

Monitoring Report MY01

**Sandy Bridge Restoration Site
DMS Contract 6400
DMS Project Number 96920**

**DWR #: 15-0414
USACE Action ID: 201500827
Rutherford County, North Carolina**



Prepared for:
NCDMS, 1652 Mail Service Center, Raleigh, NC 27699-1652

**Monitoring Data Collected: October 2017
Date Submitted: January 2018**

Monitoring and Design Firm

Prepared by:



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Project Contact: Tim Morris
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February 2018



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4505 Falls of Neuse Road, Suite 400 • Raleigh, NC 27609

February 13, 2018

Mr. Harry Tsomides
Project Manager
North Carolina Division of Mitigation Services
5 Ravenscroft Dr. #102
Asheville, NC 28801

Re: Response to Sandy Bridge Farm MY01 Report Comments

Dear Mr. Tsomides,

KCI has reviewed the comments prepared by the DMS for the Sandy Bridge Farm MY01 Report and has prepared the following responses:

General Comments

1. Site visit by DMS staff in January 2018 revealed an area of active bank erosion on both sides of the gully adjacent to the project reach along 25+00 to 26+00, the downstream end of the project. While this stream itself (noted as “Logan Creek” on the easement plat) is not a project reach, the erosion appears to be actively cutting in a westerly direction towards the project channel (as well as a steep eroding bank on the east side) and creating a water quality issue within the project limits. The fence line along this section is now falling into the creek. Photos from the site visit can be provided by DMS if helpful. In looking at the easement plat, the corners along this gully boundary are calculated points, and markers could not be found in the field so it was difficult to tell where the calculated point coordinates are in the field without a GPS. Recommend keeping an eye on this area, assessing how it changes over time, and determining the potential threat to stream assets if it keeps migrating laterally.

KCI Response: KCI will monitor this area to ensure it doesn't begin to negatively impact the project and remedial steps will be taken if it does.

2. Recommend removing the attached/loose tubular steel gate hanging off the red gates at the upstream project limit, which is just catching debris.

KCI Response: KCI will be in contact with the landowner about removing this gate.

3. A couple sign posts at the lower end of the project had easement signage on either side of the same post. Easement signage should only be evident when looking into the easement.

KCI Response: At the next site visit KCI will remove any improperly installed signs.

Goals and Objectives

1. Please indicate that the Goals and Objectives reflect those from the approved Mitigation Plan (2016).

KCI Response: This verbiage has been added to the report



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Monitoring Results

1. Spatial average of gauges is indicated, however during IRT review (see 5/30/2016 IRT memo) it was noted that spatial averaging would not be used to determine success. Recommend removing this statement.
KCI Response: This statement has been removed.
2. Typo – third paragraph, “Three addition groundwater monitoring gauges...”
KCI Response: This typo has been corrected.
3. It is indicated that three new gauges will be installed per DWR concerns over soils in a wetland reestablishment area (to the south of the abandoned stream channel); while a hand-marked map was provided in December 2017, DMS recommends coordinating/confirming with DWR before installation to optimize the exact field locations of the new gauges and to meet the intent of the comment.
KCI Response: KCI will be in contact with DWR concerning the location of these gauges.

Hydrology

1. It is unusual to have seven bank full events during the 8-month monitoring period (starting in March) in a year described as having below average rain fall. Can the as-built bank full height be reviewed / confirmed? Is the bank full elevation that is being used at the top of bank?
KCI Response: As documented in the Mitigation Plan, the riffle cross-section at the site was designed smaller than typical bankfull flow to encourage frequent overbank flooding into the stream/wetland complex. It is believed that this is the reason for the high number of bankfull events, but at the next site visit KCI will confirm that the top of gauge and bankfull elevations recorded during the baseline survey are correct.

Cross-sections – Bank Height Ratios

1. A couple of methods are currently being utilized to calculate the BHR from year to year. To compare subsequent monitoring years to the as-built condition one can hold the bankfull depth static (denominator) while allowing the low TOB max depth (numerator) to vary. Another method that has been proposed and is being evaluated is to hold the as-built cross sectional area static within each years new cross section and allow that to determine the maximum bankfull depth for each year. However if there are large changes in the W/D ratio, either method can make for somewhat distorted BHR values depending upon the direction and magnitude of the change in the W/D ratio. Please explain in detail as a table footnote how the calculations were made, and be prepared to discuss the method used for credit release and justify through context whether or not any changes observed in a cross section represent an issue.
KCI Response: Based on a draft DMS guidance from February 2018, all calculations have been updated to reflect a fixed cross-sectional area. Verbiage explaining this has been added to the report.



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Figures

1. Aerial on Asset map is dated 2010 while CCPV shows 2015 aerial. Is it possible to update the asset map with the 2015 aerial?

KCI Response: This change has been made.

2. CCPV figure indicates “EDMS” project. Should this be “DMS”?

KCI Response: This typo has been corrected.

Tables

1. Table 1 – Linear feet/acres are typically not shown in the Credits section, as they already appear in the Component Summation section. Recommend to remove.

KCI Response: This change has been made.

2. Table 2 – Photo point dates and gauge download dates need not be shown in the history table as separate line items. Vegetation and stream survey dates are the necessary elements to distinguish/ include (as you have done).

KCI Response: This change has been made.

Please contact me if you have any questions or would like clarification concerning these responses.

Sincerely,

A handwritten signature in black ink that reads 'Adam Spiller'.

Adam Spiller
Project Manager

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PROJECT SUMMARY

The Sandy Bridge Farm Restoration Site (SBFRS) was completed in March 2017 and restored a total of 6.85 acres of riparian wetland (1.29 acres of wetland rehabilitation and 5.56 acres of wetland reestablishment) and 1,626 linear feet of stream. The SBFRS is a riparian system located in the Broad River Basin (03050105 8-digit cataloging unit) in Rutherford County, North Carolina that had been substantially modified to maximize the use of the area for grazing. The completed project will restore impacted agricultural lands to a functioning stream and wetland ecosystem with enhanced water quality, restored hydrology, and improved fish and wildlife habitat.

The SBFRS is protected by a 9.5 acre permanent conservation easement, held by the State of North Carolina. The site is located off of Rock Road, approximately 3 miles north of Rutherfordton, North Carolina. The project site is bounded by interspersed pastureland and forested land to the east, agricultural land and Rock Road to the north-northwest, and Catheys Creek to the southwest.

The North Carolina Ecosystem Enhancement Program's (NCEEP) publication in 2009 identified HUC 03050105070020 (Catheys Creek) as a Targeted Local Watershed (TLW). The goals and priorities for SBFRS are based on the information presented in the Broad River Basin Restoration Priorities: to restore wetland and stream functions, to maintain and enhance water quality, to restore hydrology, and to improve fish and wildlife habitat (NCEEP 2009). The project goals, which reflect those from the approved Mitigation Plan, are in line with the following basin priorities:

- Reduce sources of sediment and nutrients by restoring riparian buffer vegetation, excluding livestock, and restoring natural geomorphology.
- Prioritize project implementation in the Catheys Creek local watershed planning area.

The goals for the project are to:

- Restore a channelized stream to a meandering C-type channel with a floodplain.
- Buffer and reduce sediment impacts to the project stream.
- Restore a Piedmont Alluvial Forest Community.
- Restore a wetland hydroperiod to drained and livestock-impacted land.

The project goals will be addressed through the following objectives:

- Relocate a channelized stream to its historic landscape position.
- Install an appropriately-sized channel cross-section.
- Install bedform diversity with pools, riffles, and habitat structures.
- Demarcate the project easement boundaries and fence out livestock.
- Plant the site with native trees and shrubs and an herbaceous seed mix that supports the development of a Piedmont Alluvial Forest.
- Fill field ditches and redevelop wetland microtopography to slow the flow of surface and subsurface drainage.

To restore the site, select ditches across the site were modified or filled and incoming surface inputs and seeps were integrated to create a stream/wetland complex. Additionally, Tributary 1 to Catheys Creek was improved with Priority 1 stream restoration to re-meander the stream and elevate the groundwater table. The entire site was planted as a Piedmont Alluvial Forest community (Schafale 2012). The site was constructed as designed with no modification from the design plan.

The monitoring components were installed in March 2017. Nine groundwater monitoring wells were installed to evaluate the attainment of jurisdictional wetland hydrology. A stream gauge was installed on Tributary 1 to Catheys Creek to record the occurrence of bankfull events. To determine the success of the planted mitigation areas, eight 10 m x 10 m permanent vegetation monitoring plots were established. The location of the planted stems relative to the origin within these plots, as well as the species, was recorded

and planted stems were grouped into size categories (0-10 cm, 10-50 cm, 50-100 cm, >137 cm). Any volunteers found within the plots were also grouped into size categories by species, but separate from the planted stems. Six permanent photo reference points were established and will be taken annually. Four permanent cross-sections (two sets of coupled riffles and pools) were also established and a detailed longitudinal profile of the stream was taken. Wolman pebble counts were performed at both of the riffle cross-sections. The cross-section measurements will be repeated in future monitoring years, but the longitudinal profile will only be repeated if there are concerns about bed elevation adjustments. Reports will be submitted to DMS by the end of each monitoring year.

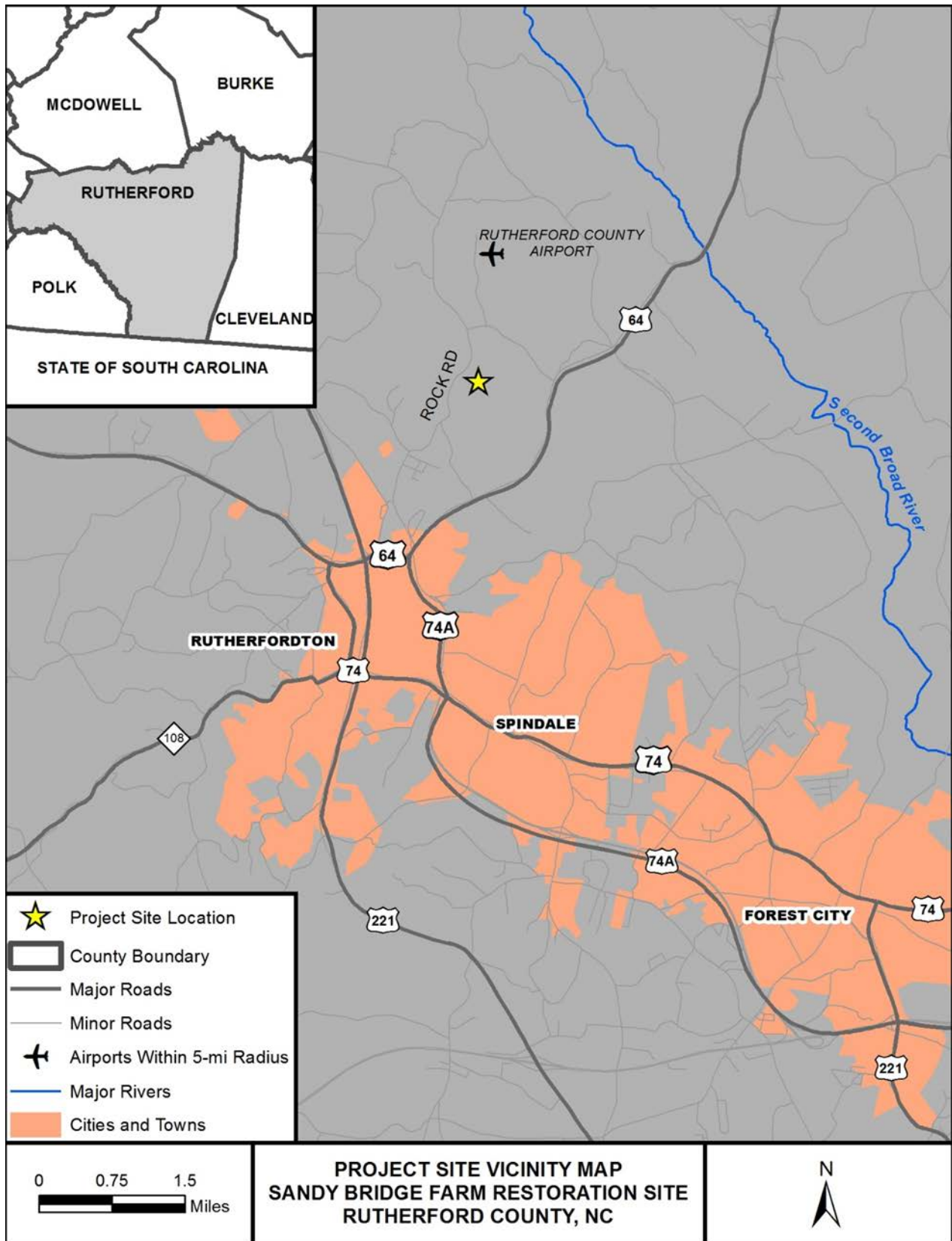
Vegetative success criteria for the site is 320 woody stems/acre after three years, 260 woody stems/acre after five years, and 210 woody stems/acre after seven years. The baseline monitoring counted an average of 728 woody stems/acre. To meet the hydrologic success criteria, the upper 12 inches of the soil profile must have continuously saturated or inundated conditions for at least 10% of the growing season during normal weather conditions. The soil survey for Rutherford County estimates the growing season begins April 4 and ends November 6 (217 days), meaning the water table must be within 12 inches of the surface for at least 22 consecutive days during the growing season. A minimum of two bankfull events must also be recorded during the monitoring period. Bank height ratios should not exceed 1.2 and the entrenchment ratios should be 2.2 or greater. Visual assessments will also be used to identify problem areas.

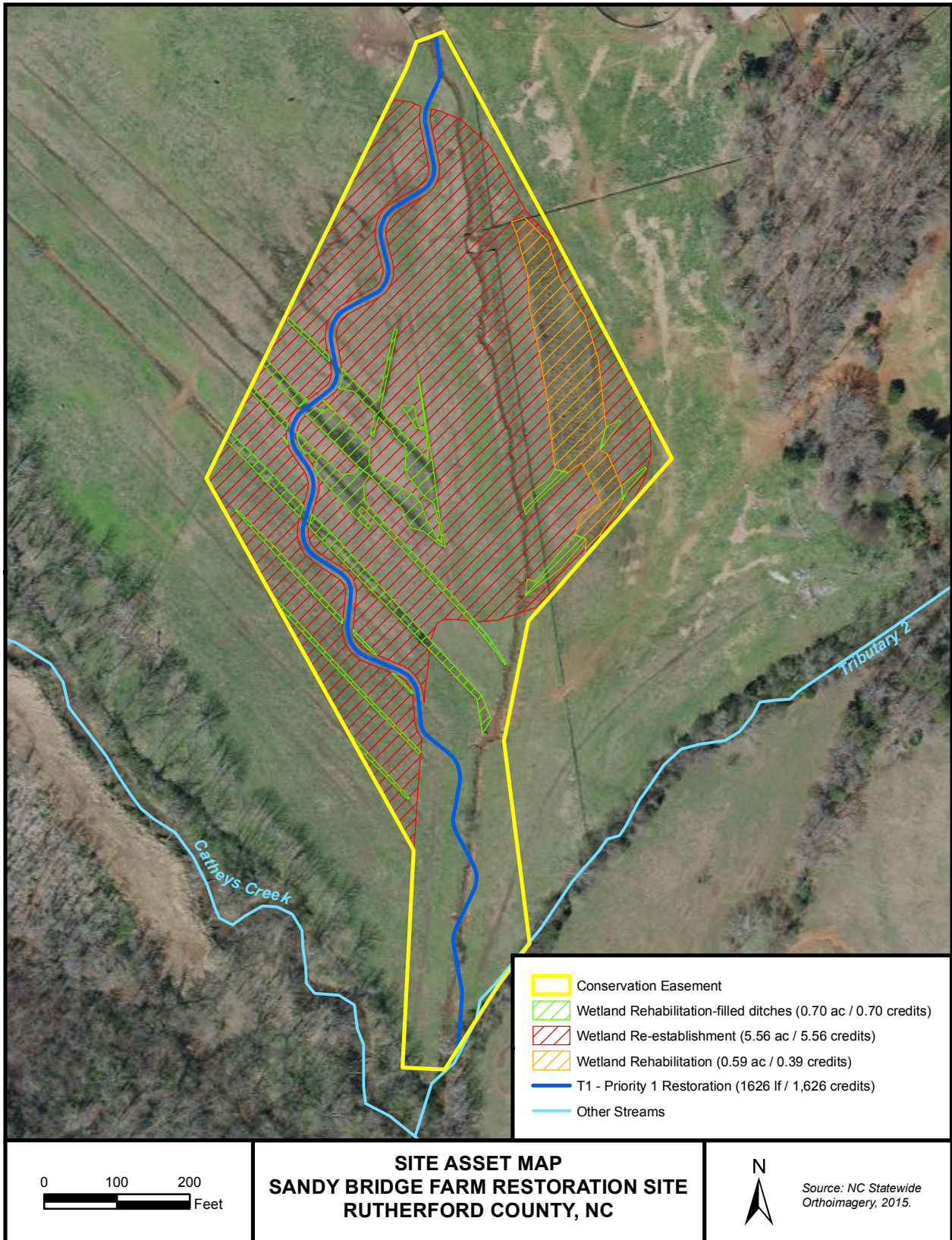
MONITORING RESULTS

The site was planted in March 2017 with tree tube protection installed around many of the planted stems. The first-year monitoring was conducted October 26, 2017. The site averaged 491 planted stems/acre across all 8 plots. Seven of the 8 plots had greater than 320 planted stems/acre, with Plot 8 being the only plot below the success criteria, likely due to the large amount of tearthumb (*Polygonum sagittatum*) growing in this area. Including volunteers, the site averaged 511 total stems/acre. In general the site is well vegetated, with widespread herbaceous coverage and healthy planted stems. KCI is evaluating the need for a supplemental planting in areas where the herbaceous vegetation is outcompeting the planted woody stems. Two additional vegetation plots are going to be installed near the southern end of the site during the second monitoring year based on comments from DWR's review of the site.

Daily rainfall data were obtained from the NC State Climate Office for a local weather station in Rutherfordton, NC. In 2017, the month of April experienced above average rainfall, while May, August, September, and October experienced average rainfall. The months of January, February, March, June, July, and November experienced below average rainfall for the site. Overall, the area experienced below average rainfall during the 2017 growing season. During the site's first growing season, 6 of the 9 groundwater monitoring wells had continuous saturation within 12 inches of the ground surface for 10% (22 days) or more of the 217 day growing season (April 4 to November 6). The stream gauge recorded 7 bankfull events in 2017. Three additional groundwater monitoring gauges will be installed before the start of the second monitoring year's growing season based on comments from DWR's review of the site.

The longitudinal profile was not repeated for the first-year survey because the baseline survey found that the stream was constructed as designed, and there were no concerns about bed elevation adjustments. The first-year cross-section survey found that the dimensions of the stream are as designed, with some small variation as is typical for stream restoration projects. The monitored cross-section data have been calculated by adjusting the bankfull elevation to maintain the Baseline Bankfull Area for each cross-section. A Total Cross-Sectional metric has been added to the cross-section data to indicate the cross-sectional area below the Baseline bankfull elevation. In instances where there has been small amounts of aggradation (XS1) the data show the cross-section having a significantly higher Width and higher Width/Depth Ratio as compared to previous years. The comparison of cross-section plots between monitoring events illustrates that this change does not appear significant. Future monitoring will determine if this is a trend or typical settling of the stream following construction.





- Conservation Easement
- Wetland Rehabilitation-filled ditches (0.70 ac / 0.70 credits)
- Wetland Re-establishment (5.56 ac / 5.56 credits)
- Wetland Rehabilitation (0.59 ac / 0.39 credits)
- T1 - Priority 1 Restoration (1626 lf / 1,626 credits)
- Other Streams

0 100 200
 ─────────── Feet

SITE ASSET MAP
SANDY BRIDGE FARM RESTORATION SITE
RUTHERFORD COUNTY, NC



Source: NC Statewide
 Orthoimagery, 2015.

REFERENCES

- NCDENR, Ecosystem Enhancement Program. 2009. Broad River Basin Restoration Priorities 2009. Raleigh, NC. Last accessed 1/2016 at:
http://portal.ncdenr.org/c/document_library/get_file?uuid=705d1b58-cb91-451e-aa58-4ef128b1e5ab&groupId=60329
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- Schafale, M.P. and A.S. Weakley. 2012. Guide to the Natural Communities of North Carolina: Fourth Approximation. Natural Heritage Program, Division of Parks and Recreation, N.C. Department of Environment and Natural Resources. Raleigh, NC.

APPENDIX A

Background Tables

Table 1. Project Components and Mitigation Credits									
Sandy Bridge Farm Restoration Site, DMS Project #96920									
Mitigation Credits									
	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Credits	1,626		6.65						
Project Components									
Project Component -or- Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach (PI, PII etc.)	Restoration -or- Restoration Equivalent	Restoration Footage/ Acreage	Mitigation Ratio	Credits		
Tributary 1	10+00 to 26+26	1,470 lf	PI	Restoration	1,626 lf	1:1	1,626		
Wetland Reestablishment				Restoration	5.56 ac	1:1	5.56		
Wetland Rehabilitation*		0.79 ac		Restoration	0.70 ac	1:1	0.70		
Wetland Rehabilitation		0.59 ac		Restoration	0.59 ac	1.5:1	0.39		
Component Summation									
Restoration Level	Stream (linear feet)	Riparian Wetlands (Acres)		Non-Riparian Wetlands (Acres)	Buffer (square feet)	Upland (Acres)			
		Riverine	Non-Riverine						
Restoration	1,626 lf								
Reestablishment		5.56 ac							
Rehabilitation		1.29 ac							
Enhancement									
Creation									
Preservation									
High Quality Preservation									

R= Restoration RE= Restoration Equivalent of Creation or Enhancement
 *=wetland rehabilitation associated with filled ditches

Table 2. Project Activity & Reporting History Sandy Bridge Farm Restoration Sites, DMS Project #96920		
Activity or Report	Data Collection Complete	Actual Completion or Delivery
Mitigation Plan		June 2016
Final Design - Construction Plans		June 2016
Construction Grading Completed		Aug 29, 2016
Planting Completed		March 11, 2017
Baseline Monitoring/Report	March 2017	April 2017
<i>Vegetation Monitoring</i>	<i>March 21, 2017</i>	
<i>Stream Survey</i>	<i>March 20, 2017</i>	
Year 1 Monitoring	November 2017	December 2017
<i>Vegetation Monitoring</i>	<i>October 26, 2017</i>	
<i>Stream Survey</i>	<i>November 6, 2017</i>	

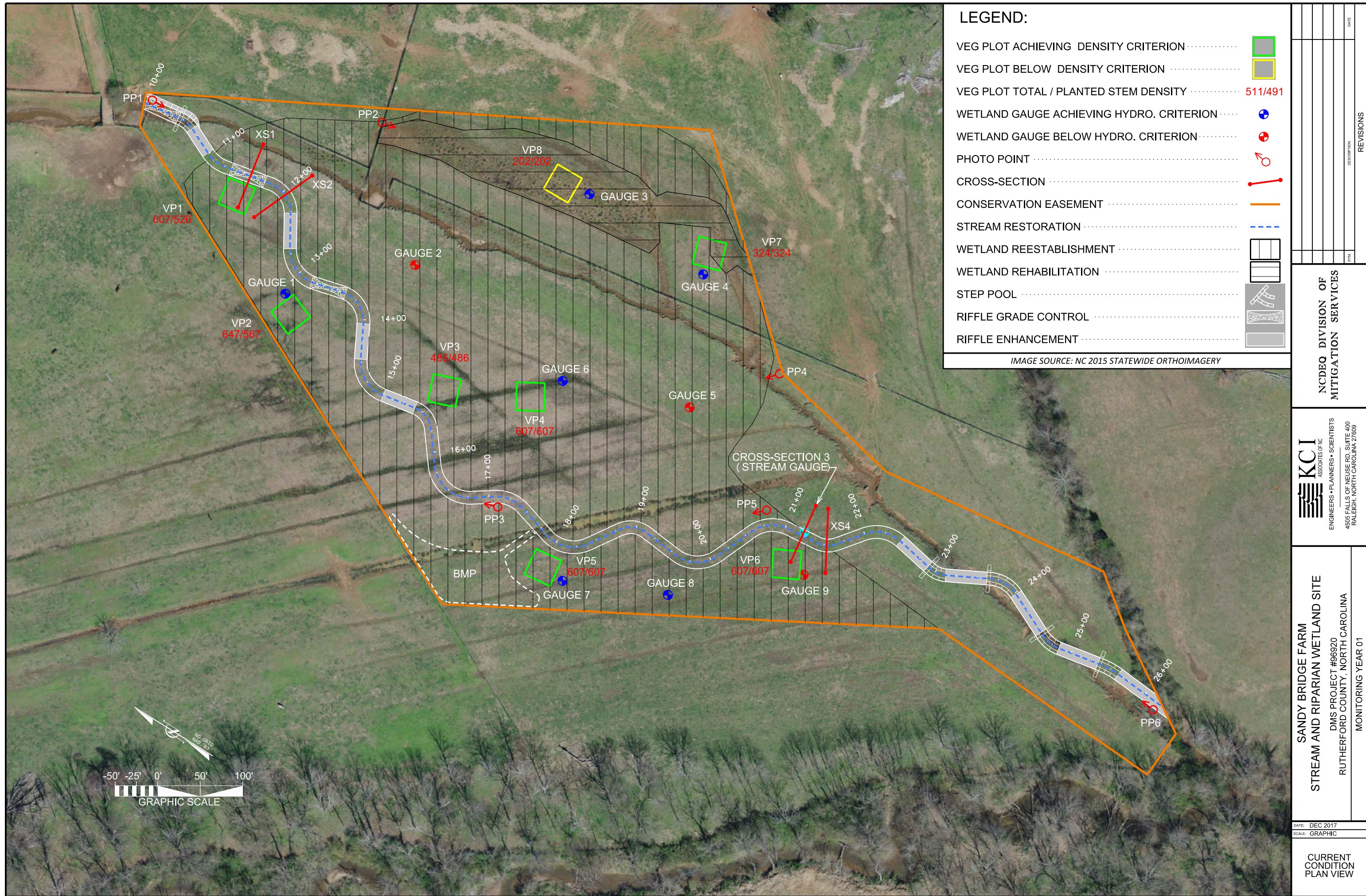
Table 3. Project Contacts Sandy Bridge Farm Restoration Sites, DMS Project #96920	
Design Firm	KCI Associates of North Carolina, PC 4505 Falls of Neuse Road Suite 400 Raleigh, NC 27609 Contact: Mr. Tim Morris Phone: (919) 278-2512 Fax: (919) 783-9266
Construction Contractor	KCI Environmental Technologies and Construction 4505 Falls of Neuse Road, Suite 400 Raleigh, NC 27609 Contact: Mr. Tim Morris Phone: (919) 278-2512
Planting Contractor	Conservation Services Inc. 1620 N. Delphine Ave. Waynesboro, VA 22980 Contact: Mr. David Coleman Phone: (540) 941-0067
Monitoring Performers	KCI Associates of North Carolina, PC 4505 Falls of Neuse Road Suite 400 Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266

Table 4. Project Information Sandy Bridge Farm Restoration Site, DMS Project #96920			
Project Name	Sandy Bridge Farm Restoration Site		
County	Rutherford County		
Project Area (acres)	9.45 acres		
Project Coordinates (lat. and long.)	35.407997° N, -81.937000° W		
Project Watershed Summary Information			
Physiographic Province	Piedmont		
River Basin	Broad		
USGS Hydrologic Unit 8-digit	03050105	USGS Hydrologic Unit 14-digit	03050105070020
DWQ Sub-basin	9-41-13-(0.5)		
Project Drainage Area (acres)	837 acres		
Project Drainage Area Percentage of Impervious Area	8%		
CGIA Land Use Classification	Mixed Hardwoods/Conifers 42% (350.0 ac), Managed Herbaceous Cover 39% (329.3 ac), Mountain Conifers 12% (99.5 ac), Mixed Shrubland 5% (43.5 ac), Low Intensity Developed 1% (11.0 ac)		
Existing Reach Summary Information			
Parameters	T1		
Length of reach (linear feet)	1,470 lf		
Valley classification	Valley Type VIII		
Drainage area (acres)	837 acres		
NCDWQ Water Quality Classification	WS-V (Water Supply – upstream)		
Morphological Description (stream type)	Ditched channel		
Evolutionary trend	Channelized		
Mapped Soil Series	Wehadkee-Chewacla Association		
Drainage class	Poorly drained; Somewhat poorly drained		
Soil Hydric status	Drained hydric		
Slope	0-1%		
FEMA classification	Zone AE		
Existing vegetation community	N/A (Pasture)		
Percent composition of exotic invasive vegetation	5%		
Existing Wetland Summary Information			
Parameters			
Size of Wetland (acres)	0.59 acres (Wetland Rehabilitation Area)		
Wetland Type	Headwater Seep		
Mapped Soil Series	Wehadkee-Chewacla Association		
Drainage class	Poorly drained; Somewhat poorly drained		
Soil Hydric Status	Drained Hydric		
Source of Hydrology	Seepage/ Precipitation		
Hydrologic Impairment	Ditching and Grazing		
Existing vegetation community	Emergent Wetland		
Percent composition of exotic invasive vegetation	5%		

Regulatory Considerations			
Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States – Section 404	Yes	DWR# 15-0414 USACE Action ID# 201500827	Jurisdictional Determination
Waters of the United States – Section 401	Yes	DWR# 15-0414 USACE Action ID# 201500827	Jurisdictional Determination
Endangered Species Act	No	N/A	N/A
Historic Preservation Act	No	N/A	N/A
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	No	N/A	N/A
Essential Fisheries Habitat	No	N/A	N/A

APPENDIX B

Visual Assessment Data



LEGEND:

- VEG PLOT ACHIEVING DENSITY CRITERION
- VEG PLOT BELOW DENSITY CRITERION
- VEG PLOT TOTAL / PLANTED STEM DENSITY 511/491
- WETLAND GAUGE ACHIEVING HYDRO. CRITERION +
- WETLAND GAUGE BELOW HYDRO. CRITERION +
- PHOTO POINT ⊙
- CROSS-SECTION —
- CONSERVATION EASEMENT
- STREAM RESTORATION
- WETLAND REESTABLISHMENT
- WETLAND REHABILITATION
- STEP POOL
- RIFFLE GRADE CONTROL
- RIFFLE ENHANCEMENT

IMAGE SOURCE: NC 2015 STATEWIDE ORTHOIMAGERY

NO.	DATE	REVISIONS

**NCDEQ DIVISION OF
MITIGATION SERVICES**

KCI
ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4505 FALLS OF NEUSE RD, SUITE 400
RALEIGH, NORTH CAROLINA 27609

**SANDY BRIDGE FARM
STREAM AND RIPARIAN WETLAND SITE**
DMS PROJECT #96920
RUTHERFORD COUNTY, NORTH CAROLINA
MONITORING YEAR 01

DATE: DEC 2017
SCALE: GRAPHIC
**CURRENT
CONDITION
PLAN VIEW**

Table 6 **Vegetation Condition Assessment**
Sandy Bridge Farm Stream Restoration Site, DMS Project #96920

Planted Acreage **9.5**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	Pattern and Color	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Pattern and Color	0	0.00	0.0%
Total				0	0.00	0.0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Pattern and Color	0	0.00	0.0%
Cumulative Total				0	0.00	0.0%

Easement Acreage **9.6**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	1000 SF	Pattern and Color	0	0.00	0.0%
				0	0.00	
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	Pattern and Color	0	0.00	0.0%

Photo Reference Photos



PP1 – MY-00 – 3/21/17



PP1 – MY-01 – 10/26/17



PP2 – MY-00 – 3/21/17



PP2 – MY-01 – 10/26/17



PP3 – MY-00 – 3/21/17



PP3 – MY-01 – 10/26/17



PP4 – MY-00 – 3/21/17



PP4 – MY-01 – 10/26/17



PP5– MY-00 – 3/21/17



PP5– MY-01 – 10/26/17



PP6– MY-00 – 3/21/17



PP6– MY-01 – 10/26/17

Vegetation Monitoring Plot Photos



Vegetation Plot 1 – MY-00 – 3/21/17



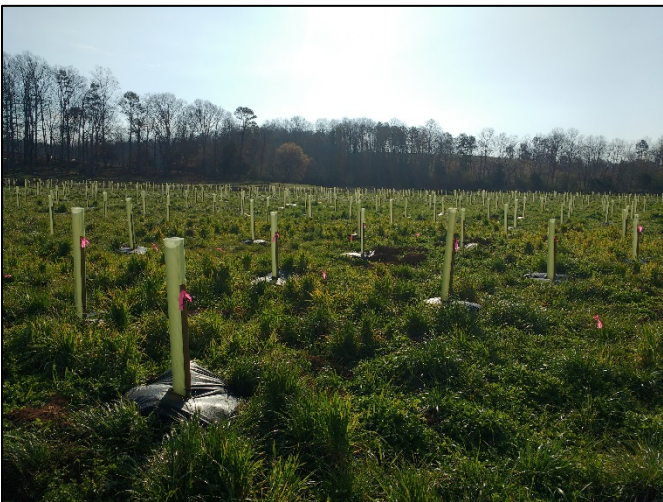
Vegetation Plot 1 – MY-01 – 10/26/17



Vegetation Plot 2 – MY-00 – 3/21/17



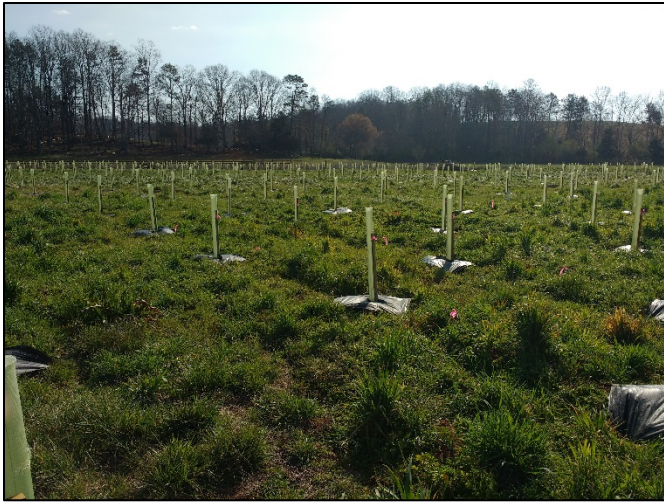
Vegetation Plot 2 – MY-01 – 10/26/17



Vegetation Plot 3 – MY-00 – 3/21/17



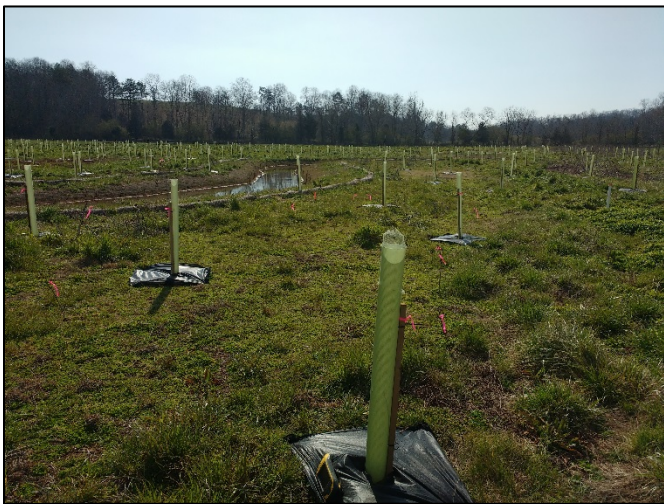
Vegetation Plot 3 – MY-01 – 10/26/17



Vegetation Plot 4 – MY-00 – 3/21/17



Vegetation Plot 4 – MY-01 – 10/26/17



Vegetation Plot 5 – MY-00 – 3/21/17



Vegetation Plot 5 – MY-01 – 10/26/17



Vegetation Plot 6 – MY-00 – 3/21/17



Vegetation Plot 6 – MY-01 – 10/26/17



Vegetation Plot 7 – MY-00 – 3/21/17



Vegetation Plot 7 – MY-01 – 10/26/17



Vegetation Plot 8 – MY-00 – 3/21/17



Vegetation Plot 8 – MY-01 – 10/26/17

APPENDIX C

Vegetation Plot Data

Table 5. Stem Count by Plot and Species
Sandy Bridge Farm Restoration Site, DMS Project #96920

Species	Current Plot Data (MY01 2017)																
	Plot 01		Plot 02		Plot 03		Plot 04		Plot 05		Plot 06		Plot 07		Plot 08		
	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	
American Elm (<i>Ulmus americana</i>)							3	3	1	1	3	3					
Black Walnut (<i>Juglans nigra</i>)					1	1											
Box Elder (<i>Acer negundo</i>)		1															
Buttonbush (<i>Cephalanthus occidentalis</i>)	3	3	2	2							1	1	3	3			
Eastern Cottonwood (<i>Populus deltoides</i>)					2	2				6	6	6	6	1	1	1	1
Oak (<i>Quercus sp.</i>)																	
Pin Oak (<i>Quercus palustris</i>)							2	2									
Red Chokeberry (<i>Aronia arbutifolia</i>)	1	1	1	1													
Red Maple (<i>Acer rubrum</i>)			1	1	1	1	4	4					2	2	1	1	
River Birch (<i>Betula nigra</i>)	1	1	2	2	4	4	3	3					1	1			
Silky Dogwood (<i>Cornus amomum</i>)	2	2	6	6					5	5							
Smooth Sumac (<i>Rhus glabra</i>)		1									1	1					
Sugarberry (<i>Celtis laevigata</i>)									1	1	3	3					
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	2	2					1	1									
Sycamore (<i>Platanus occidentalis</i>)			1	3	1	1			1	1							
Tulip Poplar (<i>Liriodendron tulipifera</i>)	3	3	1	1	1	1			1	1							
Unknown					2	2					1	1			3	3	
Willow Oak (<i>Quercus phellos</i>)	1	1															
Witch Hazel (<i>Hamamelis virginiana</i>)							2	2					1	1			
Stem count	13	15	14	16	12	12	15	15	15	15	15	15	8	8	5	5	
size (ares)	1		1		1		1		1		1		1		1		
size (ACRES)	0.025		0.025		0.025		0.025		0.025		0.025		0.025		0.025		
Species count	7	9	7	7	7	7	6	6	6	6	6	6	5	5	3	3	
Stems per ACRE	526	607	567	647	486	486	607	607	607	607	607	607	324	324	202	202	

Table 5. Stem Count by Plot and Species				
Sandy Bridge Farm Restoration Site, DMS Project #96920				
Species	Annual Means			
	MY01 (2017)		MY00 (2017)	
	Planted	Total	Planted	Total
American Elm (<i>Ulmus americana</i>)	7	7		
Black Walnut (<i>Juglans nigra</i>)	1	1		
Box Elder (<i>Acer negundo</i>)		1		
Buttonbush (<i>Cephalanthus occidentalis</i>)	9	9		
Eastern Cottonwood (<i>Populus deltoides</i>)	16	16		
Oak (<i>Quercus</i> sp.)			4	4
Pin Oak (<i>Quercus palustris</i>)	2	2		
Red Chokeberry (<i>Aronia arbutifolia</i>)	2	2		
Red Maple (<i>Acer rubrum</i>)	9	9		
River Birch (<i>Betula nigra</i>)	11	11		
Silky Dogwood (<i>Cornus amomum</i>)	13	13		
Smooth Sumac (<i>Rhus glabra</i>)	1	2		
Sugarberry (<i>Celtis laevigata</i>)	4	4		
Swamp Chestnut Oak (<i>Quercus michauxii</i>)	3	3		
Sycamore (<i>Platanus occidentalis</i>)	3	5		
Tulip Poplar (<i>Liriodendron tulipifera</i>)	6	6	1	1
Willow Oak (<i>Quercus phellos</i>)	6	6		
Witch Hazel (<i>Hamamelis virginiana</i>)	1	1		
Unknown	3	3	139	139
Stem count	97	101	144	144
size (ares)	8		8	
size (ACRES)	0.20		0.20	
Species count	17	18	3	3
Stems per ACRE	491	511	728	728

APPENDIX D

Stream Measurement and Geomorphology Data

Table 6. Baseline Stream Data Summary																
Sandy Bridge Farm Stream Restoration Site, DMS Project #96920																
Parameter	Pre-Existing Condition					Reference Reach(es) Data					Design	As-built				
Dimension - Riffle	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Proposed	Min	Mean	Max	n	
Bankfull Width (ft)	31.5	32.9	33.0	34.0	4	14.8	16.7		18.6	2	15.0	15.4	17.2	18.9	2	
Floodprone Width (ft)	60.9	72.9	69.3	92.0	4	>40	>47		>55	2	>38	>60	>68	>70	2	
Bankfull Mean Depth (ft)	2.1	2.2	2.2	2.5	4	1.3	1.5		1.7	2	0.9	0.7	0.8	0.9	2	
Bankfull Max Depth (ft)	3.1	3.4	3.4	3.7	4	1.9	2.2		2.4	2	1.3	1.5	1.5	1.5	2	
Bankfull Cross-Sectional Area (ft ²)	66.6	73.2	71.2	84.0	4	25.0	25.1		25.1	2	12.7	13.2	13.5	13.8	2	
Width/Depth Ratio	13.5	14.8	14.9	16.0	4	8.8	11.3		13.8	2	17.7	17.3	22.1	27.0	2	
Entrenchment Ratio	1.9	2.2	2.2	2.7	4	>2.5	>2.5		>2.5	2	>2.5	3.8	4.0	4.1	2	
Bank Height Ratio	1.1	1.4	1.3	1.7	4	1.2	1.4		1.5	2	1.0	1.0	1.0	1.0	2	
Pattern																
Channel Beltwidth (ft)						60				1	35-60	35		60	2	
Radius of Curvature (ft)						16			87	1	30-50	30		50	2	
Rc:Bankfull width (ft/ft)						0.9			5.9	1	2.0-3.3	2.0		3.3	2	
Meander Wavelength (ft)						66			191	1	134-160	134		160	2	
Meander Width Ratio						4.1				1	8.9-10.7	8.9		10.7	2	
Profile																
Riffle Length (ft)												23	40	56	20	
Riffle Slope (ft/ft)	0.000			0.010	2	0.013			0.035	2	0.002-0.008	0.000	0.006	0.014	20	
Pool Length (ft)	*					14			33	2	17-55	11	22	39	20	
Pool Spacing (ft)	*					50			105	2	55-90	25.9	78.3	102.2	19	
Substrate and Transport Parameters																
SC% / Sa% / G% / C% / B% / Be%	18%/39%/43%/1%/0%/0%										66%/2%/22%/10%/1%/0%					
d16 / d35 / d50 / d84 / d95 (mm)	0.076/1.2/3.3/5.2/9.4/18										0.062/0.5/17.5/25.5/40/90					
Channel length (ft)	1,470										1,626		1,626			
Drainage Area (SM)	1.31					1.49					1.31		1.31			
Rosgen Classification	E4-G4					C4					C4		C4			
Sinuosity	1.0					1.3					1.2		1.2			
Water Surface Slope (ft/ft)	0.0043					0.0050					0.0038		0.0027			

*No data shown due to channelization/lack of bed diversity

Table 7. Cross-Section Morphology Data Tables														
Sandy Bridge Farm Stream Restoration Site, DMS Project #96920														
Dimension and Substrate	Cross-Section 1 (Riffle) Station 14+75							Cross-Section 2 (Pool) Station 16+40						
	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation	866.72	866.85						866.66	866.70					
Bankfull Width (ft)	15.4	24.7						18.8	23.4					
Floodprone Width (ft)	>60	>60						-	-					
Bankfull Mean Depth (ft)	0.9	0.6						1.4	1.1					
Bankfull Max Depth (ft)	1.5	1.6						2.7	2.7					
Bankfull Cross-Sectional Area (ft ²)	13.8	13.8						26.8	26.8					
Total Cross-Sectional Area (ft ²)	13.8	10.9						26.8	26.1					
Bankfull Width/Depth Ratio	17.3	44.2						-	-					
Bankfull Entrenchment Ratio	4.1	2.4						-	-					
Bankfull Bank Height Ratio	1.0	0.9						-	-					
d50 (mm)	35	26						-	-					
Dimension and Substrate	Cross-Section 3 (Riffle) Station 101+73							Cross-Section 4 (Pool) Station 105+67						
	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Bankfull Elevation	865.34	865.29						865.26	865.16					
Bankfull Width (ft)	15.7	17.3						18.7	18.1					
Floodprone Width (ft)	>70	>70						-	-					
Bankfull Mean Depth (ft)	0.8	0.8						1.5	1.6					
Bankfull Max Depth (ft)	1.5	1.6						3.0	3.1					
Bankfull Cross-Sectional Area (ft ²)	13.1	13.1						28.8	28.8					
Total Cross-Sectional Area (ft ²)	13.1	12.4						28.8	30.7					
Bankfull Width/Depth Ratio	18.8	22.8						-	-					
Bankfull Entrenchment Ratio	4.6	4.2						-	-					
Bankfull Bank Height Ratio	1.0	1.0						-	-					
d50 (mm)	0.062	0.062						-	-					

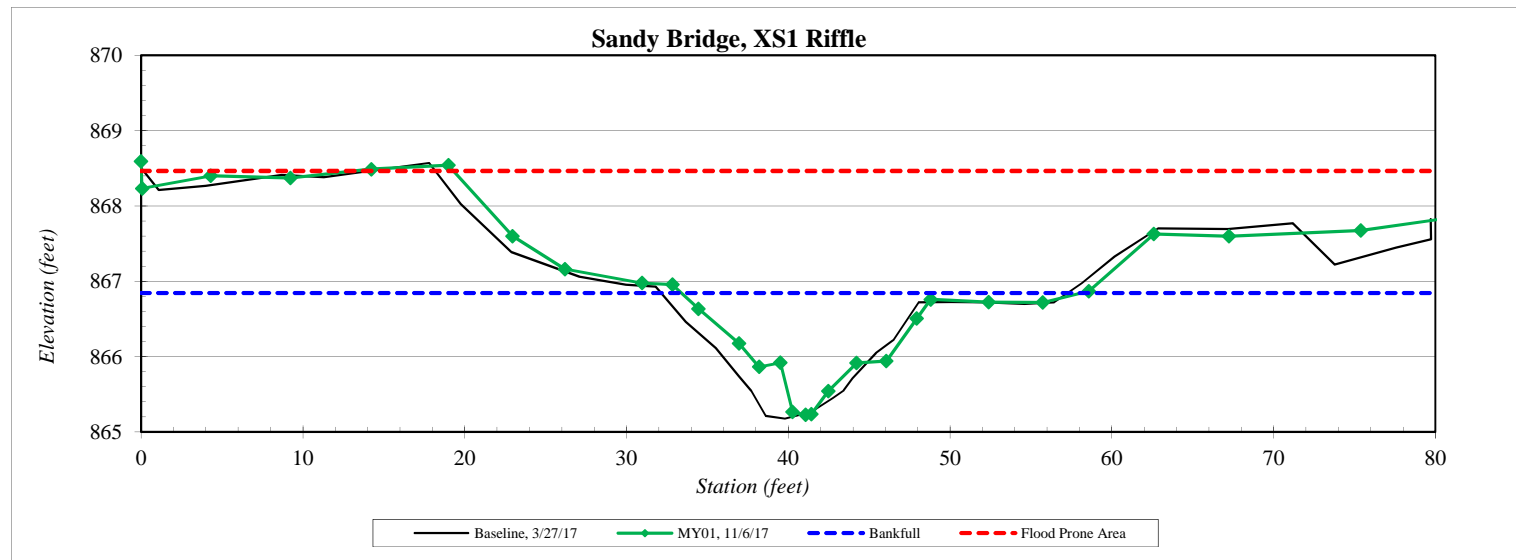
Calculations are based on a fixed bankfull area and the resulting bankfull elevation. Total Cross-Sectional Area represents the cross-sectional area measured from the baseline bankfull elevation.

River Basin:	Broad
Project Name	Sandy Bridge
XS ID	XS1
Drainage Area:	837 acres
Date:	11/6/2017
Field Crew:	T. Seelinger, J. Sullivan



Station	Elevation
0.0	868.59
0.1	868.23
4.3	868.40
9.2	868.37
14.2	868.49
19.0	868.54
23.0	867.60
26.2	867.16
31.0	866.98
32.8	866.96
34.4	866.64
37.0	866.18
38.2	865.86
39.5	865.92
40.3	865.26
41.1	865.23
41.4	865.24
42.5	865.54
44.2	865.91
46.1	865.94
47.9	866.51
48.8	866.76
52.4	866.72
55.7	866.72
58.6	866.87
62.6	867.63
67.2	867.60
75.4	867.67
80.3	867.83

SUMMARY DATA	
Bankfull Elevation:	866.8
Bankfull Cross-Sectional Area:	13.8
Total Cross-Sectional Area:	10.9
Bankfull Width:	24.7
Flood Prone Area Elevation:	868.5
Flood Prone Width:	>60
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	0.6
W / D Ratio:	44.2
Entrenchment Ratio:	2.4
Bank Height Ratio:	0.9

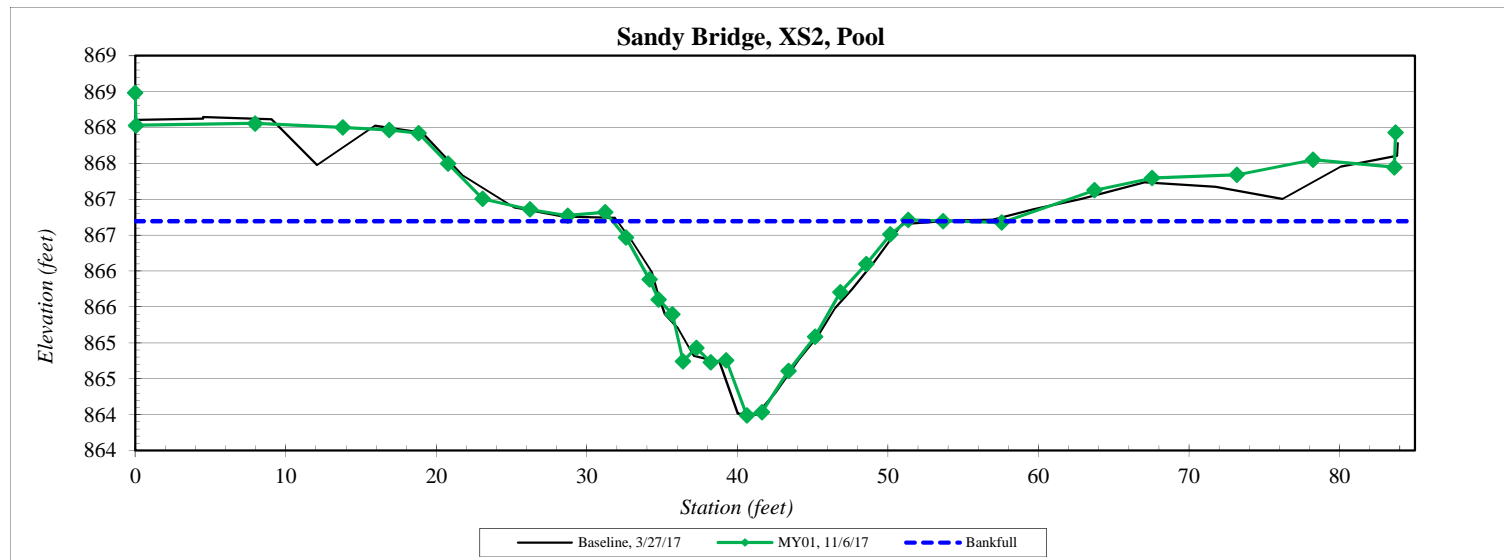


River Basin:	Broad
Project Name	Sandy Bridge
XS ID	XS2
Drainage Area:	837 acres
Date:	11/6/2017
Field Crew:	T. Seelinger, J. Sullivan



Station	Elevation
0.0	868.48
0.1	868.03
8.0	868.05
13.8	868.00
16.9	867.96
18.8	867.92
20.8	867.50
23.1	867.01
26.2	866.86
28.7	866.77
31.2	866.82
32.6	866.47
34.2	865.88
34.8	865.60
35.7	865.40
36.4	864.74
37.3	864.93
38.2	864.73
39.3	864.76
40.6	863.99
41.6	864.03
43.4	864.61
45.2	865.08
46.8	865.70
48.6	866.10
50.2	866.51
51.3	866.71
53.7	866.70
57.6	866.68
63.7	867.13
67.6	867.30
73.2	867.34
78.2	867.55
83.6	867.45
83.7	867.93

SUMMARY DATA	
Bankfull Elevation:	866.7
Bankfull Cross-Sectional Area:	26.8
Total Cross-Sectional Area:	26.1
Bankfull Width:	23.4
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	1.1
W / D Ratio:	20.4
Entrenchment Ratio:	-
Bank Height Ratio:	-

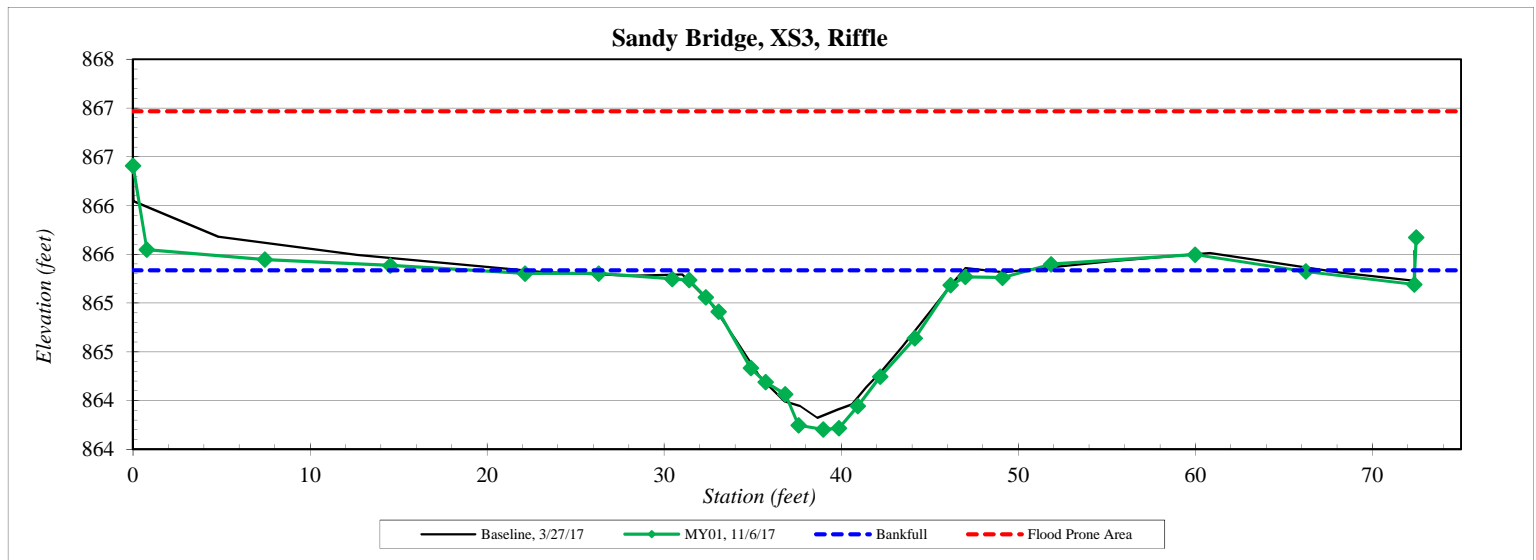


River Basin:	Broad
Project Name	Sandy Bridge
XS ID	XS3
Drainage Area:	837 acres
Date:	11/6/2017
Field Crew:	T. Seelinger, J. Sullivan



Station	Elevation
0.0	866.41
0.8	865.55
7.5	865.45
14.5	865.38
22.1	865.30
26.3	865.30
30.5	865.25
31.4	865.24
32.4	865.06
33.1	864.91
34.9	864.33
35.7	864.19
36.8	864.06
37.6	863.75
39.0	863.70
39.9	863.71
40.9	863.94
42.2	864.25
44.1	864.64
46.2	865.18
47.0	865.27
49.1	865.26
51.9	865.40
60.0	865.50
66.2	865.32
72.4	865.19
72.5	865.67

SUMMARY DATA	
Bankfull Elevation:	865.3
Bankfull Cross-Sectional Area:	13.1
Total Cross-Sectional Area:	12.4
Bankfull Width:	17.3
Flood Prone Area Elevation:	867.0
Flood Prone Width:	>72
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	0.8
W / D Ratio:	22.8
Entrenchment Ratio:	4.2
Bank Height Ratio:	1.0

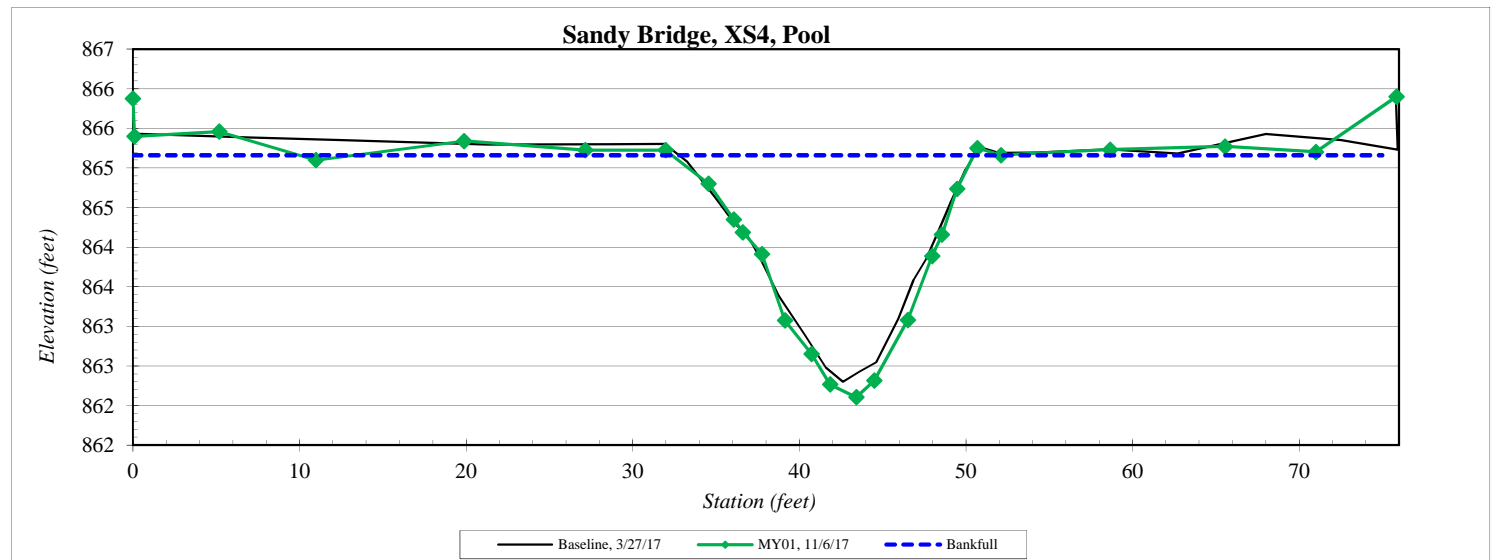


River Basin:	Broad
Project Name	Sandy Bridge
XS ID	XS4
Drainage Area:	837 acres
Date:	11/6/2017
Field Crew:	T. Seelinger, J. Sullivan

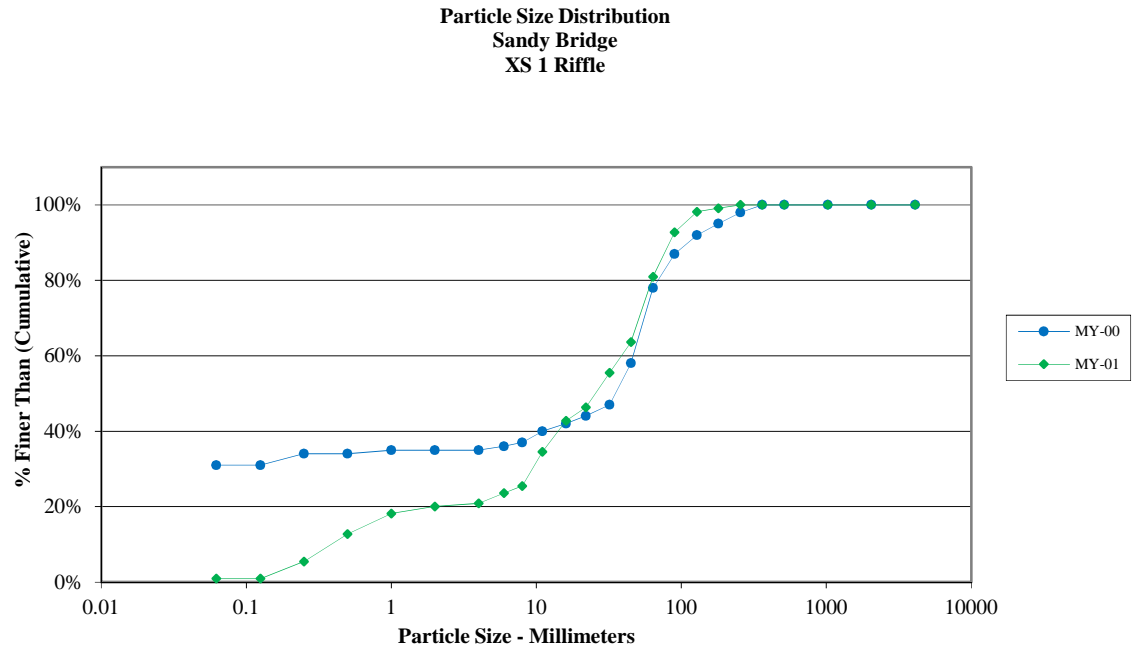


Station	Elevation
0.0	865.87
0.1	865.40
5.2	865.46
11.0	865.10
19.9	865.34
27.2	865.22
32.0	865.22
34.6	864.80
36.1	864.35
36.6	864.19
37.8	863.91
39.1	863.07
40.7	862.65
41.9	862.27
43.4	862.10
44.5	862.31
46.5	863.08
48.0	863.89
48.6	864.16
49.5	864.74
50.7	865.25
52.1	865.16
58.7	865.23
65.6	865.27
71.0	865.20
75.9	865.90

SUMMARY DATA	
Bankfull Elevation:	865.2
Bankfull Cross-Sectional Area:	28.8
Total Cross-Sectional Area:	30.7
Bankfull Width:	18.1
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.1
Mean Depth at Bankfull:	1.6
W / D Ratio:	11.4
Entrenchment Ratio:	-
Bank Height Ratio:	-



Cross-Section 1 Riffle - MY-01			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	1
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	5
Medium	.25 - .50	N	8
Coarse	.50 - 1	D	6
Very Coarse	1 - 2	S	2
Very Fine	2 - 4		1
Fine	4 - 5.7	G	3
Fine	5.7 - 8	R	2
Medium	8 - 11.3	A	10
Medium	11.3 - 16	V	9
Coarse	16 - 22.6	E	4
Coarse	22.6 - 32	L	10
Very Coarse	32 - 45	S	9
Very Coarse	45 - 64		19
Small	64 - 90	C	13
Small	90 - 128	O	6
Large	128 - 180	B	1
Large	180 - 256	L	1
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	110
Note:			

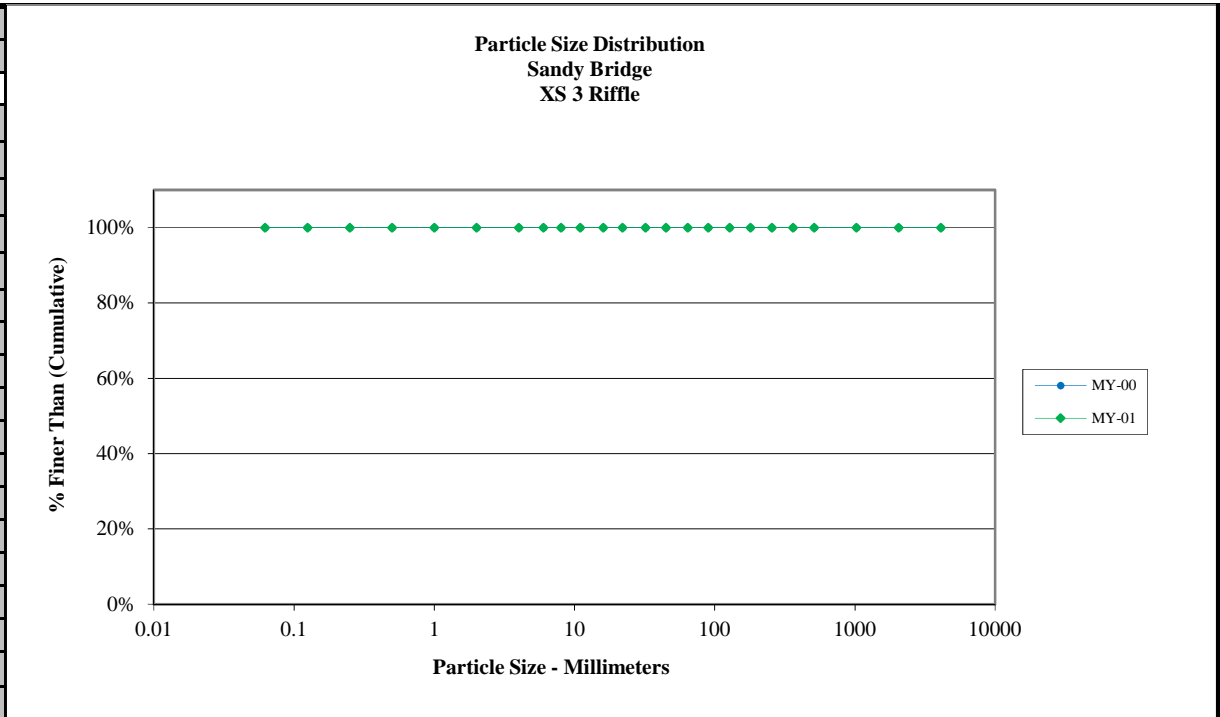


Size (mm)	
D16	0.76
D35	11
D50	26
D65	46
D84	70
D95	100

Size Distribution	
mean	7.3
dispersion	18.5
skewness	-0.39

Type	
silt/clay	1%
sand	19%
gravel	61%
cobble	19%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 3 Riffle - MY-01			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	100
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	
Coarse	.50 - 1	D	
Very Coarse	1 - 2	S	
Very Fine	2 - 4		
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	
Very Coarse	32 - 45		
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100
Note:			



Size (mm)	
D16	0.062
D35	0.062
D50	0.062
D65	0.062
D84	0.062
D95	0.062

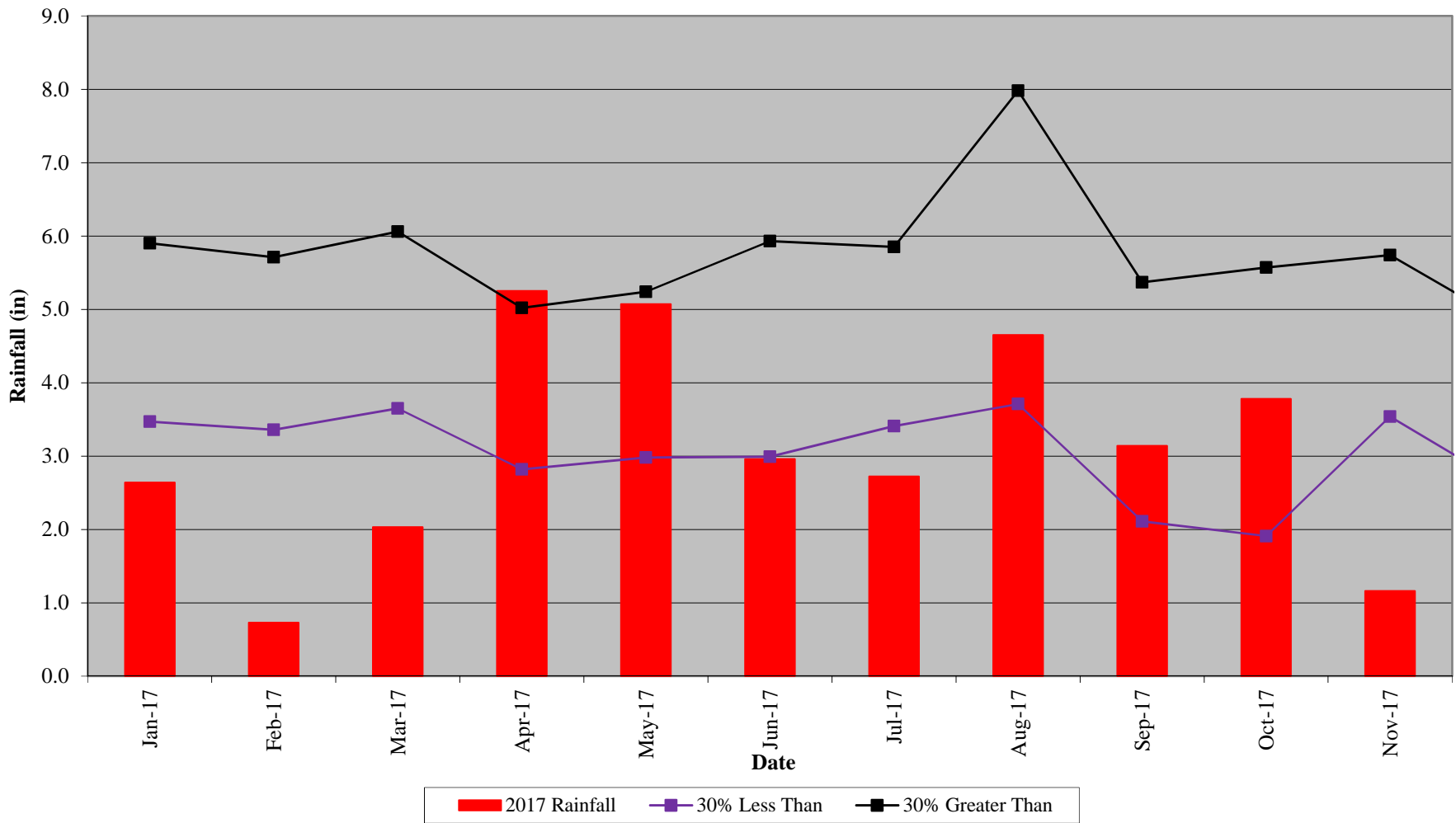
Size Distribution	
mean	0.1
dispersion	1.0
skewness	---

Type	
silt/clay	100%
sand	0%
gravel	0%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

APPENDIX E

Hydrologic Data

**Sandy Bridge Farm Restoration Site
30-70 Percentile Graph
WETS Station Name: Lake Lure 2, NC**



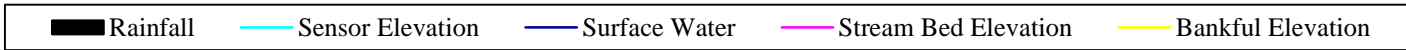
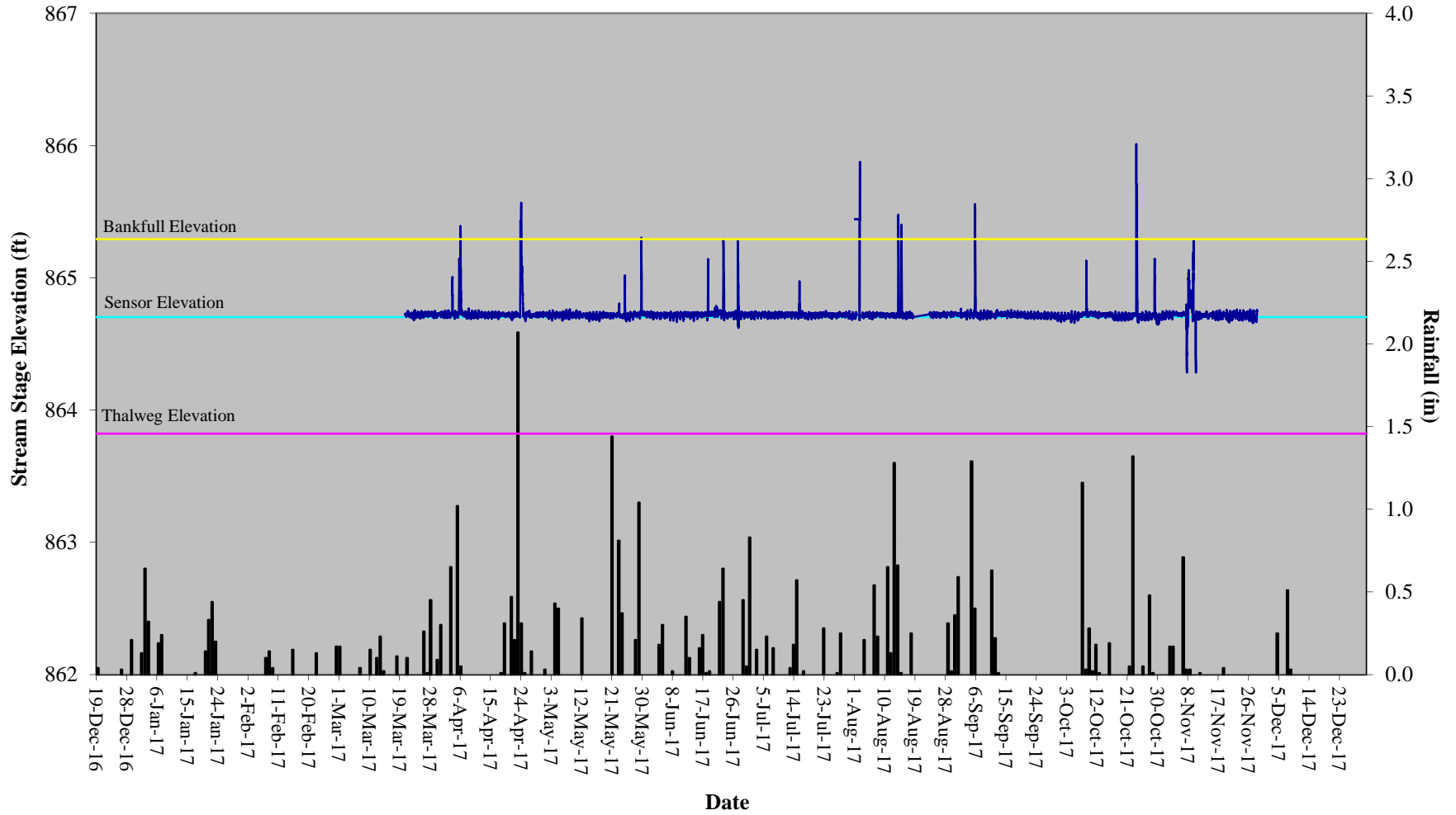
**Table 8. Verification of Bankfull Events
Sandy Bridge Farm Restoration Site, DMS Project #96920**

Date of Occurrence	Method	Photo Number
April 6, 2017	Onsite stream gauge	
April 24, 2017	Onsite stream gauge	
May 29, 2017	Onsite stream gauge	
August 3, 2017	Onsite stream gauge	
August 14, 2017	Onsite stream gauge	
August 15, 2017	Onsite stream gauge	
September 5, 2017	Onsite stream gauge	
October 23, 2017	Onsite stream gauge, photos taken on site	1

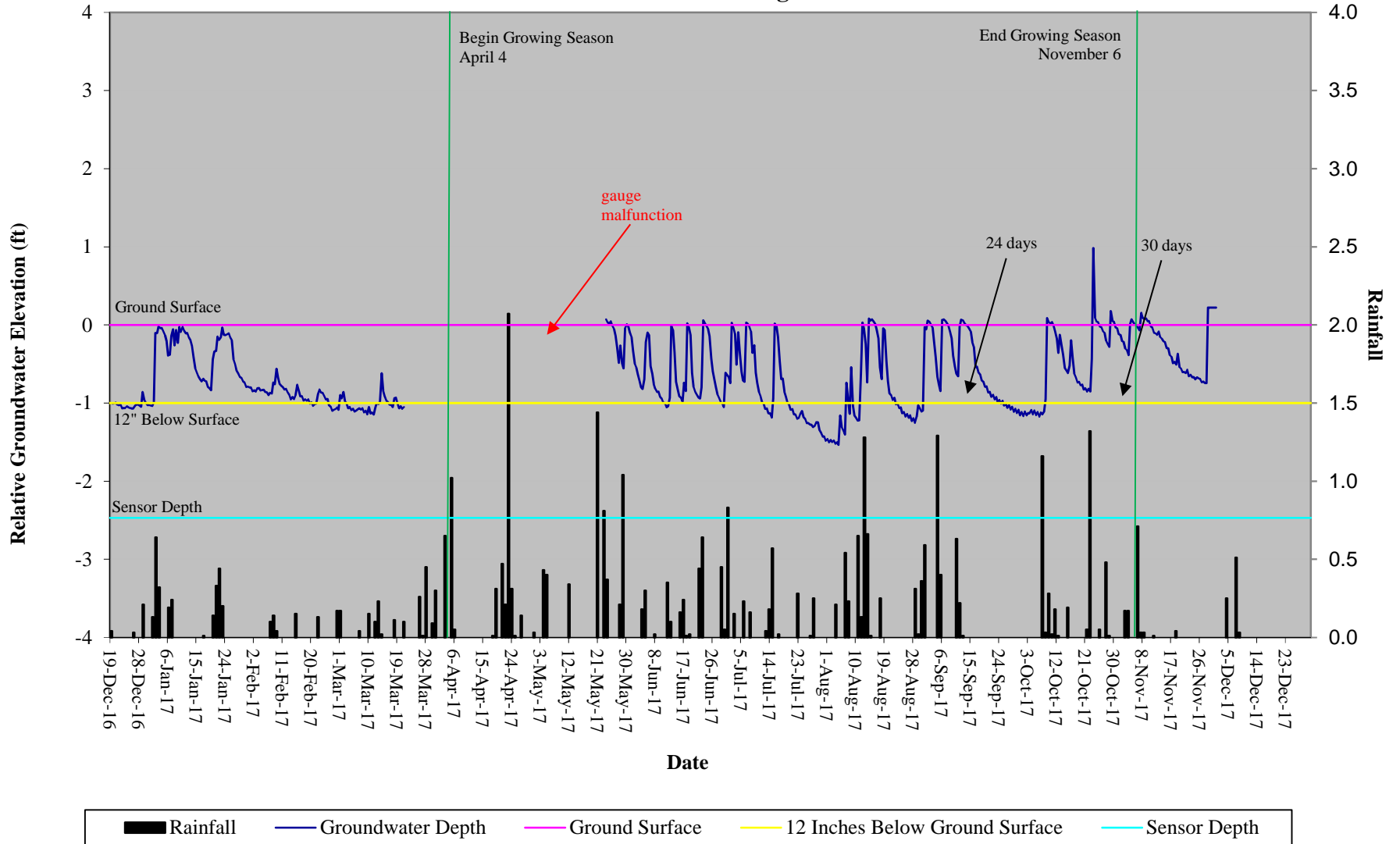


Photo 1. Sediment on plants and wrack lines above bankfull, 10/26/2017

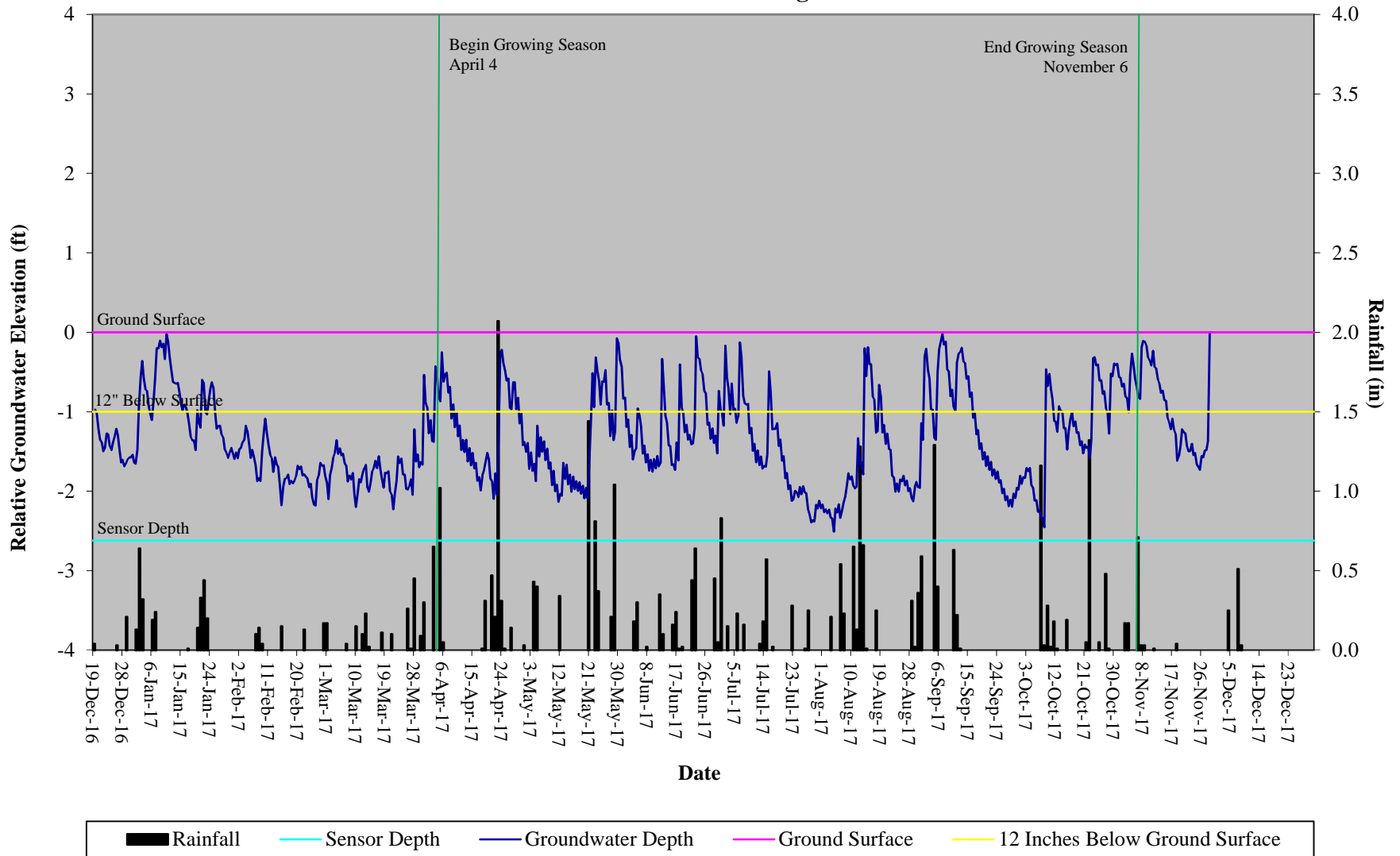
Sandy Bridge Farm Restoration Site Hydrograph Stream Gauge



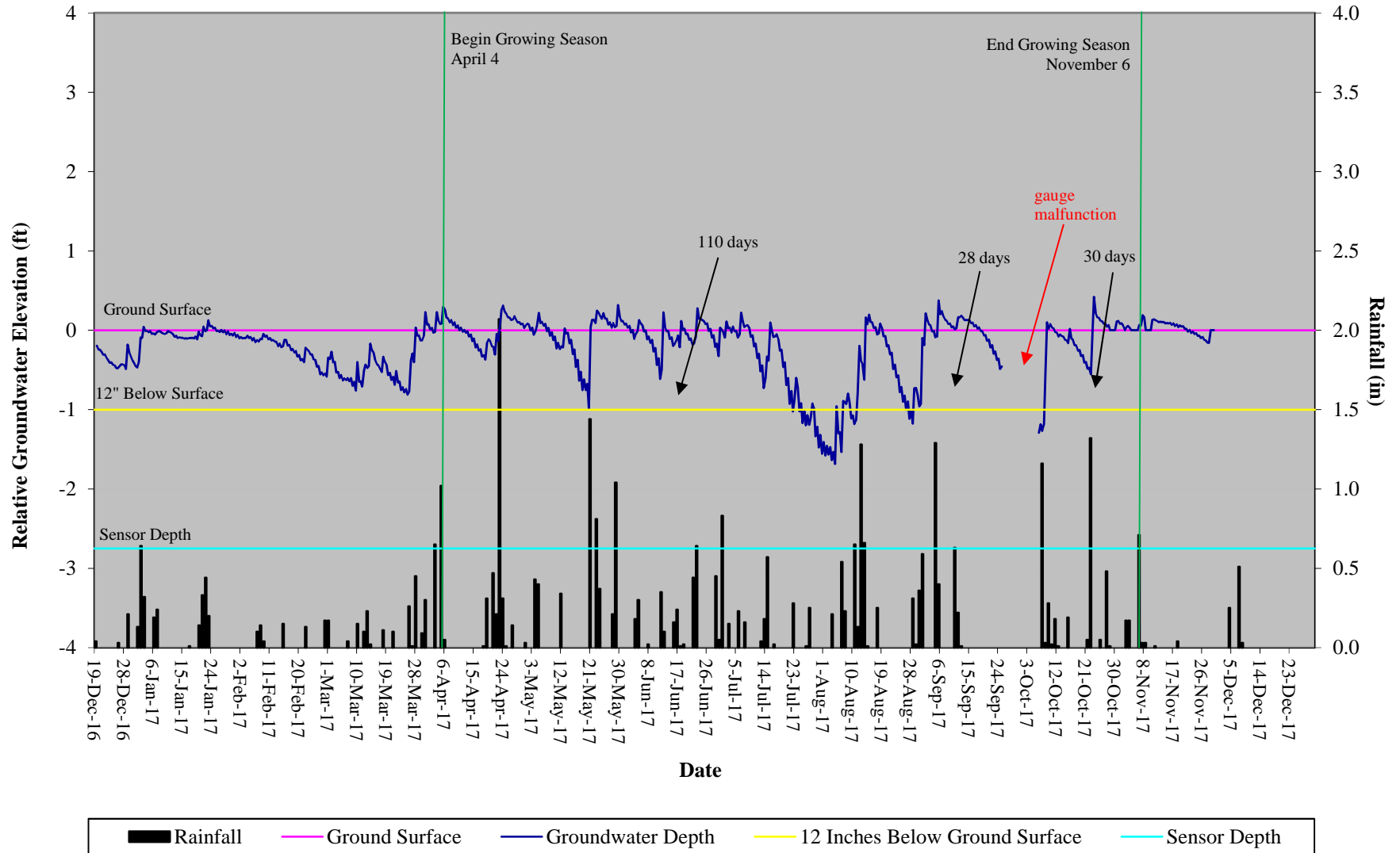
Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 1



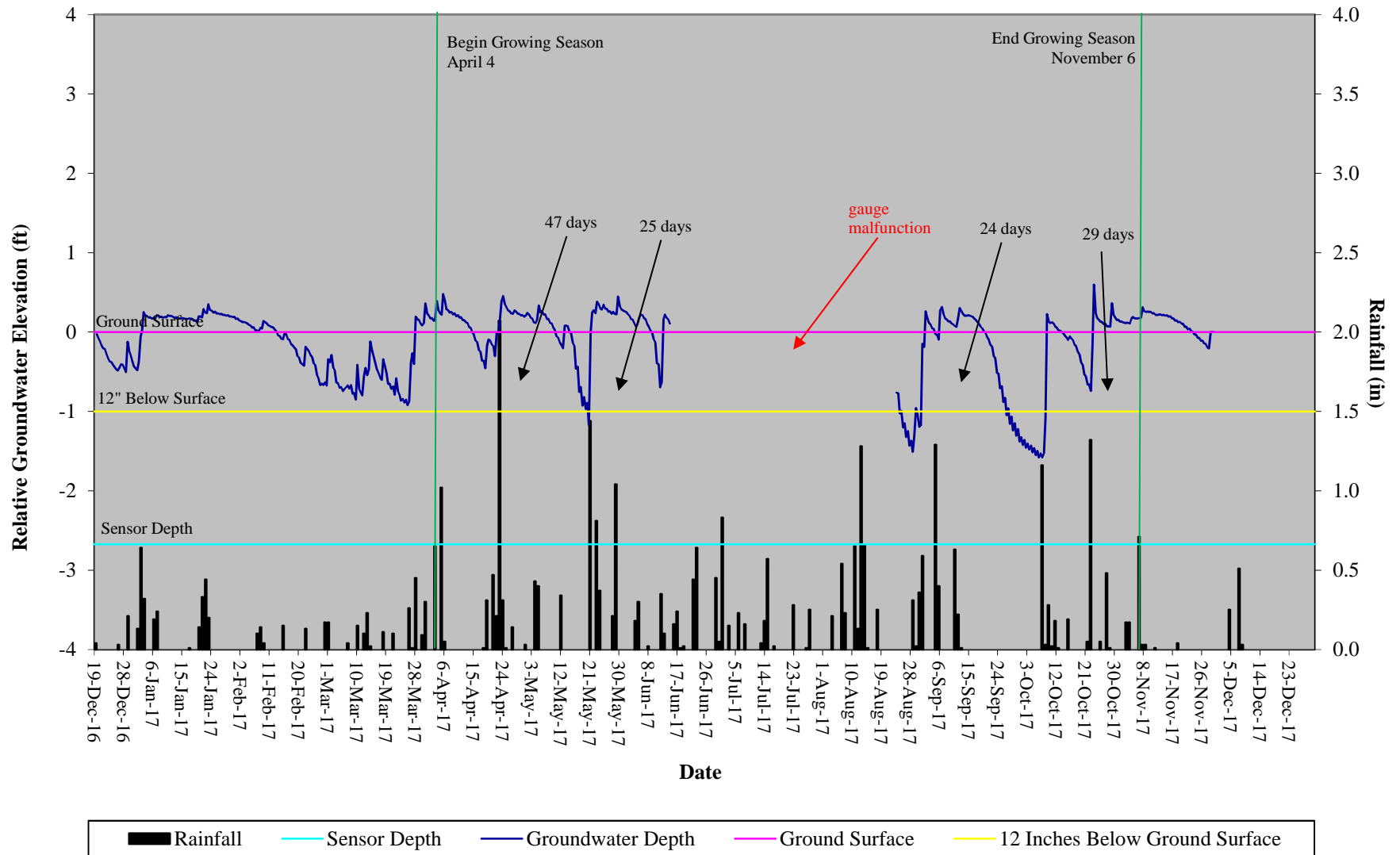
Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 2



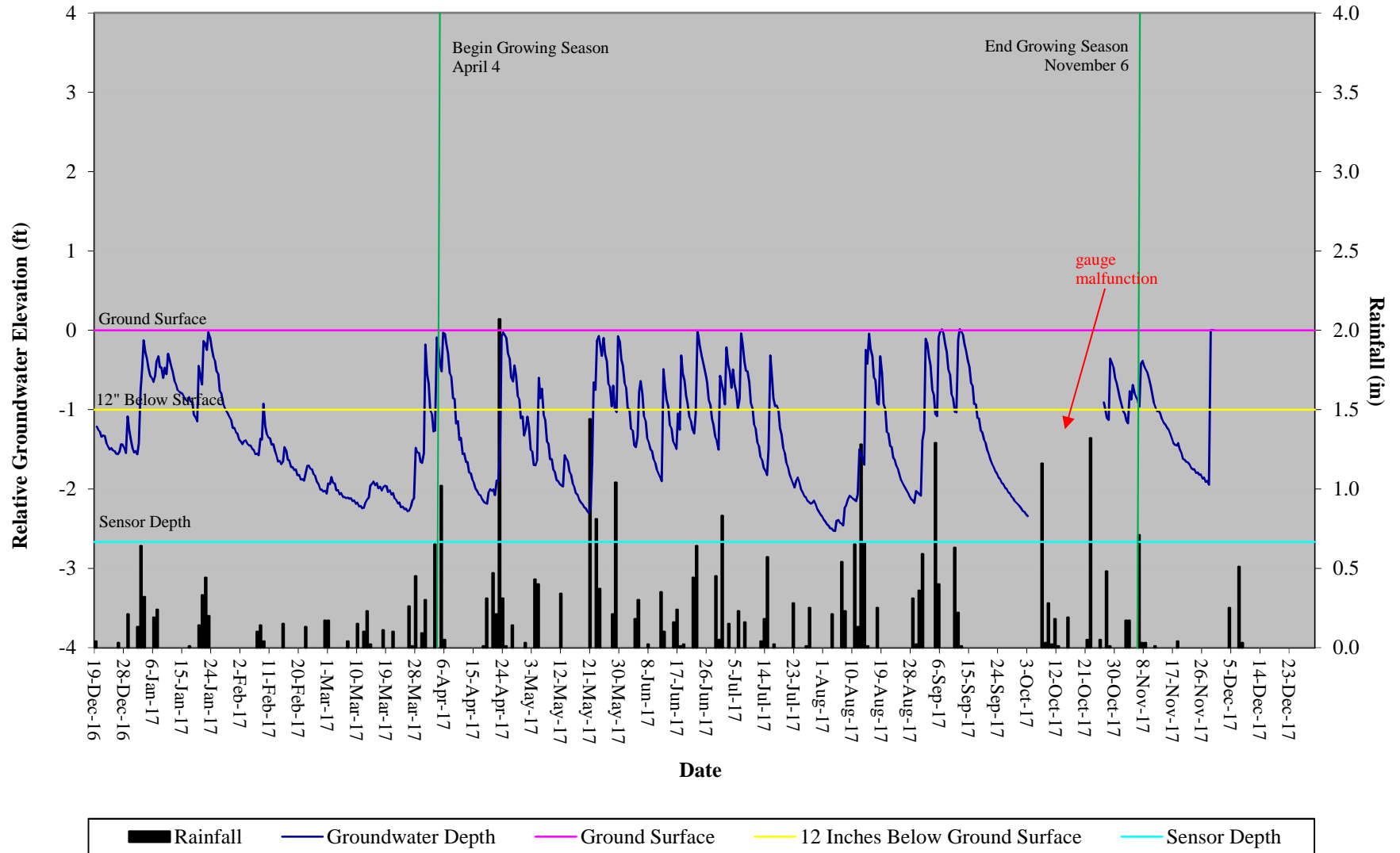
Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 3



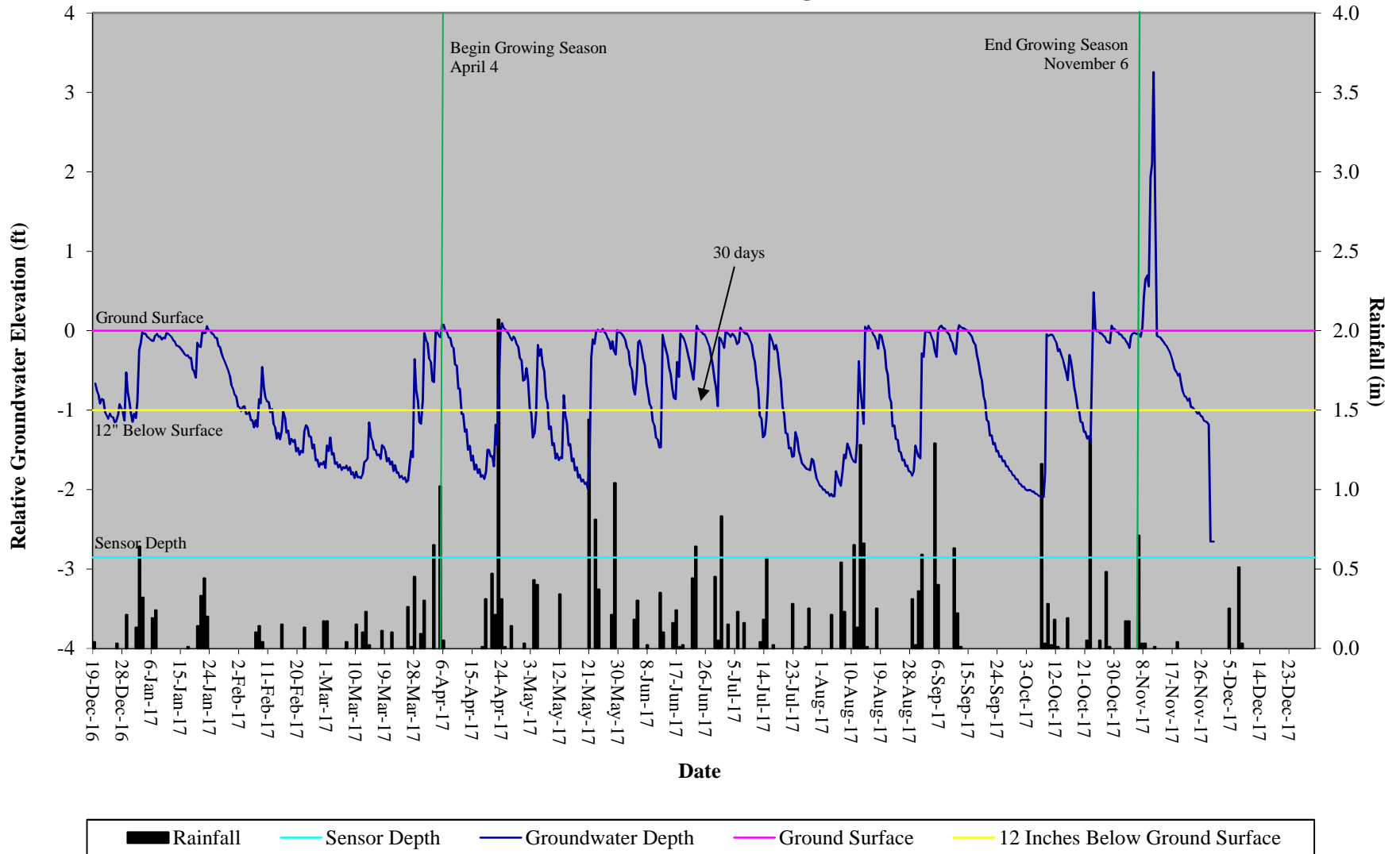
Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 4



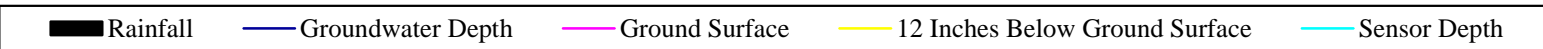
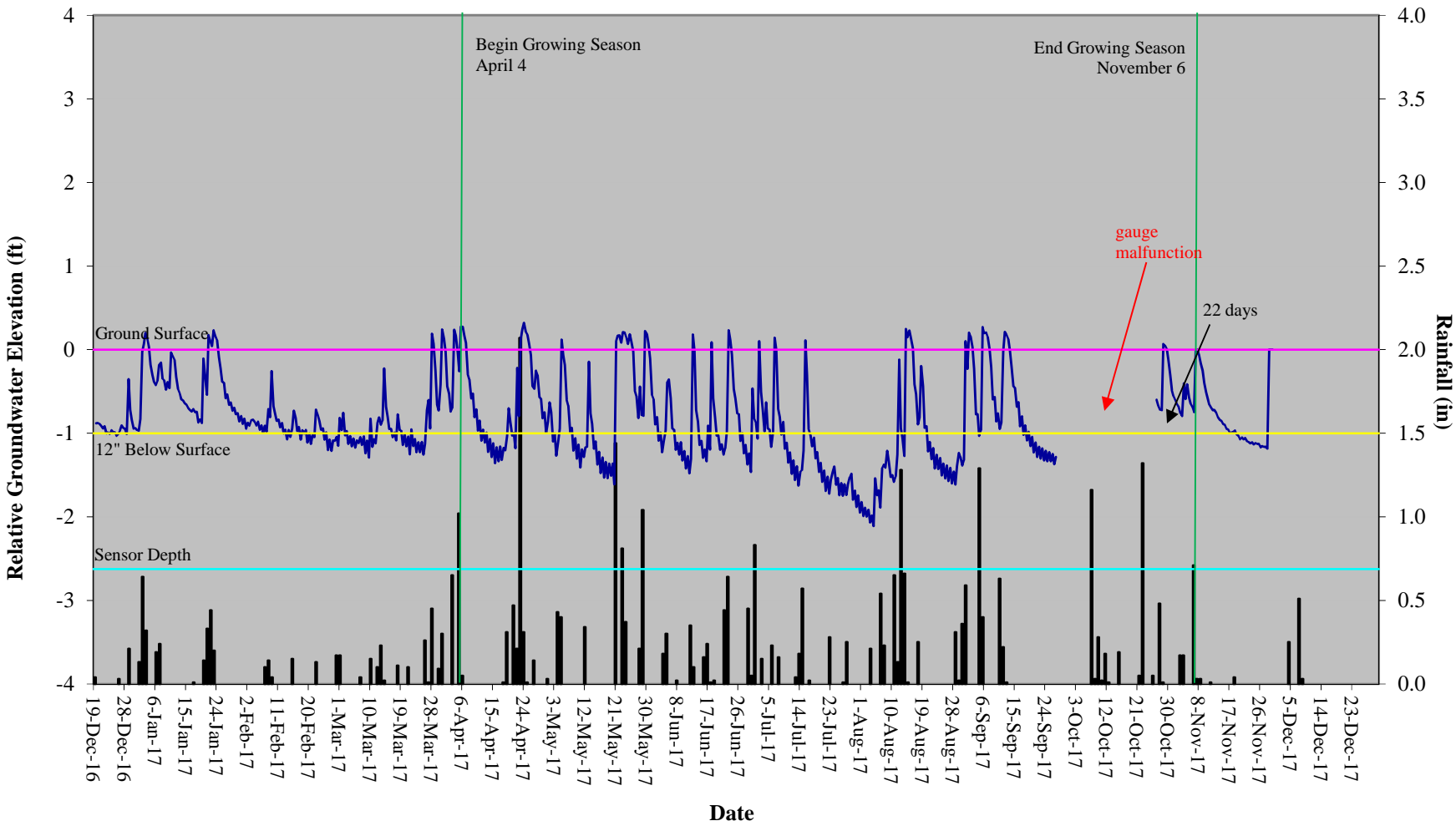
Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 5



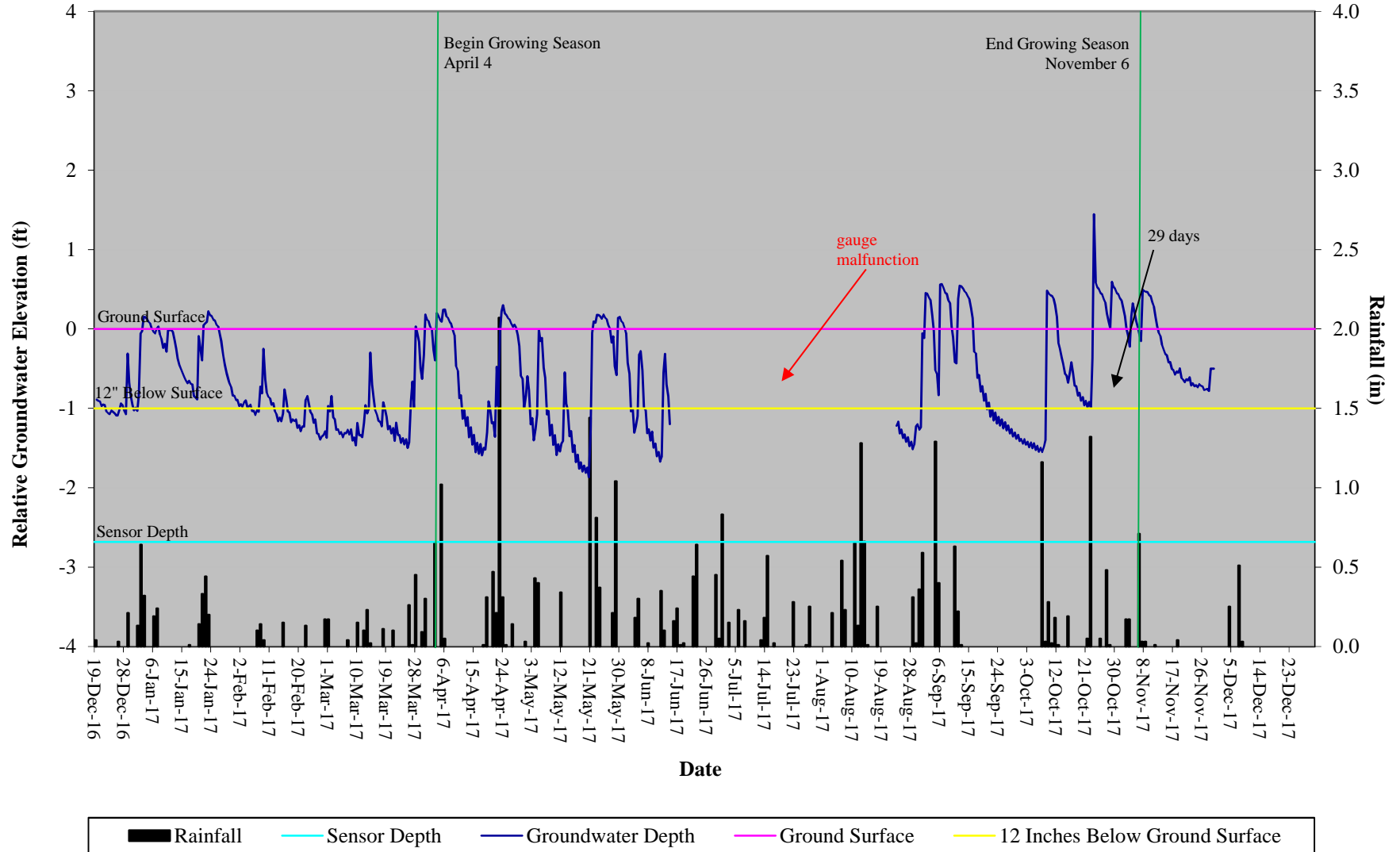
Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 6



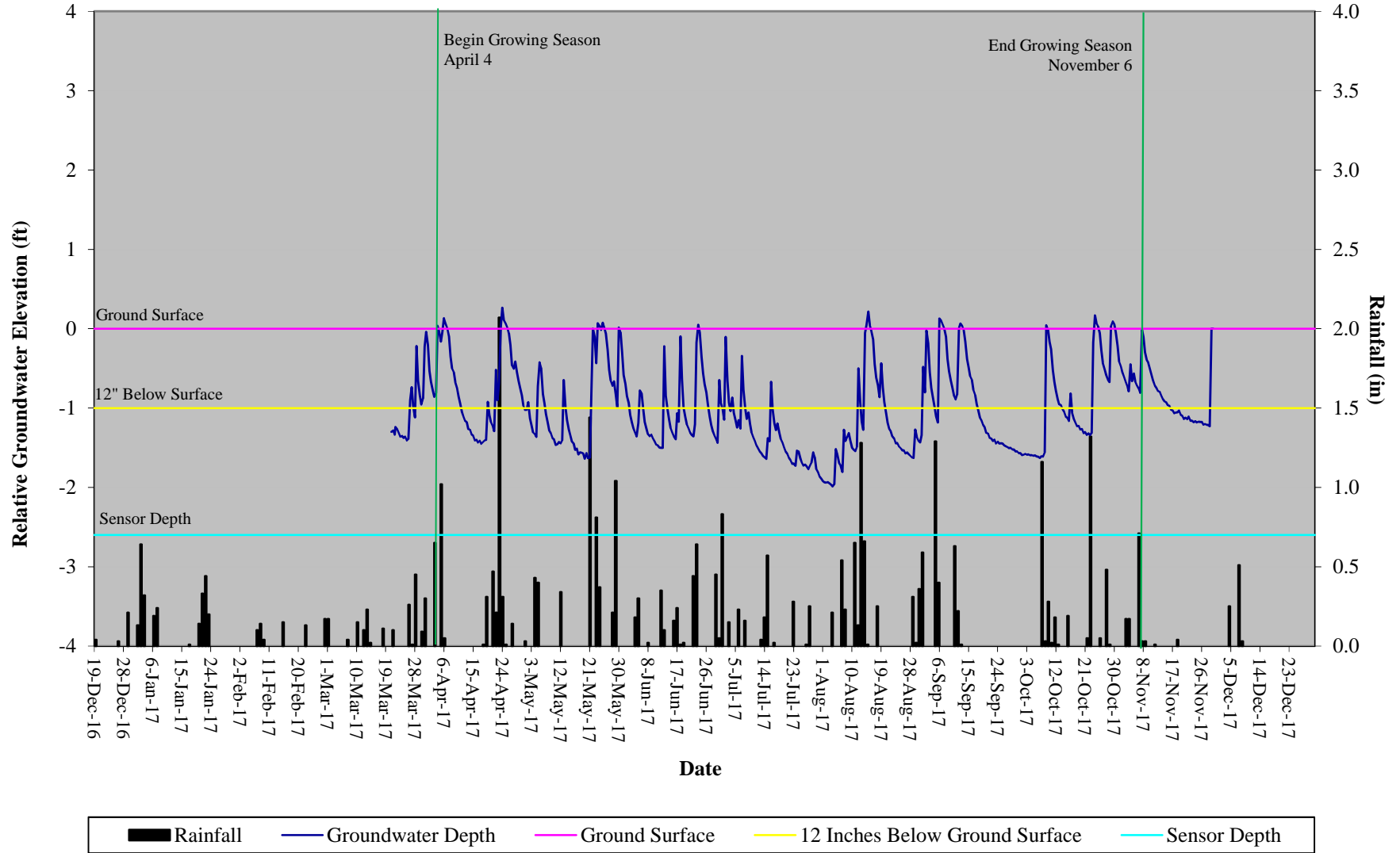
Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 7



Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 8



Sandy Bridge Farm Restoration Site Hydrograph Wetland Gauge 9



**Table 9. Wetland Hydrology Criteria Attainment
Sandy Bridge Farm Restoration Site, DMS Project #96920**

	Greater than 10% Continuous Saturation/Max Consecutive Days During Growing Season (Percentage)						
Gauge #	MY-01 2017	MY-02 2018	MY-03 2019	MY-04 2020	MY-05 2021	MY-06 2022	MY-07 2023
Gauge 1	Yes/30 (13.8%)						
Gauge 2	No/11 (5.1%)						
Gauge 3	Yes/110 (50.7%)						
Gauge 4	Yes/47 (21.7%)						
Gauge 5	No/11 (5.1%)						
Gauge 6	Yes/30 (13.8%)						
Gauge 7	Yes/22 (10.1%)						
Gauge 8	Yes/29 (13.4%)						
Gauge 9	No/15 (6.9%)						