1.9	1.7	
BF Max Depth (ft)	2.6	2.8	2.8	3	3		3.5	3.6	4.3	4.3	3.8		2.4	2.6	2.6	2.6	2.3		3.4	3.5	3.6	3.7	3.5	
Width/Depth Ratio	12.7	13.5	14.3	14.2	15.4		----	----	----	----	----		11.5	11.2	11.4	12.5	12.7		----	----	----	----	----	
Entrenchment Ratio	9.5	8.7	8.4	8.6	9.7		----	----	----	----	----		10.8	10.6	10.6	10.3	11		----	----	----	----	----	
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0		----	----	----	----	----		1.0	1.0	1.0	1.0	1.0		----	----	----	----	----	
Wetted Perimeter (ft)	27.9	30	31	30.7	26.8		23.5	23.4	24.7	22.5	24		24.7	25.5	25.1	25.8	23.8		27.1	28.7	28.9	29.5	32.4	
Hydraulic Radius (ft)	2.0	2.0	2.0	1.9	1.6		2.1	2.1	2.2	2.0	2.0		1.9	2.0	1.9	1.8	1.7		1.9	1.8	1.8	1.7	1.6	
Substrate																								
d50 (mm)	----	----	29.1	49.1	47		----	----	11.5	2.8	0.2		----	----	48.5	47	51.6		----	8.7	1.7	2.8	0.3	
d84 (mm)	----	----	51	152	114		----	----	45	13	8		----	----	90	128	83		----	64	22	13	8	

Parameter	MY-00 (2008)			MY-01 (2009)			MY-02 (2010)			MY-03 (2011)			MY-04 (2012)			MY-05 (2013)		
	Min	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Pattern																		
Channel Beltwidth (ft)	30	76	50	30	76	50	30	76	50	30	76	50	30	76	50			
Radius of Curvature (ft)	50	252	101	50	252	101	50	252	101	50	252	101	50	252	101			
Meander Wavelength (ft)	151	252	214	151	252	214	151	252	214	151	252	214	151	252	214			
Meander Width Ratio	1.2	3	2	1.2	3	2	1.2	3	2	1.2	3	2	1.2	3	2			
Profile																		
Riffle Length (ft)	17	111	51	21	121	53	23	117	51	11	141	50	19	112	39			
Riffle Slope (ft/ft)	0.43%	4.80%	1.54%	0.15%	3.08%	1.43%	0.65%	2.74%	1.42%	0.00%	7.11%	1.73%	0.53%	4.07%	1.37%			
Pool Length (ft)	26	78	46	24	69	39	27	95	44	14	82	46	26	97	47			
Pool Spacing (ft)	76	176	126	76	176	126	76	176	126	76	176	126	76	176	126			
Additonal Reach Parameters																		
Valley Length (ft)	3068			3085			3084			3111			3111					
Channel Length (ft)	3,528			3,548			3547			3578			3576					
Sinuosity	1.15			1.15			1.15			1.15			1.15					
Water Surface Slope (ft/ft)	0.0098			0.0097			0.0098			0.0097			0.0098					
BF Slope (ft/ft)	------			------			------			------			------					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 9C. Morphology and Hydraulic Monitoring Summary
Threemile Creek - Stream and Wetland Restoration Site

Parameter	Cross Section 9 Riffle						Cross Section 10 Pool (UT 1)						Cross Section 11 Riffle (UT1)					
Dimension	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY 0**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	25.7	26	25.8	27	26		9.5	9.7	9.1	8.7	10.6		6.4	6.2	6.6	8.8	2.4	
Floodprone Width (ft)	250	250	250	250	250		----	----	----	----	----		150	150	250	150	150	
BF Cross Sectional Area (ft2)	55.3	53.7	50.4	48	43.8		6.1	6.4	3.1	3.4	2.9		5.3	6.2	0.5	1.1	0.3	
BF Mean Depth (ft)	2.2	2.1	2	1.8	1.7		0.6	0.7	0.3	0.4	0.3		0.8	0.6	0.1	0.1	0.1	
BF Max Depth (ft)	2.7	2.6	2.6	2.6	2.6		1.1	1	0.6	0.7	0.5		1.2	1	0.2	0.5	0.5	
Width/Depth Ratio	11.9	12.6	13.3	15.1	15.4		----	----	----	----	----		7.7	10.3	95.1	72.1	21.5	
Entrenchment Ratio	9.7	9.6	9.7	9.3	9.6		----	----	----	----	----		23.4	24.1	22.7	17	62.5	
Bank Height Ratio	1.0	1.0	1.0	1.0	1.0		----	----	----	----	----		1.0	1.0	1.0	1.0	1.0	
Wetted Perimeter (ft)	27.1	27.4	27.2	28.3	26.8		9.6	10.1	9.2	9.1	10.7		7.1	6.6	6.6	8.9	2.4	
Hydraulic Radius (ft)	2.0	2.0	1.9	1.7	1.6		0.6	0.6	0.3	0.4	0.3		0.7	0.6	0.1	0.1	0.1	
Substrate																		
d50 (mm)	----	34.8	48.5	47	51.6		----	NA	0.1	----	----		----	87	0.4	----	----	
d84 (mm)	----	114	90	128	83		----	NA	2	----	----		----	152	6	----	----	
Parameter	**MY-00 (2008)**			**MY-01 (2009)**			**MY-02 (2010)**			**MY-03 (2011)**			**MY-04 (2012)**			**MY-05 (2013)**		
	Min	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Pattern																		
Channel Beltwidth (ft)	30	76	50	30	76	50	30	76	50	30	76	50	30	76	50			
Radius of Curvature (ft)	50	252	101	50	252	101	50	252	101	50	252	101	50	252	101			
Meander Wavelength (ft)	151	252	214	151	252	214	151	252	214	151	252	214	151	252	214			
Meander Width Ratio	1.2	3	2	1.2	3	2	1.2	3	2	1.2	3	2	1.2	3	2			
Profile																		
Riffle Length (ft)	17	111	51	21	121	53	23	117	51	11	141	50	19	112	39			
Riffle Slope (ft/ft)	0.43%	4.80%	1.54%	0.15%	3.08%	1.43%	0.65%	2.74%	1.42%	0.00%	7.11%	1.73%	0.53%	4.07%	1.37%			
Pool Length (ft)	26	78	46	24	69	39	27	95	44	14	82	46	26	97	47			
Pool Spacing (ft)	76	176	126	76	176	126	76	176	126	76	176	126	76	176	126			
Additonal Reach Parameters																		
Valley Length (ft)	3068			3085			3084			3111			3111					
Channel Length (ft)	3,528			3,548			3547			3578			3576					
Sinuosity	1.15			1.15			1.15			1.15			1.15					
Water Surface Slope (ft/ft)	0.0098			0.0097			0.0098			0.0097			0.0098					
BF Slope (ft/ft)	------			------			------			------			------					
Rosgen Classification	C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4			C/E 3/4					

Table 10. Wetland Criteria Attainment for Year 4 (2012)

Gauge ID	Hydrology Threshold Met?	Hydrophytic Vegetation Criteria Met? /Max Consecutive Days During Growing Season (Percentage)	Site Mean	Vegetation Plot ID	Vegetation Survival Threshold Met?	Site Mean
1	Yes	Yes/77 days (47 percent)	100 %	1	Yes	100 %
2	Yes	Yes/79 days (48 percent)		2	Yes	
3	Yes	Yes/79 days (48 percent)		3	Yes	
				4	Yes	
				5	Yes	
				6	Yes	
				7	Yes	
				8	Yes	

3.0 CONCLUSIONS

All three of the monitored gauges within restoration areas were inundated/saturated within 12 inches of the surface for greater than 12.5 percent of the growing season, which extends from May 1 to October 11 (163 days). A summary of groundwater gauge data is included in Table 11.

Table 11. Summary of Groundwater Gauge Results

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)				
	Year 1 (2009)	Year 2 (2010)	Year 3 (2011)	Year 4 (2012)*	Year 5 (2013)
1	Yes/101 days (62.0 percent)	Yes/64 days (39 percent)	Yes/95 days (57 percent)	Yes/77 days (47 percent)	
2	Yes/163 days (100 percent)	Yes/163 days (100 percent)	Yes/147 days (89 percent)	Yes/79 days (48 percent)	
3	Yes/163 days (100 percent)	Yes/55 days (34 percent)	Yes/101 days (61 percent)	Yes/79 days (48 percent)	
Ref	53 days (32.5 percent)	49 days (30 percent)	32 days (20 percent)	51 days (31.3 percent)	

*Data has been collected through July 16, 2012 (Gauge 1) and July 18, 2012 (Gauges 2-3 and Ref) for the Year 4 (2012) monitoring season; data will continue to be collected throughout the remainder of the growing season and will be available upon request.

Vegetation sampling across the Site was above the required average density with 622 planted stems per acre surviving. In addition, each individual plot was above success criteria (Table 12).

Table 12. Summary of Planted Vegetation Plot Results

Plot	Planted Stems/Acre Counting Towards Success Criteria				
	Year 1 (2009)	Year 2 (2010)	Year 3 (2011)	Year 4 (2012)	Year 5 (2013)
1	405	445	526	526	
2	648	445	405	405	
3	567	364	486	526	
4	931	469	728	728	
5	526	526	526	526	
6	364	405	486	526	
7	1012	971	647	688	
8	1214	1214	1133	1052	
Average of All Plots (1-8)	**708**	**637**	**612**	**622**	

4.0 REFERENCES

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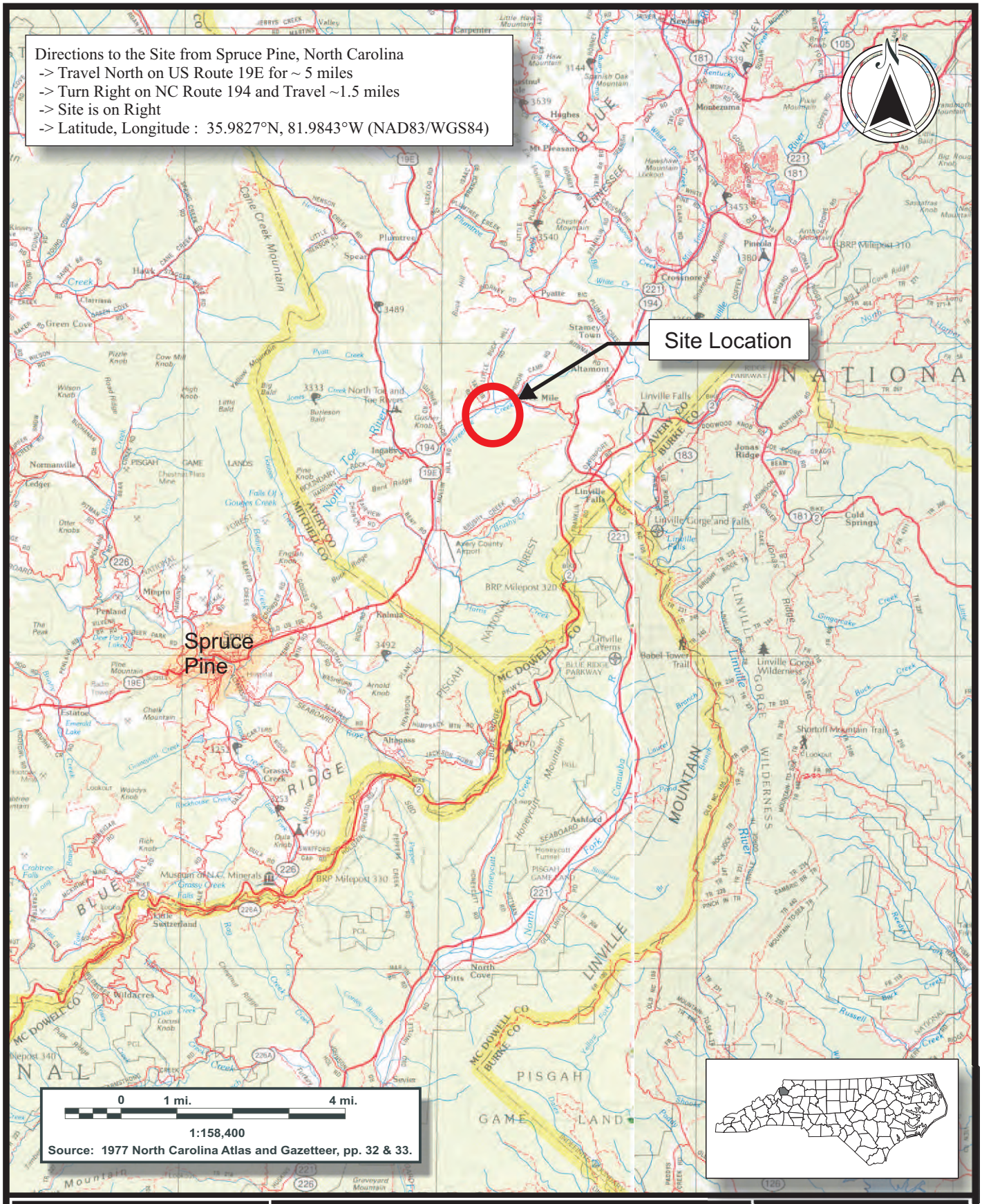
APPENDIX A
FIGURES

Figure 1. Site Location

Figure 2. Monitoring Plan View

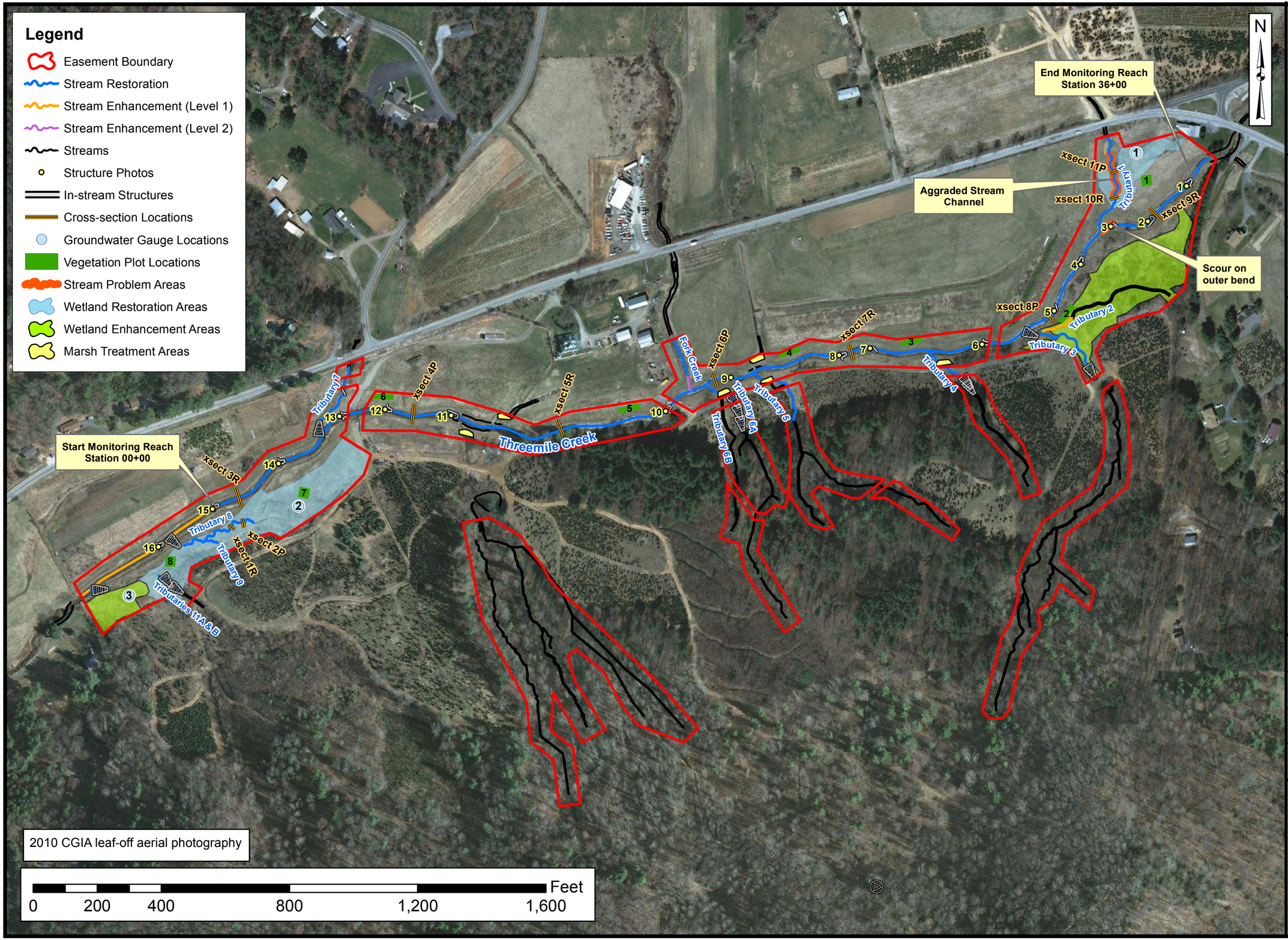


Axiom Environmental
2126 Rowland Pond Dr
Willow Spring, NC 27592
(919) 215-1693
(919) 341-3839 fax

SITE LOCATION
THREE MILE CREEK RESTORATION SITE
Avery County, North Carolina

Dwn. by:	CLF
Ckd by:	WGL
Date:	Nov 2008
Project:	07-004

FIGURE
1



Axiom Environmental, Inc.

Prepared for:

RESTORATION SYSTEMS | LLC

Project:

THREE MILE CREEK RESTORATION SITE

Avery County, NC

Title:

MONITORING PLAN VIEW

Drawn by: KRJ

Date: FEB 2013

Scale: 1:3400

Project No.: 10-001

FIGURE

2

APPENDIX B
VEGETATION DATA

1. **Vegetation Survey Data Tables**
2. **Vegetation Monitoring Plot Photos**

Report Prepared By	Corri Faquin	
Date Prepared		7/23/2012 14:31
database name	RestorationSystems-2012-A_July22_2012.mdb	
database location	C:\Documents and Settings\kjernigan\Desktop	
computer name	MATT	
file size		68661248

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	Threemile	
project Name	Threemile Stream and Wetland Restoration Site	
Sampled Plots		8

Living planted stems, excluding live stakes, per acre: Negative (red) numbers indicate the project failed to reach requirements in a particular year.

Project Code	Project Name	River Basin	Year 4
Threemile	Threemile Stream and Wetland Restoration Site	French Broad	622

Total stems, including planted stems of all kinds (including live stakes) and natural/volunteer stems:

Project Code	Project Name	River Basin	Year 4
Threemile	Threemile Stream and Wetland Restoration Site	French Broad	708

Plot Data

Date Sampled	Planted Living Stems	Planted Living Stems EXCLUDING Live Stakes	Dead/Missing Stems	Natural (Volunteer) Stems	Total Living Stems	Total Living Stems EXCLUDING Live Stakes	Planted Living Stems per ACRE	Planted Living Stems EXCLUDING Live Stakes PER ACRE	Natural (Volunteer) Stems PER ACRE	Total Living Stems PER ACRE	Total Living Stems EXCLUDING Live Stakes PER ACRE	# species
7/18/2012	13	13	0	0	13	13	526	526	0	526	526	4
7/18/2012	10	10	2	8	18	18	405	405	324	728	728	5
7/18/2012	13	13	1	0	13	13	526	526	0	526	526	4
7/18/2012	18	18	0	0	18	18	728	728	0	728	728	4
7/18/2012	13	13	0	6	19	19	526	526	243	769	769	3
7/18/2012	13	13	0	0	13	13	526	526	0	526	526	5
7/18/2012	17	17	6	1	18	18	688	688	40	728	728	2
7/18/2012	27	26	3	1	28	27	1093	1052	40	1133	1093	5

Vigor

Vigor	Count	Percent
0	5	3.7
2	9	6.6
3	29	21.3
4	86	63.2
Missing	7	5.1

Vigor by Species

Species	CommonName	4	3	2	1	0	Missing	Unknown
Alnus serrulata	hazel alder	1						
Asimina triloba	pawpaw					1		
Celtis laevigata	sugarberry	2						
Cephalanthus occidentalis	common buttonbush	2		1				
Cornus amomum	silky dogwood	2	1					
Diospyros virginiana	common persimmon	8	11	6		1	4	
Fraxinus pennsylvanica	green ash	7						
Quercus alba	white oak	2	7	2			1	
Quercus falcata	southern red oak	6	1					
Quercus michauxii	swamp chestnut oak	16	1					
Quercus pagoda	cherrybark oak	1						
Salix sericea	silky willow	1						
Cercis canadensis	eastern redbud	2	3			3	1	
Quercus rubra	northern red oak	20	5					
Platanus occidentalis	American sycamore	16					1	
15	**15**	**86**	**29**	**9**		**5**	**7**	

Damage

Damage	Count	Percent Of Stems
(no damage)	127	93.4
Deer	4	2.9
Insects	2	1.5
Diseased	2	1.5
Site Too Wet	1	0.7

Damage by Species

Species	CommonName	Count of Damage Categories	(no damage)	Deer	Diseased	Insects	Site Too Wet
Alnus serrulata	hazel alder	0	1				
Asimina triloba	pawpaw	0	1				
Celtis laevigata	sugarberry	0	2				
Cephalanthus occidentalis	common buttonbush	0	3				
Cercis canadensis	eastern redbud	0	9				
Cornus amomum	silky dogwood	0	3				
Diospyros virginiana	common persimmon	3	27		2	1	
Fraxinus pennsylvanica	green ash	0	7				
Platanus occidentalis	American sycamore	1	16			1	
Quercus alba	white oak	1	11				1
Quercus falcata	southern red oak	0	7				
Quercus michauxii	swamp chestnut oak	0	17				
Quercus pagoda	cherrybark oak	0	1				
Quercus rubra	northern red oak	4	21	4			
Salix sericea	silky willow	0	1				
15	**15**	**9**	**127**	**4**	**2**	**2**	**1**

Damage by Plot

Plot	Count of Damage Categories	Count of Damage Categories	(no damage)	Deer	Diseased	Insects	Site Too Wet
1	5	4	9	4			
2	3	0	12				
3	5	0	14				
4	5	1	17			1	
5	2	0	13				
6	2	0	13				
7	6	3	20		2	1	
8	9	1	29				1
8	**37**	**9**	**127**	**4**	**2**	**2**	**1**

Planted Stems by Plot and Species

Species	CommonName	Total Planted Stems	# plots	avg# stems	1	2	3	4	5	6	7	8
Alnus serrulata	hazel alder	1	1	1		1						
Celtis laevigata	sugarberry	2	1	2			2					
Cephalanthus occidentalis	common buttonbush	3	2	1.5			1	2				
Cercis canadensis	eastern redbud	5	1	5						5		
Cornus amomum	silky dogwood	3	3	1	1	1				1		
Diospyros virginiana	common persimmon	25	5	5	1	2	7			1	14	
Fraxinus pennsylvanica	green ash	7	2	3.5		4					3	
Platanus occidentalis	American sycamore	16	5	3.2		2	3	5	4	2		
Quercus alba	white oak	11	1	11								11
Quercus falcata	southern red oak	7	1	7								7
Quercus michauxii	swamp chestnut oak	17	3	5.67	1			8	8			
Quercus pagoda	cherrybark oak	1	1	1								1
Quercus rubra	northern red oak	25	5	5	10			3	1	4		7
Salix sericea	silky willow	1	1	1								1
14	**14**	**124**	**14**		**13**	**10**	**13**	**18**	**13**	**13**	**17**	**27**

ALL Stems by Plot and Species

Species	Common Name	Total Stems	# plots	avg# stems	1	2	3	4	5	6	7	8
Alnus serrulata	hazel alder	14	2	7		9			5			
Asimina triloba	pawpaw	1	1	1			1					
Celtis laevigata	sugarberry	2	1	2			2					
Cephalanthus occidentalis	common buttonbush	3	2	1.5			1	2				
Cercis canadensis	eastern redbud	8	3	2.67						5	1	2
Cornus amomum	silky dogwood	3	3	1	1	1				1		
Diospyros virginiana	common persimmon	26	5	5.2	1	2	7			1	15	
Fraxinus pennsylvanica	green ash	7	2	3.5		4					3	
Pinus strobus	eastern white pine	1	1	1							1	
Platanus occidentalis	American sycamore	16	5	3.2		2	3	5	4	2		
Prunus serotina	black cherry	1	1	1					1			
Quercus alba	white oak	11	1	11								11
Quercus falcata	southern red oak	7	1	7								7
Quercus michauxii	swamp chestnut oak	17	3	5.67	1			8	8			
Quercus pagoda	cherrybark oak	1	1	1								1
Quercus rubra	northern red oak	25	5	5	10			3	1	4		7
Rhus	sumac	1	1	1								1
Salix sericea	silky willow	1	1	1								1
18	**18**	**145**	**18**		**13**	**18**	**14**	**18**	**19**	**13**	**20**	**30**

Threemile Stream and Wetland Restoration Site: Planted and Natural Recruit Stems by Plot and Species

			Current Plot Data (MY4 2012)																							Annual Means												
			Threemile-AXE-0001			Threemile-AXE-0002			Threemile-AXE-0003			Threemile-AXE-0004			Threemile-AXE-0005			Threemile-AXE-0006			Threemile-AXE-0007			Threemile-AXE-0008			MY4 (2012)			MY3 (2011)			MY2 (2010)			MY1 (2009)		
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	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Alnus serrulata	hazel alder	Shrub				1	1	9									5										1	1	14	1	1	8	1	1	2			
Asimina triloba	pawpaw	Tree																												1	1	1	1	1	1	1	1	1
Celtis laevigata	sugarberry	Tree							2	2	2																2	2	2				1	1	1	1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub							1	1	1	2	2	2													3	3	3	3	3	3	3	3	3	4	4	4
Cercis canadensis	eastern redbud	Tree																5	5	5							5	5	5	9	9	9	9	9	9	11	11	11
Cornus amomum	silky dogwood	Shrub	1	1	1	1	1	1										1	1	1							3	3	3	3	3	5						
Diospyros virginiana	common persimmon	Tree	1	1	1	2	2	2	7	7	7							1	1	1	14	14	14				25	25	25	21	21	23	25	25	26	32	32	32
Fraxinus pennsylvanica	green ash	Tree				4	4	4													3	3	3				7	7	7	7	7	7	7	7	7	7	7	7
Pinus	pine	Tree																														1						
Pinus strobus	eastern white pine	Tree																					1						1									
Platanus occidentalis	American sycamore	Tree				2	2	2	3	3	3	5	5	5	4	4	4	2	2	2							16	16	16	16	16	16	17	17	17	20	20	20
Prunus serotina	black cherry	Tree															1												1									
Quercus alba	white oak	Tree																						11	11	11	11	11	11	10	10	10	12	12	12	12	12	12
Quercus falcata	southern red oak	Tree																						7	7	7	7	7	7	7	7	7	7	7	7	9	9	9
Quercus michauxii	swamp chestnut oak	Tree	1	1	1							8	8	8	8	8	8										17	17	17	17	17	17	18	18	18	19	19	19
Quercus pagoda	cherrybark oak	Tree																						1	1	1	1	1	1	1	1	1	1	1	1			
Quercus rubra	northern red oak	Tree	10	10	10							3	3	3	1	1	1	4	4	4				7	7	7	25	25	25	25	25	25	24	24	24	24	24	24
Rhus	sumac	shrub																								1			1									
Robinia pseudoacacia	black locust	Tree																																				1
Salix	willow	Shrub or Tree																														2						
Salix sericea	silky willow	Shrub																							1	1		1	1		1	1		1	1			
		Stem count	13	13	13	10	10	18	13	13	13	18	18	18	13	13	19	13	13	13	17	17	18	26	27	28	123	124	140	121	122	136	126	127	129	140	140	141
		size (ares)	1			1			1			1			1			1			1			1			8			8			8			8		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.20			0.20			0.20			0.20		
		Species count	4	4	4	5	5	5	4	4	4	4	4	4	3	3	5	5	5	5	2	2	3	4	5	6	13	14	17	13	14	16	13	14	14	11	11	12
		Stems per ACRE	526.1	526.1	526.1	404.7	404.7	728.4	526.1	526.1	526.1	728.4	728.4	728.4	526.1	526.1	768.9	526.1	526.1	526.1	688	688	728.4	1052	1093	1133	622.2	627.3	708.2	612.1	617.1	688	637.4	642.4	652.6	708.2	708.2	713.3

Color for Density

Exceeds requirements by 10%
Exceeds requirements, but by less than 10%
Fails to meet requirements, by less than 10%
Fails to meet requirements by more than 10%

PnoLS = Planted stems excluding livestakes
P-all= Planted stems including livestakes
T = Planted stems and natural recruits
Total includes stems of natural recruits

Threemile Stream and Wetland Restoration Site
Year 4 (2012) Annual Monitoring
Vegetation Plot Photos
Taken July 2012

APPENDIX C
GEOMORPHOLOGIC DATA

1. **Table C1. Qualitative Visual Stability Assessment**
2. **Cross-section Plots and Tables**
3. **Longitudinal Profile Plots**
4. **Pebble Count Data**
5. **Representative Structure Photographs**

Table C1. Visual Morphological Stability Assessment
Threemile Creek

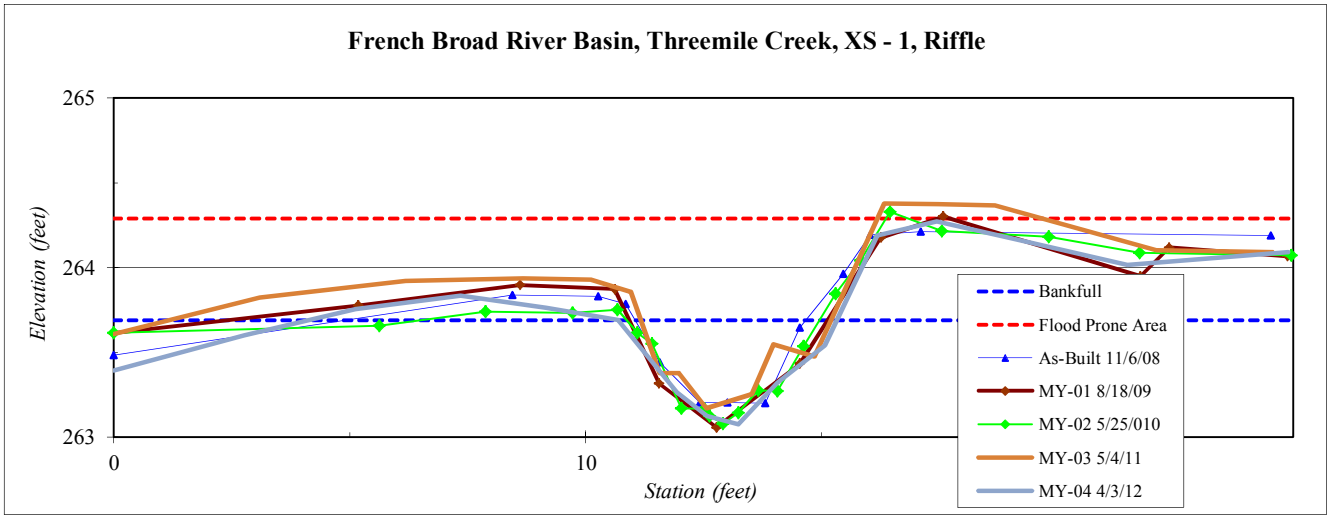
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total number	Number / feet in unstable state	% Perform in Stable Condition	Feature Perform. Mean or Total
	1. Present	37	37	NA	100%	
	2. Armor stable (e.g. no displacement)?	37	37	NA	100%	
	3. Facet grade appears stable?	36	3737	NA	97%	
	4. Minimal evidence of embedding / fining?	37	37	NA	100%	
A. Riffles	5. Length appropriate?	36	37	100	97%	99%
	1. Present? (e.g. not subject to severe aggrad. Or migrat.?)	38	38	NA	100%	
	2. Sufficiently deep (Max Pool D:Mean Bkf>1.6?)	38	38	NA	100%	
B. Pools	3. Length appropriate?	38	37	NA	100%	100%
	1. Upstream of meander bend (run/inflection) centering?	37	37	NA	100%	
C. Thalweg	2. Downstream of meander (glide/inflection) centering?	37	37	NA	100%	100%
	1. Outer bend in state of limited/controlled erosion?	38	38	NA	100%	
	2. Of those eroding, # w/concomitant point bar formation?	NA	NA	0	100%	
	3. Apparent Rc within spec?	38	38	NA	100%	
D. Meanders	4. Sufficient floodplain access and relief?	38	38	NA	100%	100%
	1. General channel bed aggradation areas (bar formation)	NA	NA	0	100%	
E. Bed General	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	NA	NA	0	100%	100%
F. Bank	1. Actively eroding, wasting, or slumping bank	37	37	15	100%	97%
	1. Free of back or arm scour?	14	14	NA	NA	
	2. Height appropriate?	14	14	NA	NA	
	3. Angle and geometry appear appropriate?	14	14	NA	NA	
G. Vanes	4. Free of piping or other structural failures?	14	14	NA	NA	100%
	1. Free of scour?	NA	NA	NA	NA	
H. Wads / Boulders	2. Footing stable?	NA	NA	NA	NA	NA

River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 1, Riffle
Drainage Area (sq mi):	0.05
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.00	263.39
2.77	263.60
5.13	263.75
7.35	263.84
9.17	263.77
10.69	263.69
11.93	263.27
12.57	263.13
13.23	263.08
14.07	263.32
15.06	263.54
16.18	264.19
17.44	264.27
19.30	264.15
21.49	264.02
24.89	264.09

SUMMARY DATA	
Bankfull Elevation:	263.7
Bankfull Cross-Sectional Area:	1.6
Bankfull Width:	4.6
Flood Prone Area Elevation:	264.3
Flood Prone Width:	>80
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.3
W / D Ratio:	13.2
Entrenchment Ratio:	>5
Bank Height Ratio:	1.0

Stream Type	E

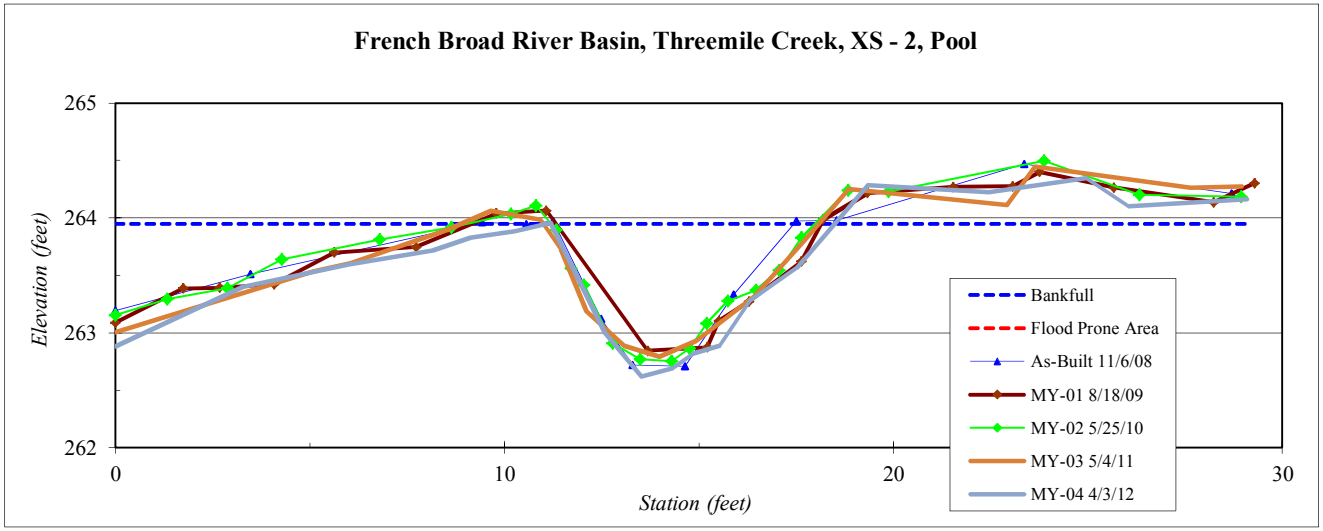


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 2, Pool
Drainage Area (sq mi):	0.05
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.00	262.88
3.28	263.40
5.99	263.59
8.15	263.72
9.13	263.83
10.27	263.88
11.18	263.95
12.59	263.00
13.52	262.62
14.33	262.69
14.87	262.82
15.52	262.88
16.30	263.28
17.52	263.57
19.34	264.29
22.5	264.23
25.0	264.35
26.1	264.10
29.09	264.16

SUMMARY DATA	
Bankfull Elevation:	264.0
Bankfull Cross-Sectional Area:	5.6
Bankfull Width:	7.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	1.3
Mean Depth at Bankfull:	0.8
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	E

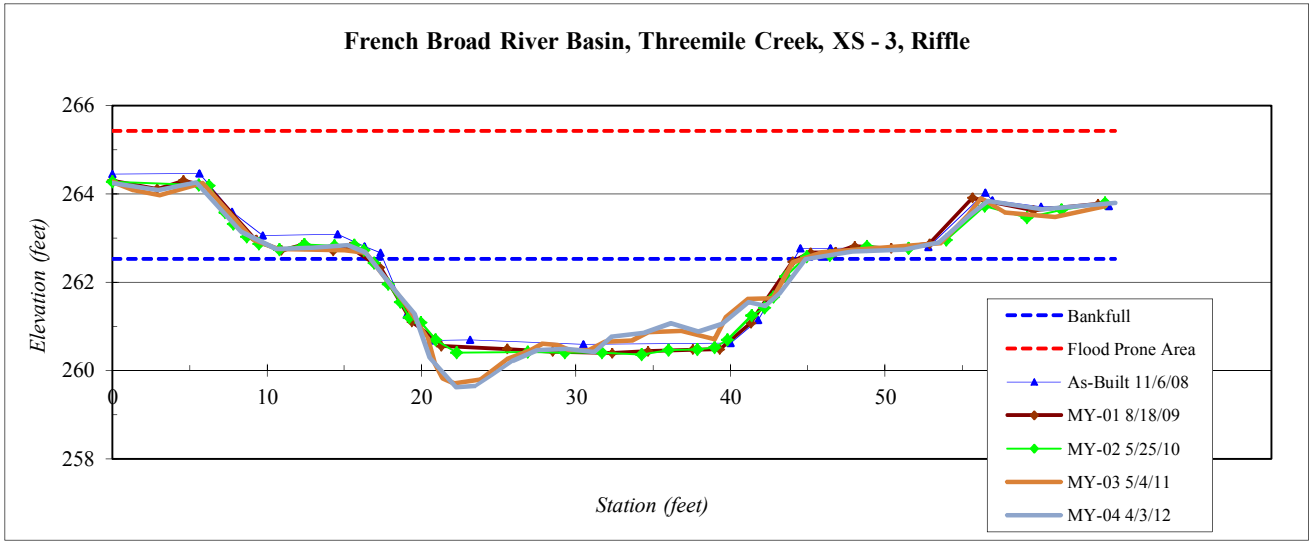


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 3, Riffle
Drainage Area (sq mi):	4.7
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.00	264.24
2.95	264.09
5.39	264.26
8.29	263.14
10.59	262.76
12.94	262.77
15.25	262.83
16.34	262.68
18.41	261.76
19.53	261.30
20.55	260.29
22.22	259.63
23.48	259.66
24.56	259.90
25.9	260.21
27.5	260.47
29.4	260.49
31.2	260.41
32.3	260.77
34.4	260.86
36.1	261.08
37.9	260.89
39.5	261.06
41.2	261.55
42.2	261.46
43.2	261.75
44.9	262.52
47.88	262.70
51.24	262.74
53.48	262.89
55.45	263.51
56.67	263.83
60.18	263.65
64.89	263.80

SUMMARY DATA	
Bankfull Elevation:	262.5
Bankfull Cross-Sectional Area:	47.0
Bankfull Width:	28.2
Flood Prone Area Elevation:	265.4
Flood Prone Width:	>65
Max Depth at Bankfull:	2.9
Mean Depth at Bankfull:	1.7
W / D Ratio:	16.9
Entrenchment Ratio:	>5
Bank Height Ratio:	1.0

Stream Type	E/C

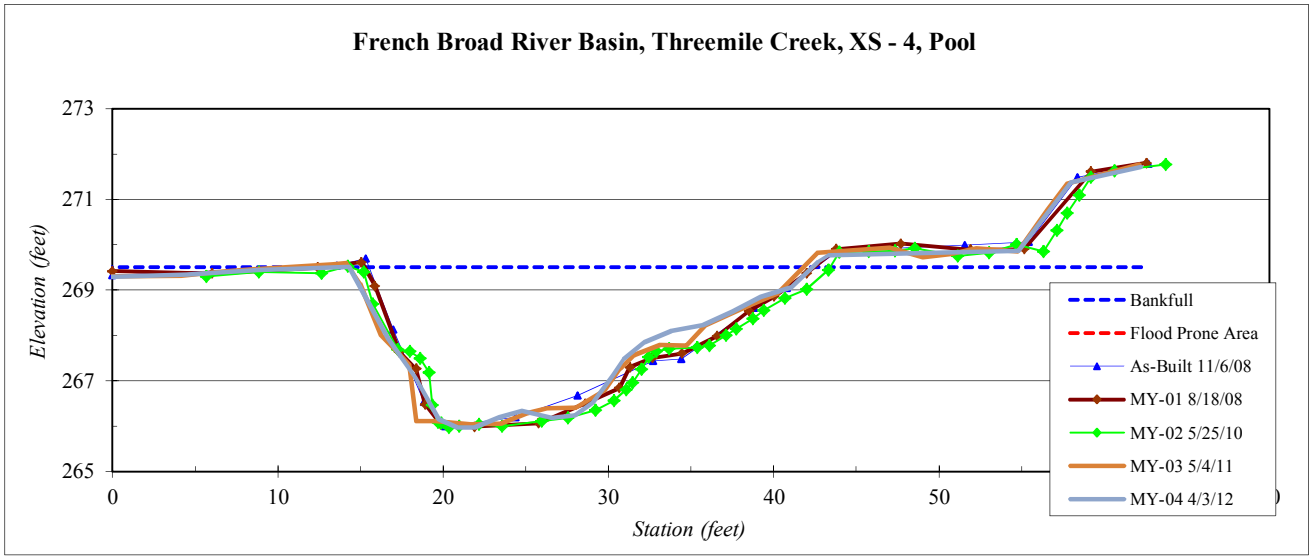


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 4, Pool
Drainage Area (sq mi):	4.7
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
-0.5	269.3
4.5	269.3
8.8	269.4
14.3	269.5
16.7	267.9
18.3	267.1
19.7	266.2
20.9	266.0
21.9	266.0
23.4	266.2
24.8	266.3
26.6	266.2
28.0	266.2
29.1	266.5
30.3	267.12
30.9	267.48
32.2	267.84
33.8	268.10
35.7	268.23
37.5	268.52
39.2	268.85
41.1	269.06
42.7	269.63
43.3	269.77
49.7	269.82
54.8	269.86
58.0	271.37
62.2	271.71

SUMMARY DATA	
Bankfull Elevation:	269.5
Bankfull Cross-Sectional Area:	56.9
Bankfull Width:	28.0
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.5
Mean Depth at Bankfull:	2.0
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	E

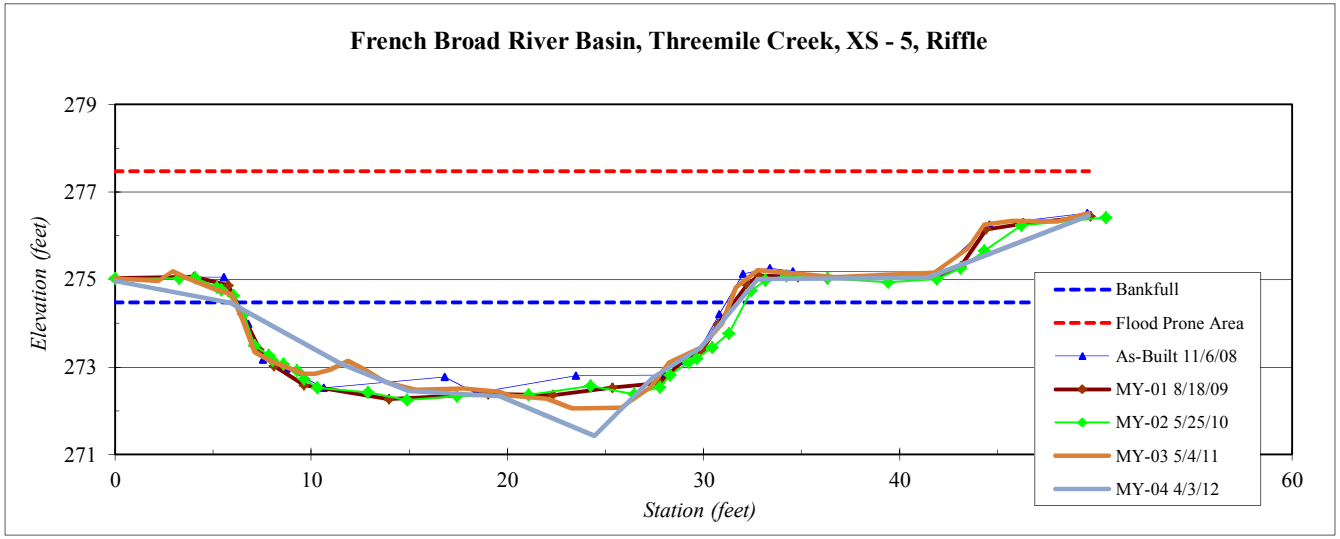


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 5, Riffle
Drainage Area (sq mi):	4.7
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.0	275.0
5.9	274.5
11.5	273.1
15.0	272.5
19.6	272.3
24.4	271.4
27.4	272.7
29.8	273.4
32.8	275.0
41.4	275.0
49.6	276.5

SUMMARY DATA	
Bankfull Elevation:	274.5
Bankfull Cross-Sectional Area:	43.4
Bankfull Width:	25.9
Flood Prone Area Elevation:	277.5
Flood Prone Width:	>65
Max Depth at Bankfull:	3.0
Mean Depth at Bankfull:	1.7
W / D Ratio:	15.5
Entrenchment Ratio:	>5
Bank Height Ratio:	1.0

Stream Type	E/C

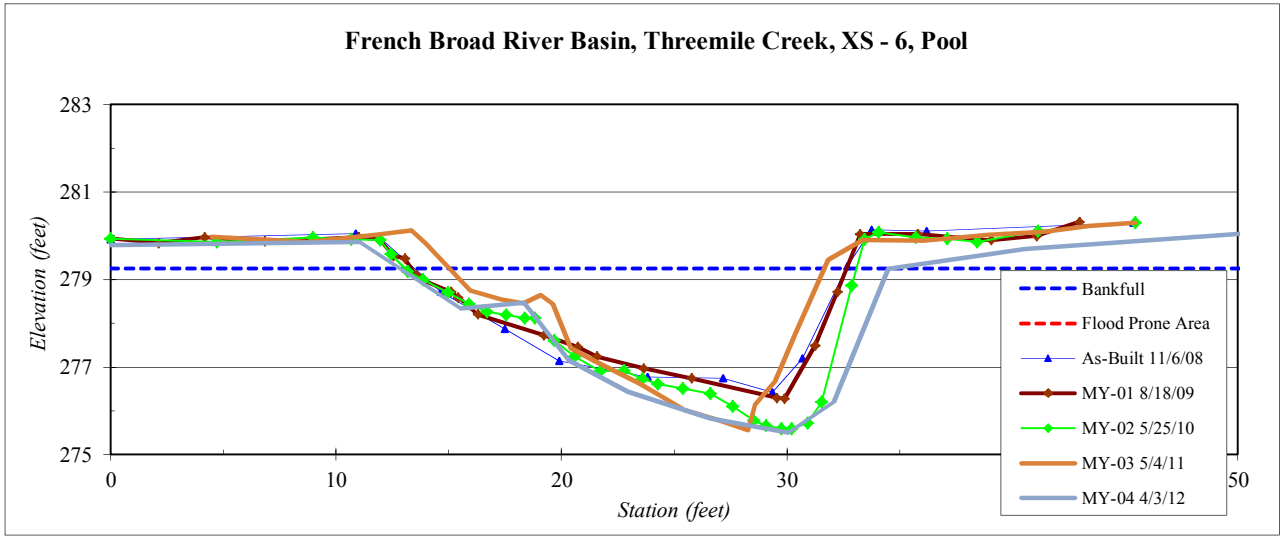


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 6, Pool
Drainage Area (sq mi):	4.7
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.0	279.8
11.0	279.9
15.5	278.3
18.3	278.5
20.3	277.2
22.9	276.4
26.6	275.8
30.1	275.5
32.1	276.2
34.5	279.3
40.6	279.7
52.2	280.1

SUMMARY DATA	
Bankfull Elevation:	279.3
Bankfull Cross-Sectional Area:	47.2
Bankfull Width:	21.6
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.8
Mean Depth at Bankfull:	2.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	E/C

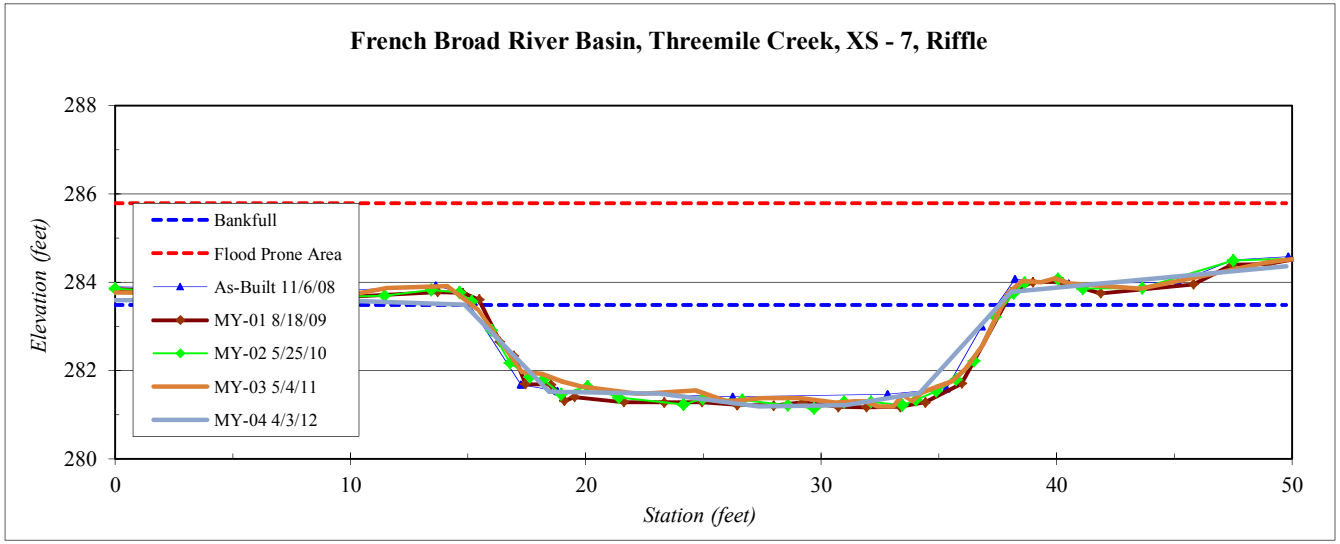


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 7, Riffle
Drainage Area (sq mi):	4.7
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.0	283.6
10.0	283.6
14.9	283.5
18.4	281.5
23.1	281.5
27.4	281.2
31.0	281.2
34.2	281.5
38.1	283.8
49.8	284.4

SUMMARY DATA	
Bankfull Elevation:	283.5
Bankfull Cross-Sectional Area:	40.4
Bankfull Width:	22.7
Flood Prone Area Elevation:	285.8
Flood Prone Width:	>65
Max Depth at Bankfull:	2.3
Mean Depth at Bankfull:	1.8
W / D Ratio:	12.8
Entrenchment Ratio:	>5
Bank Height Ratio:	1.0

Stream Type	E/C

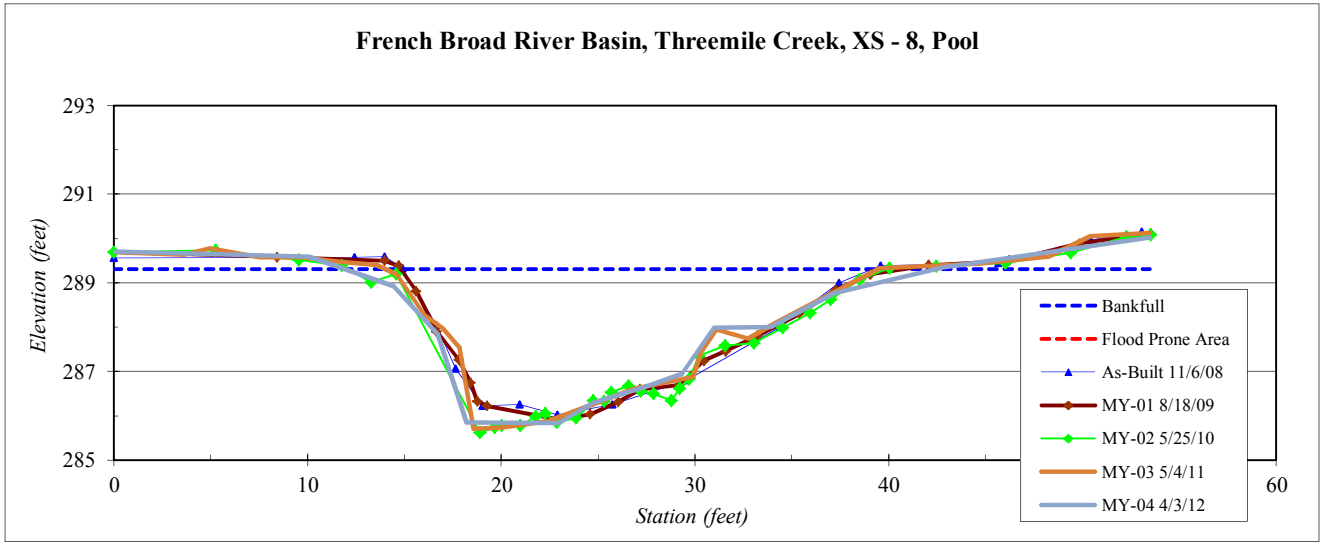


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 8, Pool
Drainage Area (sq mi):	4.7
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.0	289.7
10.1	289.6
14.5	288.9
16.7	287.8
18.2	285.9
23.0	285.8
24.8	286.3
27.4	286.6
29.3	286.9
31.0	288.0
33.9	288.0
37.2	288.8
42.8	289.3
53.5	290.03

SUMMARY DATA	
Bankfull Elevation:	289.3
Bankfull Cross-Sectional Area:	52.3
Bankfull Width:	30.6
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.5
Mean Depth at Bankfull:	1.7
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	E/C

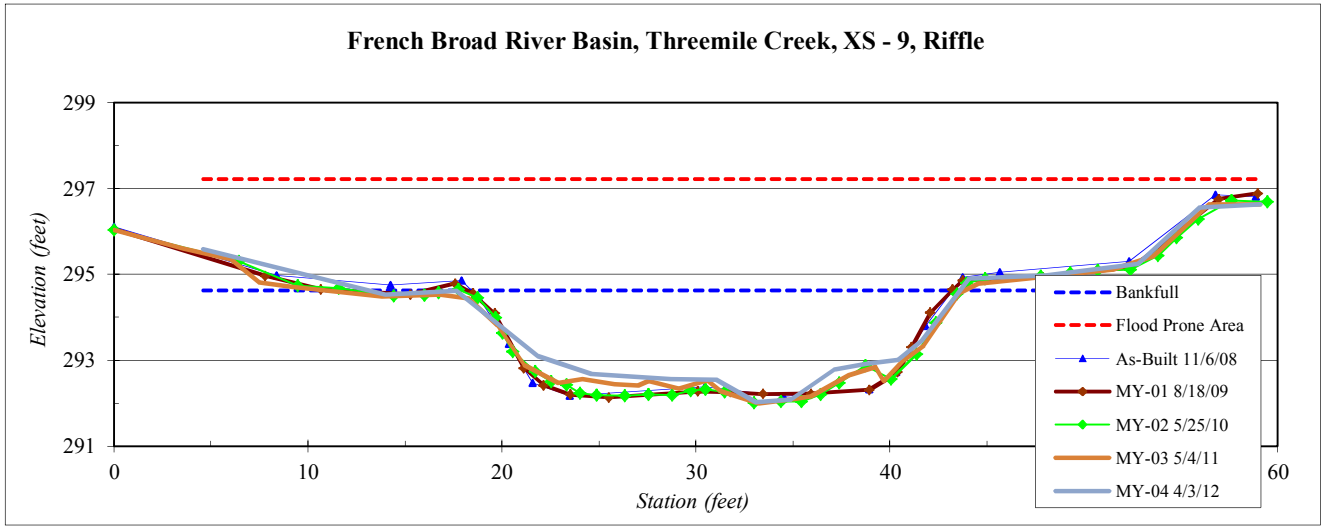


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 9, Riffle
Drainage Area (sq mi):	4.7
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
4.6	295.6
14.0	294.5
17.6	294.6
21.8	293.1
24.6	292.7
28.7	292.6
31.0	292.6
33.1	292.0
34.9	292.1
37.2	292.8
38.8	292.9
40.4	293.0
41.6	293.5
44.1	294.90
48.1	294.97
52.8	295.25
55.9	296.56
59.1	296.63

SUMMARY DATA	
Bankfull Elevation:	294.6
Bankfull Cross-Sectional Area:	43.8
Bankfull Width:	26.0
Flood Prone Area Elevation:	297.2
Flood Prone Width:	>65
Max Depth at Bankfull:	2.6
Mean Depth at Bankfull:	1.7
W / D Ratio:	15.4
Entrenchment Ratio:	>5
Bank Height Ratio:	1.0

Stream Type	E/C

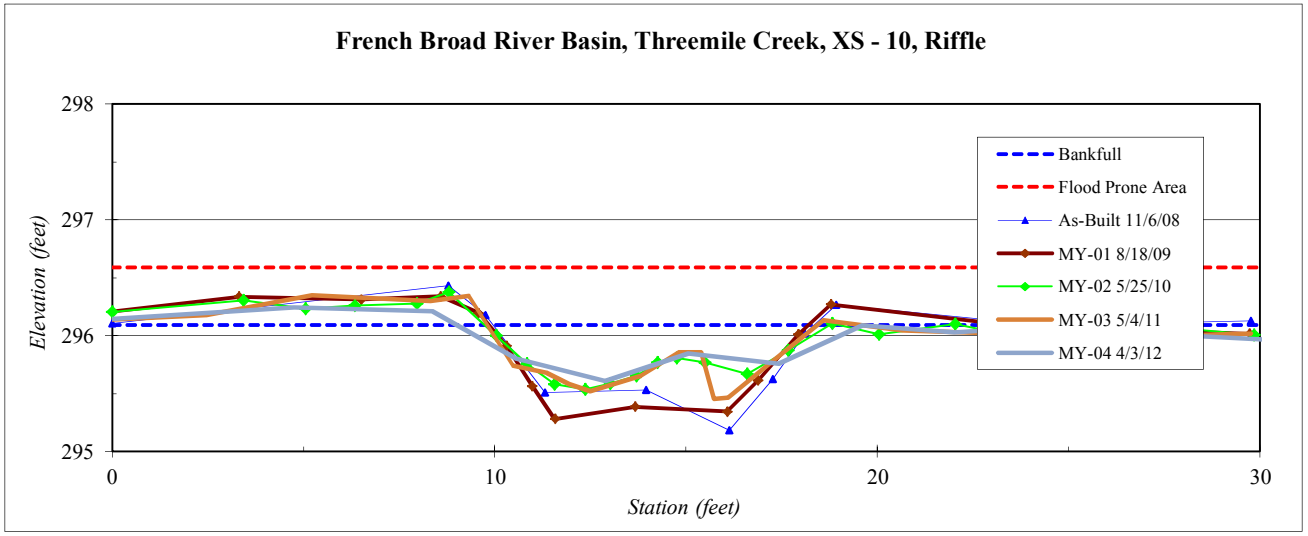


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 10, Riffle
Drainage Area (sq mi):	0.05
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.0	296.1
4.8	296.2
8.4	296.2
10.6	295.8
12.9	295.6
15.1	295.8
17.4	295.8
19.6	296.1
22.0	296.0
24.4	296.1
27.1	296.0
30.0	296.0

SUMMARY DATA	
Bankfull Elevation:	296.1
Bankfull Cross-Sectional Area:	2.9
Bankfull Width:	10.6
Flood Prone Area Elevation:	296.6
Flood Prone Width:	>35
Max Depth at Bankfull:	0.5
Mean Depth at Bankfull:	0.3
W / D Ratio:	38.7
Entrenchment Ratio:	>5
Bank Height Ratio:	1.0

Stream Type	E/C

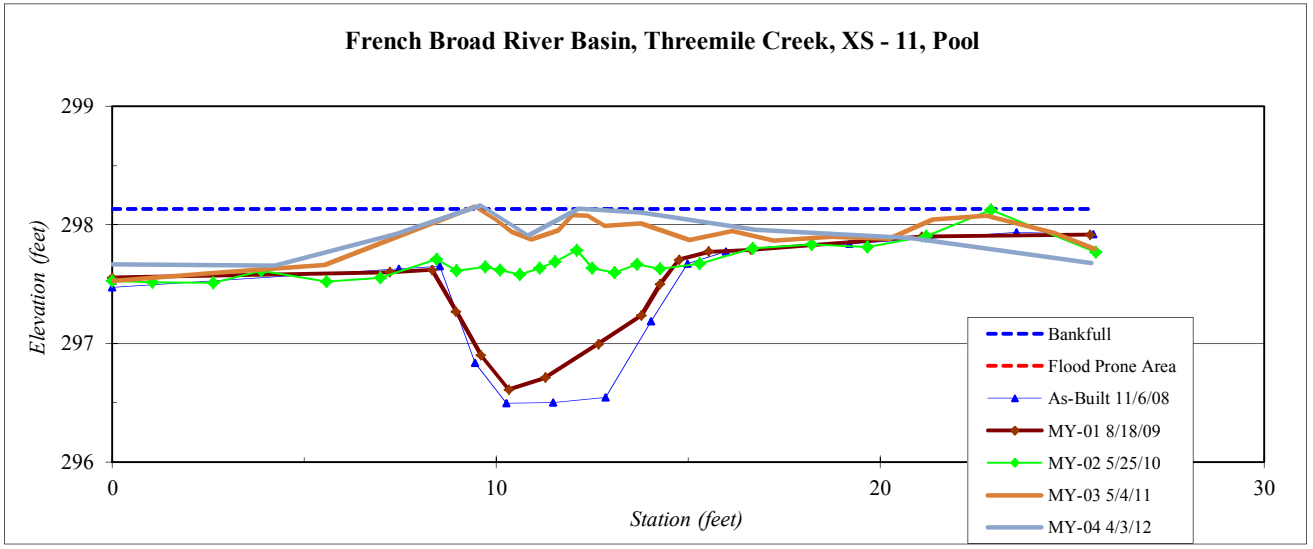


River Basin:	French Broad
Watershed:	Threemile Creek
XS ID	XS - 11, Pool
Drainage Area (sq mi):	0.05
Date:	4/3/2012
Field Crew:	Perkinson, Thomas

Station	Elevation
0.0	297.7
4.2	297.7
7.4	297.9
9.6	298.2
10.8	297.9
12.1	298.1
13.8	298.1
16.7	298.0
20.8	297.9
25.5	297.7

SUMMARY DATA	
Bankfull Elevation:	298.1
Bankfull Cross-Sectional Area:	0.3
Bankfull Width:	2.4
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	0.5
Mean Depth at Bankfull:	0.1
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

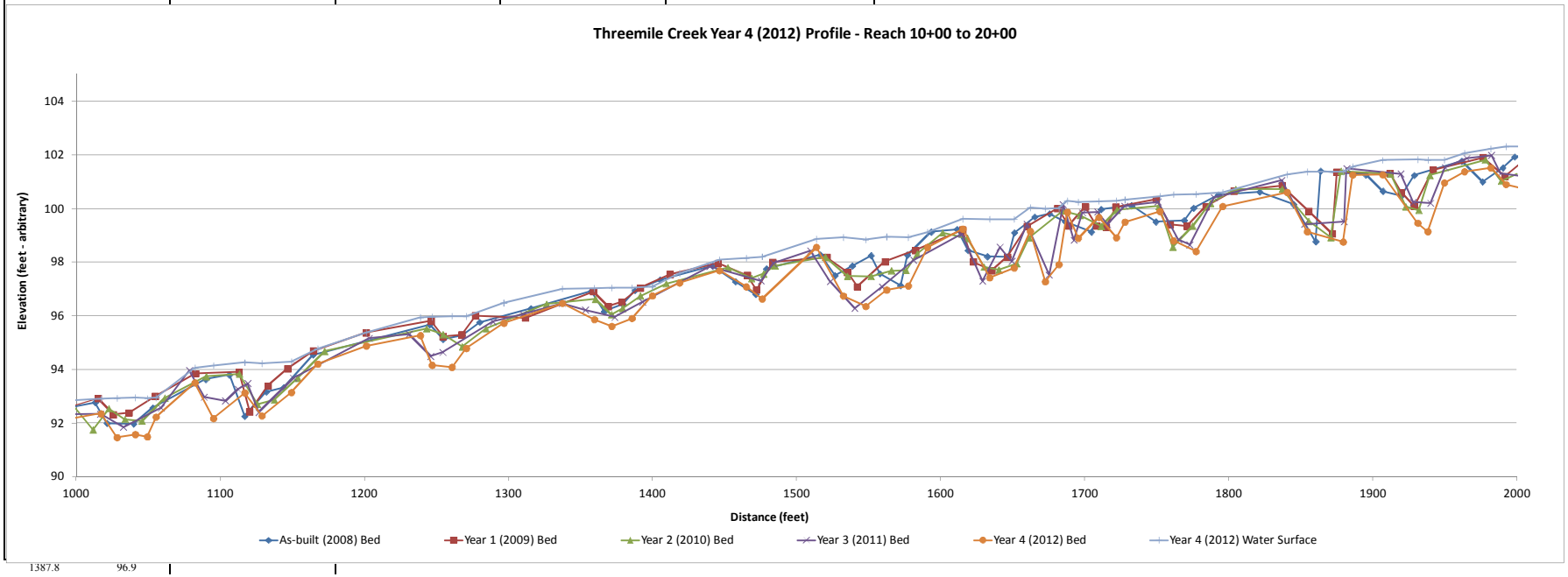
Stream Type	E/C



Project Name	Threemile Creek - Profile
Reach	10+00 - 20+00
Feature	Profile
Date	4/6/12
Crew	Perkinson, Thomas

2008 As-built Survey		2009 Year 1 Monitoring \Survey		2010 Year 2 Monitoring \Survey		2011 Year 3 Monitoring \Survey		2012 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Water Elevation**
0.0	82.5	967.1	92.1	999.7	92.6	990.6	92.3	997.4	92.2	92.8
37.1	82.8	1015.0	92.9	1011.6	91.8	1016.7	92.3	1017.0	92.3	92.9
93.1	83.4	1025.6	92.3	1022.5	92.5	1032.7	91.9	1028.2	91.5	92.9
98.8	83.2	1036.6	92.4	1033.7	92.1	1058.8	92.6	1040.9	91.6	92.9
107.4	83.2	1054.6	93.0	1045.5	92.1	1078.4	94.0	1049.3	91.5	92.9
121.0	84.1	1082.7	93.8	1061.4	92.9	1088.7	93.0	1055.3	92.2	92.9
130.4	83.4	1113.0	93.9	1090.2	93.7	1103.5	92.8	1082.3	93.5	94.1
138.8	83.4	1120.3	92.4	1113.1	93.8	1112.3	93.3	1095.2	92.2	94.1
144.7	83.7	1132.9	93.4	1125.7	92.7	1119.0	93.5	1116.9	93.1	94.3
197.0	84.7	1146.8	94.0	1137.4	92.9	1126.6	92.4	1128.8	92.3	94.2
226.7	84.1	1164.5	94.7	1153.8	93.7	1150.6	93.7	1149.3	93.1	94.3
236.5	83.3	1201.0	95.4	1172.3	94.7	1203.2	95.2	1167.6	94.2	94.8
250.9	82.1	1246.3	95.8	1243.0	95.5	1231.1	95.3	1201.3	94.9	95.4
253.2	85.2	1254.6	95.2	1254.6	95.3	1246.0	94.5	1238.8	95.3	95.9
281.5	85.4	1267.6	95.3	1267.9	94.8	1254.4	94.6	1247.0	94.2	96.0
325.5	86.0	1277.0	96.0	1284.4	95.5	1289.3	95.8	1260.7	94.1	96.0
346.6	85.2	1311.8	95.9	1326.3	96.4	1310.1	96.1	1270.7	94.8	96.0
370.6	85.4	1358.9	96.9	1360.3	96.6	1337.2	96.5	1296.7	95.7	96.5
384.2	85.7	1369.2	96.3	1371.5	96.0	1353.4	96.2	1337.4	96.5	97.0
420.6	86.8	1378.7	96.5	1379.2	96.3	1373.7	96.0	1359.6	95.9	97.0
438.2	86.1	1391.4	97.0	1391.6	96.7	1393.1	96.5	1371.7	95.6	97.0
448.3	86.2	1412.1	97.6	1409.4	97.2	1439.8	97.8	1385.7	95.9	97.0
457.1	86.8	1445.4	98.0	1452.3	97.8	1475.3	97.3	1399.8	96.7	97.1
484.0	87.2	1465.7	97.5	1468.7	97.4	1483.9	98.0	1418.7	97.2	97.6
494.7	86.5	1472.2	97.0	1477.1	97.6	1509.6	98.4	1446.4	97.7	98.1
513.8	85.6	1483.4	98.0	1485.0	97.9	1523.4	97.3	1465.1	97.1	98.2
517.6	87.9	1520.9	98.2	1520.0	98.2	1540.3	96.3	1476.1	96.6	98.2
1387.8	96.9									

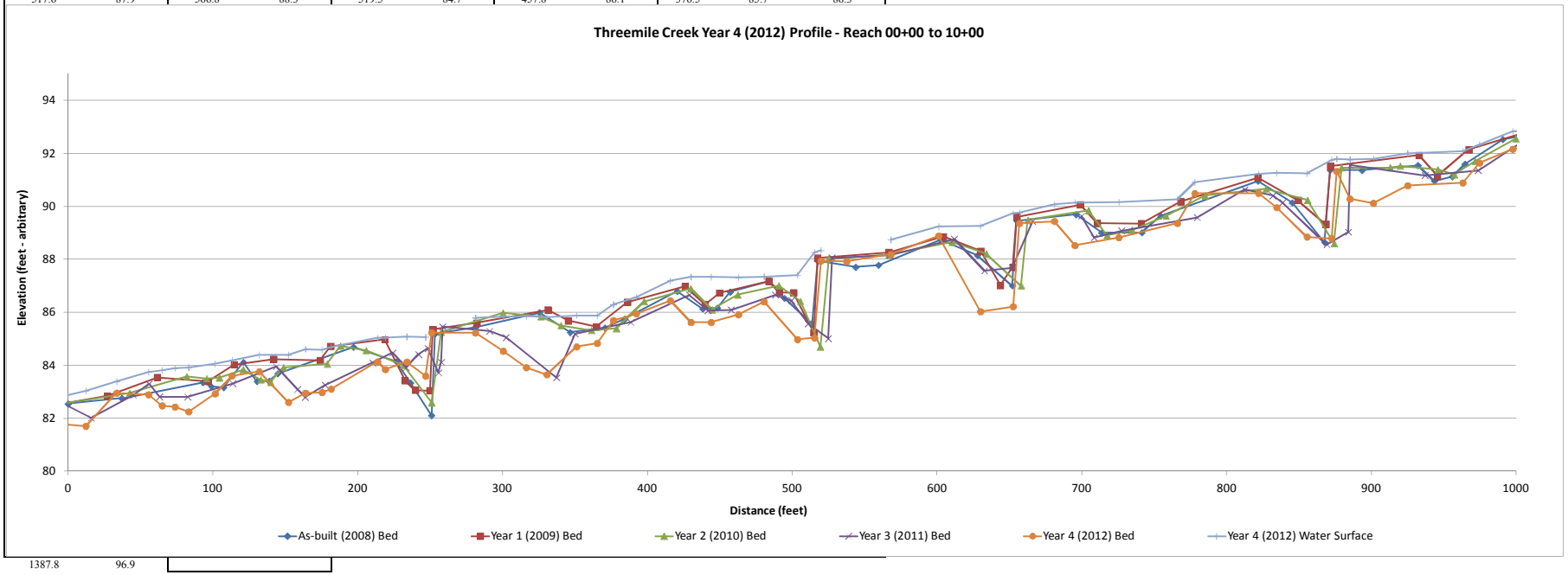
	As-built	2009	2010	2011	2012
Avg. Water Surface Slo	0.0098	0.0097	0.0098	0.0097	0.0098
Riffle Length	51	53	51	50	43
Avg. Riffle Slope	0.0154	0.0143	0.0148	0.0173	0.0155
Pool Length	46	38	44	46	53
Avg. Pool Slope	-------	0.0008	0.0038	0.0052	0.0065



Project Name	Threemile Creek - Profile
Reach	00+00 - 10+00
Feature	Profile
Date	4/6/12
Crew	Perkinson, Thomas

2008 As-built Survey		2009 Year 1 Monitoring \Survey		2010 Year 2 Monitoring \Survey		2011 Year 3 Monitoring \Survey		2012 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Water Elevation**
0.0	82.5	-3.3	82.5	-3.0	82.5	-3.0	82.5	-13.0	82.5	82.9
37.1	82.8	27.2	82.8	42.3	82.9	15.8	82.0	-5.3	81.8	82.8
93.1	83.4	61.6	83.5	81.9	83.6	45.0	82.9	12.2	81.7	83.0
98.8	83.2	96.5	83.4	95.6	83.5	55.9	83.3	33.5	83.0	83.4
107.4	83.2	114.5	84.0	104.5	83.5	63.1	82.8	55.5	82.9	83.8
121.0	84.1	141.7	84.2	120.8	83.8	82.5	82.8	64.9	82.5	83.8
130.4	83.4	173.8	84.2	133.0	83.5	113.7	83.3	73.8	82.4	83.9
138.8	83.4	181.2	84.7	139.8	83.4	143.6	84.0	83.2	82.3	83.9
144.7	83.7	218.5	85.0	148.7	83.9	158.3	83.1	101.5	82.9	84.1
197.0	84.7	232.7	83.4	178.9	84.1	163.7	82.8	113.2	83.6	84.2
226.7	84.1	239.7	83.1	188.0	84.7	177.4	83.3	131.9	83.8	84.4
236.5	83.3	249.8	83.0	205.8	84.6	210.3	84.1	152.1	82.6	84.4
250.9	82.1	251.9	85.4	231.4	84.0	224.1	84.5	163.9	83.0	84.6
253.2	85.2	282.1	85.6	250.9	82.6	233.4	83.9	175.3	83.0	84.6
281.5	85.4	331.2	86.1	257.5	85.3	242.0	84.4	181.6	83.1	84.7
325.5	86.0	345.4	85.7	300.3	86.0	248.5	84.6	213.7	84.1	85.0
346.6	85.2	364.7	85.5	326.5	85.8	255.8	83.7	219.0	83.8	85.0
370.6	85.4	386.1	86.4	340.3	85.5	257.7	84.1	233.9	84.1	85.1
384.2	85.7	426.2	87.0	361.3	85.3	258.5	85.5	246.8	83.6	85.1
420.6	86.8	439.9	86.3	378.5	85.4	291.0	85.3	251.0	85.2	
438.2	86.1	449.9	86.7	397.6	86.4	302.3	85.1	281.2	85.2	85.8
448.3	86.2	483.8	87.2	430.0	86.9	337.2	83.5	300.4	84.5	85.8
457.1	86.8	491.2	86.8	444.7	86.1	350.1	85.2	316.3	83.9	85.9
484.0	87.2	500.9	86.7	462.4	86.7	388.5	85.6	330.5	83.6	85.8
494.7	86.5	514.9	85.2	490.8	87.0	428.9	86.7	351.1	84.7	85.9
513.8	85.6	517.6	88.1	505.6	86.4	441.7	86.1	365.3	84.8	85.9
517.6	87.9	566.8	88.3	519.5	84.7	457.8	86.1	376.5	85.7	86.3
1387.8	96.9									

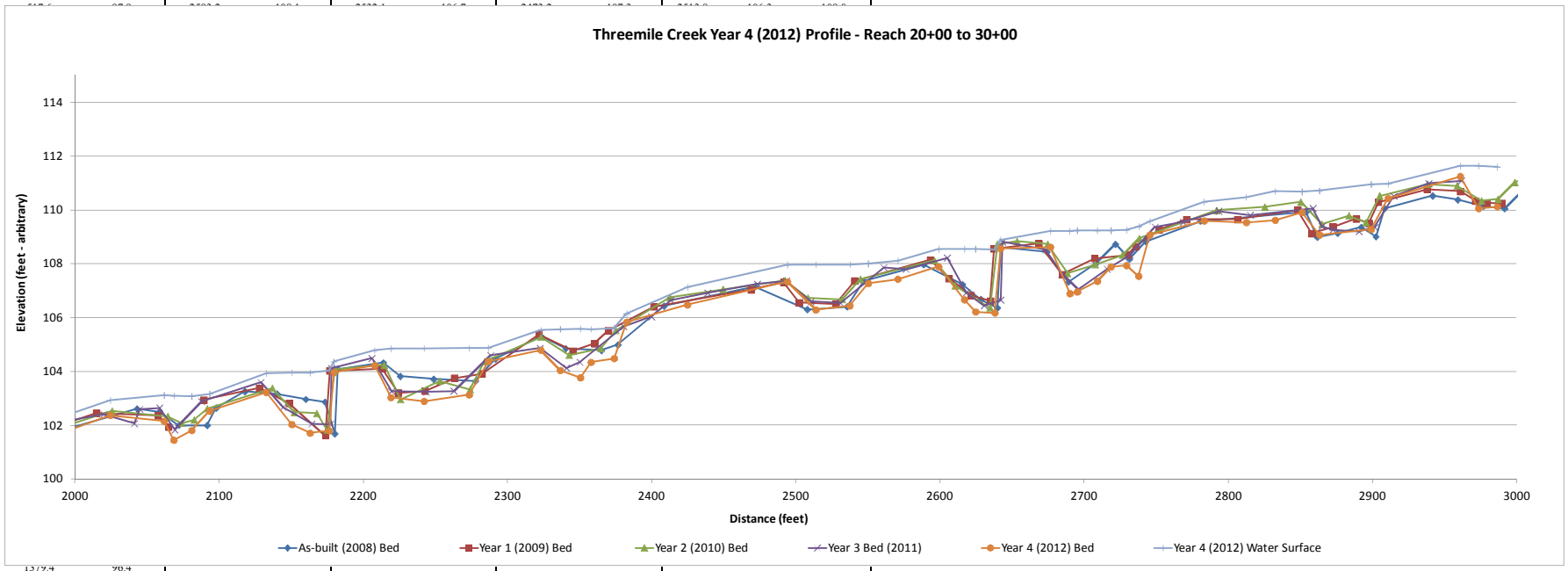
	As-built	2009	2010	2011	2012
Avg. Water Surface Slo	0.0098	0.0097	0.0098	0.0097	0.0098
Riffle Length	51	53	51	50	43
Avg. Riffle Slope	0.0154	0.0143	0.0148	0.0173	0.0155
Pool Length	46	38	44	46	53
Pool to Pool Spacing	-------	0.0008	0.0038	0.0052	0.0065



Project Name	Threemile Creek - Profile
Reach	20+00 - 30+00
Feature	Profile
Date	4/6/12
Crew	Perkinson, Thomas

2008 As-built Survey		2009 Year 1 Monitoring \Survey		2010 Year 2 Monitoring \Survey		2011 Year 3 Monitoring \Survey		2012 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Water Elevation**
0.0	82.5	1971.8	101.2	1974.2	101.0	1966.3	101.3	1970.5	100.9	102.3
37.1	82.8	1990.1	102.0	1985.1	101.3	1981.4	101.2	1983.8	100.7	102.3
93.1	83.4	2014.8	102.5	1996.8	102.0	1998.7	102.2	1998.1	101.9	102.5
98.8	83.2	2057.5	102.4	2025.6	102.5	2019.8	102.4	2024.4	102.4	102.9
107.4	83.2	2064.9	101.9	2064.2	102.3	2041.0	102.1	2061.8	102.2	103.1
121.0	84.1	2077.4		2074.1	102.1	2044.9	102.6	2068.5	101.4	103.1
130.4	83.4	2089.1	102.9	2082.5	102.2	2058.6	102.6	2080.9	101.8	103.1
138.8	83.4	2127.9	103.4	2091.6	102.6	2069.2	101.8	2093.4	102.5	103.2
144.7	83.7	2148.5	102.8	2136.7	103.4	2087.7	102.9	2132.5	103.2	103.9
197.0	84.7	2173.6	101.6	2152.0	102.5	2128.7	103.6	2150.4	102.0	104.0
226.7	84.1	2176.6	104.0	2167.6	102.4	2144.1	102.7	2162.9	101.7	104.0
236.5	83.3	2212.9	104.1	2174.7	101.8	2164.1	102.0	2176.2	101.8	104.0
250.9	82.1	2224.2	103.2	2180.4	104.1	2176.9	102.0	2179.5	104.0	104.4
253.2	85.2	2242.6	103.3	2214.4	104.2	2177.8	104.1	2207.7	104.2	104.8
281.5	85.4	2263.2	103.7	2225.7	103.0	2205.9	104.5	2219.0	103.0	104.8
325.5	86.0	2282.2	103.9	2252.9	103.6	2219.5	103.3	2242.1	102.9	104.9
346.6	85.2	2321.8	105.4	2274.0	103.3	2243.5	103.2	2273.3	103.1	104.9
370.6	85.4	2345.4	104.8	2284.0	104.4	2262.7	103.3	2286.6	104.4	104.9
384.2	85.7	2360.4	105.0	2323.1	105.3	2288.3	104.6	2323.0	104.8	105.5
420.6	86.8	2369.9	105.5	2342.6	104.6	2322.5	104.9	2336.5	104.0	105.6
438.2	86.1	2401.4	106.4	2364.6	104.9	2340.9	104.1	2350.5	103.8	105.6
448.3	86.2	2468.9	107.0	2375.0	105.5	2350.2	104.3	2357.9	104.3	105.6
457.1	86.8	2491.5	107.3	2412.6	106.8	2380.6	105.7	2373.9	104.5	105.6
484.0	87.2	2502.3	106.6	2449.5	107.1	2399.8	106.0	2382.6	105.8	106.1
494.7	86.5	2527.6	106.5	2492.4	107.4	2413.2	106.6	2424.7	106.5	107.1
513.8	85.6	2540.7	107.4	2508.4	106.7	2438.9	106.9	2494.1	107.3	108.0
1379.4	96.4									
1387.8	96.9									

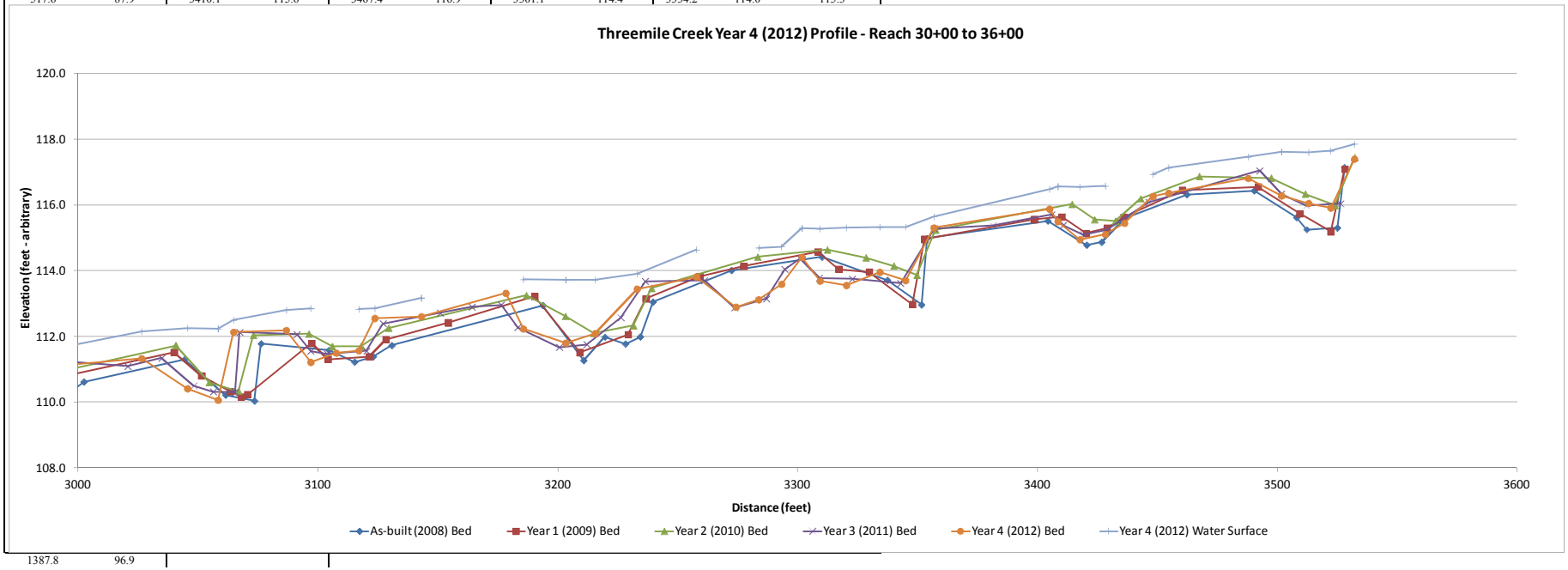
	As-built	2009	2010	2011	2012
Avg. Water Surface Slo	0.0098	0.0097	0.0098	0.0097	0.0098
Riffle Length	51	53	51	50	43
Avg. Riffle Slope	0.0154	0.0143	0.0148	0.0173	0.0155
Pool Length	46	38	44	46	53
Avg. Pool Slope	-------	0.0008	0.0038	0.0052	0.0065



Project Name	Threemile Creek - Profile
Reach	30+00 - 36+00
Feature	Profile
Date	4/6/12
Crew	Perkinson, Thomas

2008 As-built Survey		2009 Year 1 Monitoring \Survey		2010 Year 2 Monitoring \Survey		2011 Year 3 Monitoring \Survey		2012 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Station**	**Bed Elevation**	**Water Elevation**
0.0	82.5	2971.4	110.3	2975.5	110.3	2966.6	110.1	2961.6	110.1	111.6
37.1	82.8	2979.2	110.3	2987.0	110.4	2984.6	110.4	2974.6	110.1	111.6
93.1	83.4	2989.8	110.2	2998.6	111.0	2996.5	111.2	2985.4	110.2	111.6
98.8	83.2	2994.6	110.8	3040.7	111.7	3020.7	111.1	2993.0	111.1	111.7
107.4	83.2	3040.0	111.5	3054.6	110.6	3034.8	111.3	3026.4	111.3	112.2
121.0	84.1	3051.5	110.8	3066.9	110.3	3048.2	110.5	3045.6	110.4	112.2
130.4	83.4	3063.4	110.3	3073.0	112.0	3056.3	110.3	3058.3	110.1	112.2
138.8	83.4	3068.0	110.2	3096.2	112.1	3065.3	110.3	3064.8	112.1	112.5
144.7	83.7	3070.6	110.2	3105.9	111.7	3067.3	112.1	3086.7	112.2	112.8
197.0	84.7	3097.3	111.8	3117.9	111.7	3091.3	112.1	3096.9	111.2	112.8
226.7	84.1	3104.2	111.3	3129.4	112.3	3096.9	111.6	3107.6	111.5	
236.5	83.3	3121.4	111.4	3186.8	113.2	3103.8	111.5	3117.0	111.6	112.8
250.9	82.1	3128.2	111.9	3203.1	112.6	3120.2	111.6	3123.7	112.6	112.9
253.2	85.2	3154.3	112.4	3215.0	112.1	3127.1	112.4	3143.1	112.6	113.2
281.5	85.4	3190.3	113.2	3231.5	112.3	3150.9	112.7	3178.3	113.3	
325.5	86.0	3209.2	111.5	3239.1	113.5	3164.1	112.9	3185.6	112.2	113.7
346.6	85.2	3229.2	112.1	3283.3	114.4	3176.4	113.0	3203.3	111.8	113.7
370.6	85.4	3236.7	113.1	3312.3	114.6	3183.3	112.3	3215.5	112.1	113.7
384.2	85.7	3259.2	113.8	3328.5	114.4	3200.6	111.7	3233.0	113.4	113.9
420.6	86.8	3277.5	114.1	3340.0	114.1	3212.1	111.8	3257.7	113.8	114.6
438.2	86.1	3308.5	114.6	3349.7	113.9	3226.3	112.6	3274.2	112.9	
448.3	86.2	3317.1	114.0	3357.4	115.2	3236.4	113.7	3283.7	113.1	114.7
457.1	86.8	3329.7	114.0	3414.4	116.0	3261.1	113.7	3293.2	113.6	114.7
484.0	87.2	3347.9	113.0	3423.7	115.6	3273.7	112.9	3301.8	114.4	115.3
494.7	86.5	3352.9	115.0	3432.5	115.5	3286.9	113.1	3309.3	113.7	115.3
513.8	85.6	3398.6	115.6	3443.0	116.2	3294.6	114.0	3320.3	113.6	115.3
517.6	87.9	3410.1	115.6	3467.4	116.9	3301.1	114.4	3334.2	114.0	115.3
1387.8	96.9									

	As-built	2009	2010	2011	2012
Avg. Water Surface Sl	0.0098	0.0097	0.0098	0.0097	0.0098
Riffle Length	51	53	51	50	43
Avg. Riffle Slope	0.0154	0.0143	0.0148	0.0173	0.0155
Pool Length	46	38	44	46	53
Avg. Pool Slope	-------	0.0008	0.0038	0.0052	0.0065

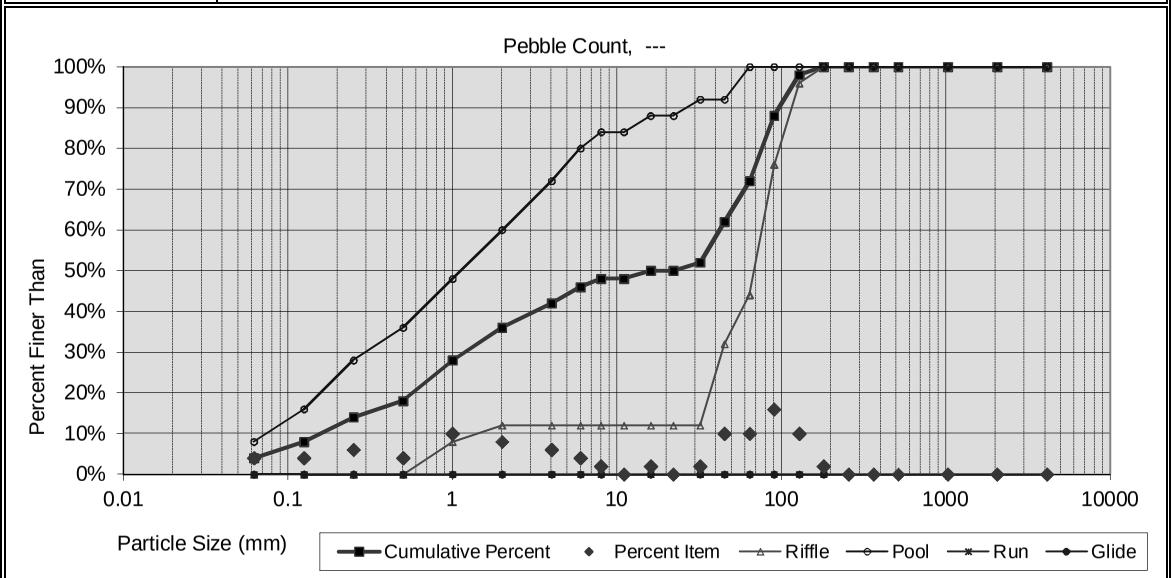


Weighted Pebble Count

Percent Riffle:	**50**	Percent Run:		Pebble Count,
Percent Pool:	**50**	Percent Glide:		

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	4.0	# #
very fine sand	0.062	0.13	4.0	# #
fine sand	0.13	0.25	6.0	# #
medium sand	0.25	0.5	4.0	# #
coarse sand	0.5	1	10.0	# #
very coarse sand	1	2	8.0	# #
very fine gravel	2	4	6.0	# #
fine gravel	4	6	4.0	# #
fine gravel	6	8	2.0	# #
medium gravel	8	11	0.0	# #
medium gravel	11	16	2.0	# #
coarse gravel	16	22	0.0	# #
coarse gravel	22	32	2.0	# #
very coarse gravel	32	45	10.0	# #
very coarse gravel	45	64	10.0	# #
small cobble	64	90	16.0	# #
medium cobble	90	128	10.0	# #
large cobble	128	180	2.0	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	0.0	# #
small boulder	362	512	0.0	# #
medium boulder	512	1024	0.0	# #
large boulder	1024	2048	0.0	# #
very large boulder	2048	4096	0.0	# #
bedrock			0.0	#
		Weighted Count:	100	
		True Total Particle Count:	50	

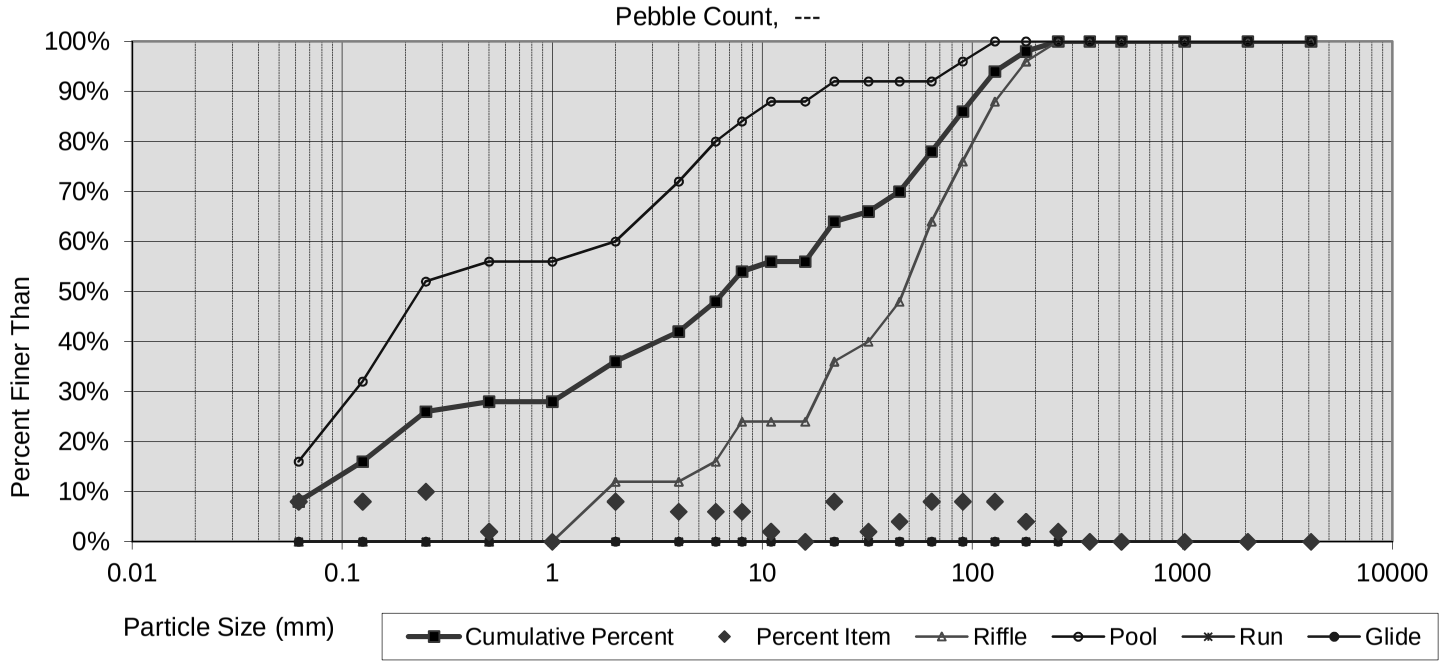
Note:	**Threemile Pebble Counts - Main Channel Lower Reach**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.354	1.83	22.0	83	115	4%	32%	36%	28%	0%	0%

Pebble Count,

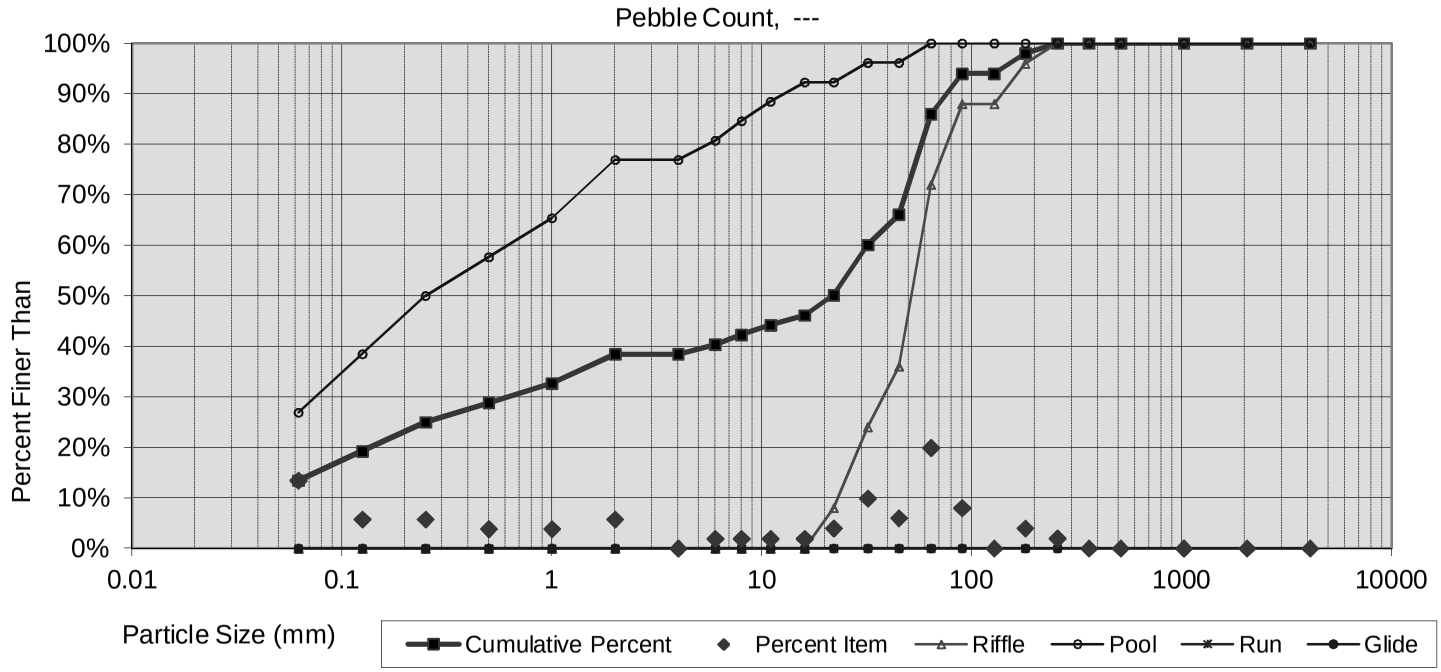
Note: **Threemile Pebble Counts - Main Channel Middle Reach**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.125	1.83	6.6	83	139	8%	28%	42%	22%	0%	0%

Pebble Count,

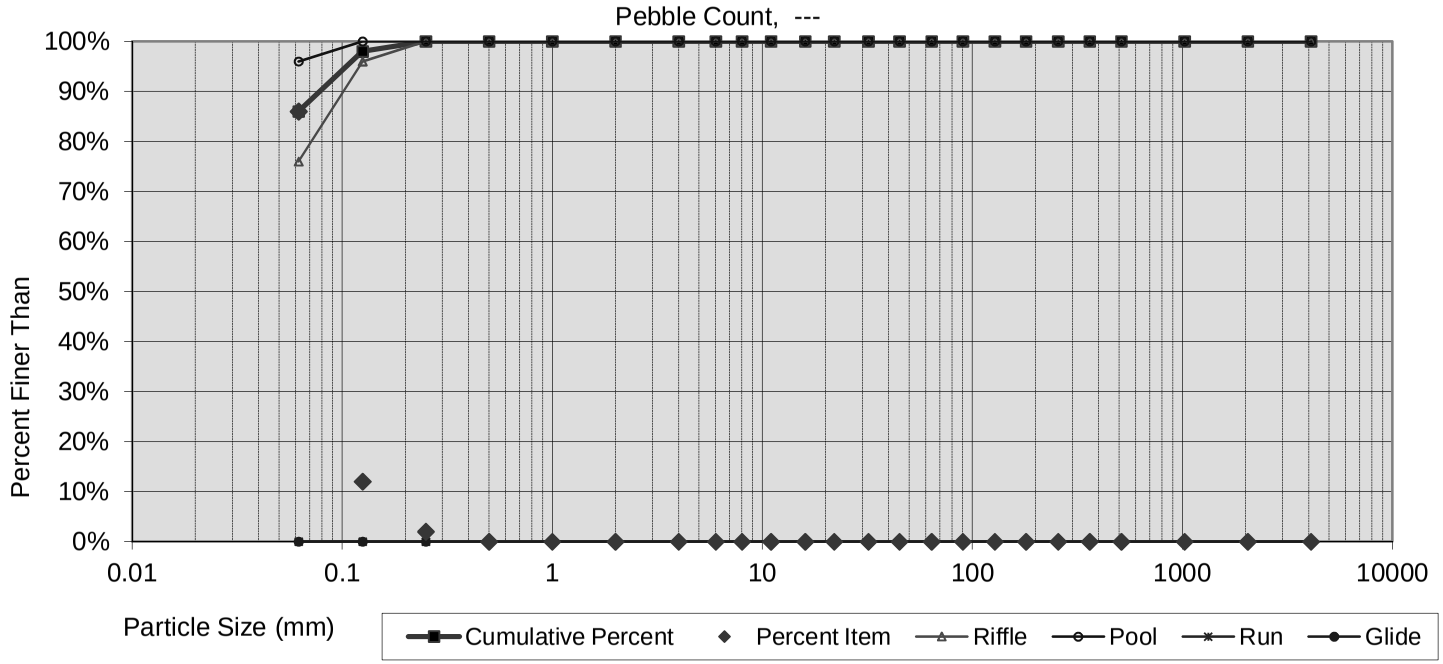
Note: **Threemile Pebble Counts - Main Channel Upper Reach**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.084	1.32	21.7	62	139	13%	25%	48%	14%	0%	0%

Pebble Count,

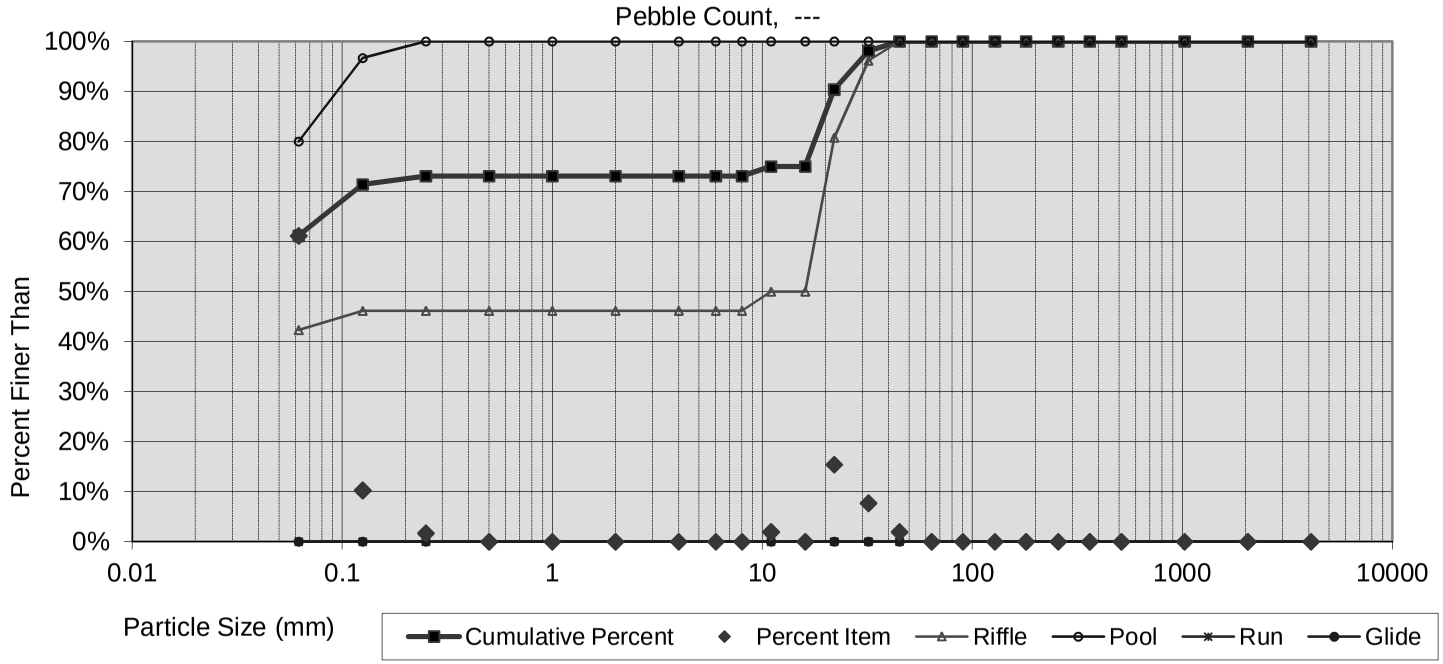
Note: **Threemile Pebble Counts - Tributary 1**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	#N/A	#N/A	#N/A	0	86%	14%	0%	0%	0%	0%

Pebble Count,

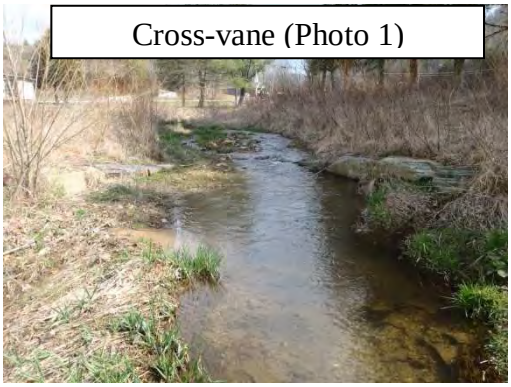
Note: **Threemile Pebble Counts - Tributary 8**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	#N/A	#N/A	19	28	61%	12%	27%	0%	0%	0%

Three Mile
Year 4 (2012) Annual Monitoring
Structure Photographs taken March 2012

Cross-vane (Photo 1)

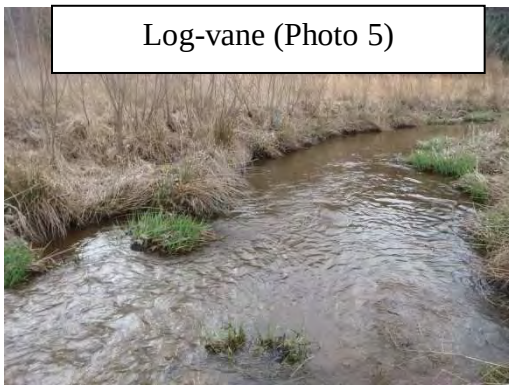


J-hook (Photo 2)

Log-Vane (Photo 3)

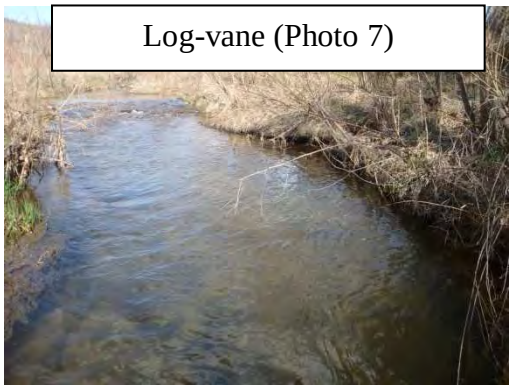
Cross-vane Station (Photo 4)

Log-vane (Photo 5)



Cross-vane (Photo 6)

Log-vane (Photo 7)

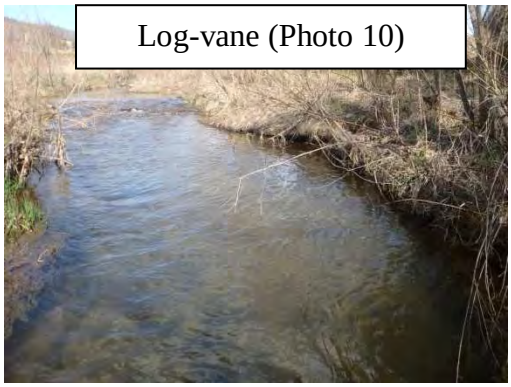


Cross-vane (Photo 8)

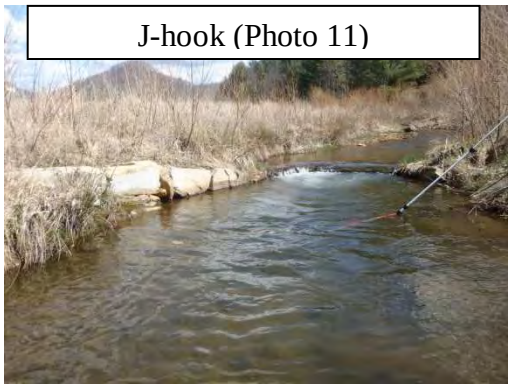
Three Mile
Year 4 (2012) Annual Monitoring
Structure Photographs taken March 2012
(continued)

Cross-vane (Photo 9)

Log-vane (Photo 10)



J-hook (Photo 11)

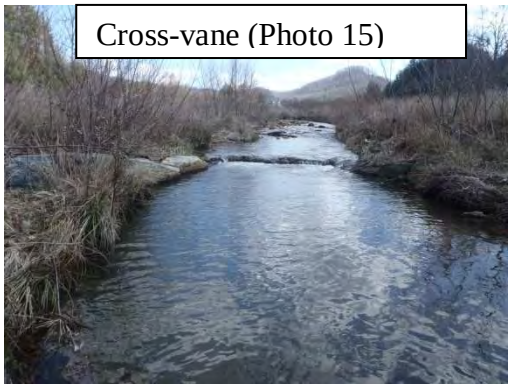


Cross-vane (Photo 12)

Cross-vane (Photo 13)

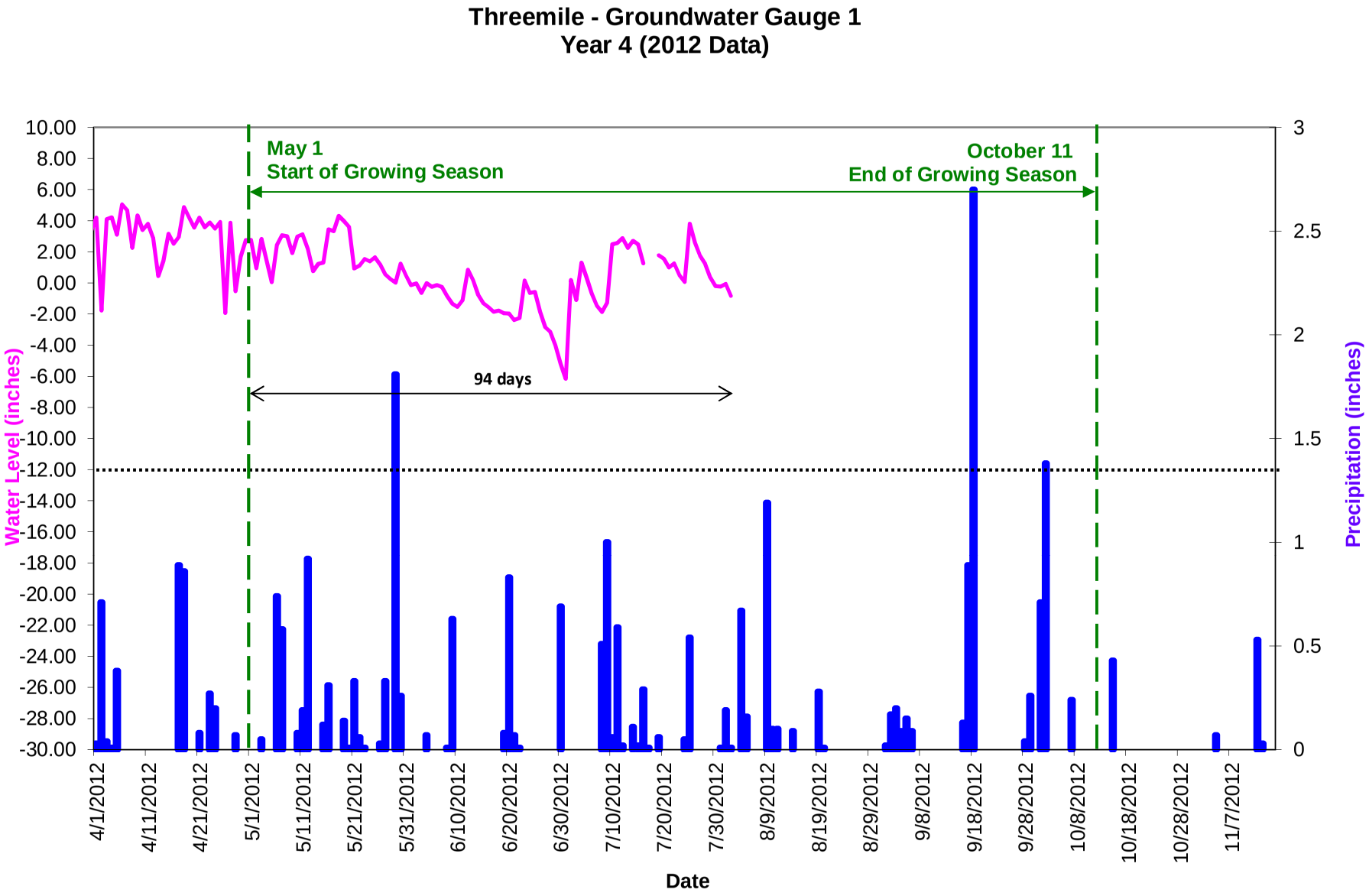
Cross-vane (Photo 14)

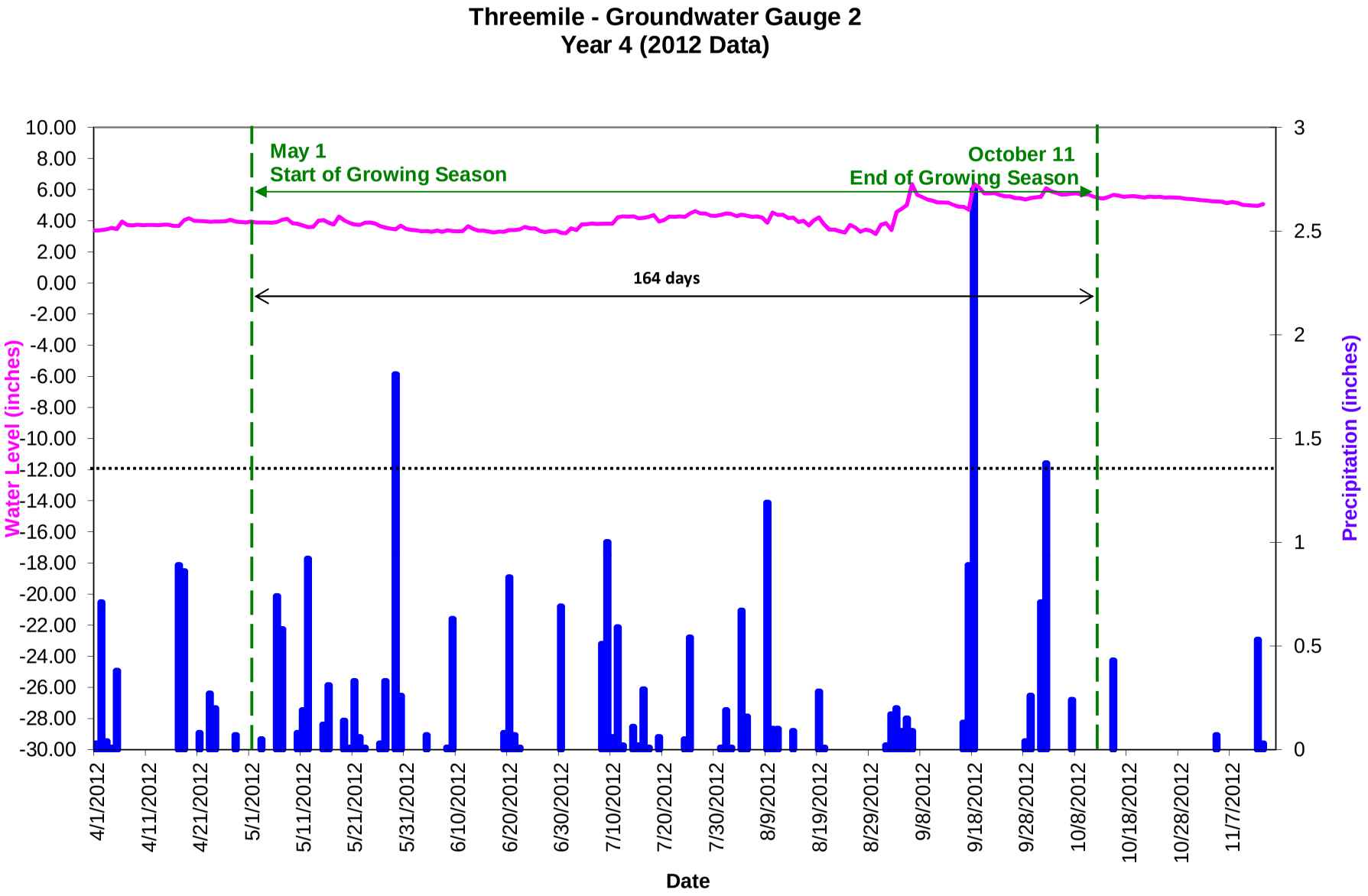
Cross-vane (Photo 15)

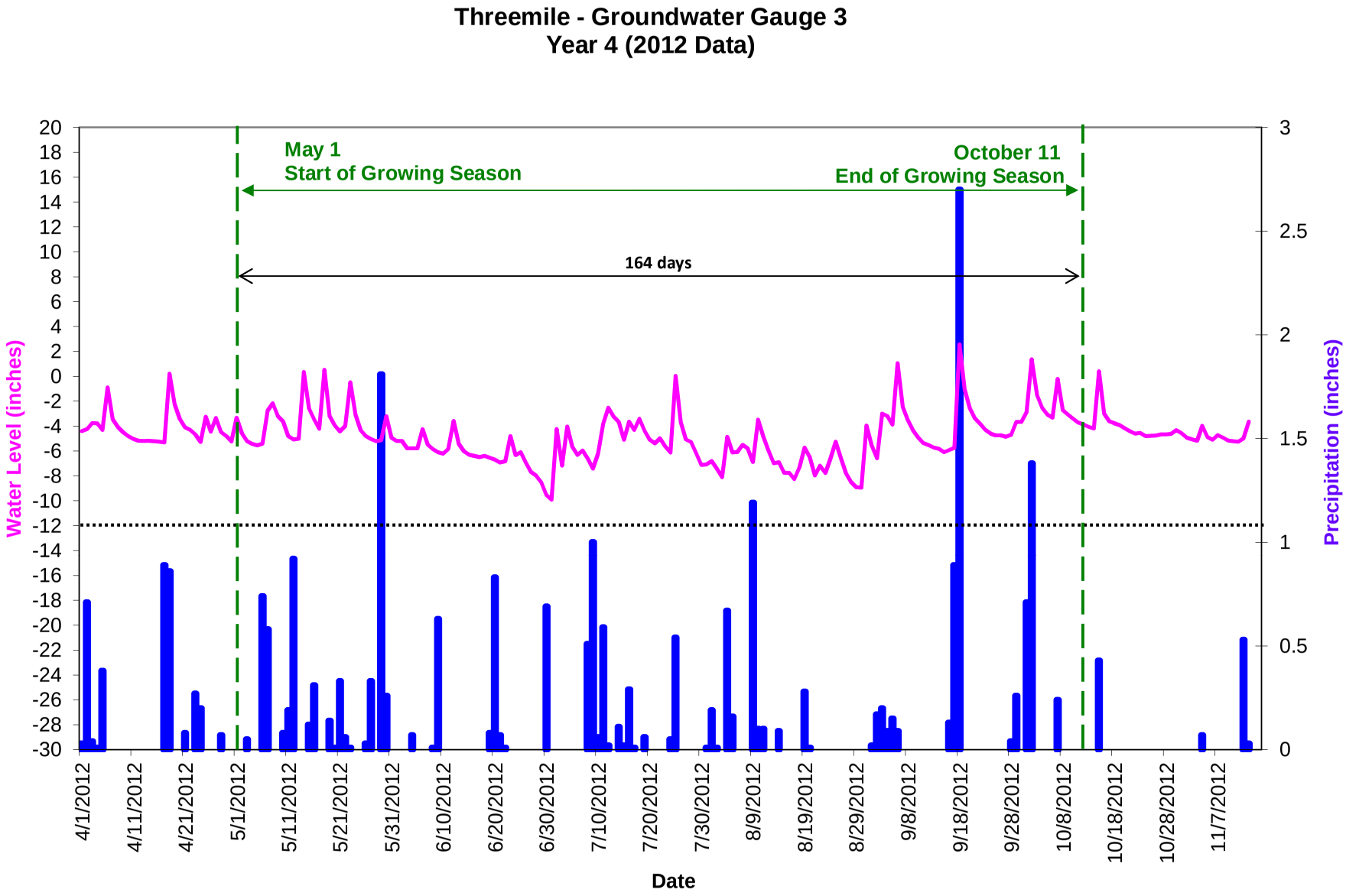


J-hook 9 (Photo 16)

APPENDIX D
HYDROLOGY DATA
2012 Groundwater Gauge Graphs


Threemile - Groundwater Gauge 1
Year 4 (2012 Data)
May 1
Start of Growing Season
October 11
End of Growing Season
94 days
Water Level (inches)
Precipitation (inches)
Date
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
-20.00
-22.00
-24.00
-26.00
-28.00
-30.00
3
2.5
2
1.5
1
0.5
0
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012


Threemile - Groundwater Gauge 2
Year 4 (2012 Data)
May 1
Start of Growing Season
October 11
End of Growing Season
164 days
Water Level (inches)
Precipitation (inches)
Date
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
-20.00
-22.00
-24.00
-26.00
-28.00
-30.00
3
2.5
2
1.5
1
0.5
0
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012


Threemile - Groundwater Gauge 3
Year 4 (2012 Data)
May 1
Start of Growing Season
October 11
End of Growing Season
164 days
Water Level (inches)
Precipitation (inches)
Date
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
-30
3
2.5
2
1.5
1
0.5
0
4/1/2012
4/11/2012
4/21/2012
5/1/2012
5/11/2012
5/21/2012
5/31/2012
6/10/2012
6/20/2012
6/30/2012
7/10/2012
7/20/2012
7/30/2012
8/9/2012
8/19/2012
8/29/2012
9/8/2012
9/18/2012
9/28/2012
10/8/2012
10/18/2012
10/28/2012
11/7/2012

Threemile - Groundwater Reference Gauge
Year 4 (2012 Data)