Armstrong Property Wetland and Stream Mitigation Project
Hyde County, NC

2009 Annual Monitoring Report
Year 2

NCEEP Project Number D06012-A
Tar-Pamlico River Basin

Submitted to
NCDENR/Ecosystem Enhancement Program
2728 Capital Blvd.
Raleigh, NC 27604

Date: January, 2010

Monitoring:
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P. O. Box 176
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Executive Summary

The Armstrong Property Wetland Mitigation Site is a headwater riverine wetland and stream mitigation project located just east of State Route 45 near its intersection with State Route 264, in Hyde County, North Carolina. It was constructed by Albemarle Restorations, LLC, under contract with EEP to provide compensatory wetland mitigation credits in the Tar-Pamlico River Basin. Construction activities, in accordance with the approved restoration plan, began October 1, 2007, and were completed on November 30, 2007. Tree and shrub planting on the project site occurred on January 28 and 29, 2008. An emergent wetland seed mixture was sown shortly afterward. With the exception of increased planting density, all planting was done in accordance with the approved restoration plan.

Five water level monitoring gauges are located at varying elevations throughout riverine wetland areas of the site to measure subsurface water elevations. Two additional gauges are located in the headwater stream (swamp run) to help monitor flow and water level within the stream. Two more gauges are installed at the reference site. One of the five gauges in the riverine wetland area met the stated hydrologic success criterion of maintained groundwater levels within 12 inches of the soil surface for 21 consecutive days during the growing season (all the gauges met success at 13 days - 5% of the growing season). The cumulative rainfall deficit during the 2009 growing season was 2.15 inches which had a dramatic effect on how the ground water levels behaved in 2009 as opposed to the previous year when the cumulative rainfall deficit was over 8 inches.

Two separate flow events were photographically documented during the 2009 growing season. The data from the water level monitoring gauges coincides with and confirms the flow of water through and off the site via the outlet pipe. Heavy rainfall in November caused over bank flooding on the project to the extent that nearly the entire site was under water for a brief period.

Four vegetative monitoring plots are installed in the riverine wetland areas and permanently monumented, one coincident with monitoring gauges 1 through 4. There are also two plots installed within the swamp run, each similarly situated and referenced at the two swamp run monitoring gauges. Each plot is a 10m X 10m square, as recommended by the CVS-EEP protocol for recording vegetation sampling. All of the plots in the riverine wetland area met the third year survival success criteria of 320 stems per acre. One of the two plots in the swamp run met the same vegetation survival criteria. Heavy cattail coverage and perennial standing water are the likely causes for lack of success at the other plot.

Table ES-1 shows the levels of success attained by each of the water level monitoring gauges and the vegetation plots since monitoring began. Success criterion for hydrology is 8% of the growing season (21 days). Table C-1 in Appendix C has a detailed breakdown of hydrologic success. Success criterion for the vegetation plots is the third year level of survival (320 stems per acre).

Table ES-1. Project Success Summary															
	Gauge							Percent	Vegetation Plot						Percent
	1	2	3	4	5	R1	R2	Success	1	2	3	4	R1	R2	Success
Year 1 (2008) Success	N	N	N	N	N	Y	Y	29%	Y	Y	N	N	N	N	33%
Year 2 (2009) Success	N	N	N	N	Y	Y	Y	43%	Y	Y	Y	Y	Y	N	83%

I. Project Background

1.0 Project Objectives

The goal of the Armstrong Property Mitigation Project was to create a riverine wetland system typically found in the middle to upper reaches of first or zero order tributary systems. The project is to serve as compensation for wetland loss in the Tar-Pamlico River Basin. The restoration plan was developed and implemented to eliminate pattern drainage and restore topography and hydrology that more closely resembled that of similar undisturbed land. Construction resulted in the development of a broad, frequently flooded swamp run following a historical path as evidenced by archived aerial photographs and signature topography. Subsequent planting was designed to restore a wetland forest ecosystem that is typically found in the immediate area characteristic of similar soils, topography and hydrology.

Ecological benefits of the restored riparian headwater system and its associated riverine wetlands are the following:

1. Water quality improvements, including nutrient, toxicant and sediment retention and reduction, increasing dissolved oxygen levels, as well as reducing excessive algae growth, and reducing surface water temperatures in receiving waters by providing permanent shading in the form of a shrub/scrub and forested headwater wetland system.
2. Wildlife habitat enhancement by adding to the existing adjacent forested areas creating a continuous travel corridor between habitat blocks and providing a wide range of habitat areas (open water, emergent, shrub/scrub and forested) for amphibians, reptiles, birds, insects and mammals.
3. Flood flow attenuation during storm events which reduces sedimentation and erosion downstream, and improves long term water quality within the Pungo River.
4. Passive outdoor recreation and educational opportunities for the landowner and the surrounding community.

2.0 Project Structure, Restoration Type, and Approach

Table I lists the estimated wetland acreage to be restored on the Armstrong Property. The mitigation plan provides for the restoration of 20.0 acres of riverine wetlands and 2,200 linear feet of stream (swamp run) restoration. Prior to construction, the easement area was used entirely for row crop agriculture, primarily soy beans, corn and cotton. The agricultural fields were drained by several ditches that traversed the site with outfall into Clark Mill Creek. Construction activities, in accordance with the approved restoration plan, began in October, 2007 and were completed in November of 2007. Native tree and shrub species were planted in January of 2008. The resulting riverine system is designed to emulate natural swamp run systems found within the Pungo River Basin.

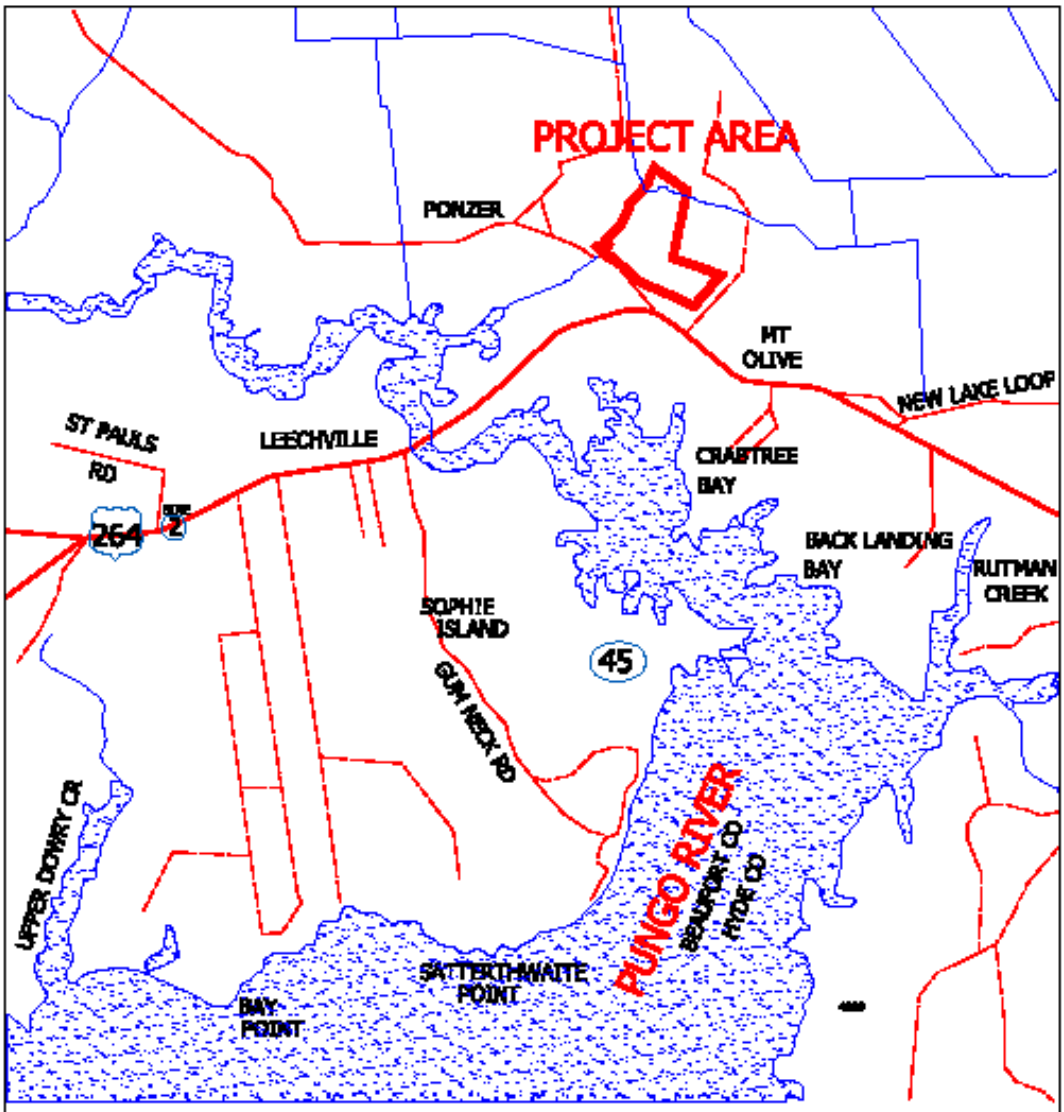
Table 1. Project Restoration Components

Restoration Type	Pre-Existing Acres/Linear Feet	Post Construction Acres/ Linear Feet	Credit Ratio (Restoration : WMU)	Total WMUs/ SMUs
Riverine Wetland	0.0 acres	20.0 acres	1:1	20.0 WMUs
Stream (Swamp Run)	0.0 linear feet	2,200 linear feet	1:1	2,200 SMUs

3.0 Location and Setting

The Armstrong Property Mitigation Site is located in Hyde County, between Ponzer and Mt. Olive on the north side of State Route 45 near its intersection with US Hwy 264. The easement area is situated in the middle of the Armstrong property and adds contiguous swamp run and forested wetlands to those of Clark Mill Creek, a tributary of the Pungo River which is less than a mile to the south. The surrounding area is primarily forest and agricultural land with residential properties as a minor component.

Figure 1 is a location map for the project site. Directions to the site are as follows: from Belhaven, travel east on US Hwy 264 approximately 10 miles and turn left (north) on State Route 45. Access to the site is approximately .25 miles north of the intersection on right.


PROJECT AREA
PONZER
MT OLIVE
NEW LAKE LOOP
ST PAULS RD
LEECHVILLE
CRABTREE BAY
264
BUS 2
BACK LANDING BAY
RUTMAN CREEK
SOPHIE ISLAND
45
GUM NECK RD
UPPER DOWRY CR
PUNGO RIVER
BEAUFORT CO
HYDE CO
SATTERTHWAITE POINT
BAY POINT
FIGURE 1
SCALE
ECOTONE, INC.
Environmental Consulting, Permitting & Design.
Forest & Wetland Creation &
Stream Restoration.
Vicinity Map
ARMSTRONG PROPERTY
RIVERINE WETLAND & STREAM RESTORATION
MITIGATION MONITORING
Scale: 1" = 4000'
11/2008
Drawn By: LMS

4.0 Project History and Background

Table II provides the history of data collection and actual completion of various milestones of the Armstrong Property Wetland Mitigation Site.

Table II. Project Activity and Reporting History Armstrong Property Wetland Mitigation Project/EEP #D06012-A		
Activity or Report	**Data Collection Complete**	**Actual Completion or Delivery**
Restoration Plan	June 2007	July 2007
Final Design -90%	June 2007	July 2007
Construction	N/A	November 2007
Temporary S & E mix applied to entire project area	N/A	February 2008
Permanent seed mix applied to entire project area	N/A	February 2008
Containerized and Bare Root Planting	N/A	January 2008
Mitigation Plan/As-built (Year 1 monitoring - baseline)	March 2008	December 2008
Year 2 monitoring	September 2009	January 2010
Year 3 monitoring		
Year 4 monitoring		
Year 5 monitoring		

Points of contact for the various phases of the APWMS are provided in Table III.

Table III. Project Contacts Armstrong Property Wetland Mitigation Site/EEP #D06012-A	
Designer Primary Project design POC	Ecotone, Inc. 1204 Baldwin Mill Road Jarrettsville, MD 21804 Scott McGill (410-692-7500)
Construction Contractor Construction contractor POC	Armstrong, Inc. P. O. Box 96 25852 US Hwy 64 Pantego, NC 27860 Tink Armstrong (252-943-2082)
Planting Contractor Planting contractor POC	Carolina Silvics, Inc. 908 Indian Trail Road Edenton, NC 27932 Mary-Margaret McKinney (252-482-8491)
Seeding Contractor Seed planting contractor POC	Armstrong, Inc. P. O. Box 96 Pantego, NC 27860 Tink Armstrong (252-943-2082)
Seed mix sources	Ernst Conservation Seeds, LLP, Meadville, PA
Nursery stock suppliers	International Paper, Inc., et. al.
Monitoring Consultants Wetland and Vegetation POC	Woods, Water and Wildlife, Inc. P. O. Box 176 Fairfield, NC 27826 Ashby Brown (800-509-0190)

Project background information for the APWMS is provided in Table IV.

Table IV. Project Background Armstrong Property Wetland Mitigation Site/EEP #D06012-A	
Project County	Hyde County
Drainage Area	25.0 acres within easement boundary
Drainage impervious cover estimate (%)	0
Physiographic Region	Coastal Plain
Ecoregion	8.5.1 Middle Atlantic Coastal Plain
Rosgen Classification of As-built	N/A
Cowardin Classification	PEM, PSS, PFO
Dominant Soil Types	Acredale Silt Loam
Reference site ID	Clark Mill Creek, Hyde County, NC
USGS HUC for Project and Reference	03020104
NCDWQ Sub-basin for Project and Reference	03-03-07
NCDWQ classification for Project and Reference	C
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	Yes, Pungo River
Reasons for 303d listing or stressor?	WWTP, ag, urban runoff, marinas
% of project easement fenced	0

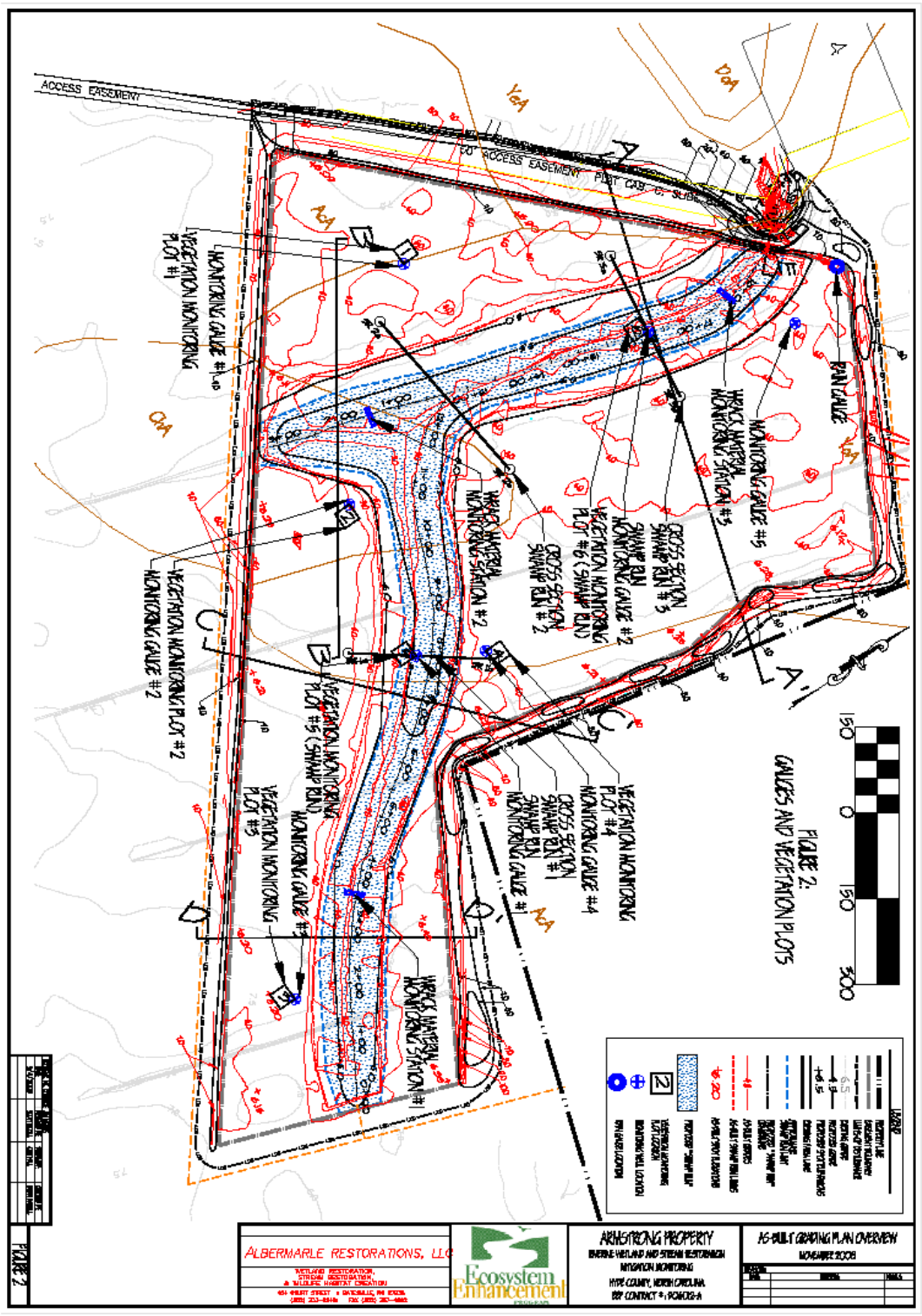
5.0 Monitoring Plan View

There are five water level monitoring gauges installed in the riverine wetland areas of the site. These gauges are suspended in two-inch pvc pipe that is set approximately four feet vertically into the ground. The gauges have been located to assess the groundwater levels throughout the year at various elevations and topographies within the site. Two gauges are also installed in the swamp runs to help verify flow. Two more gauges are installed in an offsite wetland area to serve as references for a naturally functioning riverine wetland and headwater swamp run. In addition, there is a rain gauge onsite to capture and record precipitation.

Vegetation monitoring is accomplished by surveying the six permanent sampling plots. Each plot is referenced by a monitoring gauge which serves as the plot origin and as a photo station for that plot. The plots are ten meters square and are situated to give an accurate sample of the planted and natural woody vegetation. For each site, the data recorded matches that required of the *CVS-EEP Protocol for Recording Vegetation, v 4.0, 2006,* level 1-2.

Three wrack lines were also installed as an aid in monitoring flow in the swamp run. They were designed and located to capture debris during periods of high water as evidence of water movement within the site.

Figures 2 and 3 provide plan views of the site showing the location of all monitoring features including gauges, sampling plots and the rain gauge as well as the vegetative communities.


ACCESS EASEMENT
VEGETATION MONITORING PLOT #1
VEGETATION MONITORING GAUGE #1
VEGETATION MONITORING PLOT #2
VEGETATION MONITORING PLOT #3
VEGETATION MONITORING GAUGE #3
VEGETATION MONITORING PLOT #4
VEGETATION MONITORING GAUGE #4
VEGETATION MONITORING PLOT #5 (SWAMP RUN)
VEGETATION MONITORING PLOT #6 (SWAMP RUN)
CROSS SECTION SWAMP RUN #1
CROSS SECTION SWAMP RUN #2
CROSS SECTION SWAMP RUN #3
SWAMP RUN MONITORING GAUGE #2
WRACK MATERIAL MONITORING STATION #1
WRACK MATERIAL MONITORING STATION #2
WRACK MATERIAL MONITORING STATION #3
RAIN GAUGE
FIGURE 2: GAUGES AND VEGETATION PLOTS
ALBEMARLE RESTORATIONS, LLC
Ecosystem Enhancement
ARMSTRONG PROPERTY
AS-BUILT GRADING PLAN OVERVIEW
NOVEMBER 2008

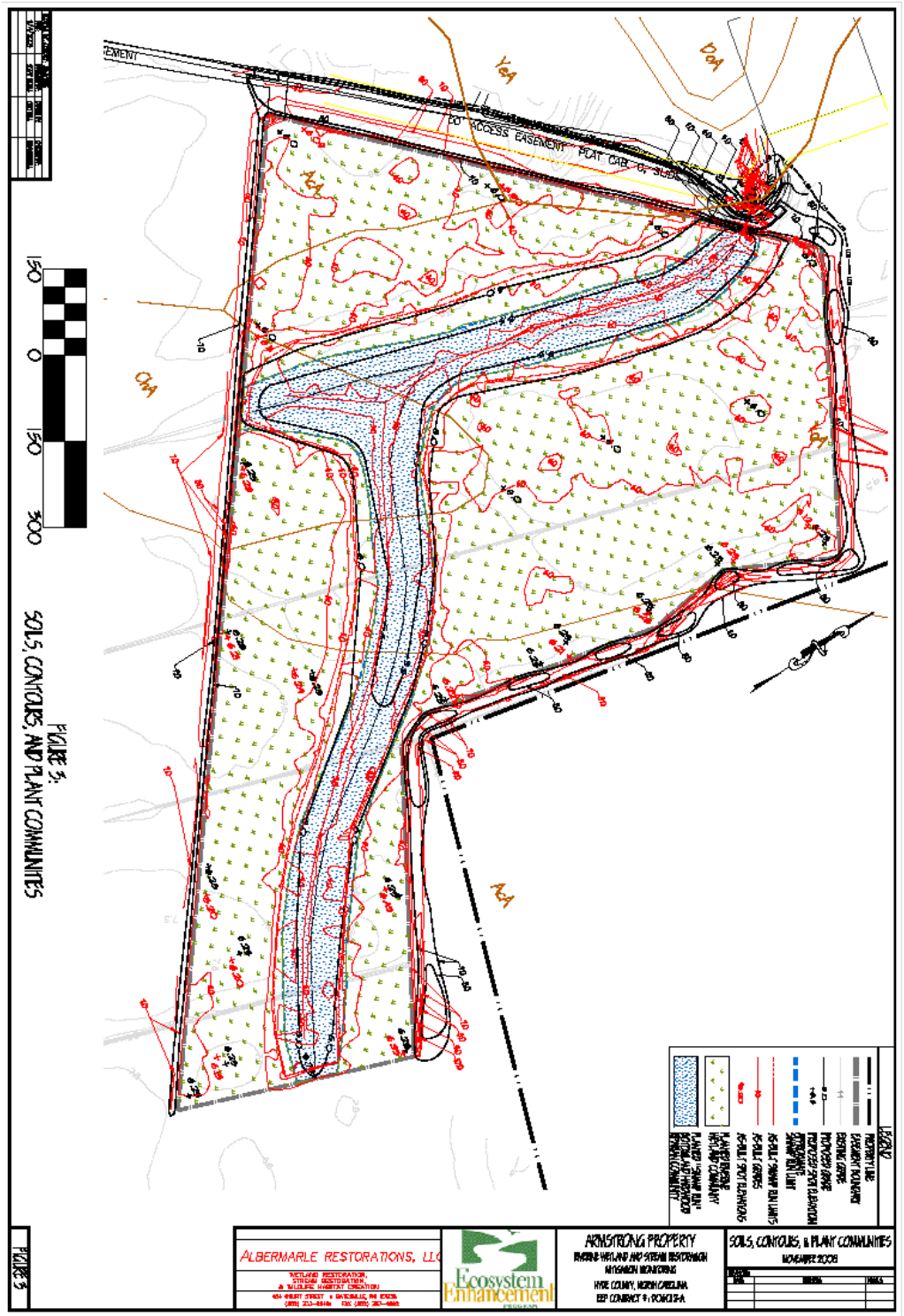


FIGURE 3:
SOILS, CONTOURS, AND PLANT COMMUNITIES
150 0 150 300
ALBEMARLE RESTORATIONS, LLC
Ecosystem Enhancement
ARMSTRONG PROPERTY
RIVERINE WETLAND AND STREAM RESTORATION
MITIGATION MONITORING
HYDE COUNTY, NORTH CAROLINA
EEP CONTRACT #: PONDER-A
SOILS, CONTOURS, & PLANT COMMUNITIES
NOVEMBER 2008
LEGEND
FIGURE 3

II. Project Condition and Monitoring Results

1.0 Vegetation Assessment

The vegetation success criterion was developed in accordance with the CVS-EEP protocol. The Armstrong project was designed to include both riverine and bottomland hardwood plant communities. The project was planted with a mixture of tree and shrub species that would resemble that of naturally occurring swamp runs and adjacent riverine wetlands in the local area. The run and area immediately adjacent were planted heavily with cypress, oaks and tupelo. The riverine wetland zone beyond the swamp run is populated by a broader mix of native hydrophytic tree and shrub species. The photos in Appendix A show the colonization of the project area by hydrophytic vegetation. The species mix was based on the vegetation noted at the reference site and all species are classified from FAC to OBL (Table V). The site was planted at a rate of 430 stems per acre in the winter of 2008. Due to poor survival attributed to heavy herbaceous competition, site maintenance, replacement planting and supplemental planting was completed in 2009. The species replanted were chosen from Table V.

Table V. Species by Community Type
Armstrong Property Wetland Mitigation Project/EEP #D06012-A
Tree/Shrub Planting Schedule - 25.0 acres

Common Name	Scientific Name	Wetland Indicator Status
Bald Cypress	Taxodium distichum	OBL
Water Tupelo	Nyssa aquatica	OBL
Swamp Black Gum	Nyssa biflora	FAC
Swamp Chestnut Oak	Quercus michauxii	FACW-
Pin Oak	Quercus palustris	FACW
Willow Oak	Quercus phellos	FACW-
Swamp White Oak	Quercus bicolor	FACW+
Water Oak	Quercus nigra	FAC
Sweetgum	Liquidambar styraciflua	FAC+
Swamp Cyrilla	Cyrilla racemiflora	FACW
Sweet Pepperbush	Clethera alnifolia	FACW
Virginia Sweetspire	Itea virginica	FACW+
Button Bush	Cephalanthus occidentalis	OBL
Wax Myrtle	Myrica cerifera	FAC+
Highbush Blueberry	Vaccinium corymbosum	FACW
Sweetbay	Magnolia virginiana	FACW+
Swamp Bay	Persea palustris	FACW

1.1 Vegetation Discussion and Problem Areas

All four plots in the riverine community met the Year 3 success criterion of a minimum of 320 stems per acre after the third growing season. The upstream plot in the swamp run met the success criterion but the lower plot did not, possibly due to the extended period of inundation and competition from heavy herbaceous cover. Over the entire project, the survival rate

averaged 426 live stems per acre. The survival rate for the riverine area was 485 live stems per acre.

During the 2009 growing season, there was a cumulative rainfall deficit of 2.15 inches (according to the normal averages per the WETS table for Belhaven, NC). Also, as can be seen in site photos in Appendix A, the project area continues to have a complete and heavy ground cover of herbaceous material. Herbaceous maintenance early in 2009 appeared to have a dramatic effect on tree survival and development.

By mid-summer, coffeeweed *(Sesbania herbacia)* had invaded the project area to the point that it needed to be removed. Manual removal by hand chopping was deemed the only viable option and it was timed after flowering but prior to seed set to maximize the effects of control. Maintenance will probably be necessary again in 2010 but the problem should be minor and treatment will be a simple issue of hand chopping again before seed set.

1.2 Vegetation Monitoring Plan View (Integrated)

Figure 4 in Appendix D illustrates the areas of the site (shaded in yellow) where the herbaceous cover is generally heavier and from visual inspections, tree survival is thought to be slightly less than that of the entire tract. Overall stocking levels are adequate but within these three areas, there are micro sites that have very low stocking levels due mainly to heavy herbaceous cover. Small, heavy thickets of coffeeweed *(Sesbania herbacia)* were also thought to be at fault to some extent, but that source of competition is now under control. No further remedial action is deemed necessary.

2.0 Wetland Assessment

The hydrologic success criterion is to achieve a minimum of 21 consecutive days where the groundwater level is within 12 inches of the soil surface during the growing season. The growing season for this site is from March 11 to November 27, a period of 261 days (WETS Table for Belhaven, NC). Success for any particular monitoring location is to show soil saturation to within 12 inches of the surface for 21 consecutive days during that period.

There are five continuous water level monitoring gauges deployed across the site (Gauges 1 through 5) to monitor fluctuations in the water table and to determine if wetland hydrology is present. A rain gauge is also kept onsite and its data are compared to that collected at the NOAA cooperator site in Belhaven, NC. To further monitor the affect of seasonal and annual variations in precipitation in restored wetlands, hydrologic success of the site was assessed in relation to the reference wetland site where two more monitoring gauges are installed (Gauge 6 as a Swamp Run reference & Gauge 7 as a Riverine reference).

Of particular note is the area near the outfall end of the project, the area in close proximity to Run Gauge 2. This area continues to capture and held water for the entire growing season at a sufficient depth as to support vertebrate aquatic life. During the monitoring data collection effort in September 2009, the presence of turtles and small fish were observed in the swamp run which

exemplifies some of the ecological benefits provided by this project as outlined in Section I, 1.0 of this report.

2.1 Wetland Discussion and Problem Areas

Rainfall from March through November was much closer to normal this year and ground water levels responded accordingly. The hydrographs confirm this in that recharge rates and durations are greater and appear to be more sensitive to precipitation this year as opposed to 2008. All of the gauges met hydrologic success at 5% of the growing season (13 days), and Gauge 5 showed wetland hydrology for 8% (21 days). A comparison of the riverine wetland reference gauge (#7) to those on site shows a remarkably similar hydrologic pattern in the reference wetlands. Gauge 7 met hydrologic success for 17 consecutive days in the 2009 growing season, 4 days shy of the 8% hydroperiod associated with wetland hydrology. This is a very similar pattern to that of Gauges 1 through 4 in the project's riverine wetland areas. During the early part of the spring, rainfall at the project site was below normal and didn't approach normal until late in May, nearly two months into the growing season. This time period is arguably the most likely to produce successful wetland hydrology, but all criteria depend on normal precipitation which was lacking during this critical period.

As an additional aid in determining the extent of wetland hydrology, a detailed study of herbaceous species on the site was performed in October 2009. Each formal vegetative sample plot (with the exception of Monitoring Plot #6 which was dominated almost entirely by broadleaf cattail) was studied, and the herbaceous species found were identified and ranked according to the approximate coverage percentage within the plot. An additional plot sample was conducted approximately 200 feet north of Monitoring Plot #3. The species within each plot were assigned the appropriate wetland indicator status, and the percentage of species with a ranking of FAC or wetter was computed. In all of the monitoring plots, hydrophytic vegetation was dominant, with ranges of coverage of FAC or wetter species from 60% at Monitoring Plot #4 to 98% at Monitoring Plot #5. To help determine if wetland hydrology is present at each monitoring location, the FAC Neutral Test was conducted for each. Each plot had a higher percentage of species wetter than FACW than species drier than FACU, providing a secondary indicator of wetland hydrology. Herbaceous monitoring tables are found in Appendix A.

The wetland problem areas as shown in Appendix D are three general spots in the riverine wetlands area that, purely from field observations, seem slightly dryer than the rest of the site. Compared to the problem areas identified in the 2008 report, the site has greatly improved and those areas of concern are becoming minimal. The data for Gauge 2 is incomplete for 2009 due to equipment malfunction, so it is not absolutely certain that particular gauge failed to show hydrologic success early in the year. Gauge 4 showed the shortest successful hydroperiod of 13 days which is the threshold for 5% of the growing season. Both gauges indicate rapid soil recharge rates and sensitivity to rainfall, but springtime rainfall was below normal again in 2009. Gauges 3, 4 and 5 indicated better recharge after rainfall and more pronounced hydrologic periods.

Both of the swamp run gauges, R1 and R2, met hydrology success. The hydrologic patterns they recorded closely correlate to that of Reference Gauge 6, which is in a similar landscape position. Comparison of the hydrographs for gauges R1, R2 and Reference 6 indicate that these three gauges are measuring very similar patterns for both above and below ground water levels which is further proof that the site is behaving like a naturally functioning headwater system.

2.15 Flow

Refer to Figures F1, F2 and F3 for the following discussion of evidence of flow within the swamp runs. Figure F1 is a composite chart showing the water level at both run gauges during a period when flow in the swamp runs was visually confirmed and recorded on video. On 5/17 the site received approximately 1.5" of rain causing the water levels to rise and gradually drain through and off the site. Because the outlet pipe is set slightly above ground level near run gauge 2, the water level at that gauge will always be elevated above ground level except during times of prolonged extreme drought which did not occur in 2009. Since the overall grade in the project is so slight, it takes several days for the water to flow through the site.

Figure F2 compares the water level in the two swamp run gauges to the water level in the two gauges adjacent to and closest to the swamp run (gauges 1 and 2) during a period of rainfall between November 11 and November 24. The resulting flow was visually confirmed and photographed. Gauges 1 and 2, which are adjacent to the southern (shorter) swamp run show the same pattern in water elevations as the swamp run gauges, indicating that water slowly receded from these higher areas into the swamp runs and gradually flowed off site.

Figure F3 illustrates the same flow pattern in the swamp run gauges during four separate rainfall events when one-day precipitation totaled an inch or more. Each of these events caused exactly the same pattern of water rise and fall that were visually confirmed and photographed. From those visual confirmations, it can be extrapolated that flow occurred each of the four times during the period from August 1 through September 21.

Included in Appendix A are photos of offsite flow in May that show the extent of site flooding, water leaving the site and a typical high water mark observed on the trees. Photos after a heavy rainfall in November show that the entire site was inundated for a brief period and one of the wrack lines caught some debris.

Onsite flow is occurring, but due to the limited changes in elevation across the length of the project, it lacks sufficient velocity and is impeded to such an extent by volunteer herbaceous vegetation, dominated by cattails (*Typha latifolia*), as to be nearly immeasurable at any location other than in close proximity to the outfall pipe. But the data captured by the gauges and substantiated by visual (and photographic) confirmation does show water movement from the riverine wetland areas toward the swamp run during periods of sufficient rainfall. In addition, photographic evidence shows that on at least one occasion, overbank flow from the swamp run inundated the riverine wetland area, indicating that the system as a whole is functioning as anticipated.

Figure F1.
Armstrong Run Monitoring Gauges 1 and 2 (R1 and R2)
Correlated to Video Evidence of Flow Across Site

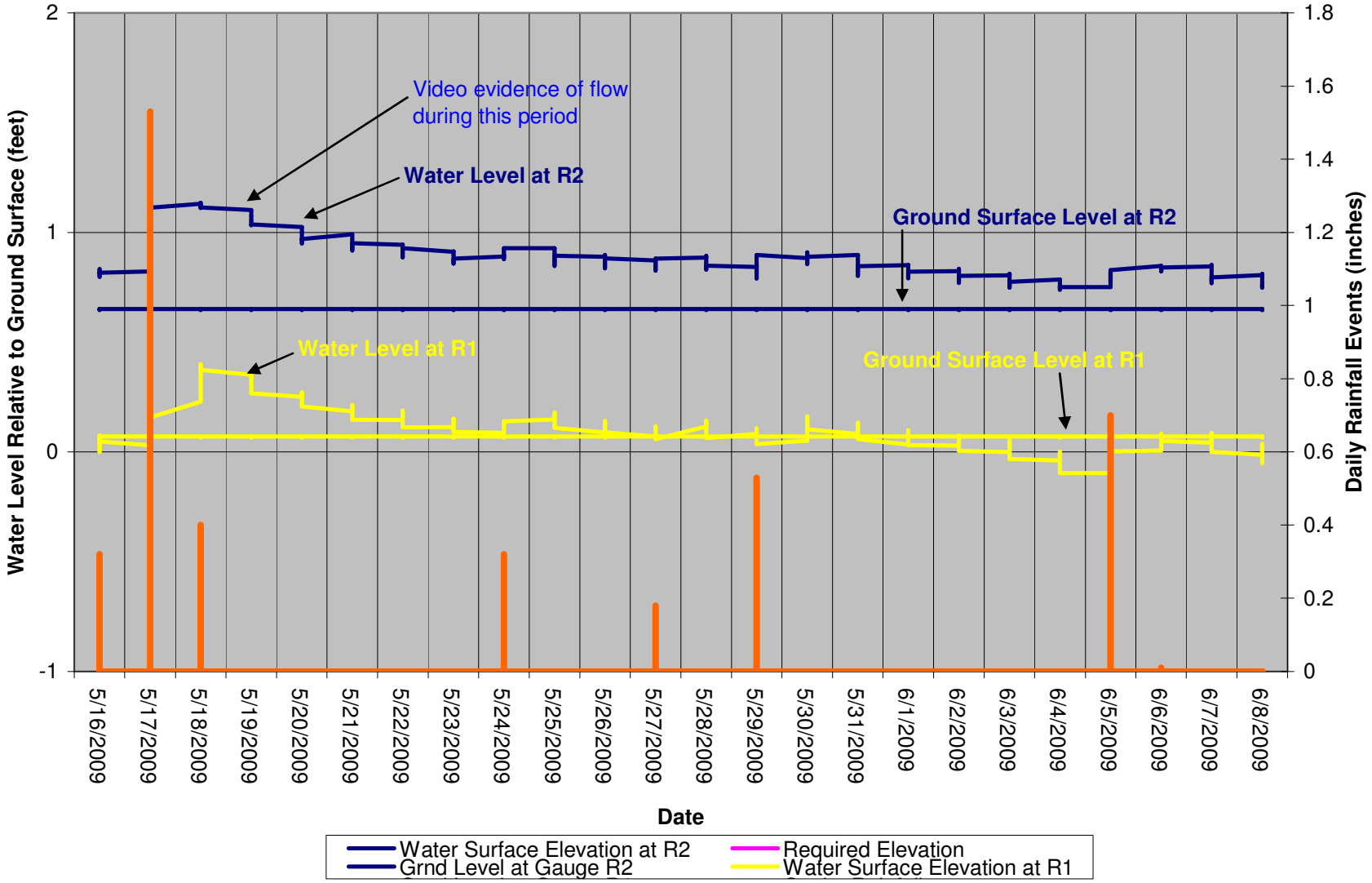


Figure F2.
Photo Evidence of Flow Correlated to
Gauges 1, 2, R1 and R2

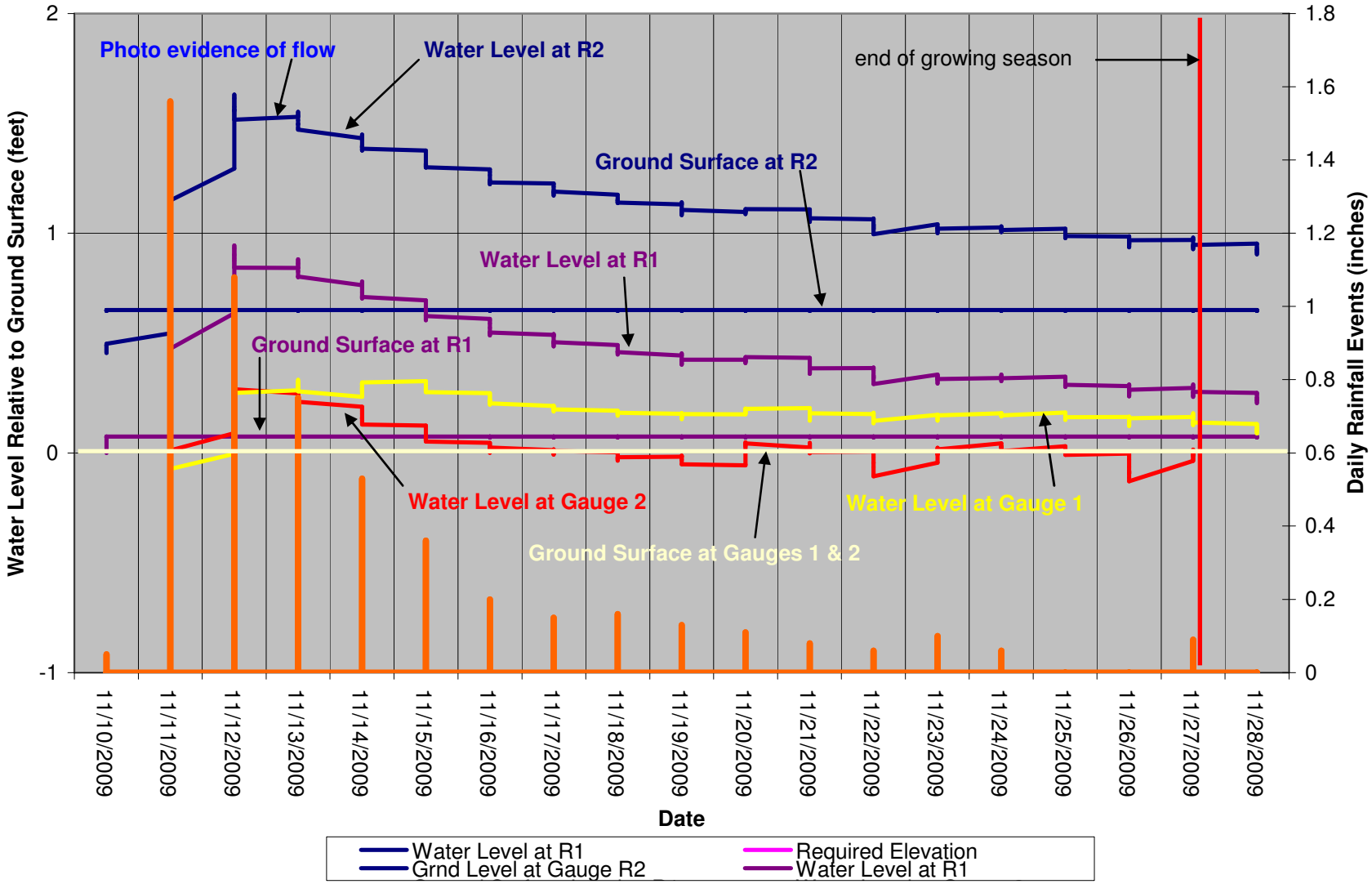
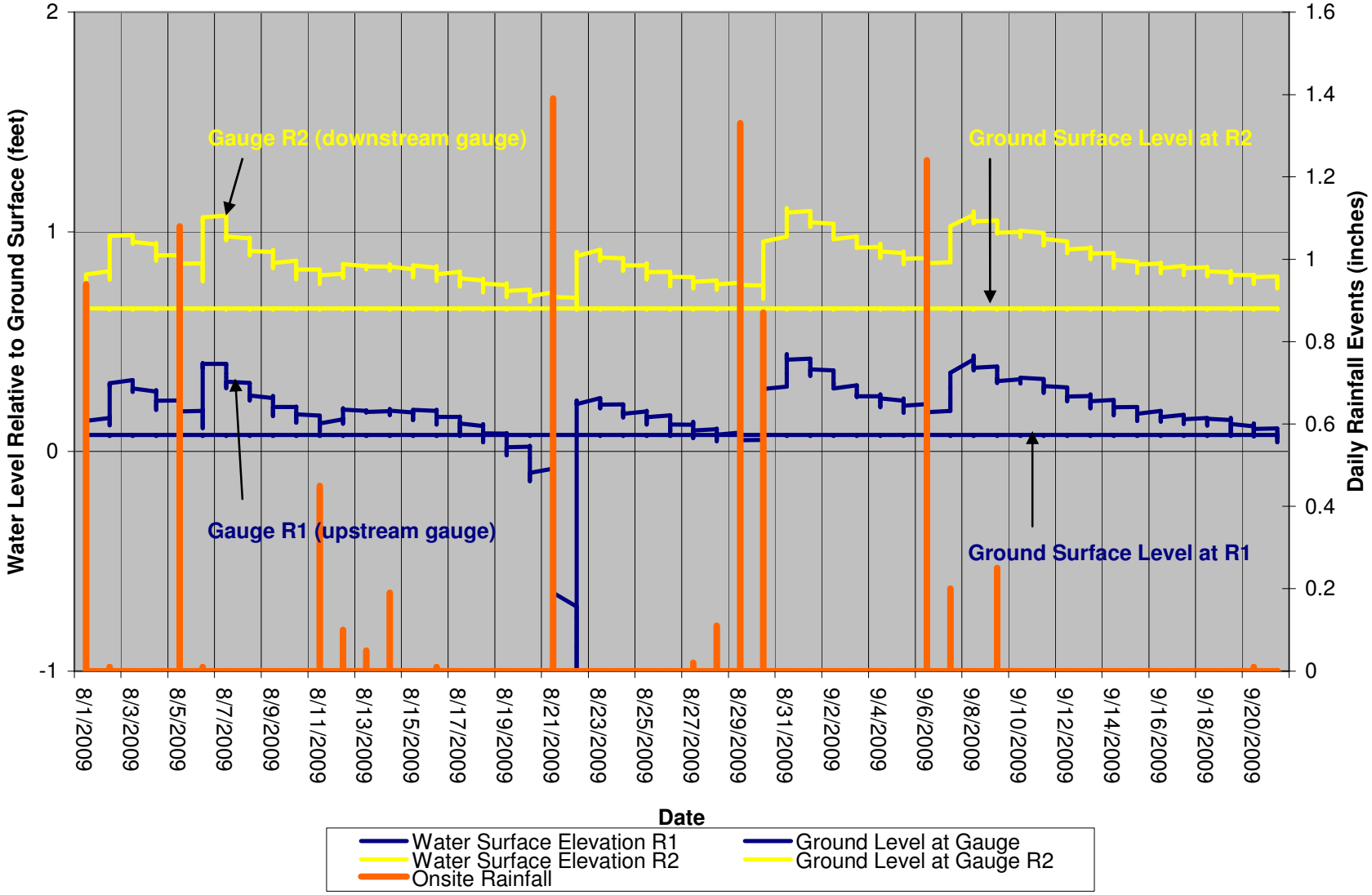


Figure F3.
4 Separate Flow Events During August and September as Recorded at Run Gauges 1 and 2 (R1 and R2)



2.2 Wetland Monitoring Plan View (Integrated)

Figure 4 in Appendix D provides an overview of the areas where hydrology is still developing. Much of the riverine wetland zone was flooded for a short length of time early and late in the growing season as evidenced by the site photos in Appendix A. For most of the summer however, these areas suffered slightly droughty conditions due to continued below-average rainfall.

Table VI. Hydrology and Vegetation Criteria Success by Plot
Armstrong Property Wetland Mitigation Project/EEP #D06012-A

Gauge	Hydrology Success Met	Hydrology Mean	Vegetation Plot	Vegetation Success Met	Vegetation Mean
1	N	43%	1	Y	83%
2**	N		2	Y	
3	N		3	Y	
4	N		4	Y	
5	Y		N/A	N/A	
R-1	Y		R-1	N	
R-2	Y		R-1	Y	
6 (Ref)*	Y		N/A	N/A	
7 (Ref)*	N		N/A	N/A	

* Gauges 6 & 7 are reference gauges on the reference site and are not included in the success percentages
** Data for gauge 2 is incomplete

3.0 Project Success Discussion

After the second year of monitoring and a season of nearly normal rainfall, the wetland hydrology of the Armstrong project has shown remarkable improvement and indications of successful restoration. Specifically, the hydrology within the swamp run has been restored and the project is beginning to function like a natural riparian headwater system. Flow of water across the site was successfully measured and documented on at least two separate occasions in 2009.

The cumulative rainfall deficit during the 2009 growing season was only 2.15" and the pattern of rainfall month to month was closer to normal. The reference gauges are measuring very similar above- and below-ground water patterns at the reference site as those measured on the project, confirming that the site is beginning to function like a natural system. It should be noted that the riverine wetland reference gauge met hydrology success at 5% of the growing season, but not at 8%. The same is true of gauges 1 through 4 which are in the riverine wetland portion of the project. The correlation of the hydrology patterns between the reference gauge and the project gauges indicates that groundwater levels in the entire region are still in recovery from the severe drought conditions of 2008, and when compared with data from the 2008 monitoring year,

evidence shows that the groundwater levels on and off-site are rising. In addition, the fact that the herbaceous monitoring showed secondary indications of wetland hydrology at the surface in all gauge locations and that overbank inundation was known to have occurred at least once, it appears that the site conditions are such that they will continue to support a community dominated by hydrophytic vegetation..

Overall tree survival is good with only a few micro areas where stocking is less than desired. The trees in the lower end of the main run have suffered most since that part of the site is almost continually under several inches of water.

III. Methodology Section

Year 2 monitoring for the Armstrong project occurred in 2008. Monitoring and vegetation sampling procedures were established in the mitigation plan for this project and no deviations were made.

Appendix A

Vegetation Data Tables

Site Photos

1. Vegetation Data Tables

Table 1. Vegetation Metadata

Report Prepared By	Ashby B. Brown
Date Prepared	10/8/2009 11:29
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	D06012A
project Name	Armstrong
Description	Armstrong Wetland Mitigation project
River Basin	Tar-Pamlico
Sampled Plots	6

Table 2. Vigor by Species

	Species	4	3	2	1	0	Missing	Unknown
	Cephalanthus occidentalis	1	4	4				
	Itea virginica		1					
	Liquidambar styraciflua	4						
	Nyssa biflora			1				
	Quercus bicolor	1	3	3				
	Quercus phellos	2	10	4				
	Taxodium distichum	5	8					
	Myrica cerifera	7	1	3				
TOT:	**8**	**20**	**27**	**15**				

Table 3. Vegetation Damage by Species

	Species	All Damage Categories	(no damage)	Insects
	Cephalanthus occidentalis	9	7	2
	Itea virginica	1	1	
	Liquidambar styraciflua	4	4	
	Myrica cerifera	11	11	
	Nyssa biflora	1	1	
	Quercus bicolor	7	7	
	Quercus phellos	16	16	
	Taxodium distichum	13	13	
TOT:	**8**	**62**	**60**	**2**

Table 4. Vegetation Damage by Plot

	Plot	All Damage Categories	(no damage)	Insects
	D06012A-ABET-0001	11	11	
	D06012A-ABET-0002	14	14	
	D06012A-ABET-0003	13	13	
	D06012A-ABET-0004	9	9	
	D06012A-ABET-R1	9	9	
	D06012A-ABET-R2	6	4	2
TOT:	**6**	**62**	**60**	**2**

Table 5. Stem Count by Plot and Species

					Plot D06012A-ABET-					
	Species	**Total Planted Stems**	**# plots**	**avg# stems**	**1**	**2**	**3**	**4**	**5**	**6**
	Cephalanthus occidentalis	9	3	3	1				3	5
	Itea virginica	1	1	1				1		
	Liquidambar styraciflua	4	1	4		4				
	Myrica cerifera	11	5	2.2	3	1	4	2	1	
	Nyssa biflora	1	1	1				1		
	Quercus bicolor	7	4	1.75		3	1	2	1	
	Quercus phellos	16	4	4	2	3	8	3		
	Taxodium distichum	13	4	3.25	5	3			4	1
TOT:	**8**	**62**	**8**		**11**	**14**	**13**	**9**	**9**	**6**
	Average Stems per Acre				**454**	**577**	**536**	**371**	**371**	**247**

Table 6. Vegetation Problem Areas			
Feature/Issue	Plot	Probable Cause	Photo #
Herbaceous competition	Swamp Run and Vegetation Problem Areas as shown in Appendix D	Dense herbaceous cover	VPA 1 and 2

Armstrong Property Wetland Mitigation Project

2009 Herbaceous Vegetation Monitoring Summary

Sample Plot #1 10/22/09 (+/-100% coverage)

Vegetation:	Common	Botannical	Density	Indicator Status
Herbaceous				
	Soft Rush	*Juncus effuses*	20%	OBL
	Joint Head Anthraxon	*Anthraxon hispidus*	15%	FACU-
	Canada Rush	*Juncus canadensis*	10%	OBL
	Valley Redstem	*Ammannia coccinea*	10%	FACW+
	Redtop	*Agrostis alba*	10%	FACW
	Fall Panicgrass	*Panicum dichotomiflorum*	5%	FACW
	Barnyard Grass	*Echinochloa crus-galli*	5%	FACW-
	Dallisgrass	*Paspalum dilatatum*	2%	FAC+
	Blunt Spikerush	*Eleocharis obtusa*	2%	OBL
	Fox Sedge	*Carex vulpinoidea*	2%	OBL
	Green Foxtail	*Setaria viridis*	2%	NI
	Dog Fennel	*Eupatorium cappilifolium*	2%	FACU
	Curly Dock	*Rumex crispus*	<2%	FAC
	Smooth Goldenrod	*Solidago gigentea*	<2%	FACW
	Virginia Broomsedge	*Andropogon virginicus*	<2%	FAC-
	Switchgrass	*Panicum virgatum*	<2%	FAC+
	White Panicled Aster	*Aster simples*	<2%	FACW
	Florida Paspalum	*Paspalum floridanum*	<2%	FACW-
	Lizard Tail	*Saururus cernuus*	<2%	OBL
	Little Bluestem	*Schizachyrium scoparium*	<2%	FACU
	Marsh Seedbox	*Ludwigia palustris*	<2%	OBL
	Broadleaf Cattail	*Typha latifolia*	<2%	OBL
	Wingleaf Primrose-Willow	*Ludwigia decurrens*	<2%	OBL
	Swamp Smartweed	*Polygonum hydropiperoides*	<2%	OBL
	White Clover	*Trifolium pretens*	<2%	FACU
	Softstem Bulrush	*Scirpus validus*	<2%	OBL

Armstrong Property Wetland Mitigation Project

2009 Herbaceous Vegetation Monitoring Summary

Sample Plot #2 10/22/09 (+/-100% Coverage)

Vegetation:	Common	Botannical	Density	Indicator Status
Herbaceous				
	Redtop	*Agrostis alba*	20%	FACW
	Barnyard Grass	*Echinochloa crus-galli*	20%	FACW-
	Green Foxtail	*Setaria viridis*	10%	NI
	Fall Panic Grass	*Panicum dichotiflorum*	10%	FACW
	Dog Fennel	*Eupatorium cappilifolium*	5%	FACU
	Dallisgrass	*Paspalum dilatatum*	5%	FAC+
	Switchgrass	*Panicum virgatum*	2%	FAC+
	Canada Rush	*Juncus canadensis*	2%	OBL
	Smooth Goldenrod	*Solidago gigentea*	2%	FACW
	Soft Rush	*Juncus effuses*	2%	FACW+
	Ragweed	*Ambrosia artemisiifolia*	<2%	FACU
	Jungle Rice	*Echinochloa colona*	<2%	FACW
	Camphorweed	*Pluchea camphorata*	<2%	FACW
	Curly Dock	*Rumex crispus*	<2%	FAC
	White Panicled Aster	*Aster simples*	<2%	FACW
	Virginia Broomsedge	*Andropogon virginicus*	<2%	FAC-
	White Clover	*Trifolium pretens*	<2%	FACU
	Slender Goldenrod	*Euthamia caroliniana*	<2%	FAC
	Beach False Foxglove	*Agalinis fasciculata*	<2%	FAC+
	Valley Redstem	*Ammannia coccinea*	<2%	FACW+

Armstrong Property Wetland Mitigation Project

2009 Herbaceous Vegetation Monitoring Summary

Sample Plot #3 10/22/09 (+/-95% coverage)

Vegetation:	Common	Botannical	Density	Indicator Status
Herbaceous				
	Smooth Goldenrod	*Solidago gigentea*	40%	FACW
	Dog Fennel	*Eupatorium cappilifolium*	20%	FACU
	Redtop	*Agrostis alba*	20%	FACW
	Dallisgrass	*Paspalum dilatatum*	10%	FAC+
	Green Foxtail	*Setaria viridis*	5%	NI
	Switchgrass	*Panicum virgatum*	2%	FAC+
	Fox Sedge	*Carex vulpinoidea*	<2%	OBL
	Fall Panicgrass	*Panicum dichotomiflorum*	<2%	FACW
	Soft Rush	*Juncus effuses*	<2%	FACW+

Sample Plot #4 10/22/09 (+/-90% Coverage)

Vegetation:	Common	Botannical	Density	Indicator Status
Herbaceous				
	Dog Fennel	*Eupatorium cappilifolium*	30%	FACU
	Redtop	*Agrostis alba*	30%	FACW
	Ground Ivy	*Glechoma hederacea*	5%	NI
	Green Foxtail	*Setaria viridis*	5%	NI
	Smooth Goldenrod	*Solidago gigentea*	5%	FACW
	Dallisgrass	*Paspalum dilatatum*	5%	FAC+
	Switchgrass	*Panicum virgatum*	2%	FACW
	Fall Panic Grass	*Panicum dichotiflorum*	2%	FACW
	Rough Cocklebur	*Xanthium strumarium*	<2%	FAC
	Virginia Broomsedge	*Andropogon virginicus*	<2%	FAC-
	Sedge	*Carex spp.*	<2%	NI
	White Panicled Aster	*Aster simples*	<2%	FACW
	Florida Paspalum	*Paspalum floridanum*	<2%	FACW-
	Soft Rush	*Juncus effuses*	<2%	FACW

Armstrong Property Wetland Mitigation Project

2009 Herbaceous Vegetation Monitoring Summary

Sample Plot #5 10/22/09 (+/-95% Coverage)

Vegetation:	Common	Botannical	Density	Indicator Status
Herbaceous				
	Broadleaf Cattail	*Typha latifolia*	80%	OBL
	Barnyard Grass	*Echinochloa crus-galli*	5%	FACW-
	Jungle Rice	*Echinochloa colona*	5%	FACW
	Soft Rush	*Juncus effuses*	2%	FACW
	Valley Redstem	*Ammannia coccinea*	<2%	FACW+
	Green Foxtail	*Setaria viridis*	<2%	NI
	Marsh Seedbox	*Ludwigia palustris*	<2%	OBL
	Blunt Spikerush	*Eleocharis obtusa*	<2%	OBL
	Slender Goldenrod	*Euthamia caroliniana*	<2%	FAC
	Smallfruit Spikerush	*Eleocharis microcarpa*	<2%	OBL
	Wingleaf Primrose-Willow	*Ludwigia decurrens*	<2%	OBL

Sample Plot #5A (200' north of Plot #3) 10/22/09 (90% coverage)

Vegetation:	Common	Botannical	Density	Indicator Status
Herbaceous				
	Barnyard Grass	*Echinochloa crus-galli*	40%	FACW-
	Dallisgrass	*Paspalum dilatatum*	30%	FAC+
	Green Foxtail	*Setaria viridis*	10%	NI
	Florida Paspalum	*Paspalum floridanum*	5%	FACW-
	Soft Rush	*Juncus effuses*	5%	FACW
	Valley Redstem	*Ammannia coccinea*	5%	FACW+
	Slender Goldenrod	*Euthamia caroliniana*	2%	FAC
	Blunt Spikerush	*Eleocharis obtusa*	2%	OBL
	Swamp Smartweed	*Polygonum hydropiperoides*	2%	OBL
	Fox Sedge	*Carex vulpinoidea*	<2%	OBL
	Goldenrod	*Solidago spp.*	<2%	NI
	Virginia Broomsedge	*Andropogon virginicus*	<2%	FAC-
	Marsh Seedbox	*Ludwigia palustris*	<2%	OBL
	Fall Panicgrass	*Panicum dichotomiflorum*	<2%	FACW
	Beach False Foxglove	*Agalinis fasciculata*	<2%	FAC-

VPA 1
Heavy herbaceous cover at plot 1 looking east

VPA 2
Continued heavy cattail coverage in swamp run

Site flooding in May, eastern side of swamp run

Watermarks show evidence of flow (water level decrease) on cypress stem (May)

Sediment plume flowing into outfall pipe (May)

Outflow from outlet pipe showing flow (May)

General site conditions mid-summer (July)

Over bank flooding to eastern project boundary (November)

Flooding in swamp run (November)

Evidence of debris movement at a wrack line in the swamp run (Nov.)

Outflow at pipe showing flow event (November)

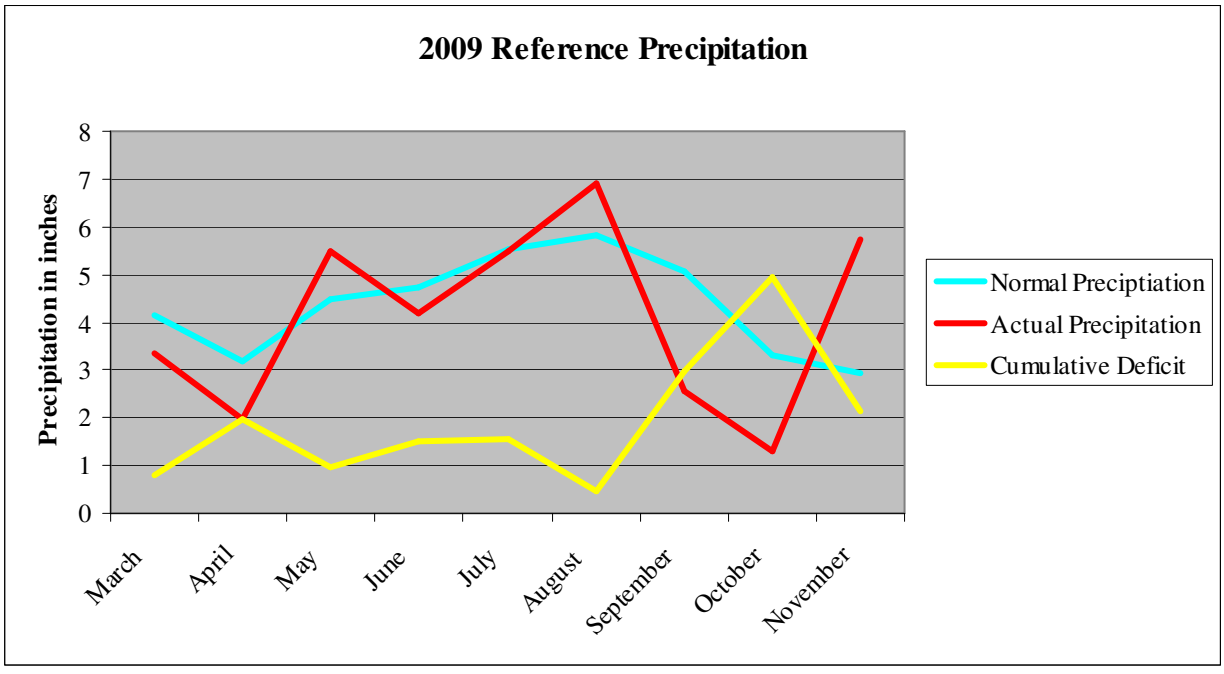
Inflow to the outlet pipe during flow event (November)

Flooding to project boundary near gauge 5 (November)

Flooding event to project boundary at hydrologic problem area near gauge 1 (Nov.)

Tabel C-1															
Longest Consecutive Successful Hydrologic Period in Days and Success at 5% and 8% of Growing Season															
	Year 1			Current Year			Year 3			Year 4			Year 5		
Gauge	Days	5%	8%	Days	5%	8%	Days	5%	8%	Days	5%	8%	Days	5%	8%
1	9	N	N	19	Y	N									
2	4	N	N	17	Y	N									
3	12	N	N	17	Y	N									
4	8	N	N	13	Y	N									
5	18	Y	N	27	Y	Y									
6 (Ref)	100	Y	Y	98	Y	Y									
7 (Ref)	14	N	N	17	Y	N									
Run 1	35	Y	Y	124	Y	Y									
Run 2	140	Y	Y	261	Y	Y									

5% of growing season is 13 days, 8% is 21 days



The period from March 1 through November 30 had a cumulative rainfall deficit of 2.15 inches.

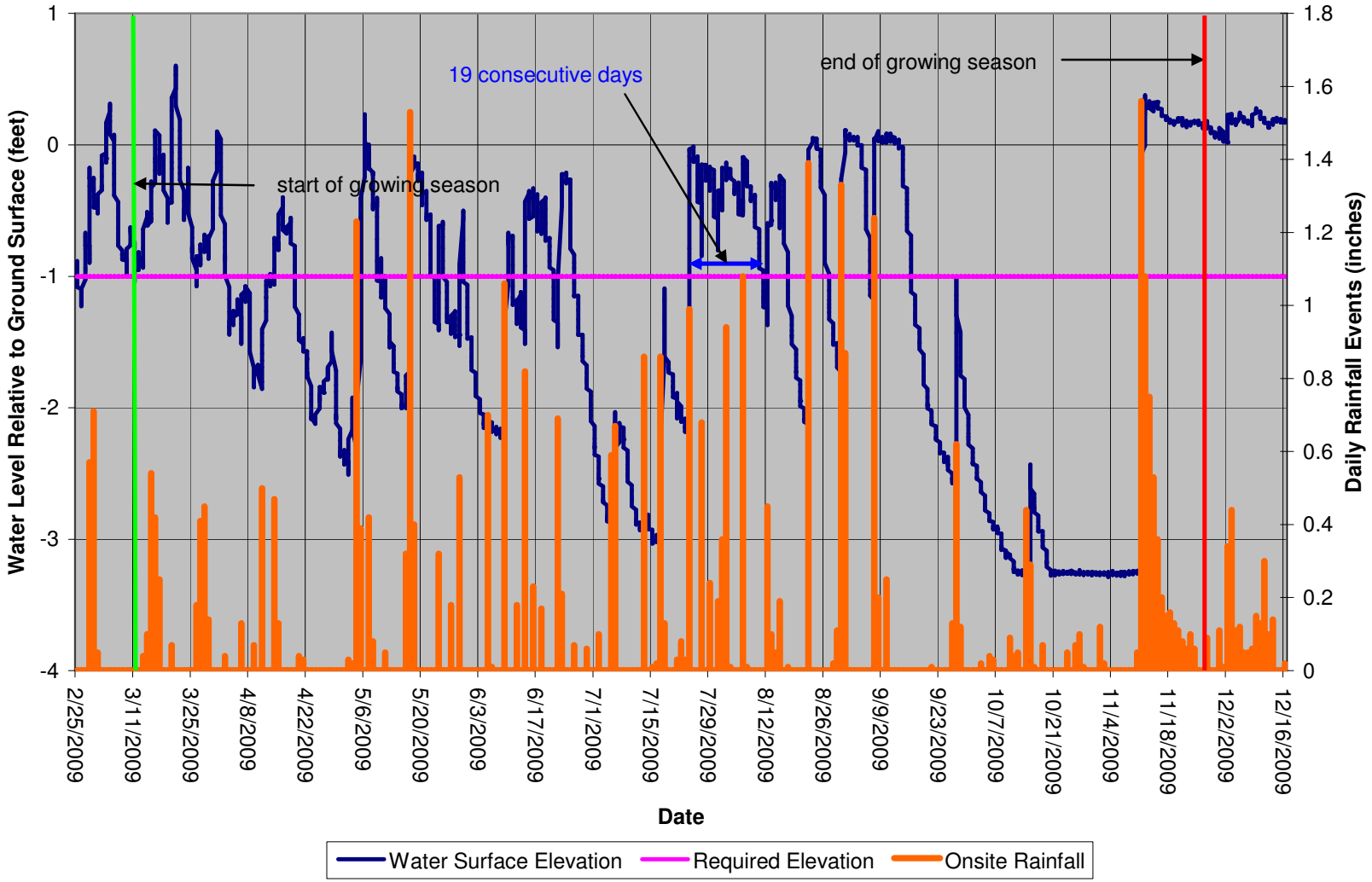
Appendix B

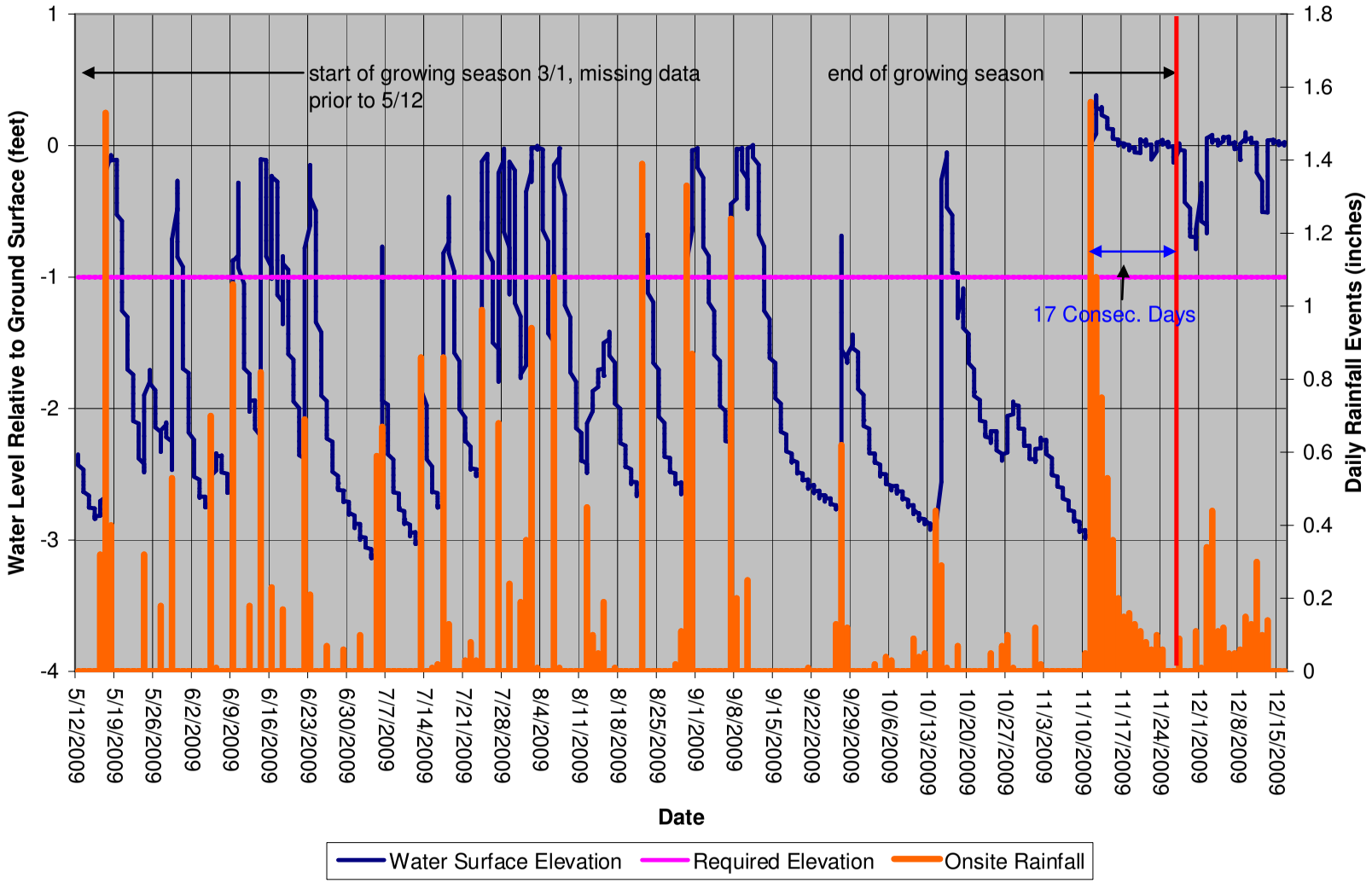
Geomorphologic Raw Data

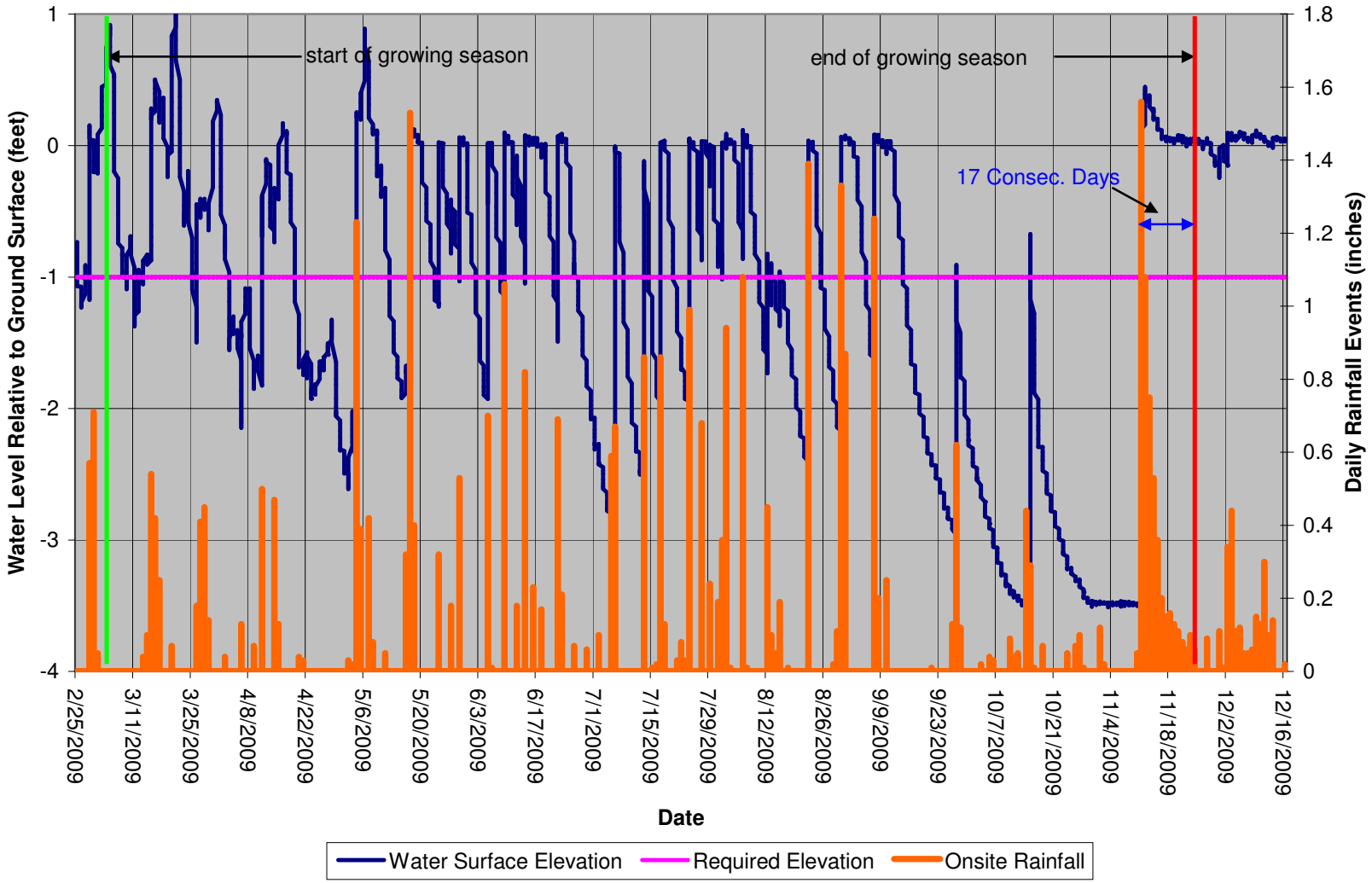
Not used in this report

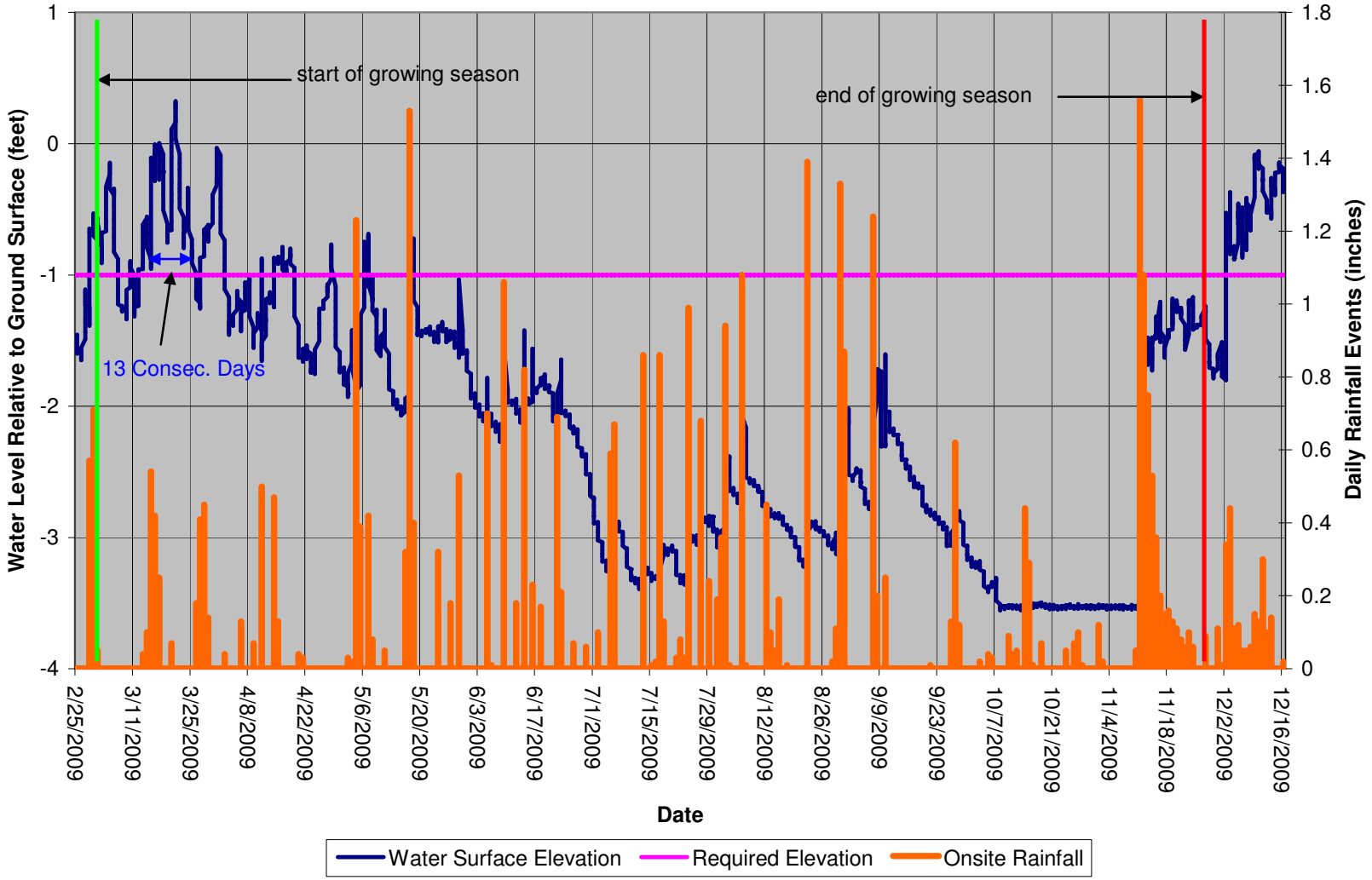
Appendix C

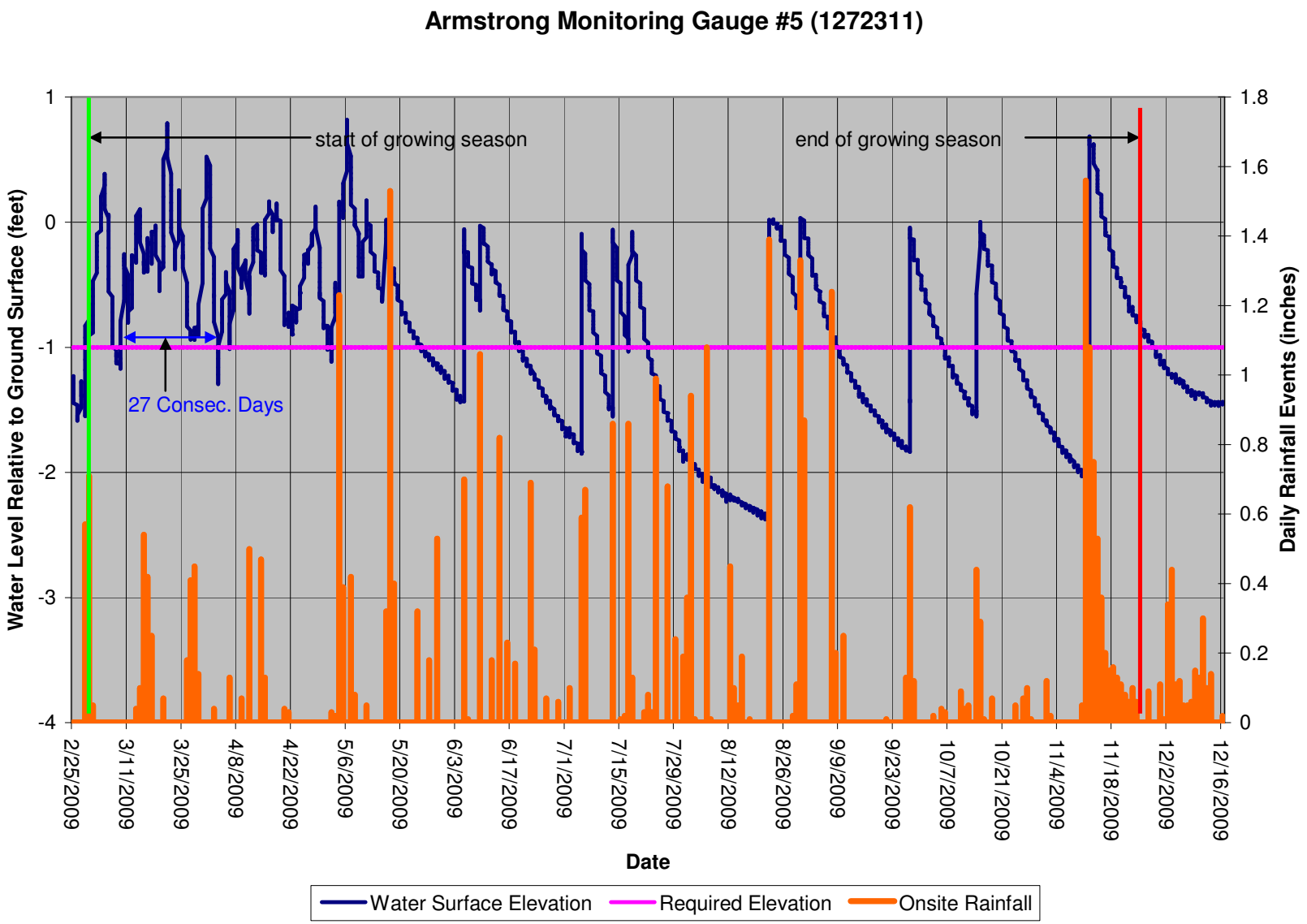
Hydrologic Data Tables

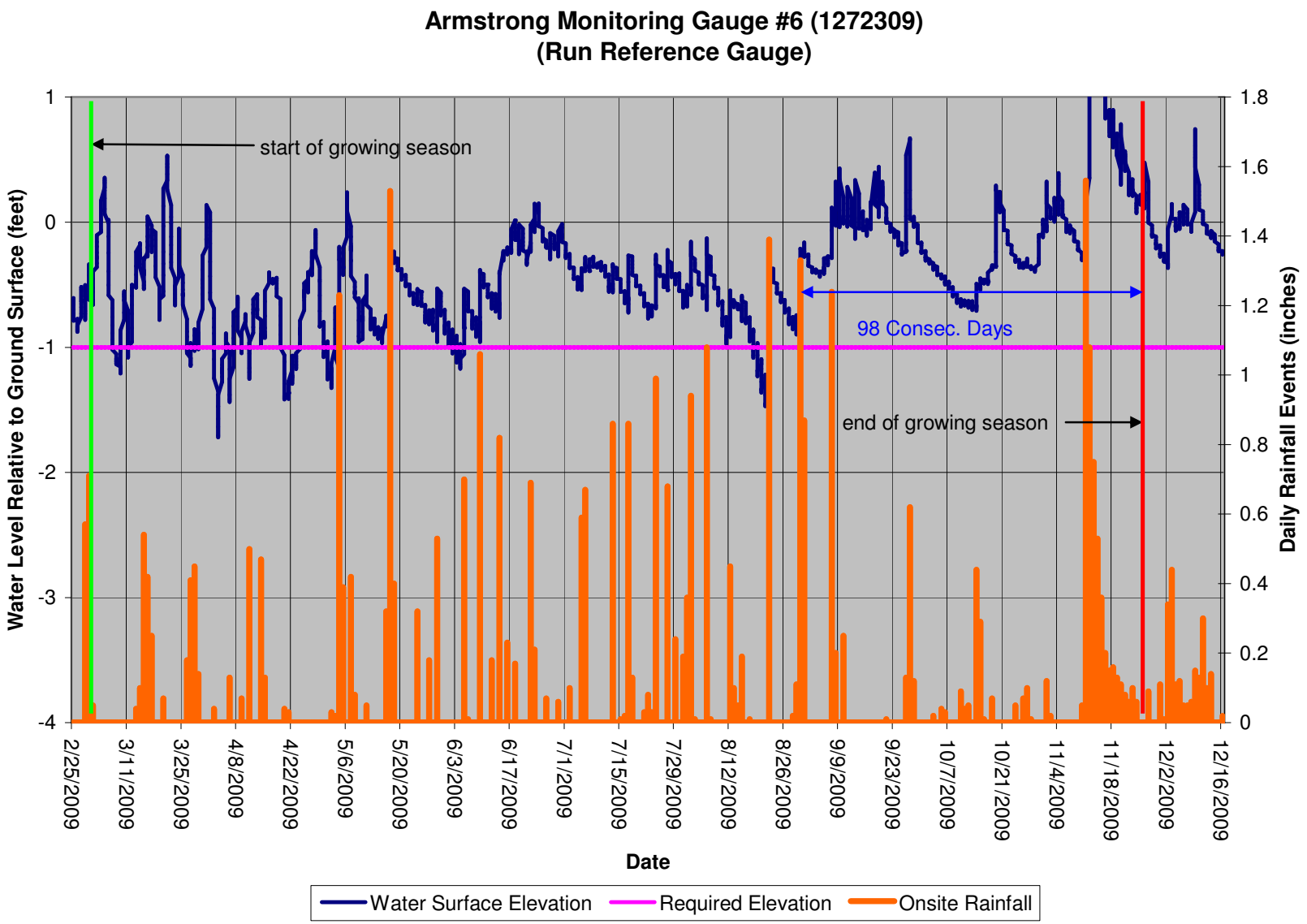

Armstrong Monitoring Gauge #1 (1272308)
19 consecutive days
end of growing season
start of growing season
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall
1
0
-1
-2
-3
-4
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/25/2009
3/11/2009
3/25/2009
4/8/2009
4/22/2009
5/6/2009
5/20/2009
6/3/2009
6/17/2009
7/1/2009
7/15/2009
7/29/2009
8/12/2009
8/26/2009
9/9/2009
9/23/2009
10/7/2009
10/21/2009
11/4/2009
11/18/2009
12/2/2009
12/16/2009

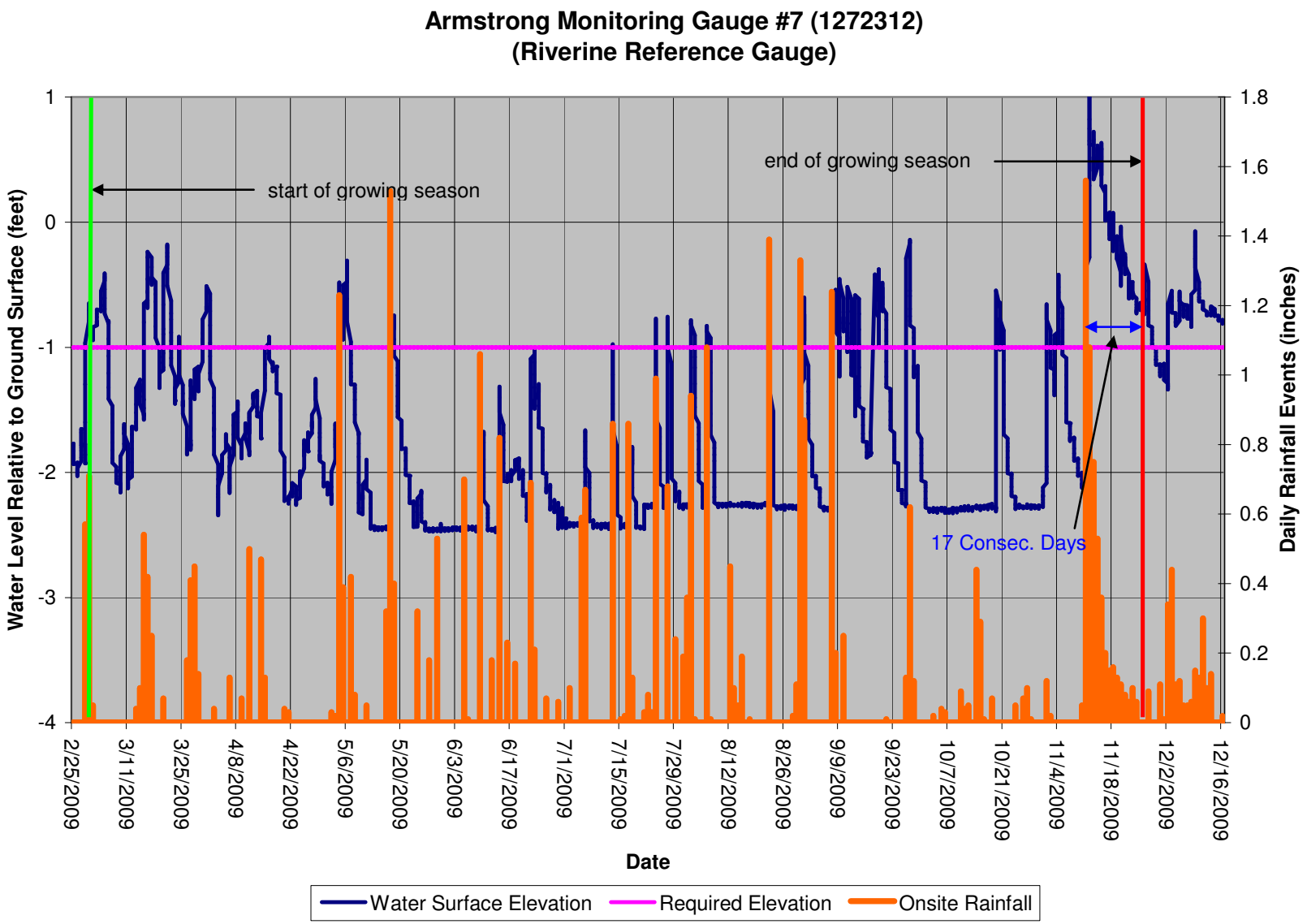

Armstrong Monitoring Gauge #2 (1272306)
start of growing season 3/1, missing data prior to 5/12
end of growing season
17 Consec. Days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall
1
0
-1
-2
-3
-4
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5/12/2009
5/19/2009
5/26/2009
6/2/2009
6/9/2009
6/16/2009
6/23/2009
6/30/2009
7/7/2009
7/14/2009
7/21/2009
7/28/2009
8/4/2009
8/11/2009
8/18/2009
8/25/2009
9/1/2009
9/8/2009
9/15/2009
9/22/2009
9/29/2009
10/6/2009
10/13/2009
10/20/2009
10/27/2009
11/3/2009
11/10/2009
11/17/2009
11/24/2009
12/1/2009
12/8/2009
12/15/2009

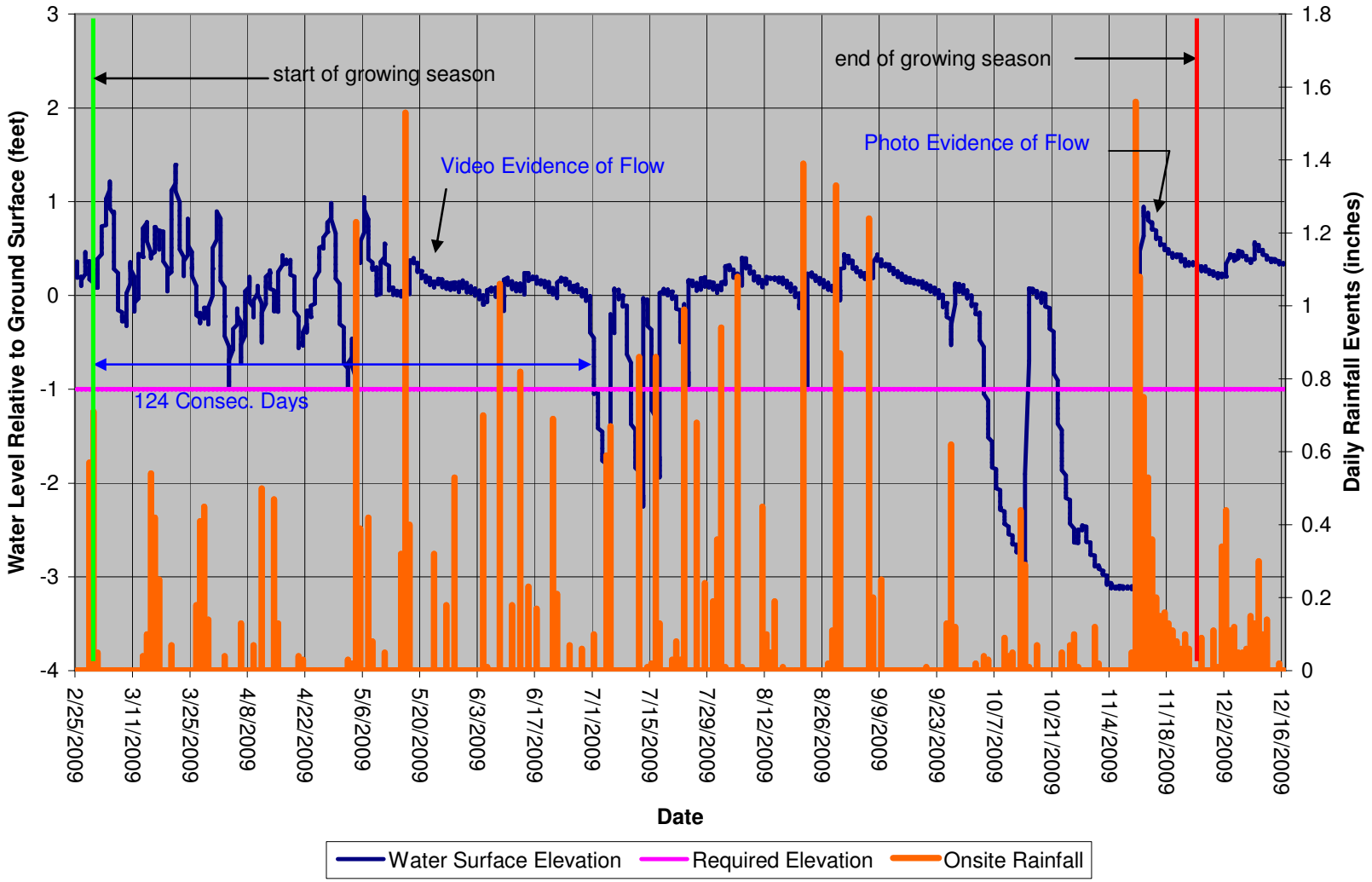

Armstrong Monitoring Gauge #3 (1272305)
start of growing season
end of growing season
17 Consec. Days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall
1
0
-1
-2
-3
-4
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/25/2009
3/11/2009
3/25/2009
4/8/2009
4/22/2009
5/6/2009
5/20/2009
6/3/2009
6/17/2009
7/1/2009
7/15/2009
7/29/2009
8/12/2009
8/26/2009
9/9/2009
9/23/2009
10/7/2009
10/21/2009
11/4/2009
11/18/2009
12/2/2009
12/16/2009


Armstrong Monitoring Gauge #4 (1272310)
start of growing season
end of growing season
13 Consec. Days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/25/2009
3/11/2009
3/25/2009
4/8/2009
4/22/2009
5/6/2009
5/20/2009
6/3/2009
6/17/2009
7/1/2009
7/15/2009
7/29/2009
8/12/2009
8/26/2009
9/9/2009
9/23/2009
10/7/2009
10/21/2009
11/4/2009
11/18/2009
12/2/2009
12/16/2009
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Monitoring Gauge #5 (1272311)
start of growing season
end of growing season
27 Consec. Days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/25/2009
3/11/2009
3/25/2009
4/8/2009
4/22/2009
5/6/2009
5/20/2009
6/3/2009
6/17/2009
7/1/2009
7/15/2009
7/29/2009
8/12/2009
8/26/2009
9/9/2009
9/23/2009
10/7/2009
10/21/2009
11/4/2009
11/18/2009
12/2/2009
12/16/2009
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Monitoring Gauge #6 (1272309)
(Run Reference Gauge)
start of growing season
98 Consec. Days
end of growing season
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/25/2009
3/11/2009
3/25/2009
4/8/2009
4/22/2009
5/6/2009
5/20/2009
6/3/2009
6/17/2009
7/1/2009
7/15/2009
7/29/2009
8/12/2009
8/26/2009
9/9/2009
9/23/2009
10/7/2009
10/21/2009
11/4/2009
11/18/2009
12/2/2009
12/16/2009
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Monitoring Gauge #7 (1272312)
(Riverine Reference Gauge)
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
start of growing season
end of growing season
17 Consec. Days
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall


Armstrong Run Monitoring Gauge #1 (1303317)
start of growing season
end of growing season
Video Evidence of Flow
Photo Evidence of Flow
124 Consec. Days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall
3
2
1
0
-1
-2
-3
-4
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/25/2009
3/11/2009
3/25/2009
4/8/2009
4/22/2009
5/6/2009
5/20/2009
6/3/2009
6/17/2009
7/1/2009
7/15/2009
7/29/2009
8/12/2009
8/26/2009
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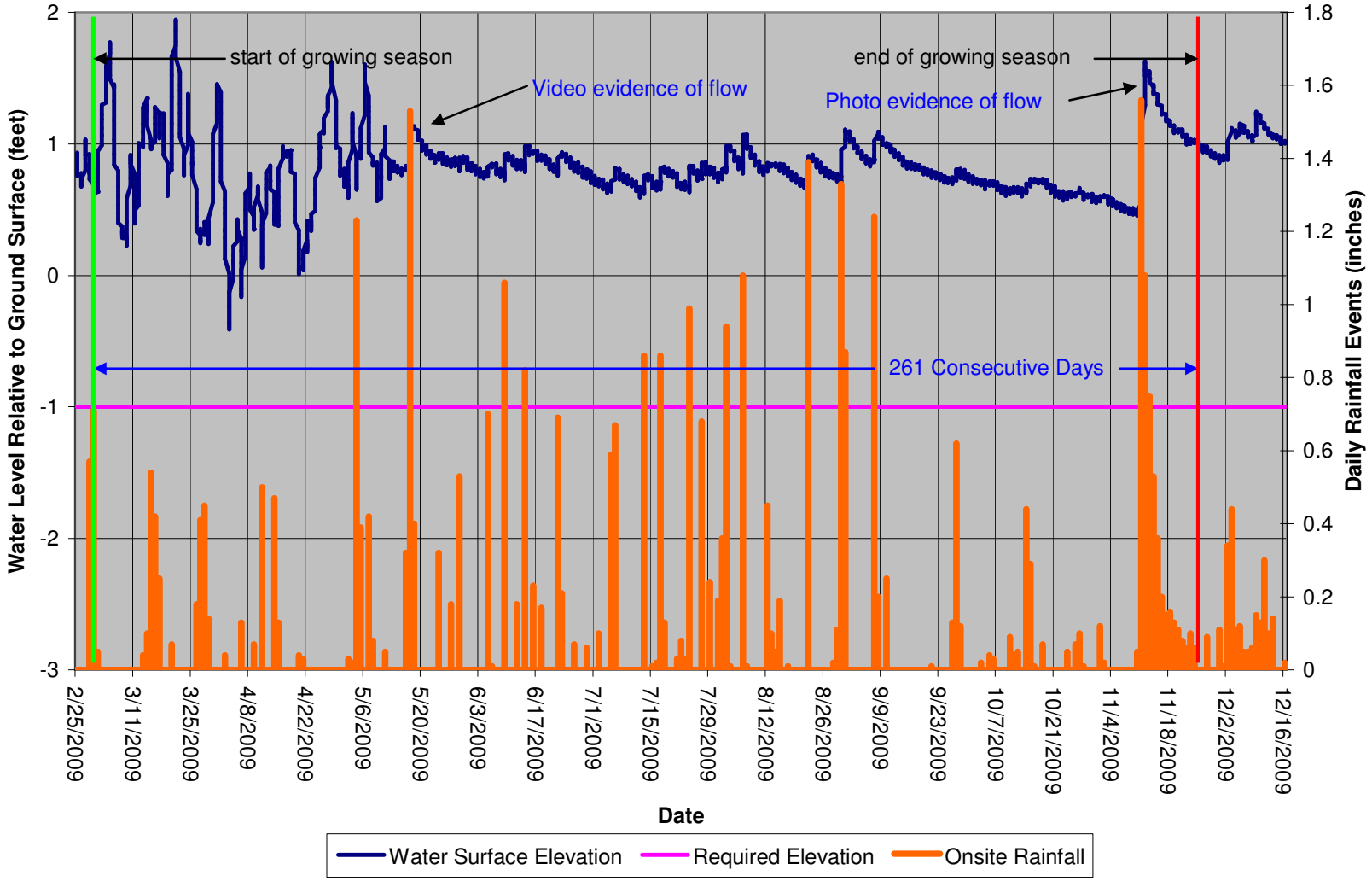
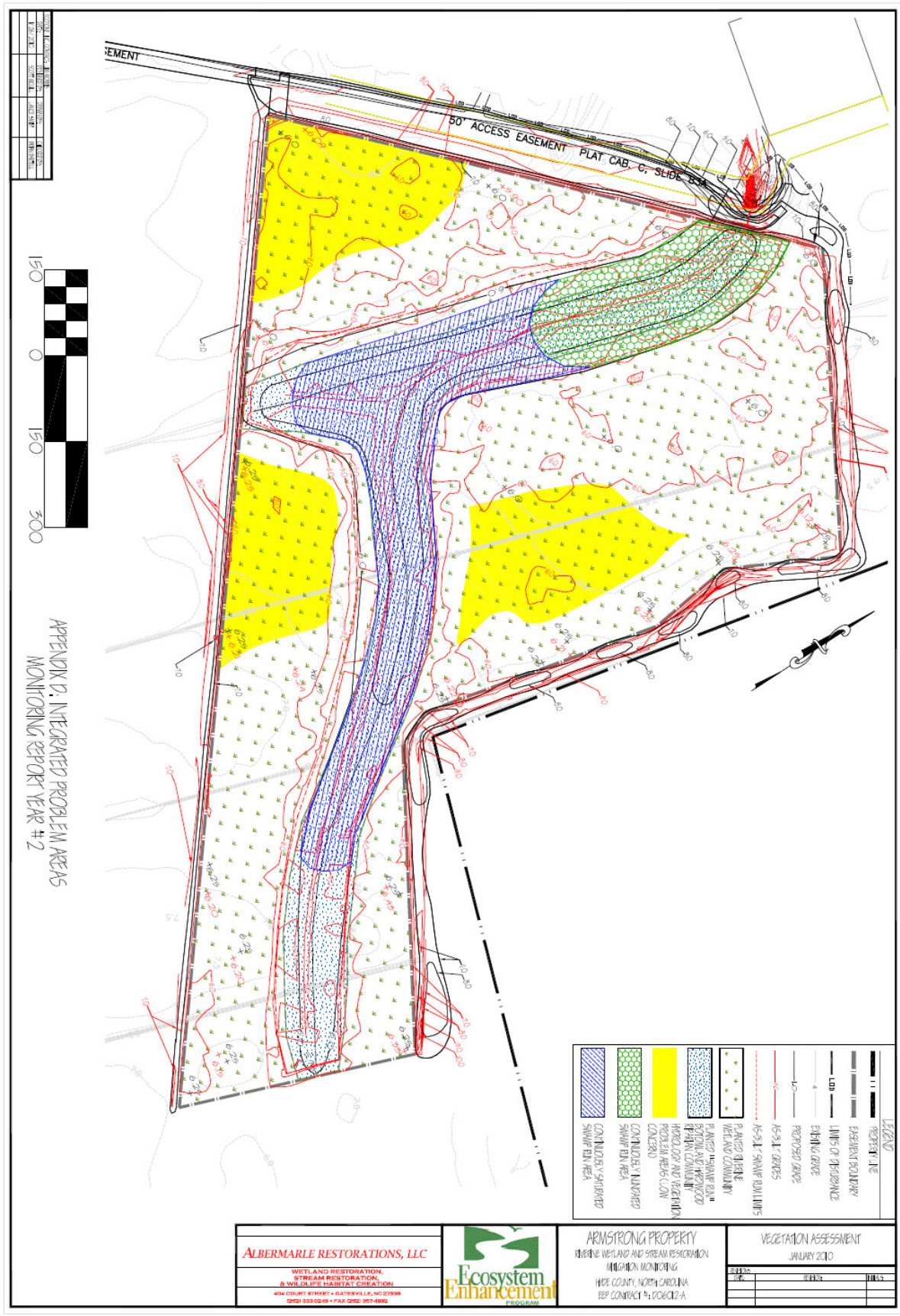
10/21/2009
11/4/2009
11/18/2009
12/2/2009
12/16/2009


Armstrong Run Monitoring Gauge #2 (1272318)
start of growing season
Video evidence of flow
end of growing season
Photo evidence of flow
261 Consecutive Days
Water Level Relative to Ground Surface (feet)
Daily Rainfall Events (inches)
Date
2
1
0
-1
-2
-3
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2/25/2009
3/11/2009
3/25/2009
4/8/2009
4/22/2009
5/6/2009
5/20/2009
6/3/2009
6/17/2009
7/1/2009
7/15/2009
7/29/2009
8/12/2009
8/26/2009
9/9/2009
9/23/2009
10/7/2009
10/21/2009
11/4/2009
11/18/2009
12/2/2009
12/16/2009
Water Surface Elevation
Required Elevation
Onsite Rainfall

Appendix D

Problem Areas Plan View (Integrated)



APPENDIX D: INTEGRATED PROBLEM AREAS
MONITORING REPORT YEAR #2

ALBERMARLE RESTORATIONS, LLC
WETLAND RESTORATION,
STREAM RESTORATION,
& WILDLIFE HABITAT CREATION
404 COURT STREET • GATESVILLE, NC 27938
(252) 333-0249 • FAX (252) 357-4892

Ecosystem Enhancement Program

ARMSTRONG PROPERTY
RIVERINE WETLAND AND STREAM RESTORATION
MITIGATION MONITORING
HYDE COUNTY, NORTH CAROLINA
EEP CONTRACT #: D06012-A

VEGETATION ASSESSMENT
JANUARY 2010

REVISIONS		
NO.	DESCRIPTION	DATE