Laurel Valley Stream Restoration

Post-construction Monitoring
Final Report - Year Three

PREPARED FOR:
The Harford County
Department of Public Works

December 2012

PREPARED BY:
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Environmental
Assessment Open End
Contract No: 10-133

Laurel Valley
Stream Restoration Project

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Harford County
Department of Public Works
Water Resources Engineering
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1.0 INTRODUCTION

The Harford County Department of Public Works (DPW) Water Resources Engineering (WRE) Section, requested that URS conduct the third year monitoring of a completed stream restoration project in a tributary to Bynum Run situated in Harford County, Maryland. The study area is located in the general vicinity of Laurel Valley, between Parallel Path and Boxthorn Road. The entire study reach includes a 3,300 linear-foot reach of the unnamed tributary to Bynum Run. The completed restoration reach extends approximately 1,400 linear feet from downstream of the stormwater retention pond near Merrick Way, and the Downstream Reach continues an additional 1,900 linear-feet to Laurel Bush Road (See Figure 1-Site Vicinity Map). Monitoring initially began in 2007 to establish baseline pre-construction conditions. Restoration construction was completed in February 2009 with post-construction monitoring beginning in April 2009. Geomorphic and biological data collected during the current monitoring period were compared with previous monitoring data to evaluate changes in the profile, cross section, bed materials, and biological and chemical characteristics of the stream as a result of the restoration efforts.

1.1 Overview of Monitoring Activities

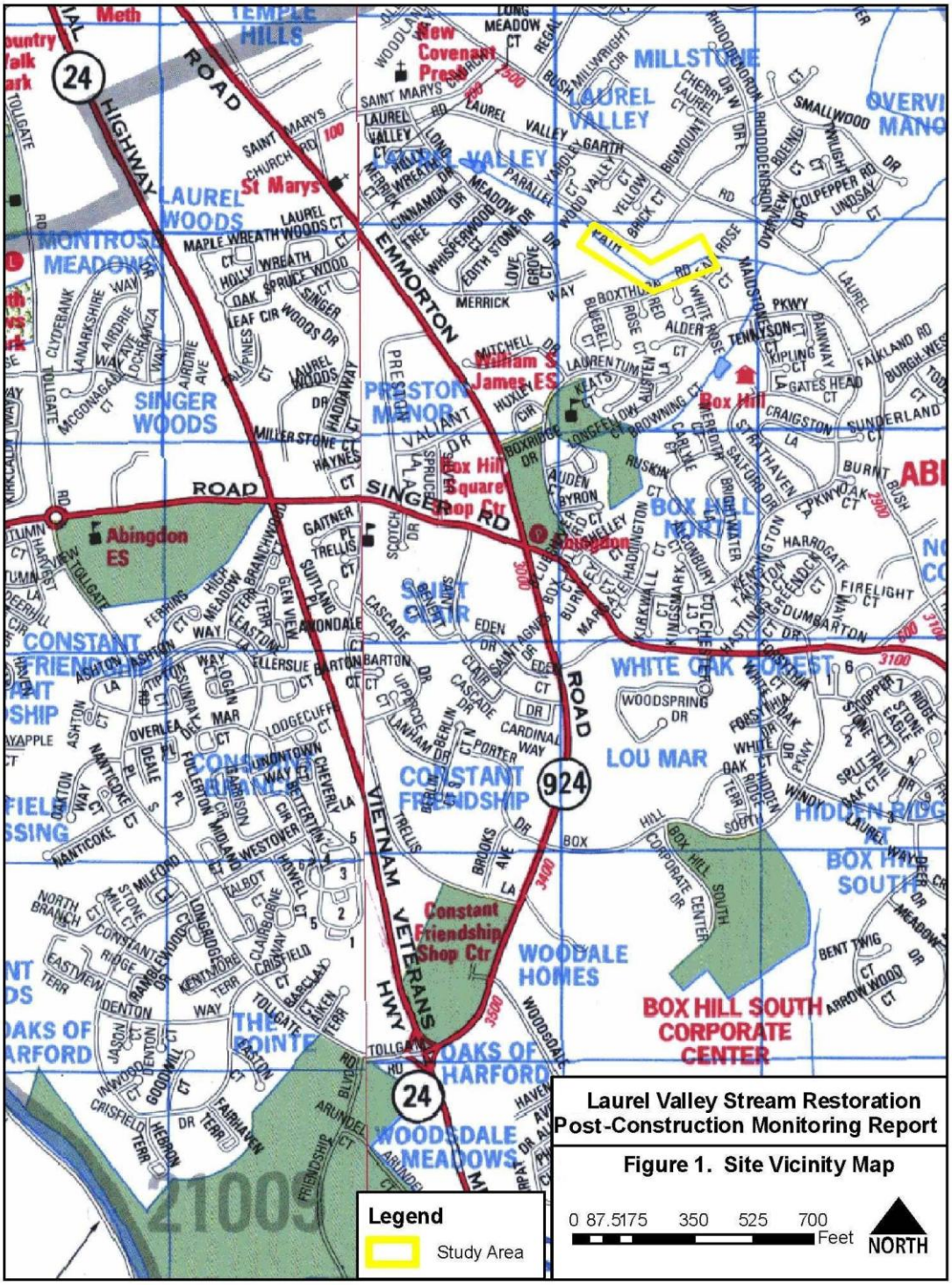
The study area was initially developed in order to compare pre-construction conditions to future post-construction restoration conditions. Monitoring protocols for the Laurel Valley site were developed to evaluate the conditions of channel geometry, sediment load and macroinvertebrate colonization. The post-construction monitoring program that began in 2009 is being conducted on an annual basis.

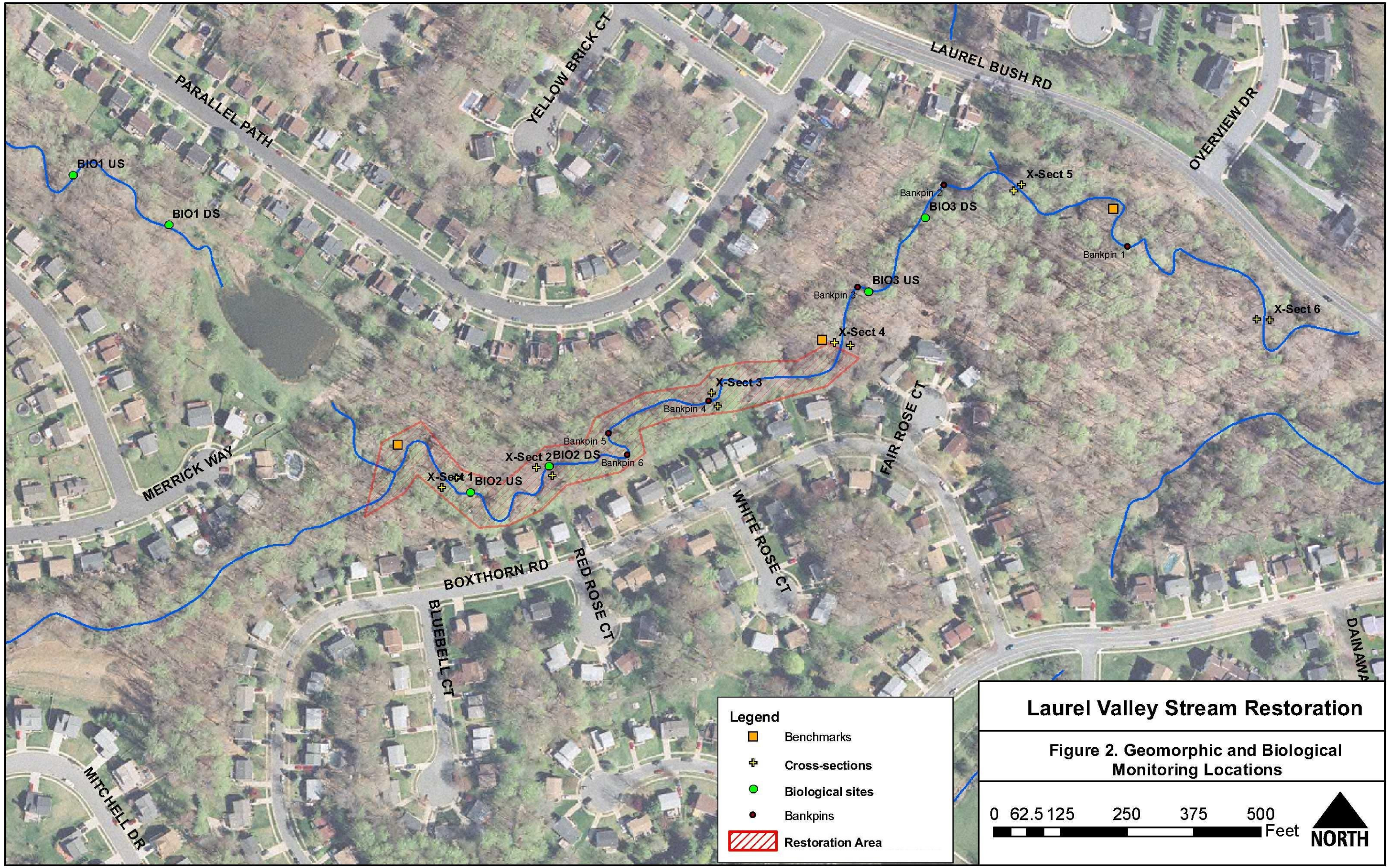
The design engineer for the project, KCI, developed a geomorphic monitoring program consisting of establishing benchmarks and cross-sections, surveying and analyzing cross-sections and thalweg profile, installing and monitoring bank pins, and evaluating substrate particle size distribution. Geomorphic monitoring is conducted to evaluate the bed and bank stability, channel profile and bed features, and bankfull event effects. Six monumented channel cross-sections were established during baseline monitoring.

In addition, biological monitoring was conducted that included the collection and analysis of the macroinvertebrate community and a physical habitat assessment in accordance with the Maryland Biological Stream Survey (MBSS), and measurement of *in situ* water chemistry. Biological assessments involved macroinvertebrate sampling at three locations (See Figure 2 – Geomorphic and Biological Monitoring Locations) and occurred on April 14, 2011 at the study reaches; two within the study reach and the one just upstream of the retention pond.

Methodologies for conducting the yearly monitoring follow those established by KCI and are not repeated in this report. Please refer to *Laurel Valley Stream Restoration Post-construction Monitoring Report – Year One* for a full discussion on the monitoring methodologies and protocols established for this project.

Figure 1- Site Vicinity Map





Laurel Valley Stream Restoration

Figure 2. Geomorphic and Biological Monitoring Locations

2.0 Fluvial Geomorphic Assessment

2.1 Longitudinal Profile and Cross-sectional Surveys

For the 2011/2012 monitoring period, a continuous longitudinal profile was measured from the culvert at Laurel Bush Road in the downstream reach up to the culvert at the stormwater management pond at the upstream limit of the restoration reach. As noted in previous monitoring years, the downstream reach continues to exhibit steep eroding banks throughout and that the banks of the restoration reach are generally stable. Refer to Appendix A for photographs depicting the overall site conditions. Appendix B contains the geomorphic assessment data.

As shown in Table 1 below, the overall slope of the channel did not change from the pre-construction to post-construction monitoring. Although the channel planform changed due to the adjustment of the alignment, several grade control structures were used in the design to achieve the appropriate grade tie-ins.

Table 1 – Channel Slope

Pre-construction	
Monitoring Year	**Channel Slope**
Year 1 – 2007	1.6%
Year 2 - 2008	1.6%
Post-construction	
Monitoring Year	**Channel Slope**
Year 1 – 2009	1.6%
Year 2 - 2010	1.7%
Year 3 - 2011	1.6%

The results of the cross-sectional surveys are included in Table 2. Data from pre-construction monitoring is included in the table for both the Restoration and Downstream Reaches. Using the top of bank cross sectional area as an indicator of stability, there were minimal changes in the Downstream Reach. Top of bank cross sectional area changed in the Restoration Reach due to the restoration construction.

Table 2 – Results of Cross-sectional Survey Analysis

Year Performed	Feature	Bankfull Width (ft)	Mean Depth (ft)	Width/Depth Ratio	Bankfull Area (ft^2)	Entrenchment Ratio	Bankfull Discharge (ft^3/s)	Top of Bank Area $(ft)^2$
Cross-section 1 - Station 27+64 – Restoration Reach								
Year 1	Riffle	15.0	1.4	10.7	21.0	1.8	110.8	74.4
Year 2	Riffle	14.9	1.2	12.3	18.0	1.6	107.2	74.0
Year 1-April	Riffle	13.7	1.4	9.7	19.1	2.9	100.1	19.1
Year 1-November	Riffle	14.0	1.7	8.4	19.8	2.9	148.0	19.8
Year 2-February	Riffle	8.3	1.2	6.8	10.1	1.7	70	24.2
Year 3-December	Riffle	8.1	1.5	5.4	12.1	2.7	69.4	26.1
Cross-section 2 - Station 26+24 – Restoration Reach								
Year 1	Pool*	14.4	1.3	11.5	18	1.5	94.3	93.5
Year 2	Pool*	13.6	1.1	12.7	14.5	1.5	76.6	93.5
Year 1-April	Riffle	12.6	1.4	8.8	18.0	1.8	89.5	85.2
Year 1-November	Riffle	12.4	1.1	11.4	13.6	1.8	57.8	76.6
Year 2-February	Riffle	13.6	1.0	14.3	13.6	1.6	69.5	73.6
Year 3-December	Riffle	15.5	0.9	17.8	13.5	1.4	65.6	79.4
Cross-section 3 - Station 20+22 – Downstream Reach								
Year 1	Pool*	17.3	1.5	11.9	25.3	1.0	141.6	91.3
Year 2	Pool*	17.6	1.4	12.7	24.4	1.0	155.1	91.4
Year 1-April	Pool*	15.1	1.4	10.7	21.4	1.4	123.0	78.9
Year 1-November	Pool*	15.1	1.5	10.0	22.7	1.5	144.9	80.4
Year 2-February	Pool*	11.3	1.0	10.8	11.9	1.6	70.9	74.6
Year 3-December	Pool*	13.1	1.0	13.1	13.1	1.5	72.1	88.1
Cross-section 4 - Station 17+45 – Downstream Reach								
Year 1	Riffle	21.3	1.1	18.8	24.2	1.2	135.7	97.7
Year 2	Riffle	22.0	1.2	17.7	27.3	1.2	141.5	97.5
Year 1-April	Riffle	18.5	0.6	32.2	10.7	1.2**	25.1	95.3
Year 1-November	Riffle	21.3	0.9	22.7	19.9	1.2**	73.4	95.1
Year 2-January	Riffle	21.5	0.9	23.4	19.7	1.1	88.7	98.6
Year 3-December	Riffle	21.4	0.9	23.3	19.7	1.2	86.2	95.5
Cross-section 5 - Station 10+99 – Downstream Reach								
Year 1	Riffle	19.5	1.1	17.1	22.1	5.1	117.6	27.2
Year 2	Riffle	16.9	0.9	19.0	15.1	5.1	57.6	27.7
Year 1-April	Riffle	16.6	0.7	22.3	12.3	5.3**	37.7	27.3
Year 1-November	Riffle	19.0	0.9	20.2	17.9	5.3**	68.3	27.5
Year 2-January	Riffle	19.5	1.0	19.0	19.9	5.3	86.8	27.2
Year 3-December	Riffle	20.2	1.0	20.6	20.2	5.3	86.3	21.3
Cross-section 6 - Station 2+57 - Downstream Reach								
Year 1	Run	15.7	1.1	13.2	18.5	5.1	115.9	54.2
Year 2	Run	14.1	1.2	12.0	16.6	5.1	96.7	54.1
Year 1-April	Run	15.5	1.1	13.6	17.8	5.2**	89.6	52.7
Year 1-November	Run	15.4	1.1	13.4	17.6	5.1**	88.9	52.0
Year 2-December	Run	14.2	1.3	11.1	18.1	5.1	100.8	56.7
Year 3-December	Run	15.7	1.2	13.6	18.2	5.1	97.0	55.5

Pre-construction data is shaded in gray.

*Bankfull dimensions and discharges are provided for pool cross-section, however measures of bankfull channel geometry and discharge from pools are not as reliable as those from runs and riffle and should be used accordingly.

**Flood prone width based on desktop analysis, not field measurements.

Table 2 includes data collected during pre-construction and post-construction monitoring events for all cross-sections. Data shown shaded in gray indicates pre-construction conditions.

Due to the difficulty in identifying bankfull indicators in the restoration reach because of the armored banks, the bankfull stage was approximated using U.S. Fish and Wildlife Service regional curves for the Maryland Piedmont as a guide. The drainage area for the site was calculated at 0.5 square mile, which yields a bankfull discharge of 72 cfs. The bankfull elevations on the cross sections were selected at points where the discharge on the cross section approximates this discharge calculated from the regional curves, and not from field indicators.

For Cross Section 1, the December 2011 measurements show minor degradation of the stream bed since March of 2011. The degradation is more noticeable between December 2011 and April 2009. This cross section occurs on the downstream side of log weir #8 and lies within a 50 foot long segment of the stream where neighborhood children have been constructing bridges and dams. Various materials such as lumber, metal grates, pallets and other miscellaneous materials were observed within the stream section. The thalweg is 0.87 feet deeper than last year with a 1.13 foot water depth in the scour pool that measures four feet long and seven feet wide.

For Cross Section 2, significant sediment aggradation is occurring in the bottom of the stream channel. As much as two feet of sediment has accumulated since April 2009 (one foot since last year). The stone toe protection on the right side has eroded and fallen away from the bank towards the center of the stream in an area 25 feet +/- up and down stream of the cross section.

Cross-section 3, located on a pool feature, indicated some change. Bottom sediments are adjusting to form normal pool features, with a point bar forming on the left bank and a deep pool forming on the right bank. Bank erosion is occurring behind the stone toe protection with several of the stones fallen away from the slope and into the channel. A good portion of the natural fiber matting is exposed on the stream bank at this location.

In the Downstream Reach, the results at Cross-Sections 4 and 5 indicate little change in channel cross section geometry. Data from 2007, 2008, 2009, and 2011 overlay very closely, with only minor shifts in bed sediments from year to year. Cross Section 5 shows the most change with approximately 0.3 feet of additional sediment deposition.

At Cross Section 6 there appears to be minor bed aggradation that has occurred since December 2010. Similar to the other Downstream Reach cross-sections, the geometry at cross-section 6 was largely unchanged from pre-construction conditions in 2007-2008 to post-construction conditions of 2009 through 2011. Minimal adjustments occurred on both the left and right banks in addition to the channel bed.

2.2 General Bank Stability

During the baseline condition monitoring, bank pins were installed in areas exhibiting considerable erosion potential, typically the outside of meander bends, and the exposed length of each pin was measured. Table 3 displays bank pin locations and measurements for the Year One Pre-construction monitoring along with 2008 and Years 1, 2 and 3 Post-construction data. Original bank pins within the Restoration Reach were removed during construction. Re-installation of pins was not feasible due to the nature of the restored banks, which have been completely altered and armored with stone protection. In general, annual erosion rates of 0.03 feet are considered typical, rates between 0.03 and 0.1 foot are considered to be moderate and rates that exceed 0.1 foot per year are considered high (Pizzuto 2007).

Table 3 – Bank Pin Locations and Measurements

Pin Number	Location in Profile/Bank	Level of Exposure/ Deposition (ft) 2007	Level of Exposure/ Deposition (ft) 2008	Level of Exposure/ Deposition (ft) 2009	Level of Exposure/ Deposition (ft) 2010	Level of Exposure/ Deposition (ft) 2011
1 Middle	7+68 R	-0.5	-0.40	-0.31	-.22	-0.35
2 Middle	13+54 L	-0.5	-0.65	-0.95	-.96	-1.09
3 Middle	16+50 L	-0.5	-0.66	-0.75	-.91	-1.10
4 Upper	20+67 R	-0.5	-0.50	Pins removed during restoration and were not re-installed.	N/A	N/A
4 Lower	20+67 R	-0.5	-0.61		N/A	N/A
5 Upper	22+94 L	-0.5	-0.49		N/A	N/A
5 Lower	22+94 L	-0.5	-0.43		N/A	N/A
6 Middle	23+82 L	-0.5	-0.80		N/A	N/A
R – indicates right bank, L – indicates left bank						

Pre-construction data is shaded in gray.

The results of the pin monitoring within the Downstream Reach indicated significant erosion since the 2010 readings were taken. Bank Pin 1, although eroded 0.13 feet since last year, shows only a .04 foot change since 2009. Bank Pin 2 and 3 have eroded 0.13 feet and 0.19 feet, respectively.

2.3 Particle Size Analysis

The 2011 riffle D50 particle size in the restoration reach riffle was 51mm, or very coarse gravel, and the weighted D50 was 63, also very coarse gravel. For the downstream reach, the 2011 riffle D50 was 54mm, almost identical to the restoration reach. Table 4 lists the D50 and D84 for the restoration reach and downstream reach for years 2007-2011. Table 5 shows the particle size distribution for the restoration reach and the downstream reach for years 2007-2011. Figures 3, 4, 5 and 6 graphically display particle size distributions for the restoration and downstream reaches.

Table 4 – Particle Size Distribution

Year	Average Size (mm)	RESTORATION REACH		DOWNSTREAM REACH	
		Riffle	Weighted	Riffle	Weighted
2007	D50	41	32	26	33
	D84	93	73	56	63
2008	D50	25	19	34	20
	D84	47	68	72	56
2009	D50	40	71	51	24
	D84	90	110	98	56
2010	D50	67	73	32	35
	D84	120	130	80	84
2011	D50	51	63	54	47
	D84	110	150	120	110

Pre-construction data is shaded in gray.

Table 5 – Particle Type Distribution

Year	Particle Type	RESTORATION REACH		DOWNSTREAM REACH	
		Riffle	Proportional	Riffle	Proportional
2007	silt/clay	0%	0%	0%	1%
	sand	5%	12%	7%	10%
	gravel	66%	68%	81%	74%
	cobble	29%	20%	12%	15%
	boulder	0%	0%	0%	0%
Year	Particle Type	RESTORATION REACH		DOWNSTREAM REACH	
		Riffle	Proportional	Riffle	Proportional
2008	silt/clay	0%	2%	0%	0%
	sand	5%	31%	18%	33%
	gravel	90%	49%	62%	57%
	cobble	5%	18%	20%	10%
	boulder	0%	0%	0%	0%
Year	Particle Type	RESTORATION REACH		DOWNSTREAM REACH	
		Riffle	Proportional	Riffle	Proportional
2009 Year 1 Post-construction	silt/clay	0%	0%	0%	0%
	sand	2%	6%	1%	22%
	gravel	66%	33%	64%	64%
	cobble	31%	61%	35%	14%
	boulder	1%	0%	0%	0%
Year	Particle Type	RESTORATION REACH		DOWNSTREAM REACH	
		Riffle	Proportional	Riffle	Proportional
2010 Year 2 Post-construction	Silt/clay	0%	0%	2%	3%
	sand	0%	2%	8%	11%
	gravel	47%	39%	68%	58%
	cobble	51%	56%	23%	28%
	boulder	2%	3%	0%	1%
Year	Particle Type	RESTORATION REACH		DOWNSTREAM REACH	
		Riffle	Proportional	Riffle	Proportional
2011 Year 3 Post-construction	Silt/clay	0%	0%	1%	1%
	sand	2%	4%	3%	4%
	gravel	63%	47%	53%	57%
	cobble	30%	44%	43%	39%
	boulder	5%	5%	0%	0%

Pre-construction data is shaded in gray.

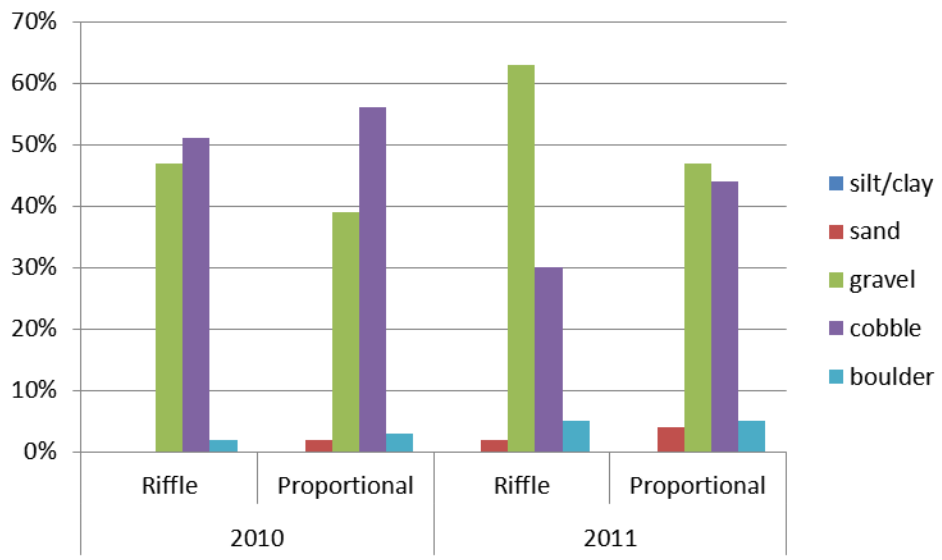


Figure 3 - Particle Type Distribution for the Restoration Reach 2010-2011

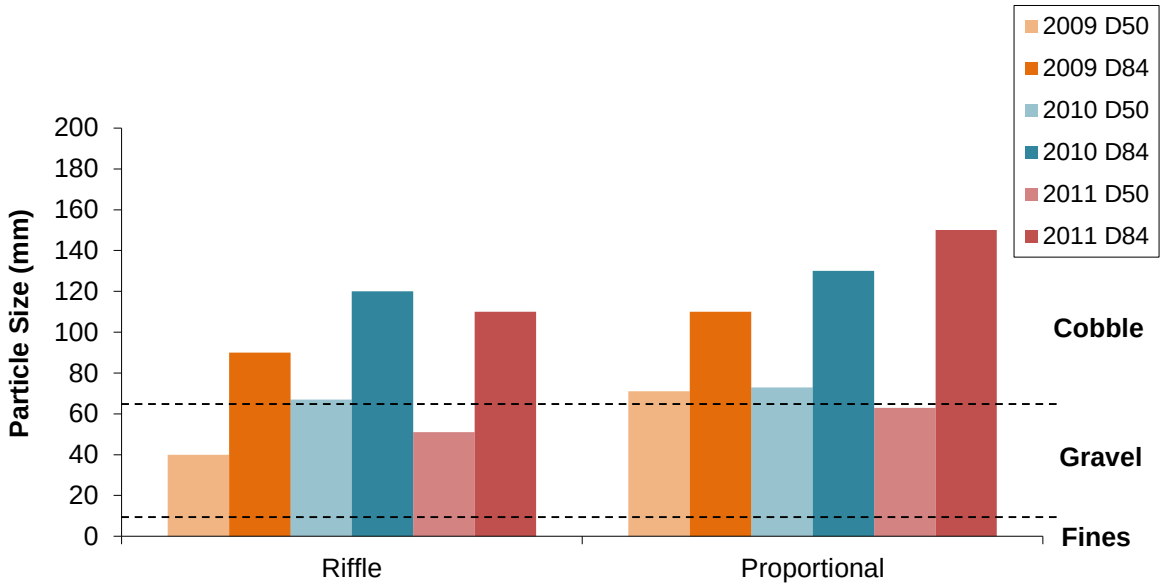


Figure 4 - Particle Size Distribution for the Restoration Reach 2009-2011

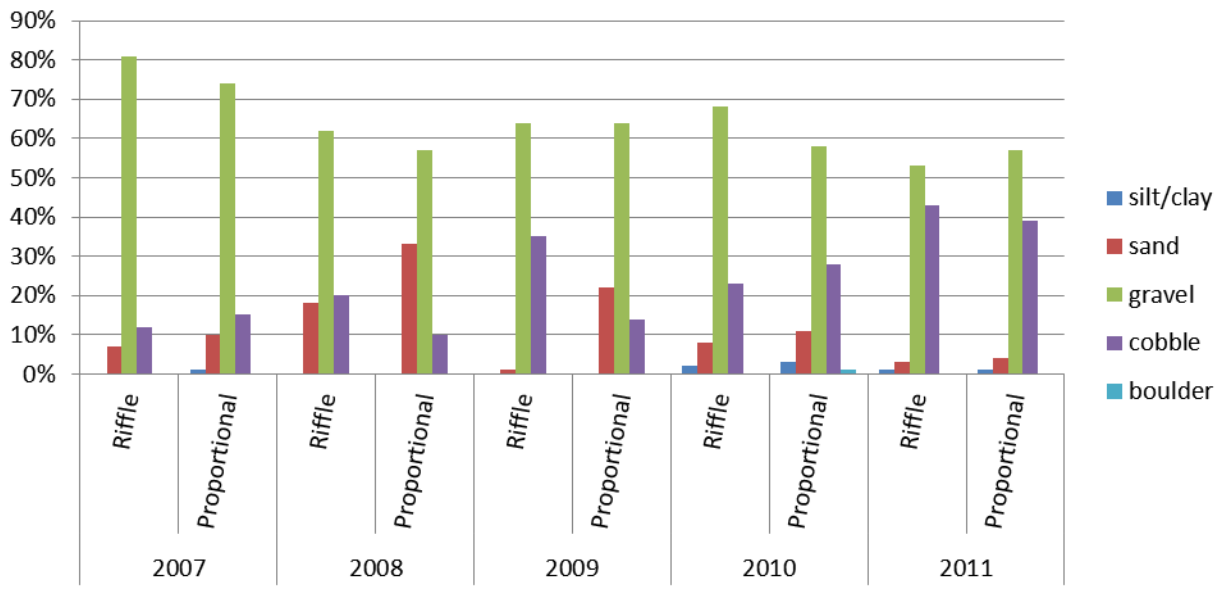


Figure 5 - Particle Type Distribution for the Downstream Reach 2007-2011

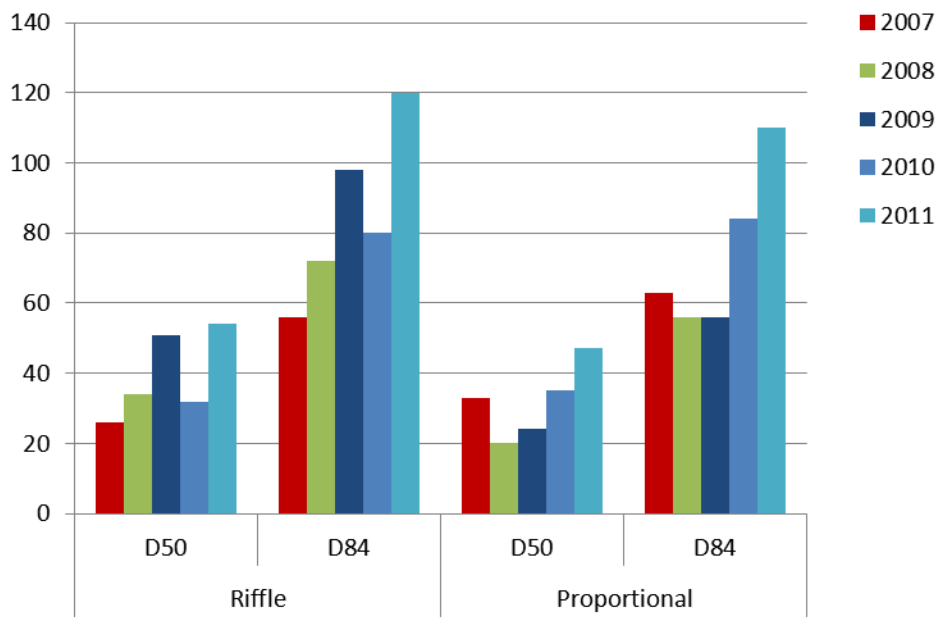


Figure 6 – Particle Size Distribution for the Downstream Reach 2007-2011

2.4 Visual Assessment of Stabilization Techniques

Channel stabilization techniques were evaluated to determine their function and stability in the Restoration Reach. The visual evaluation reviewed instream stabilization structures, including log weirs and riffle grade controls; and bank stabilization structures, including stone toe protection and imbricated bank protection. All stationing used to describe the stabilization structures refer to the design plan baseline.

Log Weirs

The log weir structures function to provide upstream grade control while utilizing existing on-site materials that have been salvaged. The use of salvaged logs provides variability in substrate material in addition to habitat diversity. The Laurel Valley Stream Restoration Project – As-Built Review conducted in March of 2009 following the completion of the project indicated no scour had occurred downstream of the logs and advised these structures be closely monitored.

In general, most of the log weirs are functioning as intended and stable in their placement (See Appendix F for the location of the log weirs). Log Weir #1, the furthest downstream, is completely submerged and not functioning. Most of it is buried in sediment. Log Weir #2 is stable and functioning well, and a 1-foot deep pool has developed immediately downstream from it. Log Weir #3 is stable and functioning well, and a 1-foot deep pool has developed downstream from it. Log Weir #4 is stable but is not functioning as intended. The stream is flowing under the weir rather than over it. A large volume of cobble has collected on the upstream side, and engine oil has collected behind it. It has a drop-off (spillway height) of 1.0 feet (12 inches) from the top of the weir crest to the water surface below the weir. This drop-off and flow under the log is a barrier to the migration of aquatic organisms.

The second set of log weirs is located further upstream. Log Weir #5 has a drop off of 0.65 feet (8 inches). Some large rocks from the adjacent slope protection have lodged around the log on the upstream and downstream side of the log. Log Weir #6 is stable and functioning with a drop-off of 0.68 feet (8 inches) from the top of the weir crest to the water surface below the weir. Log Weir #7 is stable and functioning well. The drop-off at this weir is 0.21 feet. Log Weir #8 is stable and functioning well with a drop-off of 0.38 feet. Approximately 50 feet upstream and downstream of this weir, neighborhood children have been creating bridges to cross the stream. Materials such as pallets, metal grates, lumber and other miscellaneous materials have been impeding the flow of water through this reach to some extent.

It is recommended that consideration be given to correcting the drop off at four of the log weirs; log weirs #4, #5, #6, and #8. This could be accomplished in a number of ways, such as constructing an additional log weir below the existing weir at a slightly lower elevation, installing a constructed riffle with rock below the existing weir, or constructing a rock cascade immediately below the existing weir. Also, Weir #4 needs to be repaired to prevent the stream from flowing beneath it. This can be accomplished by fastening geotextile material to the upstream side of the weir, draping the geotextile down to the stream bed, and placing gravel and cobble against the geotextile.

Stone Toe Protection

The stone toe protection functions to stabilize the banks and toe of slope in areas where the slope tie-ins are generally flat. The majority of the Restoration Reach is stabilized by stone toe protection on both sides of the bank aside from a few meanders stabilized by other structures. In general, the majority of the stone toe protection is functioning and stable. Upstream tie-ins and transitions into imbricated banks or culverts are commonly areas of concern for instability. Following is a summary of the 2011/2012 findings, using the stationing provided on the KCI landscape plans.

Station 3+15 to 3+43 lt. is stable and functioning on the lower end, but the upper end, as a result of slope erosion, has exposed geotextile and natural fiber matting. Station 3+55 to 4+65 rt. is functioning and stable on the lower end. Beginning at Station 4+25 +/- to the CMP tie-in at 4+50 +/- slope erosion has caused five boulders to push forward or tumble towards the thalweg of the stream and has exposed most of the geotextile material. Between Station 4+87 and 6+54 lt. is functional and stable. Some natural fiber matting is exposed near the top of bank. Station 5+15 to 5+78 rt. is functional and stable with minor

exposure of natural fiber matting. Station 5+88 to 6+55 rt. is functional and stable. Station 6+90 to 7+30 lt., Station 6+90 to 8+26 rt., Station 7+65 to 8+28 lt., Station 8+60 to 9+23 lt., and Station 8+75 to 9+20 rt. are functional and stable. Station 9+30 to 11+45 rt. is generally stable and functioning. Eroded slopes, exposed natural fiber matting, and displaced boulders occur between Station 9+30 and 9+75. Station 10+65 to 10+85 also has exposed natural fiber matting due to slope erosion. Station 9+50 to 10+65 lt. is stable and functioning. Station 10+85 to 11+40 lt. is stable and functioning with exposed natural fiber matting to excess foot and all-terrain vehicle traffic along both sides of this reach. The stone toe protection between Station 11+80 to 12+25 rt. and Station 11+80 to 12+40 lt. is stable and functional.

The stone toe protection failure at Station 10+30 was likely caused by vandalism. The rocks in this location are noticeably smaller than the rocks upstream and downstream of it and could have easily been pushed into the stream. There are voids between the remaining rocks, and the bank is now susceptible to erosion.

As noted above, there is also a stone toe protection failure at 4+25.

Imbricated Bank Protection

The imbricated bank protection functions to stabilize the banks and toe of slope in areas where the slope tie-ins are greater due to constraints, such as utilities and private property. There are three locations of imbricated bank protection along meanders in the Restoration Reach. The imbricated rock at Station 6+56 to 6+90 lt., 8+28 to 8+60 lt., and 11+40 to 11+80 lt. are stable and functioning to protect the banks from erosion.

Rock Vanes

Rock vanes are typically placed where stream flow enters a meander to direct flow away from the bank and prevent erosive flows from damaging banks. As shown on the design plan, there are four rock vanes designed in the restoration. Based on field observations and review of the As-Built survey by KCI in 2009, the structure noted as Vane 3 was not built. Station 3+40 (vane 1) and 2+40 (vane 4) are stable and functioning. Vane 2 at Station 3+23 is not visible and may have been disturbed as a result of the extreme bank erosion between Station 2+75 and 3+25 lt.

Riffle Grade Controls

Riffle grade controls are in-stream structures that provide stability and function to maintain a consistent slope in the form of an armored riffle. Riffle grade controls were placed in six locations. In general, all riffle grade controls indicated a consistent slope throughout the length of the structure. Bed material was well-distributed throughout the structure. Areas of concern are in the upper reach between Stations 11+25 to 11+45 and 11+80 to 12+30 where neighborhood children have been playing in the stream. Materials such as lumber, pallets, metal grates, and other miscellaneous debris have accumulated within these areas. In addition, larger size stone have found their way into the stream bed, probably due to children playing in the stream.

2.5 Riparian Planting Inspection

The riparian planting inspection evaluated all vegetation for evidence of mortality, infestation or disease, and deer browse. The percent survival of live stakes along the stream banks is highly variable. In some areas, evidence of live stakes is absent, or live stakes present are very sparse. The planting zones are shown in Appendix C, "Riparian Plantings." The initial post-construction inspection in 2009 noted that during construction several species were substituted for those shown on the design plans, and this information was verified with the County during the As-Built survey. Since the post-construction inspection, new plantings have been added to zones 16 and 2. Zone 18 is along the easement access-way. Zone 2 is the area where the former stream was encroaching into residential properties and was restored as upland as part of the restoration.

Live Stakes

The live stake zone is a narrow ribbon of land located along the majority of both stream banks throughout the entire Restoration Reach aside from areas of imbricated bank protection and stone toe protection. Live stake species included dogwood and black willow. The plants developed from the live stakes are now 8 to 12 feet tall in 2012.

The survivability of live stakes throughout the Restoration Reach was highly variable. The design plan shows live stakes were to be planted along the outfall cascade at the downstream extent of the Restoration Reach. The post-construction inspection noted there were no signs of live stakes in this area. Both banks of the outfall cascade were poorly vegetated and had significant amounts of exposed natural fiber matting. During the 2011/2012 inspection, areas of exposed natural fiber matting were observed in several areas. The matting has worn through to bare ground on the top of bank, in several locations from Station 9+00 to 12+75. In areas of vigorous live stake growth, the dominant species was dogwood. This observation is likely explained by the post-construction observations, "the species were not well mixed and consisted of concentrated areas of dogwoods or willow, despite the species randomization detail shown on the landscape details of the design plans."

As observed in the previous year, live stakes planted close to private properties along the right bank had been pruned to roughly 4 inches above ground level. These live stakes (and shrubs) did not re-sprout. They are dead and not providing bank protection. Continued disposal of yard waste in the riparian zone was also observed. The live stakes zone continues to be free of disease and infestation. As expected, the second year of post-construction monitoring reveals more about the establishment of live stakes. Only a few areas of planted live stakes show absence of growth, though as previously noted, many of the areas that should have live stakes show no evidence of planting.

Appendix C – Riparian Planting Inspection Data provides a summary of the observed plant conditions within the restoration reach. The live stake table is not included in this year's report since there has been little to no change in the plant conditions since last year's report, other than the additional growth of the willow and dogwood trees. The trees are now 6-12 feet in height.

Sod

The sod in Zone 21, at Merrick Way, and Zone 13 at Parallel Path appears to be in good health.

Turf Grass

In Zone 20, turf grass has successfully established along the access path of the stormwater management pond off of Merrick Way. The turf grass in Zone 19 is well traveled by residents and some compaction is occurring, especially under the closed woodland canopy. The area appears to be mostly successful overall. Zone 17, along the back yards of residential properties appears to be successful.

Reforestation

Reforestation zones exist landward of the riparian zone at the top of the channel bank. As noted in the previous year, volunteer species in this area include yellow poplar, American beech, and black cherry with American sycamore and a few white oak trees. Within Zone 16, from Station 11+50 to Station 7+50, several trees have died or have been cut down at the base. The planted red bud trees may have been unhealthy plant material from the start. Several trees have died and re-sprouted from the base. Within this zone, several planted oak trees in this area were either removed entirely, were cut down at the base or simply died. Signs of disease and infestation were not observed. Few dogwood trees were observed in this zone. It is estimated that approximately 60 percent of the reforestation plantings have survived in Zone 16. Recent plantings in Zone 16 at station 11+50 and 8+00 are thriving. Farther downstream, the reforestation in Zones 12 and 14 are in good health.

Riparian Shrub

The riparian shrub zone borders the channel throughout the entire restoration reach, transitioning from the live stakes zone into the reforestation zone. As seen during the first monitoring year, volunteer species are filling in between the edge of water up to and beyond the top of slope (to the reforestation zone). Invasive species are more prevalent in the upstream direction, starting from zones 8 and 9 at the downstream end to Station 11+50 in Zone 15. The invasive species are competing for resources in the downstream end of the channel. Along the left bank, zone 15, the area of herbaceous seeding is compacted by foot traffic and the natural fiber matting is exposed. Seeding did not establish in this area.

In general, the planted shrubs appeared healthy. Due to slower growth rates of woody plants, the shrubs (including the newly planted Sweetbay magnolia and azalea noted in last year's report) are superseded by the vigorous volunteer growth. Like the previous year, the effect of residential pruning of the plantings was observed. The effect is more pronounced on the top of slope in Zone 1and Zone 4, where residential activity is evident.

Herbaceous

The herbaceous zone consists of vegetative plugs planted in depressional areas which were created when the original channel bed was abandoned and filled with soil. These areas were designated as having potential wetland-like conditions. In 2010, under the direction of the County, Zone 3 was modified to be drier to relieve concerns about prolonged wetland conditions, and different plant material was included. All new plant material appears vigorous and is augmented by the vigorous growth of volunteer herbaceous plants, mostly native species.

The URS team also noted the use of large hardwood stakes to secure the natural fiber matting. It appears that these stakes are only in place on the slopes, and rarely on the top of slopes. The stakes have remained in place, however in many areas, the natural fiber matting is torn and compact soil is exposed. The banks of the restoration area and the stream itself are a play area that receives much foot traffic from local children.

2.6 Bankfull Event Inspection

An inspection immediately following a bankfull event was not conducted during this monitoring period since several bankfull events have occurred since the project was completed. No damage to the stream restoration project was attributable to these storm events.

3.0 Biological Monitoring Results

3.1 Benthic Macroinvertebrate Results

Benthic macroinvertebrate sampling data and Benthic Index of Biotic Integrity (BIBI) scores are presented in Table 6. Complete taxa lists and metric evaluation data are included in Appendix E.

The biological conditions at the upstream and restoration reach were classified as 'Very Poor', with overall BIBI scores of 1.0 for the upstream station and 1.7 for the restoration reach. The downstream station had a "Poor" classification, with an IBI score of 2.0. The Reference Reach was classified as 'Fair', with a BIBI score of 3.7 in 2009.

The upstream reach (Station 1) received an overall BIBI score of 1.0, with a biological rating of 'Very Poor'. Of the 14 taxa present in the subsample, four EPT taxa were identified. This station had a high percentage of Chironomidae present (66 percent) and only 3.4 percent of individuals were intolerant to urban stressors. This site had the lowest percentage of clingers (21 percent) of the three sites, which contributed to its low score.

The Restoration Reach (Station 2) received a low overall BIBI score of 1.7, characterizing the biological condition as 'Very Poor'. There was a high percentage of Chironomidae (80 percent) present with *Orthocladius* consisting of 17 percent of the sample. This site also had a moderate percentage of clingers (56 percent) due to the presence of three Tricoptera species (clinger taxa). Individuals intolerant to urban stressors accounted for four percent of this sample (a three percent increase over last year). Of the 22 taxa present, three genera represented EPT taxa (*Amphinemura*, T.V. = 3 and *Cheumatopsyche*, T.V. = 5, and *Hydropsyche*, T.V. = 6) and none were Ephemeroptera (mayflies).

A total of 25 taxa were identified at Station 3, just downstream of the Restoration Reach. Station 3 had a BIBI score of 2.0 and received a 'Poor' biological condition rating. Chironomids accounted for 88 percent of this sample—the majority of which were *Chricotopus* (T.V. = 7). Four EPT taxa were identified in the subsample. One taxa that is considered intolerant to urban land uses (*Amphinemura sp)* was present. Additionally, this site had a high percentage of clingers (57 percent) due to the high abundance of two Tricoptera species.

Table 6 – Summary Benthic Macroinvertebrate Results

	2007				2008				2009				2010				2011			
	Station 1	Station 2	Station 3	Reference	Station 1	Station 2	Station 3	Reference	Station 1	Station 2	Station 3	Reference	Station 1	Station 2	Station 3	Reference	Station 1	Station 2	Station 3	Reference
Raw Metric Scores																				
Total Number of taxa	15	19	21	25	11	11	11	17	15	10	11	19	13	12	12	N/A	14	22	25	N/A
Number of EPT taxa	3	4	2	11	1	1	0	7	0	2	0	10	4	3	4	N/A	4	3	4	N/A
Number of Ephemeroptera Taxa	0	0	0	7	0	0	0	4	0	0	0	4	0	0	0	N/A	0	0	0	N/A
Percent Intolerant Urban Taxa	13.2	10.3	6.9	61.3	0.9	4.3	1.0	72.9	0	4.3	0.9	66.4	7.3	0.8	5.5	N/A	3.4	4.20	4.0	N/A
Percent Chironomidae Taxa	80.6	69.2	74.7	26.4	71.3	44.1	70.5	4.2	32.1	34.5	17.0	3.7	70.6	38.3	27.3	N/A	65.5	79.7	87.9	N/A
Percent Clinger Taxa	20.2	15.4	10.3	34.0	29.6	50.5	28.6	44.1	58.0	46.6	55.4	15.9	16.5	34.2	57.3	N/A	20.7	55.9	56.5	N/A
BIBI Scores																				
Total Number of taxa	3	3	3	5	1	1	1	3	3	1	1	3	1	1	1	N/A	1	3	5	N/A
Number of EPT taxa	1	1	1	5	1	1	1	3	1	1	1	3	1	1	1	N/A	1	1	1	N/A
Number of Ephemeroptera Taxa	1	1	1	5	1	1	1	5	1	1	1	5	1	1	1	N/A	1	1	1	N/A
Percent Intolerant Urban Taxa	3	1	1	5	1	1	1	5	1	1	1	5	1	1	1	N/A	1	1	1	N/A
Percent Chironomidae Taxa	1	1	1	3	1	3	1	5	3	3	3	5	1	3	3	N/A	1	1	1	N/A
Percent Clinger Taxa	1	1	1	3	1	3	1	3	3	3	3	1	1	3	3	N/A	1	3	3	N/A
Overall BIBI Score	**1.7**	**1.3**	**1.3**	**4.3**	**1.0**	**1.7**	**1.0**	**4.0**	**2.0**	**1.7**	**1.7**	**3.7**	**1.0**	**1.7**	**1.7**	**N/A**	**1.0**	**1.7**	**2.0**	**N/A**
Narrative Rating	Very Poor	Very Poor	Very Poor	Good	Very Poor	Very Poor	Very Poor	Good	Poor	Very Poor	Very Poor	Fair	Very Poor	Very Poor	Very Poor	N/A	Very Poor	Very Poor	Poor	N/A

3.2. Physical Habitat Assessment

A summary of the physical habitat data for the three monitoring stations is presented in Table 12. Complete physical habitat assessment data can be found in Appendix E.

Table 7 – Summary of Physical Habitat Results

Site		Remoteness	Percent Shading	Epifaunal Substrate	Instream Habitat	Instream Woody Debris	Bank Stability	Riffle Quality	Embeddedness	PHI	Narrative Rating*
2007	Station 1	50.0	80.0	47.1	49.5	8.3	53.4	80.0	55.6	53.0	*Degraded*
	Station 2	56.3	66.1	52.9	60.1	8.3	75.5	82.4	55.6	57.1	*Degraded*
	Station 3	62.5	84.1	58.8	59.3	25.0	75.5	96.7	61.1	65.4	*Degraded*
	Reference Reach	81.3	72.4	88.2	97.2	25.0	100.0	98.7	94.4	82.1	*Minimally Degraded*
2008	Station 1	50.0	80.0	41.2	49.5	16.7	53.4	85.0	61.1	54.6	*Degraded*
	Station 2	56.3	66.1	47.1	53.7	16.7	75.5	77.3	55.6	56.0	*Degraded*
	Station 3	62.5	84.1	52.9	59.3	41.7	81.6	100.0	72.2	69.3	*Partially Degraded*
	Reference Reach	75.0	72.4	88.2	84.4	25.0	100.0	93.6	94.4	79.1	*Partially Degraded*
2009	Station 1	50.0	80.0	41.2	49.5	25.0	53.4	85.1	55.6	55.0	*Degraded*
	Station 2	56.3	50.3	41.2	41.0	0.0	100.0	72.2	44.4	50.7	*Severely Degraded*
	Station 3	62.5	84.1	58.8	59.3	41.7	81.6	100.0	66.7	69.3	*Partially Degraded*
	Reference Reach	75.0	72.4	88.2	90.8	25.0	100.0	98.7	88.9	79.9	*Partially Degraded*
2010	Station 1	50	80	52.9	49.5	25	53.4	80.0	55.6	45.8	*Severely Degraded*
	Station 2	50	60	64.7	66.4	0	100.0	82.4	44.4	51.0	*Degraded*
	Station 3	62.5	80	82.4	97.4	83.3	81.6	81.3	88.9	72.2	*Partially Degraded*
	Reference Reach	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	*N/A*
2011	Station 1	50.0	85	41.2	49.5	25.0	53.4	80.0	66.7	45.7	*Severely Degraded*
	Station 2	37.5	60	41.2	47.4	8.3	100.0	82.4	22.2	42.4	*Severely Degraded*
	Station 3	62.5	95	82.4	91.1	41.67	81.6	100.0	33.3	61.6	*Degraded*
	Reference Reach	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	*N/A*

*PHI Narrative Rating Categories: Minimally Degraded: 81 – 100; Partially Degraded: 66 – 80.9; Degraded: 51 – 65.9; Severely Degraded: 0 – 50.9.

Station 1, located in the upstream reach, contains a widened steam channel with eroded banks. The stream bed consists of bedrock areas and shallow pools, with limited riffle areas. The substrate is marginal for macroinvertebrates and is lacking quality instream habitat for fish. The amount of instream woody debris and rootwads, substrate embeddedness and remoteness were similar to what was observed and described

in 2009. This site also has a low remoteness score due to the presence of residential properties along both sides of the stream. The riparian buffer along the right bank (facing downstream) is adequate throughout the sampling reach. The riparian buffer along the left bank is narrow due to residential uses in close proximity to the stream channel top of bank. Station 1 had a PHI score of 45.7, with a narrative rating of 'Severely Degraded.'

Within the restoration reach (Station 2) the banks are well armored with rock, and the vegetation plantings established within the natural fiber matting (NFM) installed along the streambanks. As a result of the construction, Station 2 received the highest score for bank stability (100 percent) and the lowest score for percent shading (60 percent), since large trees were removed for construction. The stone lined section of the restoration reach is heavily used by neighborhood children. The NFM in some areas has been physically removed or dislodged due to heavy foot traffic. Plantings within this area were also removed shortly after construction was completed in 2009. The vegetation inspection was completed in the spring of 2012, during the benthic macroinvertebrate stream survey. Planted and native vegetation grows along the banks in the lower end of the restoration reach.

At the time of the inspection, the instream condition was less than optimal, due to the presence of debris located on the downstream side of log weir #8. Imbeddedness had increased from the previous year, and the rating for this category changed from degraded to severely degraded. On a positive note, during an August 2012 inspection, it was noted that trash debris had been removed from the stream channel. Removal of the debris should reduce the imbeddedness caused by those former blockages. Within Station 2, benthic and instream habitat declined from 2010 to 2011 (2012), again this is at least partially attributed to human activities. The restoration reach has become the focal point of a play area for local children, which includes activities along the top of bank and instream. As noted above, this area has been cleaned up since the spring 2012 evaluation. Shading of the Restoration Reach will continue to improve with time as the planted trees and shrubs mature. This year Station 2 had a PHI score of 42.4, with a narrative rating of 'Severely Degraded.' This area may continue to improve as children and parents living adjacent to the stream were reminded of the end goal to restore fish habitat. The children seemed interested in the fish living in this area.

Station 3, the Downstream Reach, also scored lower, from "partially degraded" in 2010 to "degraded" during the 2011 Year, (conducted spring 2012 as part of the macroinvertebrate sampling). Station 3 has an intact riparian buffer of a natural oak forest community along the right bank (facing downstream), and a healthy buffer along the left bank with only minimal human impact due to the easement clearing. Riffle quality, percent shading, embeddedness, bank erosion, remoteness, epifaunal substrate and instream habitat all scored better than the upstream sites. The abundance of woody debris and rootwads was greater than the upstream and restoration reaches. It is likely that sediment from upstream has increased the imbeddeness rating for this year. Similar to last year, Station 3 had a PHI score of 61.6, with a narrative rating of 'Degraded.'

As part of the Year 1 monitoring conducted by KCI Technologies, the Reference Reach received the highest PHI score (79.9) and was rated 'Partially Degraded'. As described in the Year 1 report, the reach is composed primarily of pool and run sequences with stable pool habitat and small riffles consisting of gravel cobble substrate. The Reference Reach has not been reevaluated as part of subsequent monitoring years.

3.3 Water Quality Measurements

Instream water quality measurements for all three stations were conducted in conjunction with macroinvertebrate sampling on April 06, 2012. Table 8 presents average instream water quality values for each station. Overall, water quality parameters fell within acceptable COMAR limits for Use III streams

and are typical of Piedmont streams. Water quality conditions in the study reach were similar to or better than those observed in the reference reach.

Table 8 – Water Quality Summary Results

Site		pH	Water Temperature (°C)	DO (mg/l)	Conductivity (µs/cm)	TDS (mg/l)	Turbidity (NTU)
2007	Station 1	7.53	13.4	10.94	140	91	2.53
	Station 2	7.83	16.1	10.07	232	138	2.44
	Station 3	7.94	14.2	9.42	213	139	1.80
	Reference Reach	8.02	9.8	11.67	134	87	n/a
2008	Station 1	6.99	14.2	10.71	119	77	1.29
	Station 2	7.01	16.5	9.63	157	102	1.85
	Station 3	7.09	14.5	9.19	151	98	1.18
	Reference Reach	7.28	17.4	10.13	151	98	4.60
2009	Station 1	6.69	15.6	9.61	125	n/a	6.83
	Station 2	7.17	15.1	10.64	131	n/a	27.77
	Station 3	7.28	14.1	11.56	130	n/a	16.43
	Reference Reach	7.69	20.5	9.24	162	n/a	9.68
2010	Station 1	6.20	14.0	10.80	n/a	n/a	< 5
	Station 2	6.60	15.0	7.80	n/a	n/a	7.00
	Station 3	6.70	16.0	8.80	n/a	n/a	< 5
	Reference Reach	n/a	n/a	n/a	n/a	n/a	n/a
2011	Station 1	6.5	9	8.0	130	n/a	< 5
	Station 2	6.5	13	5.6	170	n/a	5
	Station 3	6.5	12	6.8	170	n/a	5
	Reference Reach	n/a	n/a	n/a	n/a	n/a	n/a

n/a = not available

4.0 CONCLUSION

In 2009, the Harford County Department of Public Works, Water Resources Engineering Division requested URS perform post-construction monitoring within a 3,300-foot reach of an unnamed tributary to Bynum Run at Laurel Valley, following the restoration of a portion of the channel. The post-construction baseline data (Year 1) has been compared geomorphic and biological data collected in Year 2 and Year 3 monitoring events (2010 and 2011) to evaluate the success of the restoration project.

Post-construction baseline conditions indicated the Restoration Reach to be functioning as a stable reach. The Downstream Reach appeared more active with shifts in bed features and areas of erosion. The evaluation of structures indicates most of the log weirs are functioning as intended and stable in their placement. It is recommended that consideration be given to correcting the drop off at four of the log weirs; log weirs #4, #5, #6 and #8. Weir #4 needs to be repaired to prevent the stream from flowing beneath it. Possible methods of correction for these areas are discussed in section 2.4, Visual Assessment of Stabilization Techniques.

The overall health and vigor of the various vegetation zones described during the third year of post-construction monitoring appears to be as expected, despite a decrease in survival of some species and impacts from homeowners. Native vegetation has filled in, and the original plantings are no longer obvious.

The macroinvertebrate sampling indicates impaired biological conditions throughout the study reach. As a result of habitat degradation and recent construction, low benthic macroinvertebrate scores continue to be observed for Stations 1, 2, and 3. The results of the physical habitat assessments indicate the same degraded habitat quality at Stations 1 and 2 as in the prior monitoring years. Shading of the stream channel within the restoration reach will continue to improve as the riparian vegetation matures.

Water quality conditions within the study reach are comparable to conditions observed in previous years.

In summary, the results of the Year 3 Post-construction monitoring indicate the Restoration Reach is functioning and mostly stable. The Downstream Reach observations indicate similar conditions as previous years with continued erosion and adjustments within the channel profile and cross-sections. Established vegetation will impact biological conditions and ultimately water quality. Areas of concern were noted during field observations of Year Three. Some improvements to the stream channel and adjacent land uses within the Restoration Reach were observed after the habitat monitoring conducted in the spring of 2012.

5.0 REFERENCES

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APPENDIX A
SITE PHOTOGRAPHS

View facing upstream at cross-section 6.

View facing downstream at cross-section 6.

View facing left bank at cross-section 6.

View facing right bank at cross-section 6.

View facing upstream of cross-section 5.

View facing downstream of cross-section 5.

View facing left bank of cross-section 5

View facing right bank of cross-section 5.

View facing upstream of cross-section 4.

View facing downstream of cross-section 4.

View facing left bank of cross-section 4.

View facing right bank of cross-section 4.

View facing upstream of cross-section 3.

View facing downstream of cross-section 3.

View facing left bank of cross-section 3.

View facing right bank of cross-section 3.

View facing upstream of cross-section 2.

View facing downstream of cross-section 2.

View facing left bank of cross-section 2.

View facing right bank of cross-section 2.

View facing upstream of cross-section 1.

View facing downstream of cross-section 1.

View facing left bank of cross-section 1.

View facing right bank of cross-section 1.

View of culvert at downstream end at Laurel Bush Road. Beginning of geomorphic survey.

View facing downstream at Station 18+00 at end of geomorphic survey.

View of head cut and debris jam at Station 6+86.

View of log jam and debris upstream of Station 8+50

View of log weir #2 at Station 5+50; stable and functioning well.

View of log weir #3 at Station 6+15; stable and functioning well.

View of log weir #4 at Station 6+55; stable
but is not functioning as intended.

View of log weir #5 at Station 10+35; with a drop off of 8 inches.

View of weir #6 at Station 10+65; stable
and functioning with a drop-off of 8 inches.

View of log weir #7 at Station 10+85; stable and functioning well.

View of log weir #8 at Station 11+25; stable and functioning

View of bank between Station 3+15 to 3+43 lt.
The area is stable and functioning on the lower end.

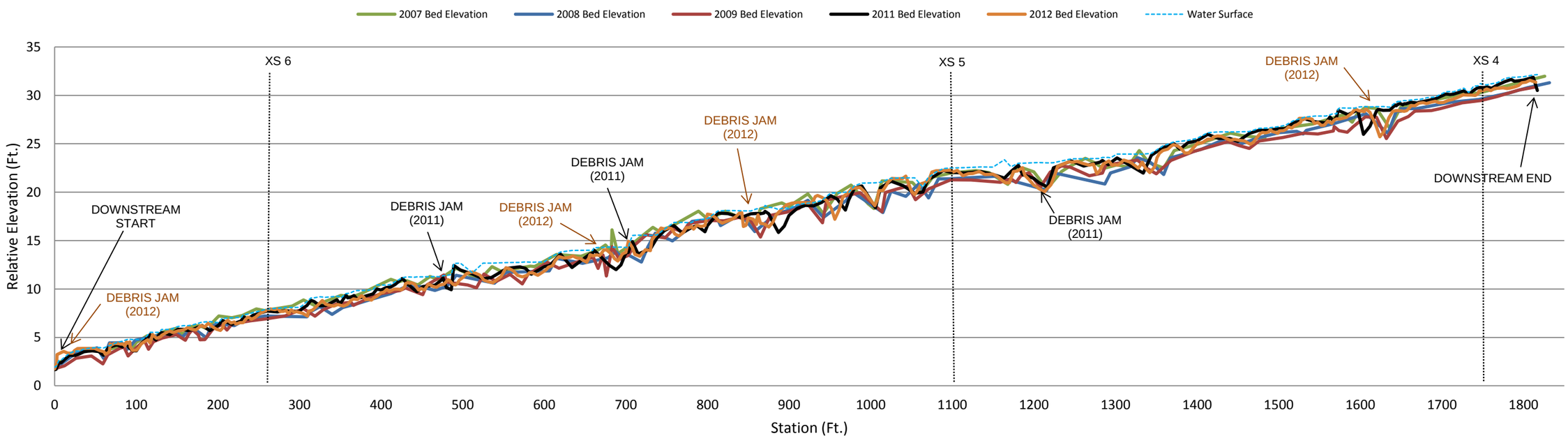
View of stone protection between 3+15 and 3+4.
At the upper end, slope erosion has exposed geotextile and natural fiber matting.

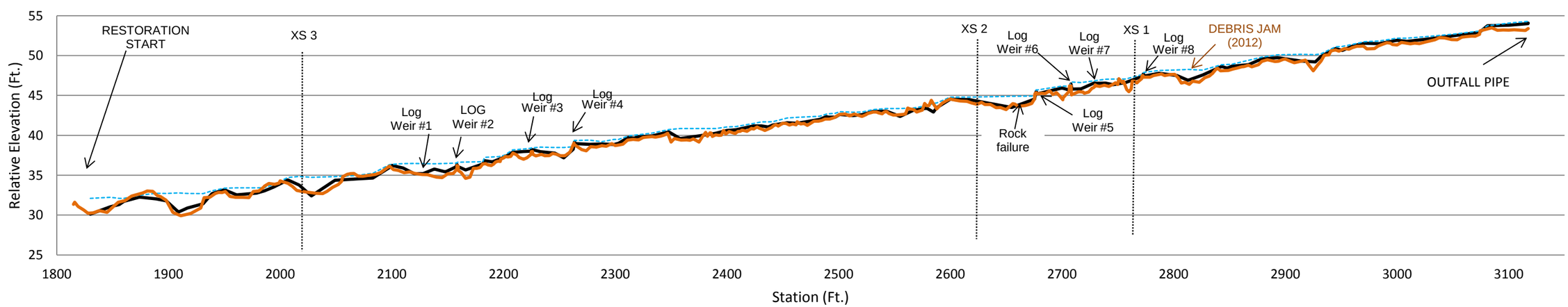
View of stone protection failure at 4+25.

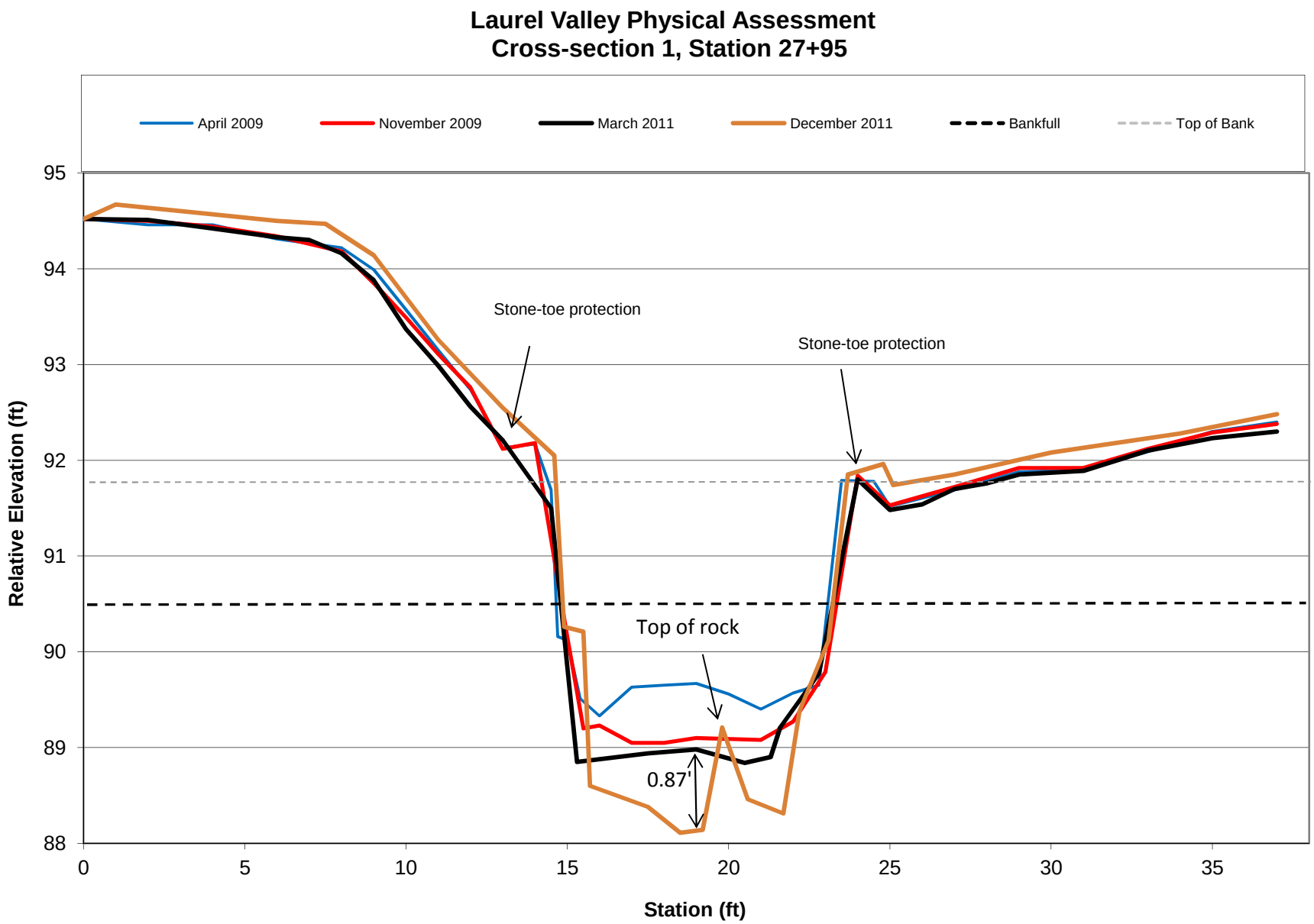
APPENDIX B
GEOMORPHIC ASSESSMENT DATA

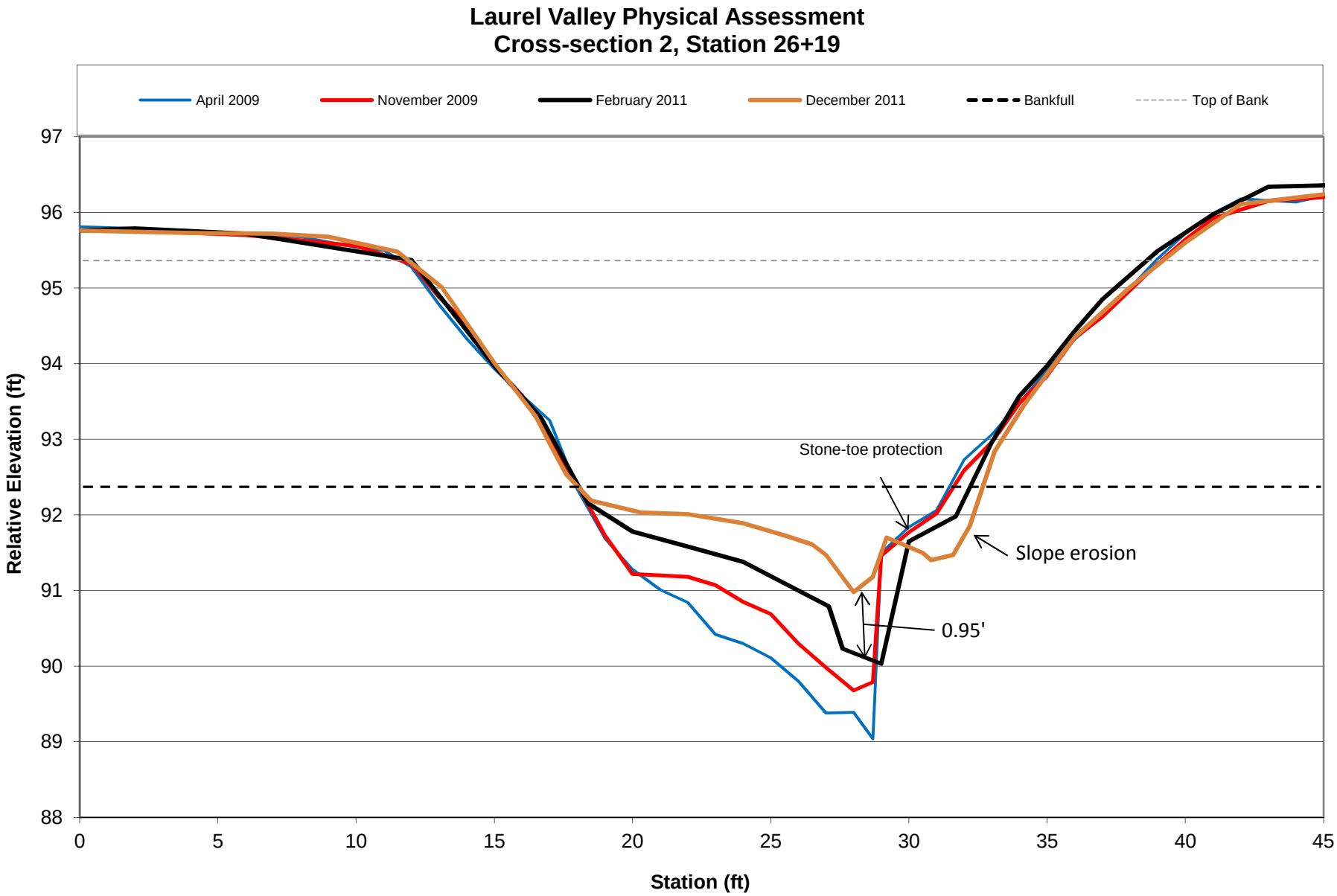
Laurel Valley Post-Construction Monitoring

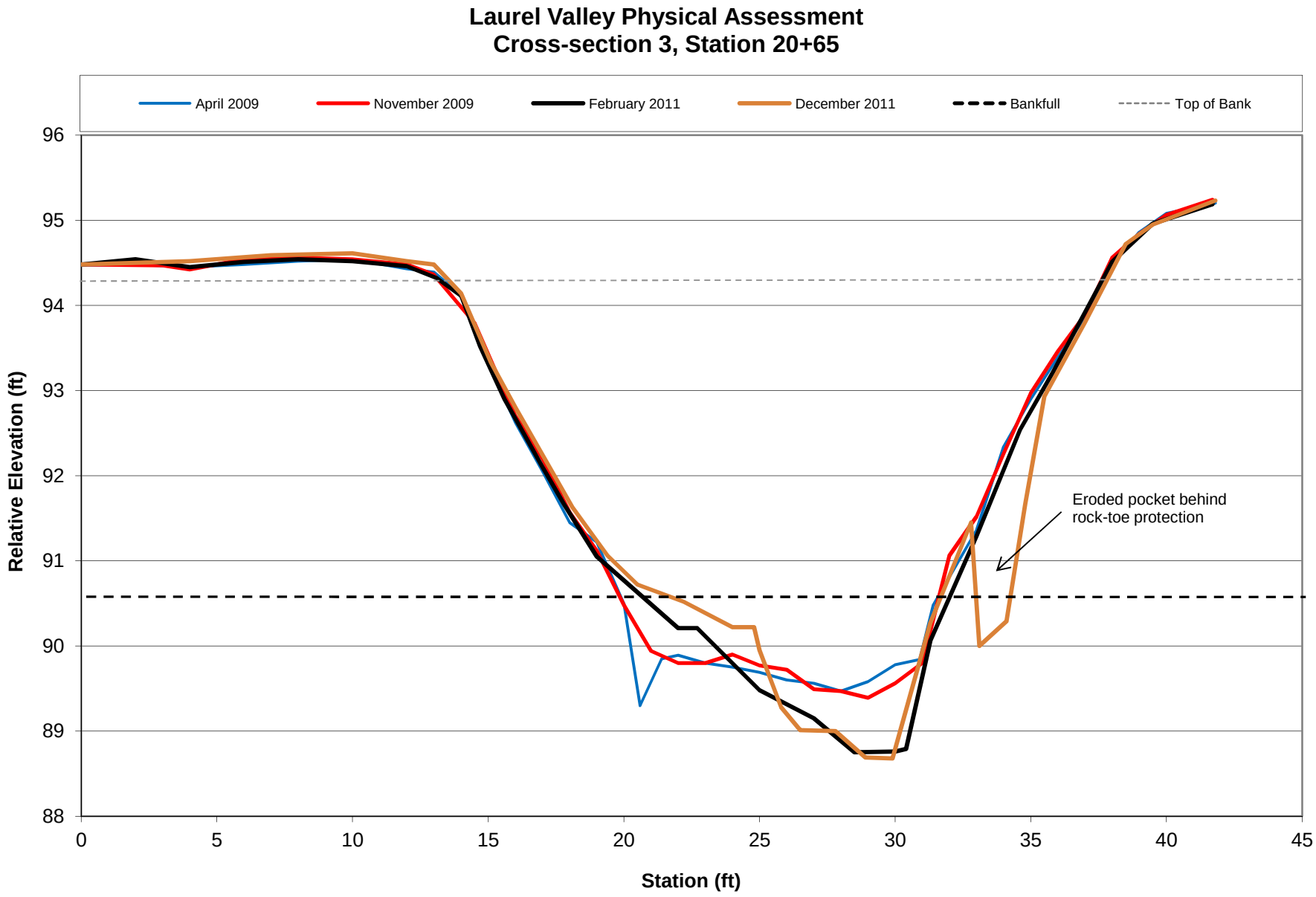
Longitudinal Profile 2007 - 2012

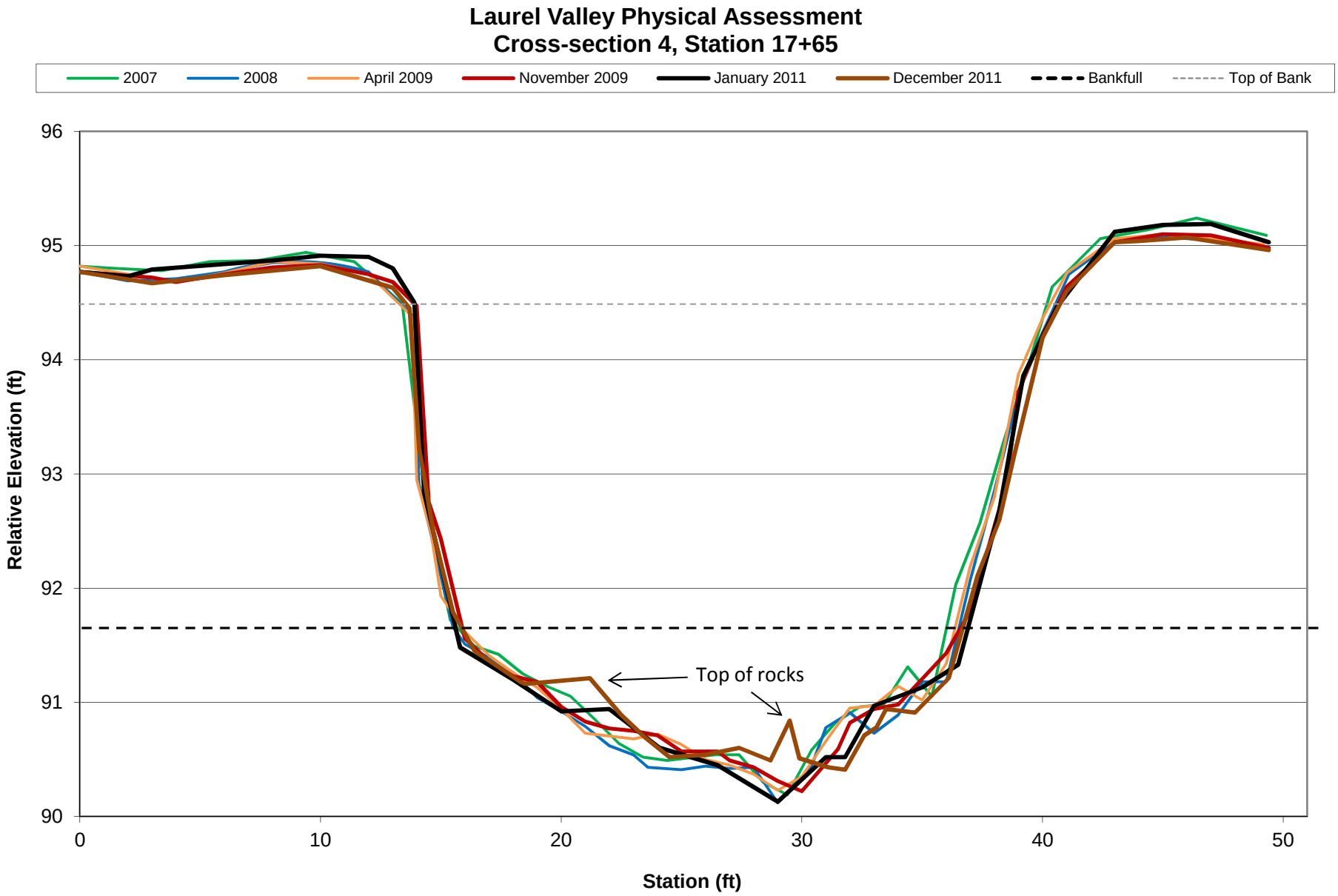


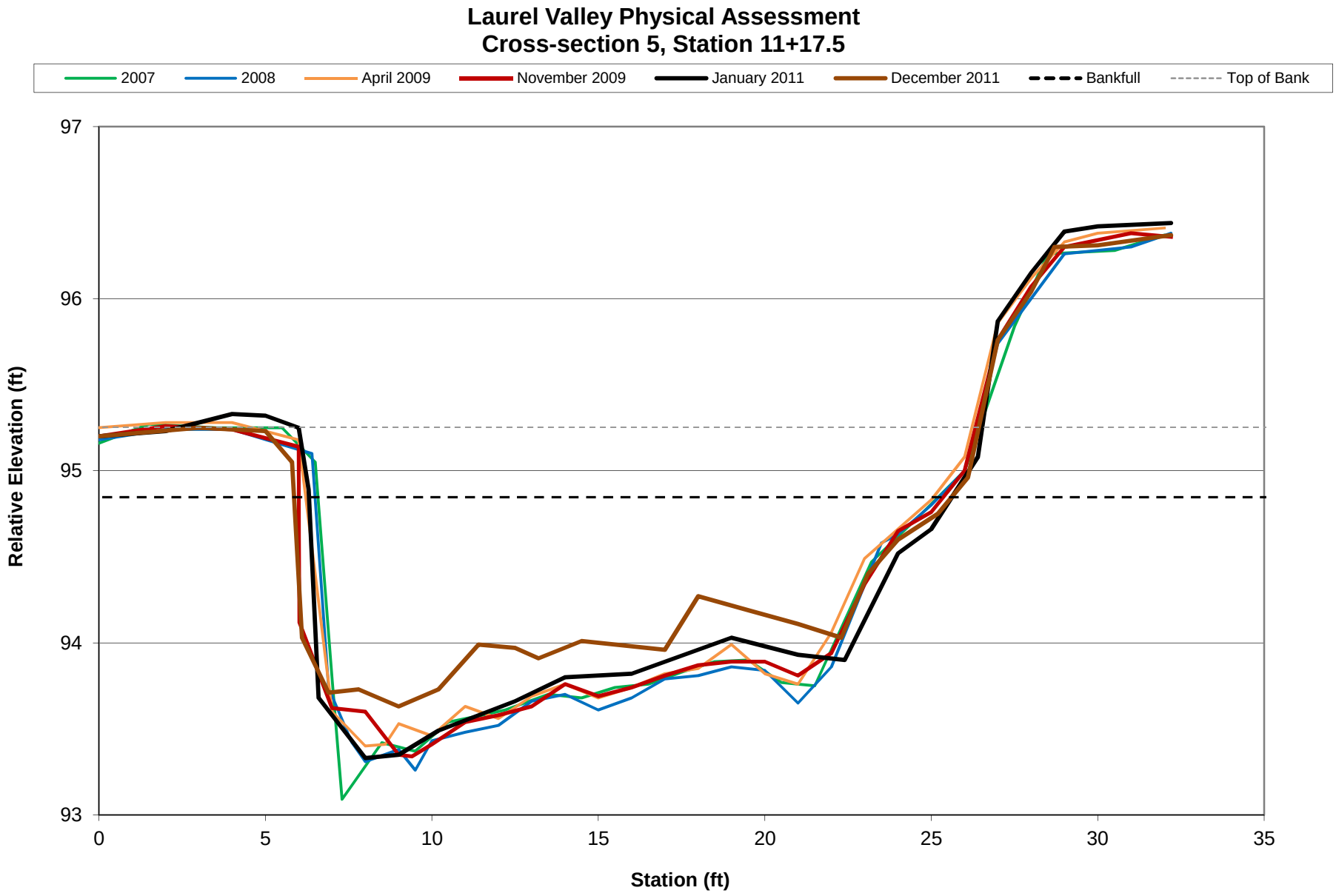


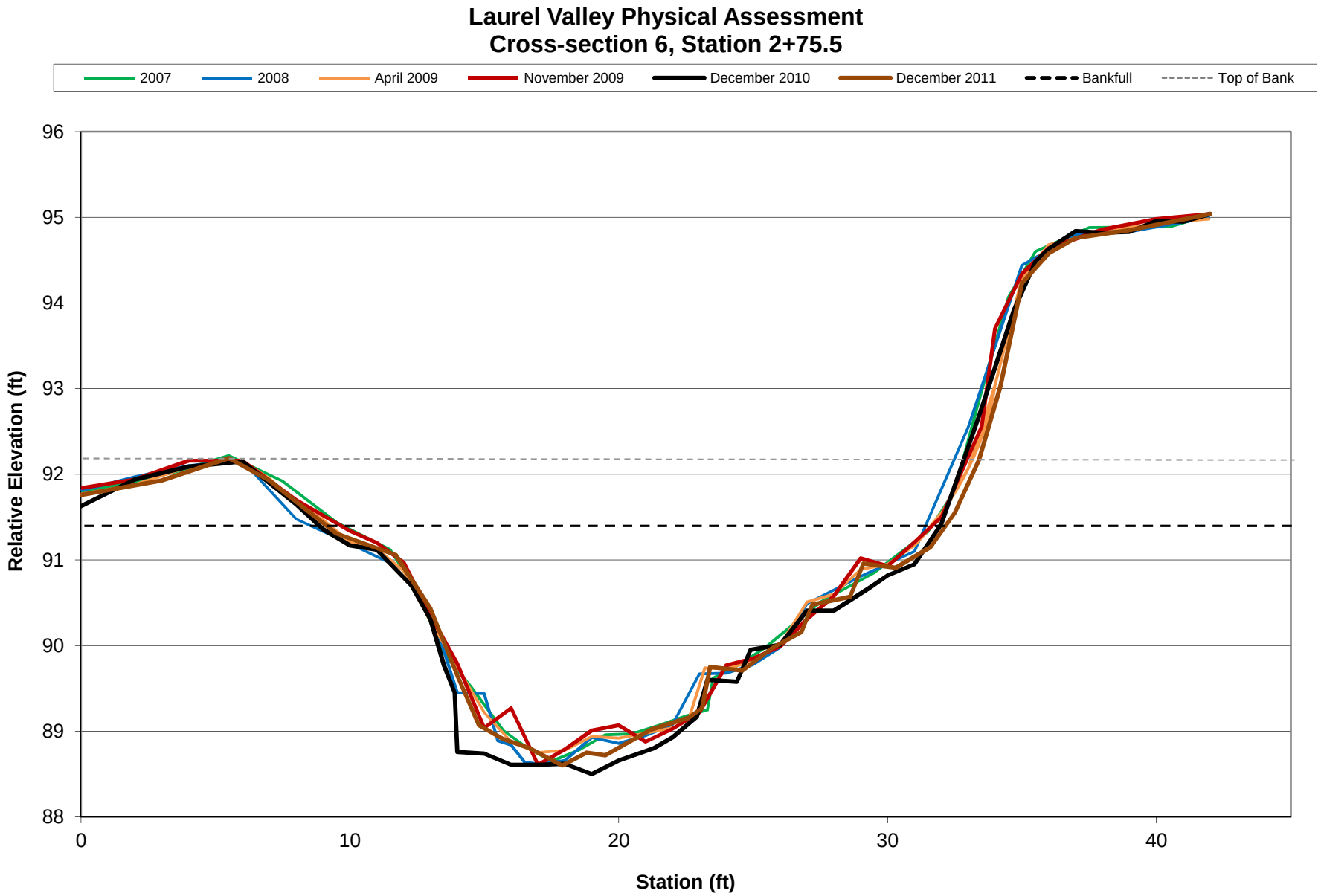

Laurel Valley Physical Assessment
Cross-section 1, Station 27+95
April 2009
November 2009
March 2011
December 2011
Bankfull
Top of Bank
Stone-toe protection
Stone-toe protection
Top of rock
0.87'
Relative Elevation (ft)
Station (ft)
95
94
93
92
91
90
89
88
0
5
10
15
20
25
30
35


Laurel Valley Physical Assessment
Cross-section 2, Station 26+19
April 2009
November 2009
February 2011
December 2011
Bankfull
Top of Bank
Relative Elevation (ft)
97
96
95
94
93
92
91
90
89
88
0
5
10
15
20
25
30
35
40
45
Station (ft)
Stone-toe protection
Slope erosion
0.95'


Laurel Valley Physical Assessment
Cross-section 3, Station 20+65
April 2009
November 2009
February 2011
December 2011
Bankfull
Top of Bank
Relative Elevation (ft)
96
95
94
93
92
91
90
89
88
0
5
10
15
20
25
30
35
40
45
Station (ft)
Eroded pocket behind
rock-toe protection


Laurel Valley Physical Assessment
Cross-section 4, Station 17+65
2007
2008
April 2009
November 2009
January 2011
December 2011
Bankfull
Top of Bank
Relative Elevation (ft)
96
95
94
93
92
91
90
0
10
20
30
40
50
Station (ft)
Top of rocks


Laurel Valley Physical Assessment
Cross-section 5, Station 11+17.5
2007
2008
April 2009
November 2009
January 2011
December 2011
Bankfull
Top of Bank
Relative Elevation (ft)
97
96
95
94
93
0
5
10
15
20
25
30
35
Station (ft)


Laurel Valley Physical Assessment
Cross-section 6, Station 2+75.5
2007
2008
April 2009
November 2009
December 2010
December 2011
Bankfull
Top of Bank
Relative Elevation (ft)
96
95
94
93
92
91
90
89
88
0
10
20
30
40
Station (ft)

APPENDIX C
RIPARIAN PLANTING INSPECTION DATA

View of minimal buffer vegatation in upstream end of zone 1, right bank.

View of minimal buffer vegatation in zone 1, right bank continued.

View of minimal riparian vegetation further downstream in zone 1, right bank.

View of planting zones in the restoration reach.

View of vegetated riparian area in zone 7.

View of vegetation in riprap channel of zone 8.

View of bank erosion along left bank in zone 8.

View of deposited leaf debris,
covering slope toe protection in Zone 9.

View of vegetation along bank in zone 10.

View of reforestation plantings in zone 14.

View facing upstream of riparian area in zone 15.

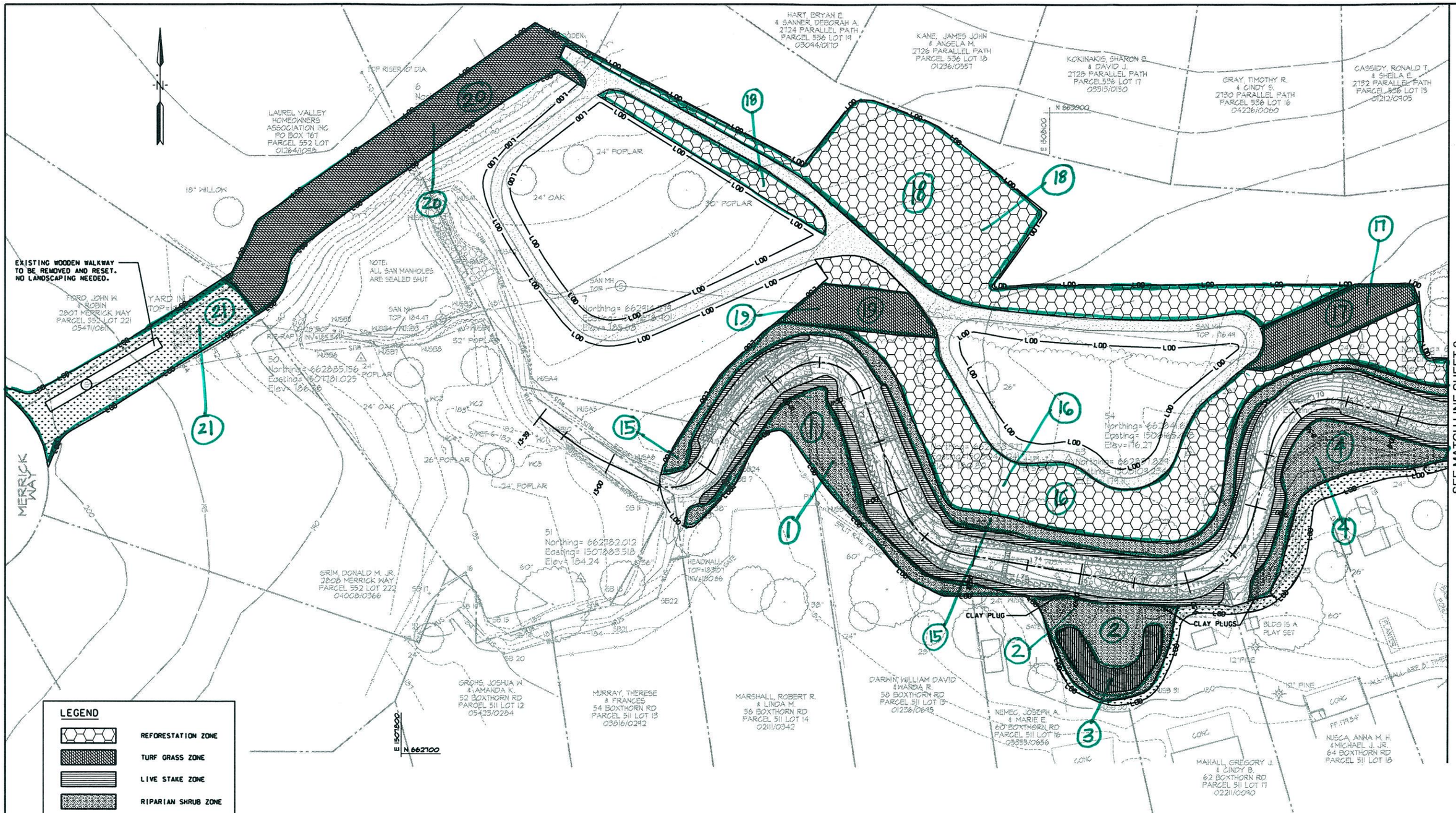
View of reforestation area in zone 15.

View of fort in reforestation area of zone 16.

View of stream channel and right bank within zone 16.

View of riparian zone adjacent to zone 16.

View of stream channel near zone 16.



LEGEND

- REFORESTATION ZONE
- TURF GRASS ZONE
- LIVE STAKE ZONE
- RIPARIAN SHRUB ZONE
- HERBACEOUS ZONE
- SOD

NOTE:

DO NOT PLANT TREES, SHRUBS, OR LIVE STAKES INTO AREAS DIRECTLY OVER THE TOP WIDTH OF THE CLAY PLUGS.

PROFESSIONAL CERTIFICATION:

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND. LICENSE NO. 18470 EXPIRATION DATE: 10-28-2008

ENGINEER'S SEAL

LS01 OF 02

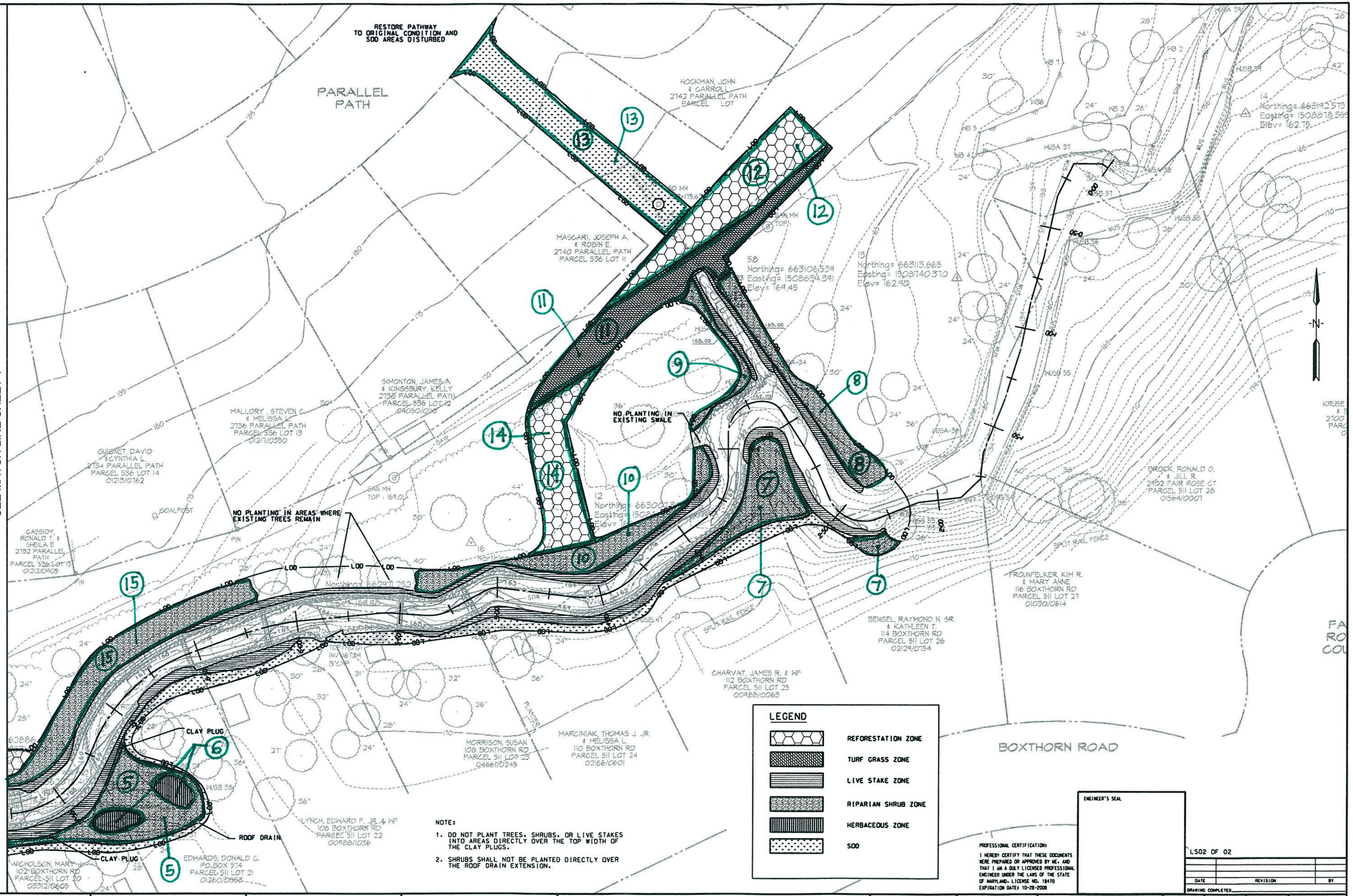
DATE	REVISION	BY

DRAWING COMPLETED

HARFORD COUNTY MARYLAND		LANDSCAPE PLAN	LAUREL VALLEY STREAM RESTORATION	KCI TECHNOLOGIES	DESIGNED KLH TRACED JMS CHECKED MDT
SCALE 1" = 20'	TAX MAP	POSITION SHEET	SHEET NO. 27 OF 30	J.O.	FILES

PLOTTED: "12:58 PM on Wednesday, February 24, 2010"
BY: Harmony, Miller, Division: PD50 Natural Res GMA Emp
FILE: M:\2003\03134.07\drawings\ld\Base#.dgn

SEE MATCH LINE SHEET 1



LEGEND

- REFORESTATION ZONE
- TURF GRASS ZONE
- LIVE STAKE ZONE
- RIPARIAN SHRUB ZONE
- HERBACEOUS ZONE
- SOD

NOTE:

1. DO NOT PLANT TREES, SHRUBS, OR LIVE STAKES INTO AREAS DIRECTLY OVER THE TOP WIDTH OF THE CLAY PLUGS.
2. SHRUBS SHALL NOT BE PLANTED DIRECTLY OVER THE ROOF DRAIN EXTENSION.

PROFESSIONAL CERTIFICATION:

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND. LICENSE NO. 18470
EXPIRATION DATE: 10-28-2008

ENGINEER'S SEAL

LS02 OF 02

DATE	REVISION	BY

DRAWING COMPLETED

HARFORD COUNTY
MARYLAND

LANDSCAPE PLAN

LAUREL VALLEY STREAM RESTORATION

KCI TECHNOLOGIES
Engineers
Planners
Surveyors
Construction Managers
10 North Park Place
Hunt Valley, MD 21030
Phone (410) 316-7800
Fax (410) 316-7817
www.kci.com

DESIGNED KLH	SCALE 1" = 20'	TAX MAP	SHEET	J.O.	
TRACED JMS		POSITION SHEET	NO. 28	FILES	
CHECKED MDT			OF 30		

PLOTTED: "12:59 PM on Wednesday, February 24, 2010"
DGN: "Harford County Laurel Valley Phase 2 Plan.dgn"
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APPENDIX D
MACROINVERTEBRATE DATA

Upstream Reach
2011-2012

Project Name: Laurel Valley Post-Construction Monitoring Report, Year 3 — Appendix E
Project Number: 20834486 — Laurel_Valley_2012_Bioassessment.xls
Prepared by: TH JP — Version: 1
Prepared date: 7/3/2012 8/9/2012 — Site Name: LV STA1 - Upstream

Sample Date	Sample ID	Phylum	Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]	No. Taxa	No. EPT Taxa	No. of Ephem Taxa	% Intolerant Urban (0,1,2,3)	% Chiro	% Clingers
4/9/2012	LV-1	Annelida	Oligochaeta	Lumbriculida	Lumbriculidae	not identified	not identified	A	1	Collector	bu	10.0	1	0	0	0	0	0
4/9/2012	LV-1	Annelida	Oligochaeta	Oligochaeta	Tubificidae	not identified	not identified	A	0	Collector	bu	10.0	1	0	0	0	0	0
4/9/2012	LV-1	Arthropoda	Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	0	Shredder	sp	3.0	1	1	0	0	0	0
4/9/2012	LV-1	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	3	Filterer	cn	5.0	1	1	0	0	0	3
4/9/2012	LV-1	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Diplectrona		I	0	Filterer	cn	2.0	1	1	0	0	0	0
4/9/2012	LV-1	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	3	Filterer	cn	6.0	1	1	0	0	0	3
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	0	Shredder	cb	6.0	1	0	0	0	0	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	1	Collector	sp	5.0	1	0	0	0	1	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Chironomidae	Corynoneura	Corynoneura	I	1	Collector	sp	2.0	1	0	0	1	1	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	3	Collector	sp	6.0	1	0	0	0	3	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Orthocladinae				1	Collector	sp	6.0	1	0	0	0	0	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	6	Collector	sp	6.0	1	0	0	0	6	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	7	Shredder	cn, bu	9.6	1	0	0	0	7	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	0	Collector	sp	5.0	1	0	0	0	0	0
4/9/2012	LV-1	Arthropoda	Insecta	Diptera	Tipulidae	Tipula	Tipula	I	3	Shredder	bu	4.0	1	0	0	0	0	0
									29				**15**	**4**	**0**	**3**	**62**	**21**

1 Life Stage, I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland; na indicates information for the particular taxa was not available.

Restoration Reach
2011-2012

Project Name: Laurel Valley Post-Construction Monitoring Report, Year 3
Project Number: 20834486
Prepared by: TH Checked by: JP
Prepared date: 7/4/2012 Checked date: 8/9/2012

Appendix E
Laurel_Valley_2012_Bioassessment.xls
Version: 1
Site Name: LV STA2

Sample Date	Sample ID	Phylum	Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]	No. Taxa	No. EPT Taxa	No. of Ephem Taxa	% Intolerant Urban (0,1,2,3)	% Chiro	% Clingers
4/6/2012	LV-2	Annelida	Oligochaeta	Lumbriculida	Lumbriculidae	not identified	not identified	A	0	Collector	bu	10.0	1	0	0	0	0	0
4/6/2012	LV-2	Annelida	Oligochaeta	Tubificida	Naididae	not identified	not identified	A	9	Collector	bu	10.0	1	0	0	0	0	0
4/6/2012	LV-2	Arthropoda	Insecta	Odonata	Calopterygidae	Calopteryx	Ca;p[terux	A	1	Predator	cb	6.0	1	0	0	0	0	0
4/6/2012	LV-2	Arthropoda	Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	1	Shredder	sp	3.0	1	1	0	1	0	0
4/6/2012	LV-2	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	9	Filterer	cn	5.0	1	1	0	0	0	9
4/6/2012	LV-2	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	I	0	Filterer	cn	6.0	1	1	0	0	0	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Endochironomus	Endochironomus	I	0	Shredder	cn	10.0	1	0	0	0	0	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Glyptotendipes	Glyptotendipes	I	1	Filterer	bu	10.0	1	0	0	0	1	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	3	Shredder	cb	6.0	1	0	0	0	3	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	0	Collector	sp	6.0	1	0	0	0	0	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Chironomus	Chironomus	I	3	Collector	bu	10.0	1	0	0	0	3	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Potthastia	Potthastia	I	4	Collector	sp	2.0	1	0	0	4	4	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	12	Collector	sp	6.0	1	0	0	0	12	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladinae	Orthocladinae	I	8	Collector	sp	6.0	1	0	0	0	8	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	53	Shredder	cn	7.0	1	0	0	0	53	53
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	3	Collector	sp	8.0	1	0	0	0	3	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	4	Collector	sp	5.0	1	0	0	0	4	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Chironomidae	Micropsectra	Micropsectra	I	3	Collector	cb	7.0	1	0	0	0	3	0
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Simuliidae	Simulum	Simulum	I	3	Filterer	cn	7.0	1	0	0	0	0	3
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Tipulidae	Antocha	Antocha	I	1	Collector	cn	5.0	1	0	0	0	0	1
4/6/2012	LV-2	Arthropoda	Insecta	Diptera	Tipulidae	Tipula	Tipula	I	0	Shredder	bu	4.0	1	0	0	0	0	0
4/6/2012	LV-2	Platyhelminthes	Turbellaria	Tricadida	Dugesiidae	Girardia	Girardia	A	1	unk	unk	na	1	0	0	na	0	0
			119										**22**	**3**	**0**	**4**	**80**	**56**

1 Life Stage, I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland; na indicates information for the particular taxa was not available.

Downstream Reach
2011-2012

Project Name: Laurel Valley Post-Construction Monitoring Report, Year 3
Project Number: 20834486
Prepared by: TH Checked by: JP
Prepared date: 7/3/2012 Checked date: 7/5/2012

Appendix E
Laurel_Valley_2012_Bioassessment.xls
Version: 1
Site Name: LV STA3 - Downstream

Sample Date	Sample ID	Phylum	Class	Order	Family	Genus	Final ID	Note[1]	# of Org	FFG[2]	Habit[3]	Tolerance Value[4]	No. Taxa	No. EPT Taxa	No. of Ephem Taxa	% Intolerant Urban (0,1,2,3)	% Chiro	% Clingers
4/6/2012	LV-3	Annelida	Oligochaeta	Tubificida	Naididae	not identified	not identified	A	0	Collector	bu	10.0	1	0	0	0	0	0
4/6/2012	LV-3	Annelida	Gastropoda	Basommatophora	Ancylidae	Ferressia	Ferressia	A	1	Scraper	cb	8.0	1	0	0	0	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Plecoptera	Nemouridae	Amphinemura	Amphinemura	I	5	Shredder	sp	3.0	1	1	0	5	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	I	4	Filterer	cn	5.0	1	1	0	0	0	4
4/6/2012	LV-3	Arthropoda	Insecta	Trichoptera	Hydropsychidae	unk	unk	I	1	Filterer	cn	na	1	1	0	0	0	1
4/6/2012	LV-3	Arthropoda	Insecta	Trichoptera	Philopotamidae	Dolophilodes	Dolophilodes	I	0	Filterer	cn	0.0	1	1	0	0	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Coleoptera	Dytiscidae	Neoporus	Neoporus	I	0	Predator	sw	5.0	1	0	0	0	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Odonata	Coenagrionidae	not identified	not identified	I	1	Predator	cb	8.0	1	0	0	0	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Odonata	Calopterygidae	Calopteryx	Calopteryx	I	1	Predator	cb	8.3	1	0	0	0	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Polypedilum	Polypedilum	I	2	Shredder	cb	6.0	1	0	0	0	2	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Chaetocladius	Chaetocladius	I	8	Collector	sp	6.0	1	0	0	0	8	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Orthocladius	Orthocladius	I	14	Collector	sp	6.0	2	0	0	0	14	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	I	0	Filterer	sp	6.0	1	0	0	0	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Chironomini		I	1	unk	unk	na	1	0	0	na	1	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Tanytarsus	Microspectra	I	3	Filterer	cb	6.0	1	0	0	0	3	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Cricotopus	Cricotopus	I	58	Shredder	cn	7.0	1	0	0	0	58	58
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	I	9	Collector	sp	8.0	1	0	0	0	9	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Tvetenia	Tvetenia	I	8	Collector	sp	5.0	1	0	0	0	8	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Simulium	Simulium	I	5	Filterer	cn	7.0	1	0	0	0	5	5
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Chironomidae	Tipula	Tipula	I	1	Shredder	bu	4.0	1	0	0	0	1	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Empididae			I	1	Shredder	bu	4.0	1	0	0	0	0	0
4/6/2012	LV-3	Arthropoda	Insecta	Diptera	Empididae	Clinocera	Clinocera	I	1	Predator	cn	un	2	0	0		0	1
4/6/2012	LV-3	Cnidaria	Anthomedusae	Hydrozoa	Hydridae	Hydra	Hydra	A	2	unk	unk	na	1	0	0	0	0	0
4/6/2012	LV-3	Platyhelminthes	Turbellaria	Tricadida	Dugesiidae	Girardia	Girardia	A	1	unk	unk	na	1	0	0	na	0	0
			127										**26**	**4**	**0**	**4**	**88**	**56**

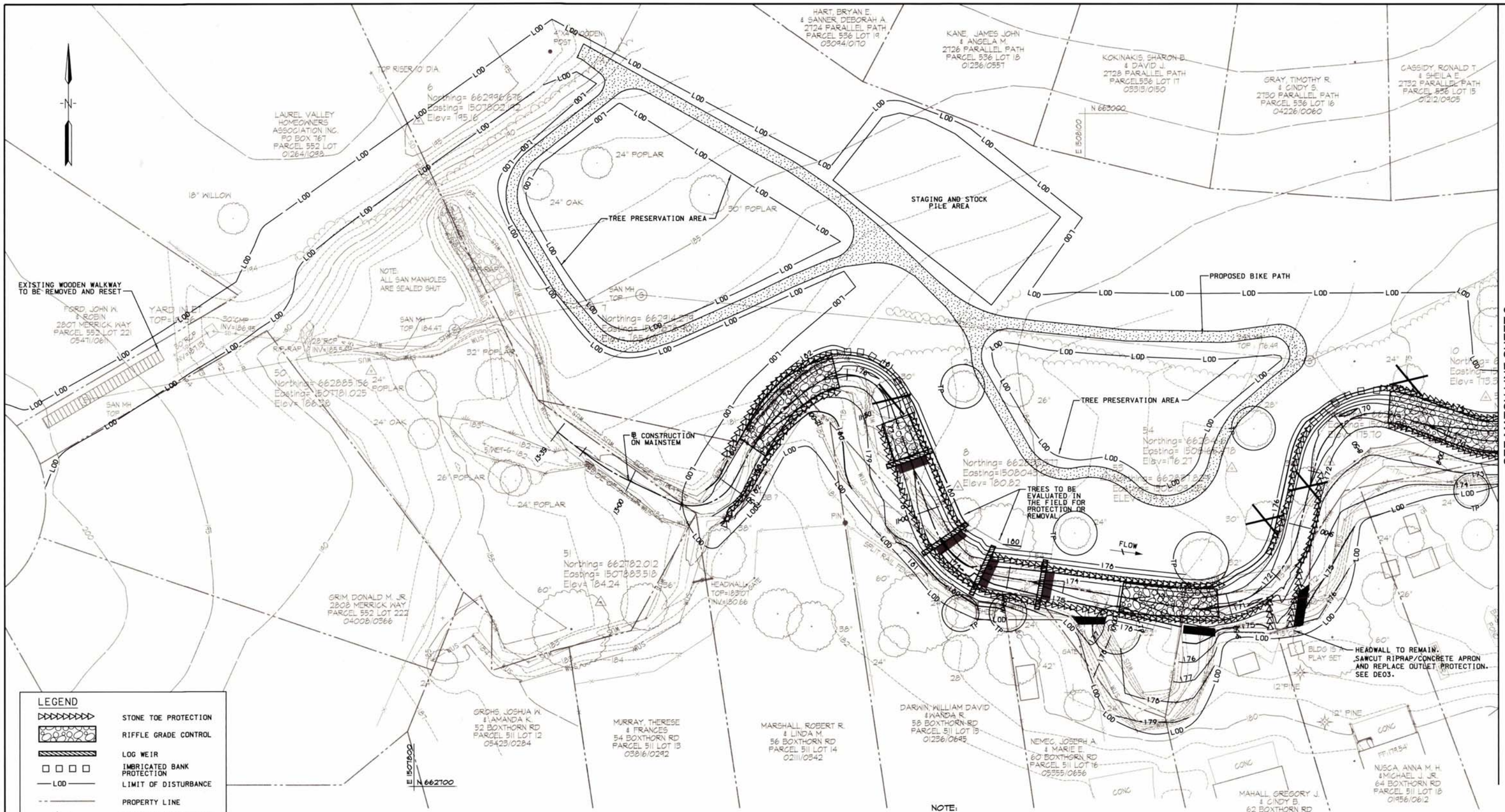
1 Life Stage, I - Immature, P- Pupa, A - Adult; 2 Functional Feeding Group; 3 Habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler; 4 Tolerance Values, based on Hilsenhoff, modified for Maryland; na indicates information for the particular taxa was not available.

APPENDIX E
PHYSICAL HABITAT DATA

Laurel Valley Post-Construction Monitoring - Year 3
Piedmont
2011/Spring 2012

RAW DATA									
Site	**Subshed Area (ac)***	**Instream Habitat**	**Epifaunal Substrate**	**Bank Stability (0-20)**	**Embedded-ness**	**Percent Shading**	**Remoteness Score**	**# Woody Debris/ Rootwads**	**Riffle Quality**
STA 1 - Upstream 2012	90	8	8	4	40	85	8	3	10
STA 2 - Restoration 2012	148.3	8	8	16	80	60	6	1	11
STA 3 - Downstream 2012	177.6	15	15	8	70	95	10	5	15
REF-Carsins Run 2009	834	16	16	18	20	75	12	3	16

APPENDIX F
STREAM RESTORATION CONSTRUCTION DRAWINGS



LEGEND

- STONE TOE PROTECTION
- RIFFLE GRADE CONTROL
- LOG WEIR
- IMBRICATED BANK PROTECTION
- LOD — LIMIT OF DISTURBANCE
- PROPERTY LINE
- EXISTING TREE (TO BE REMOVED AND TRUNK STOCKPILED)
- TP — TREE PROTECTION
- 150 — EXISTING CONTOUR
- 178 — PROPOSED CONTOUR
- PROPOSED BIKE PATH
- COBBLE BED MATERIAL
- CLAY CHANNEL BLOCK

STONE TOE PROTECTION SCHEDULE		
FROM STA.	TO STA.	STREAM SIDE*
12+63	11+80	R
12+40	11+80	L
11+40	10+85	L
10+65	9+50	L
11+45	9+30	R
9+20	8+75	R
9+23	8+60	L
8+26	7+77	R
8+28	7+77	L

* FACING DOWNSTREAM, MEASURED FROM THE BASELINE OF CONSTRUCTION

RIFFLE GRADE CONTROL SCHEDULE	
FROM STA.	TO STA.
12+30	11+80
11+45	11+25
9+99	9+55
8+28	7+77

IMBRICATED BANK SCHEDULE		
FROM STA.	TO STA.	STREAM SIDE*
11+80	11+40	L
8+60	8+28	L

* FACING DOWNSTREAM, MEASURED FROM THE BASELINE OF CONSTRUCTION

LOG WEIR SCHEDULE	
STATION	ELEVATION*
11+25	176.18
10+85	174.94
10+65	174.79
10+35	173.86

* INDICATES THALWEG ELEVATION ON TOP LOG

POOL THALWEG LOCATION SCHEDULE			
STA.	OFFSET	ELEVATION	STREAM SIDE*
11+65	3.0'	175.8	L
10+70	3.0'	173.9	R
9+40	3.0'	170.7	R
8+45	3.0'	169.6	L

* FACING DOWNSTREAM, MEASURED FROM THE BASELINE OF CONSTRUCTION

NOTE:

1. EXACT LOCATION OF BIKE PATH TO BE FIELD DETERMINED BY THE ENGINEER. BIKE PATH WILL BE CONSTRUCTED TO AVOID EXISTING TREES.
2. ALL TREES WITHIN THE LOD GREATER THAN 6" IN DIAMETER, OTHER THAN THOSE DESIGNATED TO BE REMOVED OR SAVED, SHALL BE EVALUATED IN THE FIELD AND SHALL BE APPROVED BY THE ENGINEER PRIOR TO REMOVAL.

SCALE - 1 inch

PROFESSIONAL CERTIFICATION:
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND. LICENSE NO. 18470
EXPIRATION DATE: 10-28-2008

ENGINEER'S SEAL
STATE OF MARYLAND · TERRY B. HEWITT · 18470 · PROFESSIONAL ENGINEER

PS01 OF 02

080703

DATE	REVISION	BY

DRAWING COMPLETED

HARFORD COUNTY
MARYLAND

GRADING PLAN

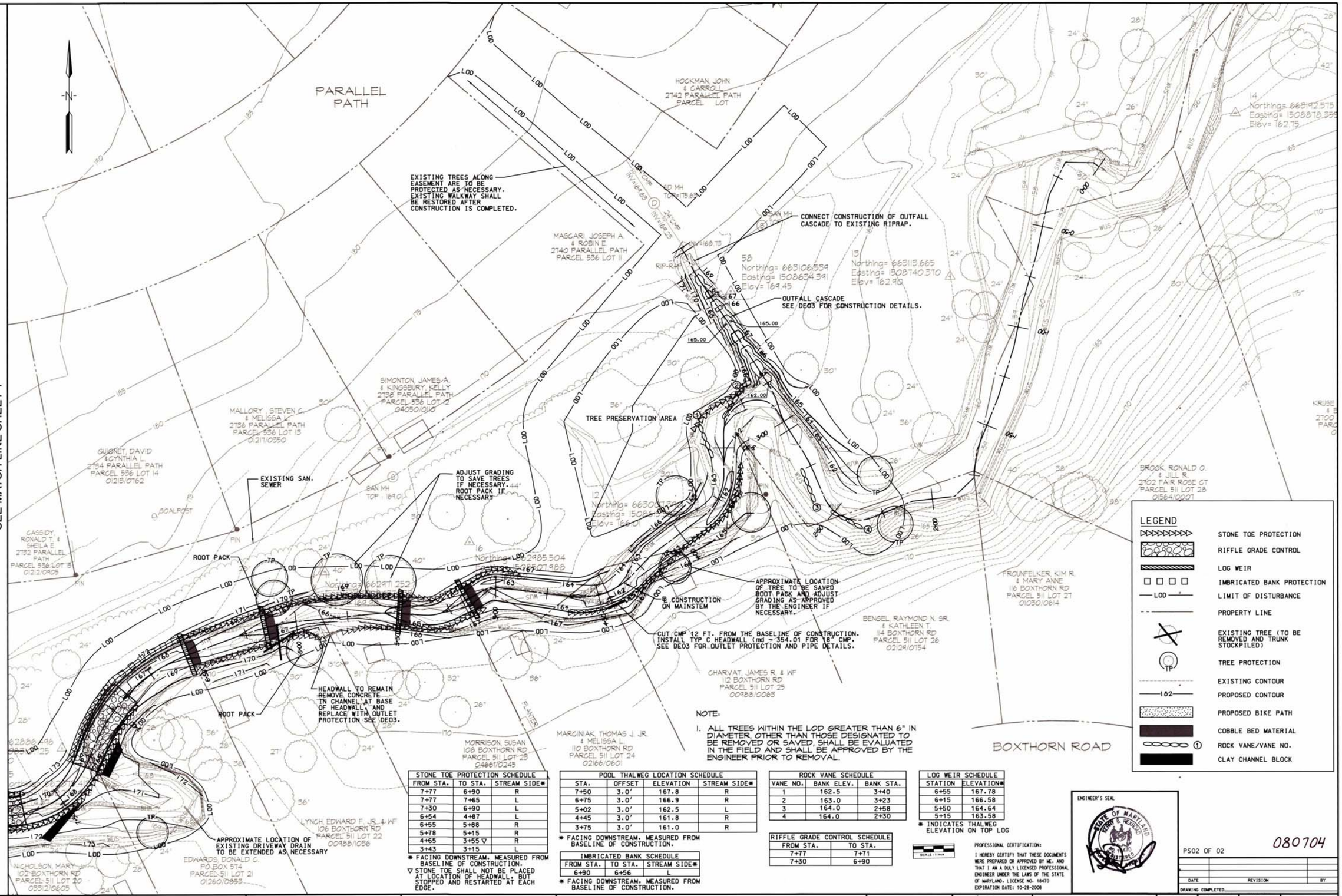
LAUREL VALLEY STREAM RESTORATION

KCI TECHNOLOGIES
ENGINEERS · PLANNERS · SURVEYORS · CONSTRUCTION MANAGERS
10 North Bond Street, Bel Air, MD 21014
Phone (410) 638-7800
Fax (410) 638-7812
www.kci.com

DESIGNED KLH	SCALE 1" = 20'	TAX MAP	SHEET NO. 5 OF 30	J.O.
TRACED JMS		POSITION SHEET		FILES
CHECKED MDT				

PLOTTED: "10:07 AM on Friday, June 06, 2008"
BY: Hornsby, Mike; Division: 0309, Natural Resource Management
FILE: M:\2006\06034\07-drawings\gdbase.dgn

SEE MATCH LINE SHEET 1



NOTE:

1. ALL TREES WITHIN THE LOD GREATER THAN 6" IN DIAMETER, OTHER THAN THOSE DESIGNATED TO BE REMOVED OR SAVED, SHALL BE EVALUATED IN THE FIELD AND SHALL BE APPROVED BY THE ENGINEER PRIOR TO REMOVAL.

STONE TOE PROTECTION SCHEDULE		
FROM STA.	TO STA.	STREAM SIDE*
7+77	6+90	R
7+77	7+65	L
7+30	6+90	L
6+54	4+87	L
6+55	5+88	R
5+78	5+15	R
4+65	3+55 ▽	R
3+43	3+15	L

* FACING DOWNSTREAM, MEASURED FROM BASELINE OF CONSTRUCTION.
▽ STONE TOE SHALL NOT BE PLACED AT LOCATION OF HEADWALL, BUT STOPPED AND RESTARTED AT EACH EDGE.

POOL THALWEG LOCATION SCHEDULE			
STA.	OFFSET	ELEVATION	STREAM SIDE*
7+50	3.0'	167.8	R
6+75	3.0'	166.9	R
5+02	3.0'	162.5	L
4+45	3.0'	161.8	R
3+75	3.0'	161.0	R

* FACING DOWNSTREAM, MEASURED FROM BASELINE OF CONSTRUCTION.

IMBRICATED BANK SCHEDULE		
FROM STA.	TO STA.	STREAM SIDE*
6+90	6+56	L

* FACING DOWNSTREAM, MEASURED FROM BASELINE OF CONSTRUCTION.

ROCK VANE SCHEDULE		
VANE NO.	BANK ELEV.	BANK STA.
1	162.5	3+40
2	163.0	3+23
3	164.0	2+58
4	164.0	2+30

RIFFLE GRADE CONTROL SCHEDULE	
FROM STA.	TO STA.
7+77	7+71
7+30	6+90

LOG WEIR SCHEDULE	
STATION	ELEVATION*
6+55	167.78
6+15	166.58
5+50	164.64
5+15	163.58

* INDICATES THALWEG ELEVATION ON TOP LOG

SCALE : 1 inch

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EXPIRATION DATE: 10-28-2008

ENGINEER'S SEAL
STATE OF MARYLAND
GERRY S. MCCRAY
No. 18470
REGISTERED PROFESSIONAL ENGINEER

PS02 OF 02

080704

DATE	REVISION	BY

DRAWING COMPLETED

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MARYLAND

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DESIGNED	KLH
TRACED	JMS
CHECKED	MDT

SCALE 1" = 20'

TAX MAP

POSITION SHEET

SHEET NO. 6 OF 30

J.O.

FILES

PLOTTED: 10:07 AM on Friday, June 06, 2008
BY: Harmony Miller, Division: 0109 Natural Resource Management
FILE: M:\2003\2003134.07\drawings\psd\Journal.dgn