HILLCREST BAY WETLAND RESTORATION SITE
(Contract # D04013-2)
MONITORING YEAR 6 (2010)
January 2011

Offered By and Monitored By:

EarthMark North Carolina, LLC
1960 Derita Road
Concord, NC 28027

Designed By:

Stantec Consulting, Inc.
801 Jones Franklin Road, Suite 300
Raleigh, NC 27606

Submitted To:

North Carolina Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, North Carolina 27699-1652

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

On behalf of the North Carolina Ecosystem Enhancement Program (NCEEP), EarthMark North Carolina, LLC (EarthMark) with technical assistance from Stantec Consulting, Inc. (Stantec) restored a 47-acre ditched and drained clay-based Carolina bay in Hoke County, North Carolina. The Hillcrest Bay Wetland Mitigation Site (Site) is located in the Beaver Creek Watershed of the Cape Fear River Basin (HUC 03030004). Construction of the project began on March 21, 2005 and was completed on April 15, 2005. Additional planting of the site was done in February 2006. A small replant was done in 2008. The Hillcrest Bay project will provide at least 15 non-riverine wetland mitigation units.

Hillcrest Bay in its preconstruction condition had been ditched and drained for agricultural purposes for at least 40 years. Its most current use was for agricultural (cotton) production. The Site was drained by five connected ditches that eventually flow into Beaver Creek offsite. Scurlock Elementary School sits on the southwestern edge of the bay and a young loblolly pine (*Pinus taeda*) stand borders the Site to the west. Agricultural fields occur north and east of the Site, and residential housing occurs to the south.

The goal of this wetland restoration is to restore the unique natural community associated with the clay based bays of the Sandhills Region of North Carolina. Historically, these clay-based bays differ both in hydrology and vegetation from organic/peat based Carolina bays. Restoration of Hillcrest Bay will improve filtration of nutrients and pollutants from adjacent agricultural fields, parking lots, and roads as well as recharge groundwater and increase base flow in adjacent streams.

In order to restore the Site, drainage ditches were filled using spoil material from the berms located along existing ditches. Clay plugs were used to block flow within existing ditches to interrupt historic drainage patterns and recharge groundwater within the bay. Hydrologic analysis of the site was conducted to ensure success. Data gathered from groundwater monitoring gauges supplemented the results of DRAINMOD, Pierce, and HEC-RAS. The 2-year, 5-year, and 100-year flood elevations were analyzed to examine the potential for hydrologic trespass on property occupied by the elementary school and residents located along the rim of the bay. The 100-year storm event predicted that the elevations of water during these events would have some potential for hydrologic trespass on adjacent residences unless precautions are taken in the design of the restoration. For this reason, two weirs were installed on the north end of the Site to relieve water above the 100-year storm event elevation. Data was also obtained from four reference bays and was used as guidance for the planting plan and to assess hydrologic success criteria.

The following table summarizes the construction sequence for the Hillcrest Bay Restoration Site.

Exhibit Table I. Dates of Construction

Event	Date
Begin Construction	March 21, 2005
Ripping and Seeding of Site	March 21, 2005
Filling of Ditches	March 22, 2005 through April 5, 2005
Planting of Interior Portions of Site	March 31, 2005
Installation of Clay Plugs	April 6, 2005 through April 10, 2005
Installation of Weir	April 11, 2005
Planting of Travel Lanes	April 13, 2005
Demobilization	April 15, 2005
Supplemental Planting #1	February 2006
Supplemental Planting #2	May 2008

Six 100m^2 vegetation plots were installed on-site on May 25, 2005. Survivability within these plots establishes the vegetative success of the Site. Seven groundwater gauges were installed within Hillcrest Bay, and one in a reference site. The gauges will be used to determine the hydrologic success of the Site and will be compared to the reference bay's hydroperiod if needed. Monitoring began Fall 2005, however Year 1 failed to achieve success criteria for both vegetation and hydrology, therefore monitoring was carried out in fall 2010. The site also failed to meet even partial hydrology in Year 4 (2008), the worst year since Year 1, which led to the addition of new wells and a tighter focus on the interior 15 acres of the bay. Ten groundwater gauges are now installed within Hillcrest Bay. The methodology behind the placement of these gauges will be discussed in Section 3.2.

The Sixth year monitoring was performed on October 28th, 2010. Groundwater and rain gage data were downloaded monthly until the end of October 2010 at both the Site and the reference bay, Goose Pond Bay. Gage data was downloaded and evaluated monthly, throughout the year as well. Site conditions have been extremely variable, but mostly dry throughout the last six years. To remediate problems experienced during the first year, the mitigation area was completely re-planted in February 2006. Competing herbaceous vegetation was treated with herbicide and several techniques were used to increase survival (tree tubes and tree mats). Because this is a Carolina Bay wetland, hydrology will be dependant upon rain events in the area significant enough to recharge ground water resources. On October 13th, 2009 an additional ditch plug was installed below the confluence of Ditches 1 and 2 near Photo Station 4. This area is on the outer edge of the Conservation Easement, but inside the property line.

The Mitigation Plan defined Hydrologic Success as jurisdictional hydrology for 5% of the growing season in a dry year. The growing season for this area is approximately 239 days beginning in March and ending in October. Therefore, successful hydrology will be indicated by 12 or more days meeting jurisdiction during that time period. Reference bays were examined in conjunction with monitoring of the site. Hydrologic data was downloaded from the reference gage that was installed in Goose Pond Bay. Over the next few years the hydrology will be monitored in comparison to the reference bays to determine if the hydrologic success criteria have been achieved. In 2005, no gages indicated jurisdictional hydrology, including the reference gage. In 2006, only gage 5 indicated jurisdictional hydrology, once again the reference gage did not indicate jurisdictional hydrology. In 2007, all gages indicated greater than 12 consecutive days of jurisdictional hydrology, except gage 3 and the reference gage which both indicated 8 days of jurisdictional hydrology. In 2008, the reference gage indicated firm jurisdictional hydrology in early spring, while none of the Site gages indicated jurisdictional hydrology during that time. In August and September 2008 hurricane remnants brought much needed rain all over the state, all gages responded to the September event, but none, including the reference gage, indicated the requisite 12 days of jurisdictional hydrology as a result. Distribution of ground water gages at that time included the sand rim area of the bay (Gages 3 and 4) and areas between the rim and the "bay pond". Because the areas outside of the 15-acre "bay pond" are not meeting jurisdictional hydrology, Gages 3 and 4 were relocated into the bay interior. The new well configuration now focuses on the interior of the bay which comprises the 15 acre restoration area. Details are discussed in Section 3.2. 2009 was the first year with the gages in the new configuration. Gages 1, 2, and 5, all original gages and the three historically wettest gages, demonstrated some level of hydrologic success. The reference gage also posted jurisdictional hydrology in 2009. In 2010, all site gages (except Gage 5) and the reference gage displayed jurisdictional peaks in February just prior to the start of the growing season. The reference gage continued this trend into the growing season resulting in jurisdictional hydrology. The site gages all dried out prior to the start of growing season with Gages 1 and 7 performing best with 10 consecutive days each.

2.0 PROJECT BACKGROUND

2.1 LOCATION AND SETTING

The Hillcrest Bay Site is located on a 47-acre parcel now owned by Hoke County. The Site is located east of the Town of Raeford in Hoke County. The Bay is situated north of SR 1406 (Rockfish Road) and west of SR 1408 (Club Pond Road) on the Raeford 7.5 minute topographic quadrangle (Figures 1 and 2). Scurlock Elementary School is situated along the southwestern property boundary of the site.

The Hillcrest Bay Site lies in the Cape Fear River Basin, US Geologic Survey (USGS) hydrologic unit 03030004, NC Division of Water Quality (NCDWQ) subbasin 03-06-15.

Property ownership was transferred to Hoke County in 2005. Project success is being monitored by Mid-Atlantic Mitigation and the conservation easement is held by the State of North Carolina Property Office.

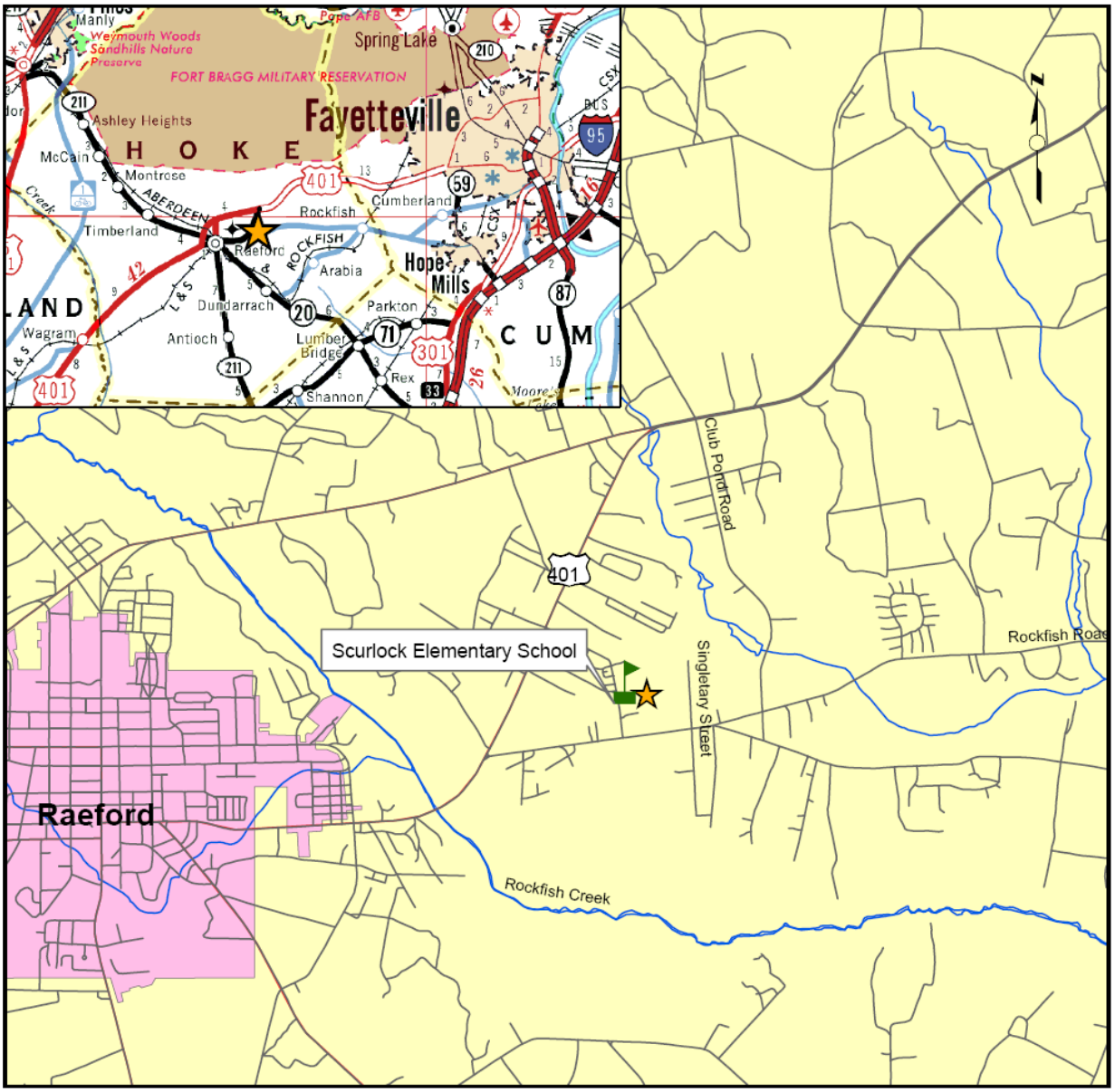
2.2 STRUCTURE AND OBJECTIVES

The Hillcrest Bay Site has a drainage area of approximately 80 acres (Figure 3 in the Mitigation Plan). Five ditches were actively draining the Site for agriculture. Two additional ditches were present, but were not well maintained and, consequently, had filled with sediment. The latter are no longer draining the Bay and are now vegetated with mature sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), and loblolly pine (*Pinus taeda*). Ditches within the bay were approximately four feet in width and four feet in depth. The main collector ditches that flowed north toward Beaver Creek were considerably deeper and wider (six feet wide and 10 feet deep) where they have been dug through the northern rim of the Bay.

The restoration of Hillcrest Bay entailed the filling of the drainage ditches present within the bay to restore the historic hydrology of the site. The restoration of the wetland hydrologic regime will, in turn, support the native plant community endemic to such clay-based bays. Reference bays were used to develop a planting plan that would initiate the restoration of the native plant community.

Land use within the watershed is a mixture of agriculture and low-density residential areas. The entire middle portion of the watershed area is currently, or very recently was, in row crop production. Agriculture comprises nearly 50 percent of the watershed. The remaining 50 percent consists of low-density residential development to the south and northwest (40 percent) and a narrow strip of disturbed, mixed forest located between the agricultural fields and residences to the northwest (10 percent).

The Hillcrest Bay Site lies in the Cape Fear River Basin, US Geologic Survey (USGS) hydrologic unit 03030004, NC Division of Water Quality (NCDWQ) subbasin 03-06-15. The Bay is located in the watershed of Beaver Creek. Beaver Creek flows into Rockfish Creek, which continues on to the Cape Fear River. The creek is listed as 'Class C' waters, indicating waters suitable for secondary recreation (NCDWQ, 2004a), and is not a CWA 303(d) listed waterbody (NCDWQ, 2004b). Visual inspection of water within the ditches revealed the presence of a considerable amount of algae, suggesting that the Site receives some nutrient input from the surrounding residential community, as well as pollutants from agricultural runoff. According to the Hoke County Environmental Health Department, Scurlock Elementary School is on the city sewer system, however, the homes located east of Scurlock Elementary, north of Rockfish Road are on septic systems. Topography around the Site suggests that the septic systems may be draining towards the ditches of the Hillcrest Bay Site. Site restoration will further help treat septic effluent prior to reaching the Cape Fear River.



NOT TO SCALE

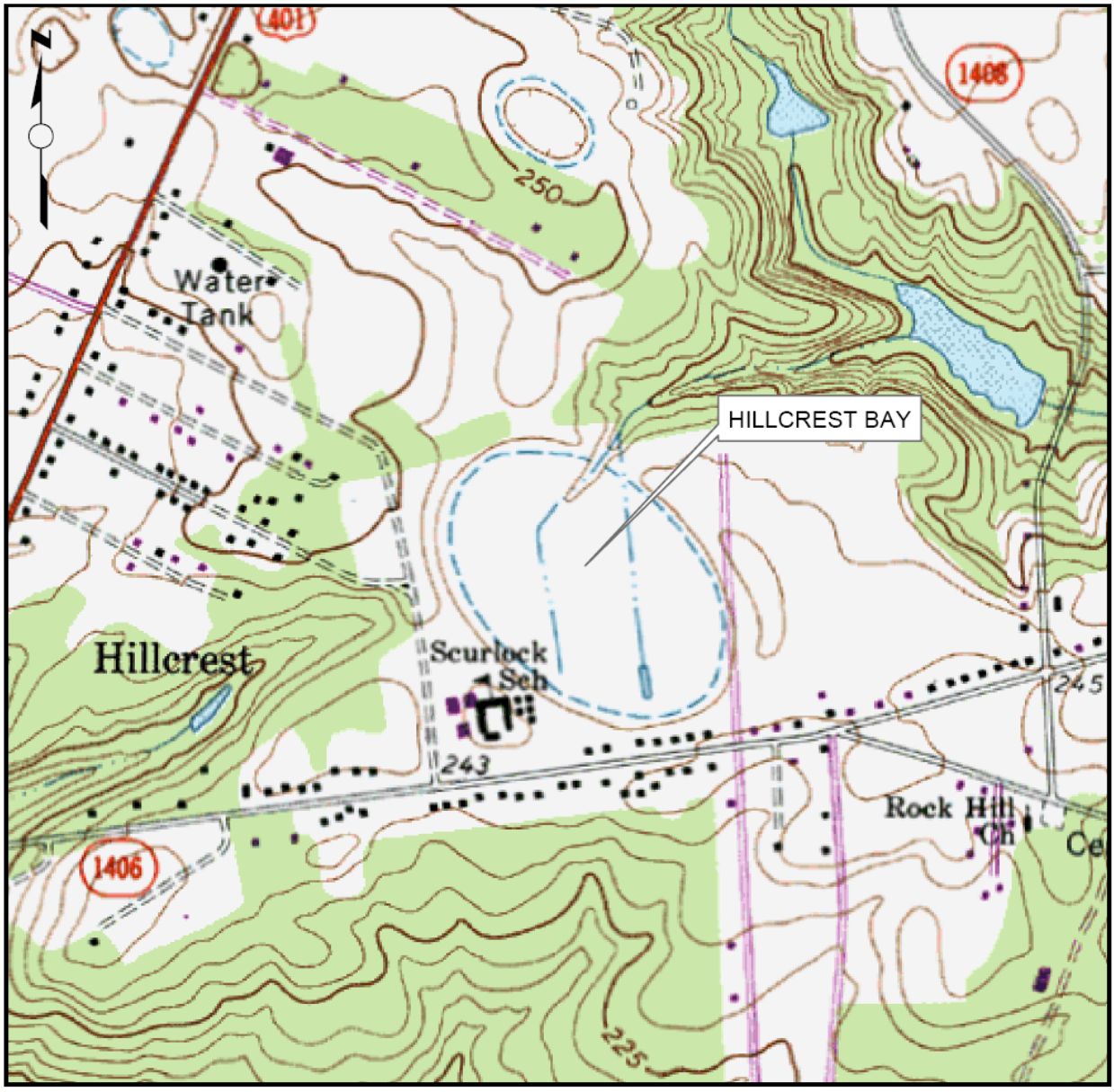
Legend

- Hoke County
- Hillcrest Bay

Stantec Consulting
Mid-Atlantic Mitigation, LLC

Hillcrest Bay Wetland Restoration
Mitigation Plan
Hoke County, North Carolina

Figure 1. Project Vicinity



Stantec Consulting
Mid-Atlantic Mitigation, LLC

Hillcrest Bay Wetland Restoration
Mitigation Plan
Hoke County, North Carolina

Figure 2. Project Location

The Cape Fear Basin is characterized by highly urban and industrialized areas around the cities of Greensboro, High Point, Burlington, Chapel Hill, and Durham in the upper part of the watershed and around Fayetteville and Wilmington in the middle and lower part (NCDWQ, 2004c). Water quality in the basin has been affected by the impacts of numerous dischargers and non-point source runoff. There is only one NPDES permitted discharger in the watershed for the Site. The Town of Raeford's Waste Water Treatment Plant is discharging three MGD into Rockfish Creek approximately 1.3 miles downstream of Hillcrest Bay. Even with this discharge, the bioclassification in Rockfish Creek has improved from Good-Fair in 1993 to Good in 2003 (NCDWQ, 2004c).

2.3 PROJECT HISTORY AND BACKGROUND

Exhibit Table II. Project Objectives Table

Segment/Reach ID	Objectives	Linear Feet or Acreage	Comment
Hillcrest Bay	Restoration	15 acres	Bay interior
Buffer	Restoration	32 acres	Bay rim

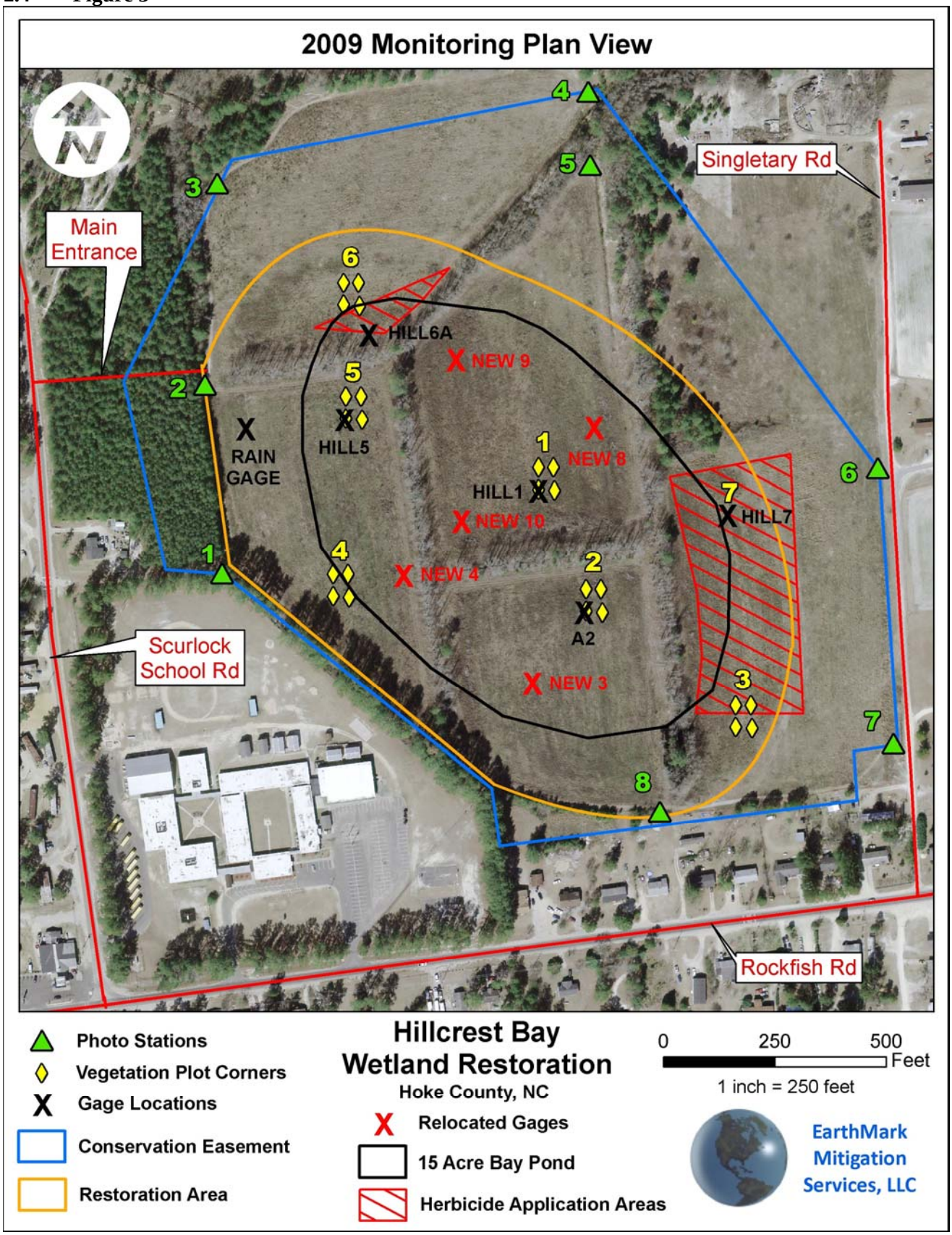
Exhibit Table III. Project Activity and Reporting History

Activity or Report	Calendar Year of Completion or Planned Completion	Actual Completion Date
Restoration Plan	February 2005	February 2005
Mitigation Plan	June 2005	June 2005
Construction	March 2005	April 2005
Temporary and Permanent S&EC mix applied to entire project area	March 2005	April 2005
Bare Root Plantings	April 2005	April 2005
As-Built report	June 2005	June 2005
Initial – Year 1 monitoring Report	September 2005	September 2005
Supplemental Planting #1	N/A	February 2006
Year 2 Monitoring Report	October 2006	October 2006
Year 3 Monitoring Report	October 2007	October 2007
Year 4 Monitoring Report	October 2008	October 2008
Supplemental Planting #2	N/A	May 2008
Year 5 Monitoring Report	October 2009	November 2009
Year 6 Monitoring Report	October 2010	January 2011
Year 7 Monitoring/ Hydrology Report	Spring or Fall 2011	

Exhibit Table IV. Project Contact Table	
Project Manager Rich Mogensen	 Mid-Atlantic Mitigation, LLC 1960 Derita Road Concord, North Carolina 28027
Designer Tim Baumgartner	 Stantec Consulting, Inc. 801 Jones Franklin Road, Suite 300 Raleigh, North Carolina 27606
Construction Contractor Michael Granson	 Shamrock Environmental Corporation P.O. Box 14987 Browns Summit, North Carolina 27214
Planting Contractor Dwight McKinney	 Carolina Silvics 908 Indian Trail Road Edenton, North Carolina 27932
Monitoring Performers Christine Cook and David Horne	 Mid-Atlantic Mitigation, LLC 1960 Derita Road Concord, North Carolina 28027

Exhibit Table V. Project Background Table	
Project County	Hoke
Drainage Area	80 Acres
Drainage cover estimate (%)	50% Residential and Commercial
	50% Agricultural
Physiographic Region	Piedmont
Ecoregion	Atlantic Southern Loam Plains
Wetland Type	Clay-based Carolina Bay
Cowardin Classification	PFOE
Dominant soil types	McColl Loam
Reference site ID	Goose Pond Bay
USGS HUC for Project and Reference	Project – 03030004; Reference - 03040203
NCDWQ Sub-basin for Project and Reference	Project 03-06-15;
% of project easement fenced	None

2.4 Figure 3


2009 Monitoring Plan View
Singletary Rd
Main Entrance
Scurlock School Rd
Rockfish Rd
HILL6A
NEW 9
HILL5
RAIN GAGE
HILL1
NEW 8
NEW 10
HILL7
NEW 4
A2
NEW 3
Photo Stations
Vegetation Plot Corners
Gage Locations
Conservation Easement
Restoration Area
Hillcrest Bay Wetland Restoration
Hoke County, NC
Relocated Gages
15 Acre Bay Pond
Herbicide Application Areas
0 250 500 Feet
1 inch = 250 feet
EarthMark Mitigation Services, LLC

* All coordinates are NAD83 Feet

Exhibit Table VI. Groundwater Gage Locations		
GAGE NAME	**NORTHING**	**EASTING**
Hill 1	450647.757	1947265.452
A2	450392.144	1947361.305
~~A3~~	~~450116.862~~	~~1947718.567~~
New 3	450222.654	1947247.036
~~A4~~	~~450358.361~~	~~1946842.579~~
New 4	450464.929	1946830.785
A5	450824.825	1946830.785
~~A6~~	~~451095.286~~	~~1946826.596~~
Hill 6A	451004.187	1946879.716
Hill 7	450567.997	1947649.191
New 8	450795.778	1947411.158
New 9	450949.479	1947077.704
New 10	450587.369	1947090.729
REFERENCE GAUGE	412088.484	1970586.301

Exhibit Table VII. Vegetative Plot Locations			
PLOT NAME	**CORNER**	**NORTHING**	**EASTING**
1	SOUTHWEST	450647.757	1947265.452
	SOUTHEAST	450649.267	1947294.462
	NORTHWEST	450679.136	1947264.119
	NORTHEAST	450679.246	1947297.660
2	SOUTHWEST	450392.144	1947361.305
	SOUTHEAST	450395.209	1947390.554
	NORTHWEST	450420.501	1947357.121
	NORTHEAST	450425.304	1947385.113
3	SOUTHWEST	450116.862	1947718.567
	SOUTHEAST	450120.614	1947744.164
	NORTHWEST	450146.589	1947713.052
	NORTHEAST	450151.292	1947741.291
4	SOUTHWEST	450358.361	1946842.579
	SOUTHEAST	450359.633	1946878.293
	NORTHWEST	450391.017	1946839.244
	NORTHEAST	450390.707	1946868.286
5	SOUTHWEST	450824.825	1946830.785
	SOUTHEAST	450828.675	1946863.150
	NORTHWEST	450855.395	1946829.126
	NORTHEAST	450857.607	1946858.865
6	SOUTHWEST	451095.286	1946826.596
	SOUTHEAST	451097.566	1946854.836
	NORTHWEST	451123.635	1946822.248
	NORTHEAST	451127.353	1946851.780

Exhibit Table VIII. Photo Station Locations		
STATION NUMBER	**NORTHING**	**EASTING**
1	450487.259	1946575.702
2	450918.781	1946501.761
3	451333.583	1946507.378
4	451553.001	1947376.249
5	451370.668	1947379.959
6	450823.779	1948027.547
7	450065.682	1948042.086
8	449930.666	1947534.274

3.0 PROJECT CONDITION AND MONITORING RESULTS

3.1 VEGETATION ASSESSMENT

3.1.1 Soil Data

Exhibit Table IX. Preliminary Soil Data					
Series	**Max Depth (in.)**	**% Clay on Surface**	**K**	**T**	**OM %**
McColl loam (Mc)	72	10 to 30	0.24	5	1-8
Autryville loamy sand (AuA)	80	0 to 14	0.1	4	0.5-1
Wagram loamy sand (WaB)	72	0 to 14	0.15	5	0.5-2

3.1.2 Vegetative Problem Areas

Exhibit Table X. Vegetative Problem Areas		
Feature/Issue	**Station # / Range**	**Probable Cause**
Invasive Vegetation	Throughout the bay	Scattered sweet gum , large stand around Gage 7 (not invasive, but may create monoculture) Treated with herbicide in 2009
	Bay entrance	Mimosa – small population significantly reduced by herbicide applications in 2009

As noted in previous monitoring reports, herbaceous plants are present throughout the Bay and compete with the planted trees and shrubs for resources. Initial growth of *polygonum* was replaced by other native forbs including dog-fennel (*Eupatorium cpillifolium*), golden rod (*Solidago sp*.), daisy fleabane (*Erigeron strigosus*) and some brambles (*rubus sp.*). These species are still prevalent in the plots

and throughout the site. Thick herbaceous plant growth will continue to be present until the trees and shrubs begin to provide shaded canopy cover. Although the herbaceous plants are not helpful, they are not considered invasive and will be addressed each monitoring year as necessary. Mimosa at the front entrance and sweet gum trees in the area between Vegetation Plot 3 and Monitoring Gage 7, and in the area around Vegetation Plot 6 were treated with herbicide in June 2009 and areas missed in the first treatment were treated in September 2009. Several individuals of *Baccaris halimifolia* were noted in the area of Plots 5 and 6. *Baccharis* can be mildly invasive but has not continued to spread significantly and does not exist in large numbers. Loblolly pine, a desirable native, has colonized the sand rim areas of the bay, particularly around Veg Plot 4, in great numbers. Growth of Loblolly Pines has not hampered the growth of the other species, planted or volunteer.

3.1.3 Stem Counts

Six vegetation survival plots were established within Zones 1 and 2 of Hillcrest Bay on May 25, 2005. Each plot encompasses $100m^2$ (10m x 10m). Success of the vegetation at Hillcrest Bay will be achieved if 320 stems per acre remain after 3 years. A total of 260 stems per acre must survive after five years. Only those species that were planted within, and are desirable on the Site will be counted. Other volunteers and/or invasive species will be noted, but will not figure into the yearly stem count requirements.

On October 28th, 2010, the Sixth year vegetative monitoring was performed on the established vegetative plots. Live planted species that could be identified were noted. Initial totals for Exhibit Table XIIa include counts done after planting in February 2006 and a small planting done in April of 2008. The 2008 planting consisted of approximately 35 of each of *Magnolia virginiana* and *Taxodium ascendens* were planted within and in the area of the vegetation plots. Plant counts from 2008 monitoring were used to slightly update the initial count numbers to determine percent survival.

Exhibit Table XI. Hillcrest Bay Supplemental Planting (02 – 2006)

Zone 1 Plantings			
1030	*Taxodium ascendens*	"Pond Cypress"	bareroot seedling
650	*Cyrilla racemiflora*	" TiTi"	bareroot seedling
323	*Nyssa biflora*	"Swamp Tupelo"	bareroot seedling
350	*Nyssa biflora*	"Swamp Tupelo"	1 gallon
1000	*Pinus serotina*	"Pond Pine"	tubeling
230	*Persea borbonia*	"Redbay"	bareroot seedling
200	*Cephalanthus occidentalis*	"Buttonbush"	1gallon
Zone 2 Plantings			
100	*Lyonia lucida*	"Fetterbush"	tubeling
322	*Nyssa biflora*	"Swamp Tupelo"	bareroot seedling
535	*Aronia arbutifolia*	"Red chokeberry"	1 gallon
415	*Magnolia virginiana*	"SweetBay"	bareroot seedling
169	*Magnolia virginiana*	"SweetBay"	1gallon
30	*Clethra alnifolia*	"Sweetpepper bush"	1 gallon
Zone 3 Plantings			
500	*Quercus laevis*	"Turkey Oak"	bareroot seedling
500	*Quercus marilandica*	"Blackjack Oak"	bareroot seedling
500	*Quercus stellata*	"Post Oak"	bareroot seedling
Total 6,854			

Overall, 74 of 111 stems were counted which equals a survival percentage of 67% and an average of 499 stems per acre. All plots are above 320 stems per acre except Plot 3 which was counted at 243 stems per acre. The goal for Year 6 is 260 stems per acre and Plot 3 misses this goal by only 17 planted stems. Additionally, two desirable volunteers a *Cornus Florida* and a *Prunus serotina* are present in the plot bringing the count to 323 stems per acre. Species diversity for all plots and zones averages 5 woody species per plot. All stems counted are planted individuals.

Exhibit Table XIIa: Stem Counts for Planted Species Arranged by Plot

Species	Plots						Initial Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals	Year 5 Totals	Year 6 Totals	Survival %
	1	2	3	4	5	6								
Aronia arbutiflora	6	1	1	6	6	4	33	0	21	21	20	24	23	70%
Cephalanthus occidentalis		1	1		1		6	0	6	4	2	3	1	17%
Clethra alnofolia							2	0	0	0	0	0	0	0.0%
Cyrilla racemiflora			3		2		3	0	4	4	5	5	4	>100%
Diospyros virginiana	1		1				2	1	0	0	0	2	1	50%
Lyonia lucida							1	0	1	1	0	0	1	100.0%
Magnolia virginiana	1		2				11	1	10	0	5	3	2	18%
Nyssa biflora		1	1	1	1	1	13	0	4	5	3	5	6	46%
Persea borbonia							3	0	7	1	1	0	2	67%
Pinus serotina				4	5	2	14	0	12	12	12	9	13	93%
Quercus laevis		1					2	0	0	0	1	1	1	50.0%
Taxodium ascendens	5	4	6	4	3	2	21	1	8	4	21	24	20	95%
Totals	13	8	15	15	18	9	111	3	73	52	70	76	74	67%
Percent survival	-	-	-	-	-	-	-	10%	70%	50%	63%	68%	67%	
Stems per acre	647	324	243	607	688	486	749	-	492	351	472	513	499	

Table XIIb shows volunteer stems (both desirable and undesirable) counted within the plots. *Liquidambar styraciflua* and *Pinus taeda* tend to form dense thickets in the sand rim areas of the site, but are also present to a lesser degree within the bay pond area. Neither species is technically considered invasive however herbicide treatments were applied to the densest sweet gum stands to avoid creation of a monoculture. High numbers of *L. styraciflua* were noted in Plots 2, 3 and 6. High numbers of *P. taeda* were noted in Plot 4. All other volunteer species are either reasonable in number and/or desirable species. A slight adjustment has been made to the numbers from previous years based on the numbers of *P. serotina* vs. *P. taeda*. Trees of significant size and the distinguishable features of the pond pine were counted as such and held to numbers equal to or lower than baseline counts. All pine volunteers were identified and counted as loblolly pine. The vegetation survey data is included in Appendix A.

Exhibit Table XIIb: Stem Counts for Volunteer Species Arranged by Plot												
	Plots						Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals	Year 5 Totals	Year 6 Totals
Species	1	2	3	4	5	6						
Acer rubrum			2									2
Baccharis halimifolia					3	3	0	0	0	5	4	6
Catalpa speciosa						1						1
Cornus florida			1				0	0	0	0	1	1
Ligustrum sinese							0	0	0	1	0	0
Liquidambar styraciflua	6	17	7	3	8	18	43	48	44	38	57	59
Pyrus calleryana		3	7	3	2		2	2	6	10	11	15
Nyssa sylvatica							1	0	0	0	2	0
Pinus palustris							0	0	4	3	0	0
Pinus taeda	9	4	6	40	8	3	0	0	5	23	47	72
Platanus occidentalis			1				0	3	1	1	1	0
Populuds deltoides							0	1	0	0	0	0
Prunus serotina		3	1	1	1		0	0	0	0	2	6
Salix nigra		1					0	0	1	1	1	1
Totals	10	24	17	47	14	12	46	54	61	82	127	159

Exhibit Table XIIc: Stem Counts by Year

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Site Average
Mon. Y1 (05)	40	40	0	0	0	0	**14**
Mon. Y2 (06)	850	202	242	688	728	647	**559**
Mon. Y3 (07)	364	202	283	728	445	364	**398**
Mon. Y4 (08)	485	405	405	445	607	607	**493**
Mon. Y5 (09)	525	323	606	606	727	363	**525**
Mon. Y6 (10)	647	324	243	607	688	486	**499**

Blocks highlighted in red indicate failure to meet established success criteria. The latest, small replant was done in the spring of 2008 therefore three years of vegetation success are now documented. At this stage of the project, a replant would only be considered if stems per acre were to drop below 260. However, as mentioned previously Plot 3 only missed this goal by one stem and desirable volunteers are present. Assuming hydrologic monitoring will continue into 2011, additional vegetation monitoring will be done, particularly with a focus on monitoring of invasive, aggressive or exotic species.

3.1.4 Precipitation and Drought Information

Data from the onsite rain gage, which was installed on May 9th, 2006 was compared to data from several CRONOS gages for quality check purposes each year (2006 – 2010) and found to be reliable. This data, as presented in Table XIII, has been compared to monthly normal precipitation ranges for the Fayetteville area, northeast of the site and reference. Fayetteville is the closest area with an available, updated USDA-NRCS WETS table. Fayetteville is used by NRCS for both the Cumberland and Hoke (Hillcrest Bay site) county soil surveys. The Laurinburg area, southwest of the site and reference, in Scotland County was included for a general reference. Updated WETS tables for Lumberton in Robeson County, where the

Goose Pond reference site (Reference Site) is located, were not available, but an older version from the Soil Survey was used. However, the reference site is also closer to Fayetteville than Lumberton or Laurinburg. Figure 4 shows each of these locations in relation to both the project site and reference bay. A table showing the normal ranges is located in Appendix B.

Exhibit Table XIII: Monthly Precipitation - Onsite Rain Gage

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	3.55	4.77	2.29	0.89	6.18	5.21	4.67	4.44	7.06	**.39**			
2009	1.99	3.11	3.80	1.83	3.54	0.67	**-**	**-**	**2.19**	1.87	4.4	4.17	-
2008	1.69	3.09	3.3	2.99	3.23	3.62	3.69	6.44	8.51	1.48	4.97	1.78	44.79
2007	3.14	2.19	3.25	3.22	0.65	5.33	1.59	1.17	2.45	3.74	0.57	4.75	32.05
2006	-	-	-	-	**0.48**	5.16	2.58	2.13	**0.25**	**1.26**	7.54	3.02	-

	Above Average
	Dry
	Drought Conditions
-	Record incomplete

Questionable data in Table XIII is noted in bold and explained as follows:

* **May 2006** - As noted previously, the onsite rain gage was installed on May 9th, 2006. While 8 days of the May record are missing, more then an inch and a half of rainfall would be needed to bring this record within the normal range. Data from both the county and the region indicate that May 2006 exhibited moderate drought conditions.

* **September and October 2006** – A clog in the collection bucket may have resulted in a loss of collected rainfall due to evaporation or overflow. Clearance of the clog registered .06 inches of rain into the datalogger. September is noted as normal to abnormally dry in the county and regional data, while October was noted as normal. Rain in October led to jurisdictional conditions for gages 5 and 6 and comparison with gages in the CRONOS network indicate that the numbers from the on site gage are most likely low. Ernesto, a category 1 hurricane, hit Oak Island, NC on August 31st, 2006. It is likely that this storm event caused the clog with high winds and debris and that rain data is underestimated for September and October.

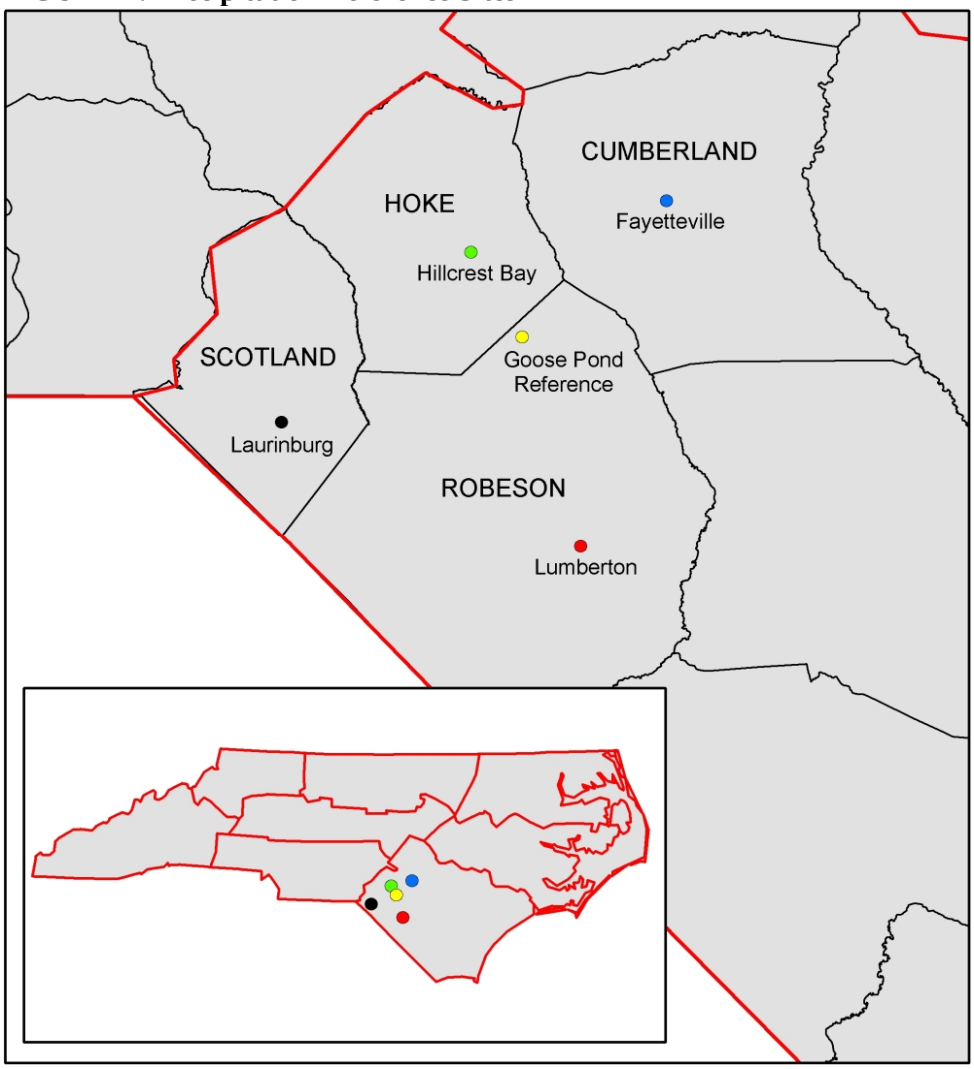
* **July, August, and September 2009** - A fire the week of July 6th, 2009 put the rain gage out of commission for July and August. The gage was replaced on September 15th, 2009. While the record for September is incomplete, comparison with gages in the CRONOS network indicates a lack of significant rainfall in the first two weeks of September. September is noted as normal to abnormally dry in the county and regional data. The reading of 2.19 is considered dry for the Fayetteville area.

*** October 2010 –** Final data collection was done on October 27th. The Fayetteville PWC gage indicates only a tenth of an inch more rainfall then the onsite gage and also indicates that no rainfall was missed onsite during this last week of October.

Drought history information has been compiled on both the County and regional levels using information from the NC Drought Management Advisory Council (NCDMAC) and the National Climatic Data Center: Palmer Drought Severity Index (PDSI). Hoke, Scotland, Cumberland and Robeson Counties are included in the Southern Coastal Plain Region. However, Hoke and Scotland Counties fall along the

border of the two Climate Divisions and close comparison of PDSI data from both the Southern Piedmont and the Southern Coastal Plain indicate that the Southern Piedmont region more accurately corresponds with the data for Hoke County (NCDMAC). Tables for both regions are included in Appendix B.

FIGURE 4: Precipitation Reference Sites



An in-depth study of onsite rainfall, drought history of Hoke County and the southern piedmont and coastal regions, as well as the occurrence of hurricanes off the NC coast were used to determine if onsite conditions were commiserate with climatic conditions and to compare the hydrology of the project site and the reference site.

2004 (Pre-Construction): The Restoration Plan indicates that both the reference site (visual inspection) and the project site (2 Gages) were jurisdictional in the fall of 2004. 2004 posted moderate drought conditions in the piedmont in the spring (March – May) with the rest of the year being normal and not in drought conditions.

2005 (ZERO HYDROLOGY): Both the reference site and the project site failed to meet jurisdictional conditions. Water level gage data shows that conditions were somewhat wet, but not wet enough to produce jurisdictional or prolonged jurisdictional conditions on either site. 2005 was not a drought year.

2006 (PARTIAL HYDROLOGY): As the site began to recharge post restoration, somewhat wetter conditions included slight effects from Hurricane Ernesto on August 31st, 2006 allowed gages 5 and 6 on the project site to meet jurisdiction in late October. The reference site was somewhat wet as well, but failed to produce jurisdictional conditions. 2006 posted moderate drought conditions in the piedmont in the spring (April – May) with the rest of the year being normal and not in drought conditions.

2007 (FULL HYDROLOGY): Jurisdictional conditions for all gages are indicated in spring of 2007. The reference site improved, but still failed to produce prolonged jurisdictional conditions and meet the 5% criteria for jurisdiction.

2008 (ZERO HYDROLOGY): Immediately following the jurisdictional conditions of spring 2007, drought conditions began in Hoke County and the region in May 2007 which continued until Category 1 Hurricane Hanna hit Myrtle Beach, SC on September 6th, 2008. The site itself received over 5 inches of rain in two days and was effectively recharged following the extended drought. The reference site indicated jurisdictional conditions in Spring of 2008 for the first time since project construction, despite drought conditions. Some on site gages show corresponding peaks at this time including Gages 5 and 6.

2009 (PARTIAL HYDROLOGY): Similar to the 2006 pattern, gages in the wetter areas of the site indicated jurisdictional conditions in spring of 2009. It is therefore likely, given normal rainfall over winter, that the site will achieve jurisdictional conditions (full hydrology) in spring of 2010. The reference site achieved full hydrology giving it spring hydrology two consecutive years out of five (2008 & 2009).

2010 (PARTIAL BORDERLINE HYDROLOGY): Despite normal rainfall conditions coming into the 2010 growing season and initial peaks which indicated favorable trends in February the site did not achieve sustained jurisdictional success. The reference gage, however, maintained the February trend and jurisdictional conditions continued into the growing season achieving its third consecutive year of jurisdictional success. In late September large amounts of rainfall were recorded both in the Fayetteville area and on site. These storms are most closely associated with Tropical Storm Nicole. While TS Nicole never made land fall in North Carolina, it delivered significant rain to coastal areas and triggered record rainfall and flooding in the Wilmington area.

At this time, EarthMark proposes to continue hydrological monitoring into 2011.

3.1.5 Reference Site

The Goose Pond Bay reference site shows a slow pattern of recharge; not meeting true jurisdiction until spring of 2008, despite drought conditions, and has maintained this pattern into the spring of 2010. Fall of 2006 through Spring of 2007 the project site showed jurisdictional conditions, while the reference gage failed to achieve prolonged jurisdictional conditions. In the spring of 2008, after approximately 12 months of drought conditions the project site did not achieve jurisdictional conditions. The reference site achieved jurisdictional hydrology for the first time since project completion and maintained jurisdictional hydrology for the last three consecutive years, Spring 2008, Spring 2009 and Spring 2010. Except for Year 4 (2008), at least one on-site gage each year has matched data from the reference gage. Corresponding peaks were registered on site in the spring of 2008. Gage 5 in particular may have achieved jurisdictional conditions, but data was lost. Hydrologic conditions on the project site do appear to be more erratic then those on the reference site, but a favorable comparison can still be made,

particularly with Gage 7 which is in a similar location on the eastern rim of the Hillcrest Bay as the reference gage on Goose Pond Bay.

The Goose Pond reference site, along with three other area bays, was used to develop the planting plan for the project site. Species composition in Goose Pond Bay and all of the reference bays is documented in Section 6.1 of the Restoration Plan. Soils on the project site and all of the reference bay(s) (except Singletons Bay) are similar as well. Figure 5 shows a soils map for Goose Pond Bay which can be compared to the Figure 5 in the Restoration Plan (Hillcrest Bay Soils Map).

Of the four bays studied pre-construction, the Goose Pond Bay reference site is the most similar to the predicted final state of the Hillcrest Bay Restoration Site. The reference site is three times the size of Hillcrest Bay but maintains a similar drainage area to bay area ratio. Figure 6 shows the approximate drainage area of the reference site. The map used to determine the drainage area, which includes topography is located in the Restoration Plan, Figure 9. The land use surrounding the reference site is predominantly agricultural and forested, with several smaller bays in close proximity and large swamp areas to the north and south.

Additionally, a large farming operation exists on adjacent property to the west and south of the bay. There is also a ditch feeding into Goose Pond Bay from the general direction of the farming operation. Water from this area would naturally flow into the bay regardless of the ditching, but ditching would increase the speed at which run-off reaches the bay. Extensive irrigation takes place on this adjacent farm as well. Depending on the source of water for the irrigation, these activities could artificially lower and or raise the ground water table in the vicinity of Goose Pond Bay. It is safe to assume that Goose Pond Bay has a unique hydrologic regime compared to the other reference bays and the project site.

The reference gage is located near the perimeter of the reference site bay for ease of installation and maintenance. It is therefore reasonable that this area would be drier than the deep interior of the bay. For reference gage location see Figure 6.

Figure 5.

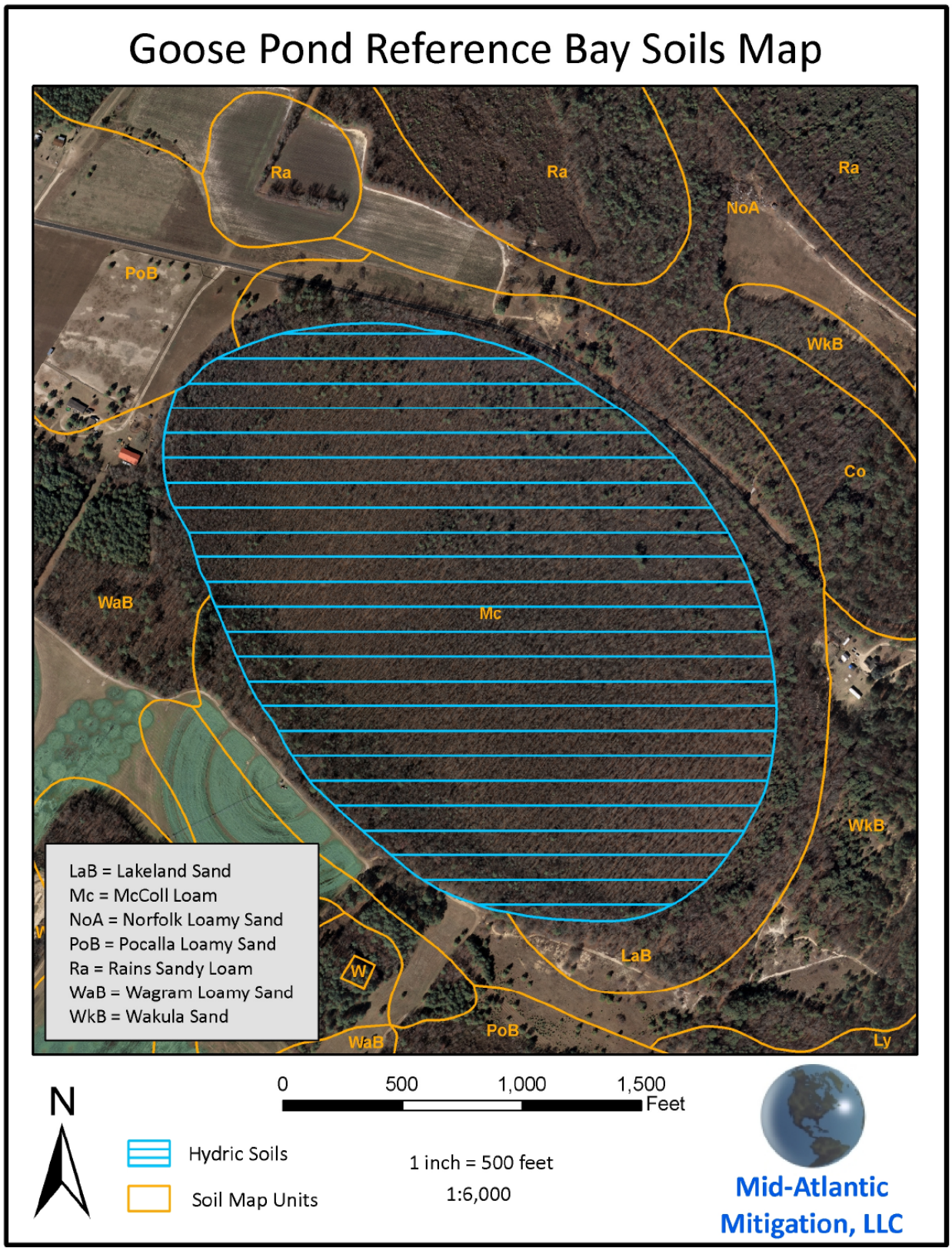
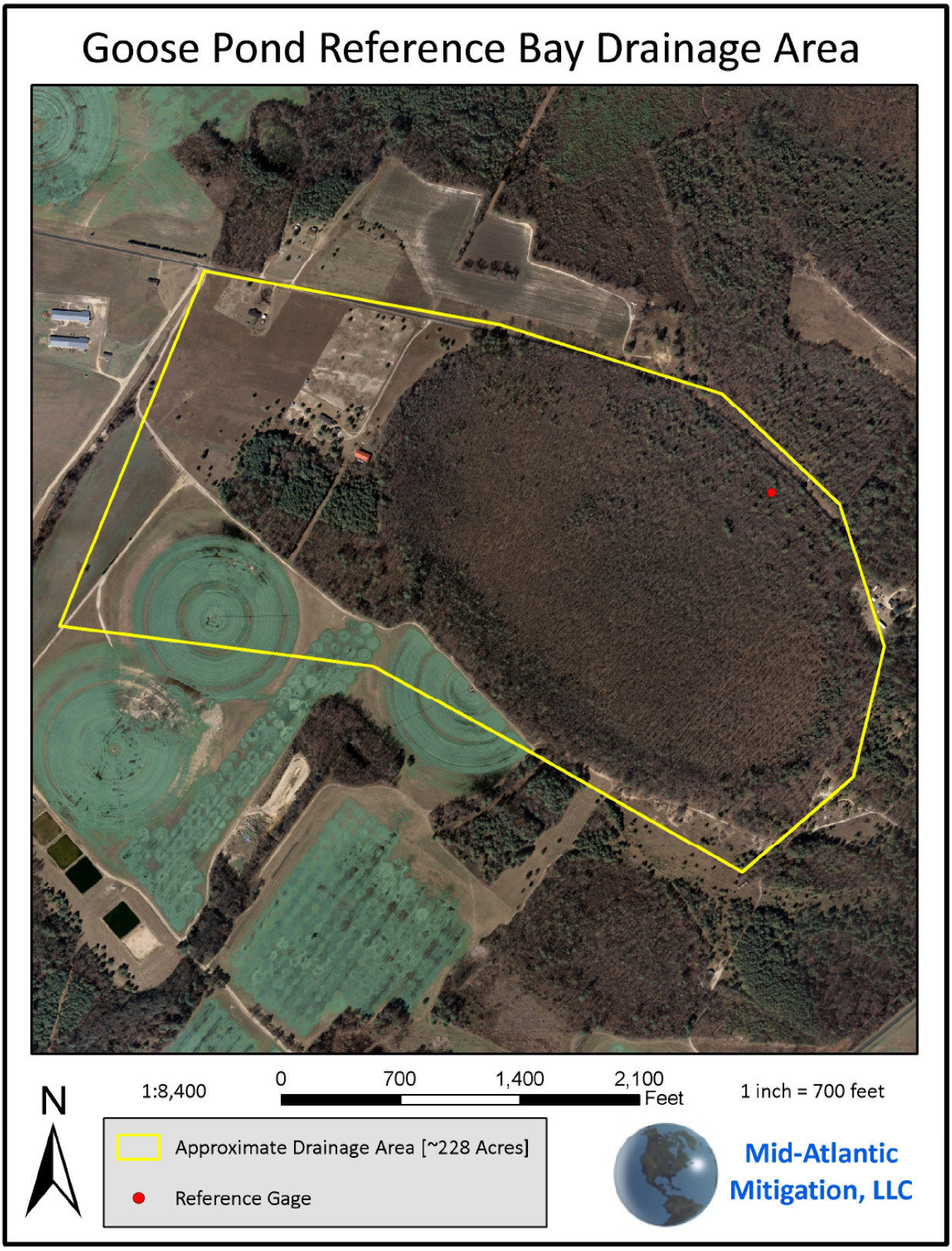

Goose Pond Reference Bay Soils Map
Ra
Ra
Ra
NoA
PoB
WkB
Co
WaB
Mc
WkB
LaB = Lakeland Sand
Mc = McColl Loam
NoA = Norfolk Loamy Sand
PoB = Pocalla Loamy Sand
Ra = Rains Sandy Loam
WaB = Wagram Loamy Sand
WkB = Wakula Sand
W
LaB
WaB
PoB
Ly
N
0
500
1,000
1,500
Feet
Hydric Soils
Soil Map Units
1 inch = 500 feet
1:6,000
Mid-Atlantic
Mitigation, LLC

Figure 6.


Goose Pond Reference Bay Drainage Area
N
1:8,400
0
700
1,400
2,100
Feet
1 inch = 700 feet
Approximate Drainage Area [~228 Acres]
Reference Gage
Mid-Atlantic
Mitigation, LLC

3.2 WETLAND HYDROLOGY ASSESSMENT

Jurisdictional hydrology was defined in the Mitigation Plan as 5% of the growing season or 12 consecutive days of groundwater within 12 inches of the surface in a dry year. In the last 6 years, Hoke County has experienced cycles of severe drought conditions. Periods of normal rainfall occurred in Fall of 2006 to Spring of 2007 and in the last two years, Spring of 2009 and Spring of 2010. The Site has been plagued with data loss due to gage sensors being plugged with the thick wet clay present in the bay's clay layer. Significant data loss was not experienced during the first monitoring year of 2005. Significant data loss began in Year 2 (2006). As the Site began to respond to the recovering water table it is believed that the tight clay layer of the bay which is approximately 20 to 40 inches below the surface began to get wet and thick. The bay goes through cycles where gage sensors become clogged with thick wet clay. The site is visited monthly to minimize loss of data and graphs indicated that no jurisdictional data was lost in 2006 or 2007. However, in an effort to further reduce data loss, MAM began replacing gages with new gages installed with filter sock and sand or installing alternate gages with filter sock and sand near their companion gages. The current configuration of gages contains no alternate gages and Gages 1, 2, 5 and 7 (4 of 10) lack filter sock and sand on the outside of the well casing. A filter sock was placed directly around the sensor on Gage 5 and this did not prevent loss of data. Only filter sock and sand placed on the outside of the casing during installation seems to be effective in preventing data loss. In 2010, only Gage 2 lost data due to the problem of the wet clay layer clogging the sensor. There is no evidence that any of the lost data on Gage 2 is jurisdictional data. Gage 5 was removed after a malfunction in October 2009 and returned to the manufacturer for service. Data missing from Gage 6 is due to removal of the gage for service after repeated malfunction and was replaced as soon as possible with a new gage. Both Gages 8 and 9 also experienced malfunctions. A shortage of available functioning replacement gages caused gaps in the data to be larger then expected.

2010

Gage 1 recorded 10 continuous days of jurisdictional data from February 5th to February 14th.

Gage 2 recorded 3 continuous days of jurisdictional data from February 9th to February 11th.

Gage 3 recorded 1 day of jurisdictional data on February 6th.

Gage 4 recorded 2 continuous days of jurisdictional data on February 6th and 7th and again on February 9th and 10th separated an outlier of -18.34 on the 8th.

Gage 5 recorded 0 continuous days of jurisdictional data.

Gage 6 recorded 3 continuous days of jurisdictional data February 5th to 7th and again on February 9th to 11th separated an outlier of -17.04 on the 8th.

Gage 7 recorded 10 continuous days of jurisdictional data from February 5th to February 14th.

Gage 8 recorded 0 continuous days of jurisdictional data due to missing data from a gage malfunction and lack of available replacement gage.

Gage 9 recorded 3 continuous days of jurisdictional data from February 9th to February 11th.

Gage 10 recorded 2 continuous days of jurisdictional data from February 9th and 10th.

While these readings are outside of the official start of the growing season and do not demonstrate jurisdictional hydrology, they do demonstrate a certain level of constancy throughout the site and correspond with the data from the reference gage. The reference gage at Goose Pond Bay indicated 81 days of jurisdictional hydrology from February 5th to April 2^{5th}, 2010. Approximately 55 of these days fall within the official growing season.

As previously stated, Groundwater sampling techniques for 2005 through 2008 included the sand rim area of the project. Beginning in 2009 groundwater monitoring efforts were focused on the 15 acre bay pond area. The revised monitoring plan view map on page 8 shows the locations for Gages 1 through 10. The black line shows the approximate boundary of the Bay Pond area. Graphs showing data for all gages, including the reference, for the 2009 to 2010 monitoring year, a composite graph of all gages for 2010 and several composites over the life of the project are available in Appendix B.

Exhibit Table XIVa: Attainment Criteria

Well ID	Well Hydrology Threshold Met?	Mean	Vegetation Plot ID	Vegetation Survival Threshold Met?	Mean
Hill 1	N	0%	Plot 1	Y	100%
Hill 2	N		Plot 2	Y	
New 3	N		Plot 3	N/Y w/vols.	
New 4	N		Plot 4	Y	
Hill 5	N		Plot 5	Y	
Hill 6	N		Plot 6	Y	
Hill 7	N				
New 8	N				
New 9	N				
New 10	N				
Goose Pond	Y				

Exhibit Table XIVb: Wetland Attainment Criteria

Well ID	Well Hydrology Threshold Met?	Total days w/ Jurisdictional Hydrology	Percent of Growing Season w/ Jurisdictional Hydrology
Hill 1	N	10	4.2
Hill 2	N	3	1.3
New 3	N	1	.4
New 4	N	2	.8
Hill 5	N	0	0
Hill 6	N	3	1.3
Hill 7	N	10	4.2
New 8	N	0	0
New 9	N	3	1.3
New 10	N	2	.8
Goose Pond	Y	81	33.9

Exhibit Table XIVc: Wetland Attainment Criteria Percentages by Year (Currently Installed Gages)

	Gage 1	Gage 2	New 3	New 4	Gage 5	Gage 6A	Gage 7	New 8	New 9	New 10	Goose Pond - Ref
Mon. Year 1 (05)	< 1	0	-	-	0	-	0	-	-	-	0
Mon. Year 2 (06)	< 1	< 1	-	-	13	-	< 1	-	-	-	0
Mon. Year 3 (07)	25	24	-	-	13 +	5 +	7 +	-	-	-	4.2
Mon. Year 4 (08)	3.8	3.8	-	-	2.9*	1.2*	< 1	-	-	-	10 +
Mon. Year 5 (09)	5.4	18.0	2.5	2.5	6.3+	3.8	3.8	3.3	2.9	3.3	10.9
Mon. Year 6* (10)	4.2	1.3	.4	.8	0	1.3	4.2	0*	1.3	.8	33.9

(Previously Installed Gages)**

	Gage 3	Gage 3 Alt	Gage 4	Gage 5 Alt	Gage 6
Mon. Year 1 (05)	0	-	0	-	1.2
Mon. Year 2 (06)	< 1	-	< 1	-	5
Mon. Year 3 (07)	3.8	9 +	5	-	6 +
Mon. Year 4 (08)	1.7	0	< 1	1.2	2.5

***** Jurisdictional data may have been lost due to clogged sensors. Given the pattern 2006 forward, it is likely that Gage 5 did in fact achieve jurisdictional hydrology in Spring 2008. In 2010, jurisdiction data may have been lost on Gage 8 due to gage malfunction.

****** EarthMark felt it was unnecessary to devote limited resources to monitoring dry areas of the site, therefore Gages 3 and 4 were moved to their new locations prior to the 2009 growing season. Alternate Gages were originally installed near their counterparts to provide parallel data for comparison when data was lost. Once Gage 3 was removed, Gage 3 Alternate was deemed no longer necessary. Gage 5 Alternate never produced comparable readings to its Gage 5 counterpart and was removed after only one growing season. Of the 5 gages which were removed Gage 6 was the most favorable and, in retrospect, should have been left in place. However, had it been left in place, it would have been destroyed in the fire of June 2009.

4.0 METHODOLOGY SECTION

Construction and planting of Hillcrest Bay Wetland Restoration Site was completed on April 13, 2005. Mortality of the planted species during the first monitoring year was due primarily to the lack of rain throughout the growing season and a late planting schedule. Competition with weeds left from the prior agricultural operation on the Site also contributed to mortality of the planted species. For the second monitoring year MAM mowed the restoration area in January 2006, replanted parts of Zones 1, 2, and 3, used a combination of tree tubes and tree mats throughout the Site, and spot treated with herbicide throughout the site to ensure re-establishment of planted species within the Bay so that the goals of the nonriverine wetland restoration could be met. Forested wetland restoration projects typically go through stages of ecological succession prior to achieving all success criteria. It is not uncommon for herbaceous wetland plants to dominate for the first few years after construction. The largest of the woody individuals on site are now four to five years old and exceed breast height, with many individuals (planted and volunteers) exceeding five and six feet in height. At this stage of the project, replants would only be considered necessary if stems per acre for the site drop below 260 and this is not the case.

Drier conditions have persisted on the Site more regularly than normal to wet conditions since construction. The reference site also demonstrated periods of dry conditions, but has achieved hydrology in the spring of the last three years (2008, 2009 and 2010) indicating recharge of ground water in this area following several periods of drought conditions. It is anticipated that it may take several consecutive years of average or above average rainfall to fully recharge the aquifers in the area of the project site. On site gages show favorable trends towards jurisdictional hydrology but only Gage 5 has ever achieved consecutive years showing jurisdictional conditions.

4.1 SITE MAINTENANCE

The mimosa trees at the front entrance and two sweet gum stands on site were treated with herbicide in 2009. These areas show a slow rate of return by these species so far. MAM will continue to make monthly site visits to assess the needs of the site and minimize lost gage data. No supplemental plantings or herbicide treatments are necessary at this time.

Achievement of on-site hydrology goals continues to be a challenge. In addition to continuing to monitor the site and wait for several consecutive years of non-drought conditions, we have changed our monitoring focus to the 15 acre bay pond area. 2010 did not produce the anticipated results given favorable rain fall and non-drought conditions entering the spring, but late season rains from TS Nicole may increase the chances of a favorable spring for 2011.

A new ditch plug was installed at the confluence of Ditches 1 and 2 as they exit the site near Photo Point 4 after significant amounts of water were observed draining from the site in this area in the spring of 2009. This ditch plug is intended to hold water on the site long enough to improve jurisdictional readings by four to six days. In December of 2009, ponded water was observed above the ditch plug but did not provide favorable results for the spring of 2010.

MAM will continue to monitor the Hillcrest Bay site for another year.

APPENDIX A. **Vegetation Data**

Vegetation Survey Data Tables
Permanent Photo Point Photos

Veg plot 1	Quantity					
Species	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Ambrosia artemisiifolia	Sparse	Sparse	Sparse			
Erigeron strigosus			Dominant			
Eupatorium capillifolium	Sparse	Dominant	Sparse			
Polygonum pennsylvanicum	Dominant					
Solidago L.	Sparse	Common	Sparse			Dominant
Aronia artbutifolia		7	5	5	6	8
Cephalanthus occidentalis		8				
Diospyros viginiana	1				1	
Nyssa sylvatica					1	1
Persea borbonia		4				1
Liquidambar styraciflua	2	5	6	2	6	6
Magnolia virginiana	1	4		2	1	1
Pinus taeda			2	3	3	9
Pinus serotina			1	1		1
Taxodium ascendens		2	1	4	5	4

Veg plot 2	Quantity					
Species	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Ambrosia artemisiifolia	Sparse	Sparse	Sparse			
Erigeron strigosus			Dominant			
Eupatorium capillifolium	Sparse	Dominant				
Polygonum pennsylvanicum	Dominant					
Setaria italica	Sparse	Sparse				
Solidago L.	Sparse	Sparse	Sparse			Dominant
Ipomea purpurea	Sparse	Sparse	Sparse			
Aronia artbutifolia		1	1	1	1	
Cephalanthus occidentalis		1	1	1	1	
Liquidambar styraciflua	12	14	7	11	17	17
Malus augustifolia	1		1	3	3	3
Magnolia virginiana		1		1		
Nyssa biflora			1	1	1	2
Pinus serotina		2	2	2		2
Pinus taeda				1	1	4
Prunus serotina					2	3
Quercus laevis				1	1	1
Salx nigra			1	1	1	1
Taxodium ascendens	1	2		3	4	3

Veg plot 3	Quantity					
Species	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Ambrosia artemisiifolia	Sparse	Sparse	Sparse			Dominant
Andropogon virginicus	Dominant	Dominant	Dominant			
Conyza canadensis	Sparse	Sparse	Sparse			
Crotalaria spectabillis	Dominant	Dominant				
Eupatorium capillifolium		Common	Dominant			
Rubus sp.			Sparse			
Polygonum pennsylvanicum	Dominant					
Setaria italica	Sparse	Sparse				
Solidago L.	Sparse	Sparse	Common			
Aronia artbutifolia		1	1	1	1	
Acer rubrum						2
Cephalanthus occidentalis		3	2	1	1	
Cornus florida					1	1
Cyrilla racemiflora			3	3	3	1
Diospyros virginiana					1	1
Liquidambar styraciflua	24	15	13	12	10	7
Magnolia virginiana				2	2	1
Malus augustifolia				3	4	7
Nyssa biflora			1	1	1	
Persea borbonia		1				
Pinus taeda				2	1	6
Prunus serotina			1			1
Plantanus occientalis		3	1	1	1	
Taxodium ascendens		2		2	6	2

Veg plot 4	Quantity					
Species	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Ambrosia artemisiifolia	Sparse	Sparse	Sparse			
Andropogen virginicus			Common			
Eupatorium capillifolium		Common	Dominant			Dominant
Polygonum pennsylvanicum	Dominant					
Setaria italica	Sparse	Sparse				
Solidago L.	Sparse	Sparse	Common			
Toxicodendron radicans			Sparse			
Ipomea purpurea	Sparse	Sparse	Sparse			
Aronia artbutifolia		5	5	5	6	6
Cephalanthus occidentalis		2	1			
Liquidambar styraciflua	1		2		6	3
Lyonia lucida			1			
Malus angustifolia		1	2	3	1	3
Nyssa biflora		1	1		1	1
Persea borbonia		1				
Pinus serotina		5	4	4	4	4
Pinus taeda		small vols		14	40	40
Pinus palustris			3	3		
Prunus serotina						1
Taxodium ascendens		3	3	2	4	4

Veg plot 5	Quantity					
Species	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Ambrosia artemisiifolia	Sparse	Sparse	Sparse			
Andropogon virginicus						Dominant
Erigeron strigosus			Sparse			
Eupatorium capillifolium		Common	Common			
Polygonum pennsylvanicum	Dominant					
Setaria italica	Sparse	Sparse				
Sida spinosa	Sparse	Sparse				
Solidago L.			Common			
Ipomea purpurea	Sparse	Sparse	Sparse			
Lespedeza cuneata	Sparse	Sparse	Sparse			
Aronia artbutifolia		4 (1 stressed)	4	4	6	5
Baccharis halimifolia				4	3	3
Cephalanthus occidentalis		3			1	1
Cyrilla racemiflora		1	1	2	2	2
Liquidambar styraciflua	2	2	2	5	8	8
Lyonia lucida		2 (stressed)				1
Magnolia virginiana		3				
Malus angustifolia	1	1		1	3	2
Nyssa biflora		2 (1 stressed)	1		1	1
Pinus serotina		3	3	3	3	3
Pinus taeda			2	3	2	8
Prunus serotina						1
Taxodium ascendens		1		3	3	4

Veg plot 6	Quantity					
Species	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**
Andropogon virginicus	Dominant	Dominant	Dominant			Dominant
Crotalaria spectabillis	Dominant	Dominant				
Eupatorium capillifolium	Sparse	Common	Common			
Solidago L.	Sparse	Common	Common			
Ipomea purpurea	Sparse	Sparse	Sparse			
Aronia artbutifolia		4	5	4	4	4
Baccharis halimifolia				1	1	3
Catalpa speciosa					1	1
Cephalanthus occidentalis		5				
Cyrilla racemiflora		3				1
Liquidambar styraciflua	1	12	14	10	10	18
Magnolia virginiana		2				
Nyssa biflora		1	1	1	1	1
Nyssa sylvatica	1					
Persea borbonia		1	1	1	1	1
Pinus serotina		2	2	2	2	2
Pinus taeda						3
Populus deltoides		1				
Taxodium ascendens		1		7	2	3

Exhibit Table XIIa: Stem Counts for Planted Species Arranged by Plot

Species	Plots						Initial Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals	Year 5 Totals	Year 6 Totals	Survival %
	1	2	3	4	5	6								
Aronia arbutiflora	8			6	5	4	33	0	21	21	20	24	23	70%
Cephalanthus occidentalis					1		6	0	6	4	2	3	1	17%
Clethra alnofolia							2	0	0	0	0	0	0	0%
Cyrilla racemiflora			1		2	1	3	0	4	4	5	4	4	>100%
Diospyros virginiana			1				2	1	0	0	0	2	1	50%
Lyonia lucida					1		1	0	1	1	0	0	1	100%
Magnolia virginiana	1		1				11	1	10	0	5	3	2	18%
Nyssa biflora	1	2		1	1	1	13	0	4	5	3	5	6	46%
Persea borbonia	1					1	3	0	7	1	1	1	2	67%
Pinus serotina	1	2	1	4	3	2	14	0	12	12	12	9	13	93%
Quercus laevis		1					2	0	0	0	1	1	1	50%
Taxodium ascendens	4	3	2	4	4	3	21	1	8	4	21	24	20	95%
Totals	16	8	6	15	17	12	111	3	73	52	70	76	74	67%
Percent survival	-	-	-	-	-	-	-	10%	70%	50%	63%	68%	67%	
Stems per acre	647	324	243	607	688	486	749	-	492	351	472	513	499	

Exhibit Table XIIb: Stem Counts for Volunteer Species Arranged by Plot

Species	Plots						Year 1 Totals	Year 2 Totals	Year 3 Totals	Year 4 Totals	Year 5 Totals	Year 6 Totals
	1	2	3	4	5	6						
Acer rubrum			2									2
Baccharis halimifolia					3	3	0	0	0	5	4	6
Catalpa speciosa						1	0	0	0	0	1	1
Cornus florida			1				0	0	0	0	1	1
Ligustrum sinese							0	0	0	1	0	0
Liquidambar styraciflua	6	17	7	3	8	18	43	48	44	38	57	59
Malus augustifolia		3	7	3	2		2	2	6	10	11	15
Nyssa sylvatica							1	0	0	0	2	0
Pinus palustris							0	0	4	3	0	0
Pinus taeda	9	4	6	40	8	3	0	0	5	23	47	72
Platanus occidentalis							0	3	1	1	1	0
Populuds deltoides							0	1	0	0	0	0
Prunus serotina		3	1	1	1		0	0	0	0	2	6
Salix nigra		1					0	0	1	1	1	1
Totals	15	28	22	47	22	25	46	54	61	82	127	159

Stems per Acre w/o volunteers

1	16	646
2	8	323
3	6	242
4	15	606
5	17	687
6	12	485
Total	74	498

Plot size 10m x 10m = Sq. Ft.
1076.4
x 6
6458.4

1 x 485.65
1076 43560

Stems per Acre with desirable volunteers

1	16	646	
2	11	444	1 Black Willow, 2 large black cherry
3	8	323	1 dogwood, 1 large Black Cherry
4	16	646	1 black cherry (plot 4 is filled with loblolly saplings)
5	18	727	1 black cherry
6	12	485	3 loblolys
Total	81	545	

Vegetation Plot Photo Log

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

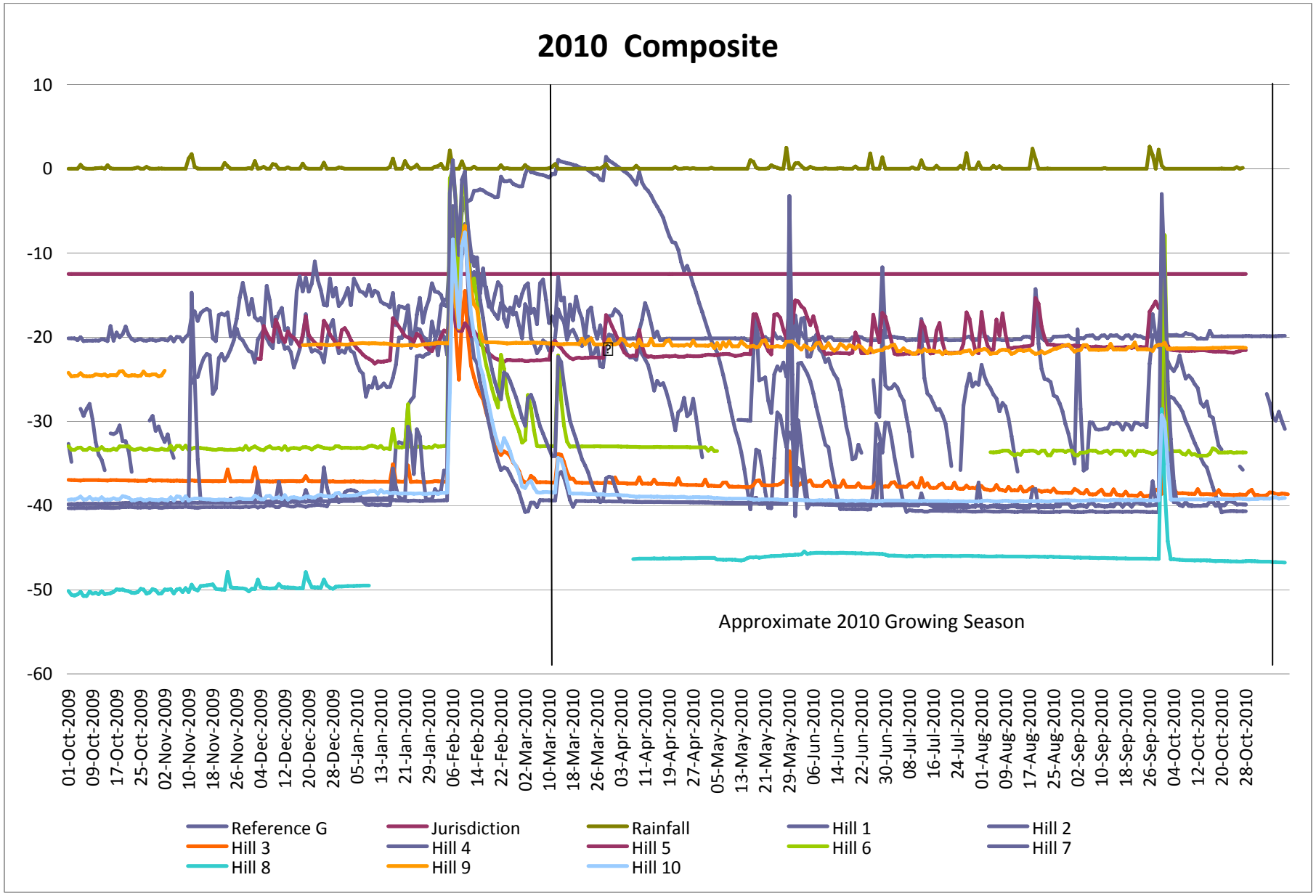
Vegetation Plot 4

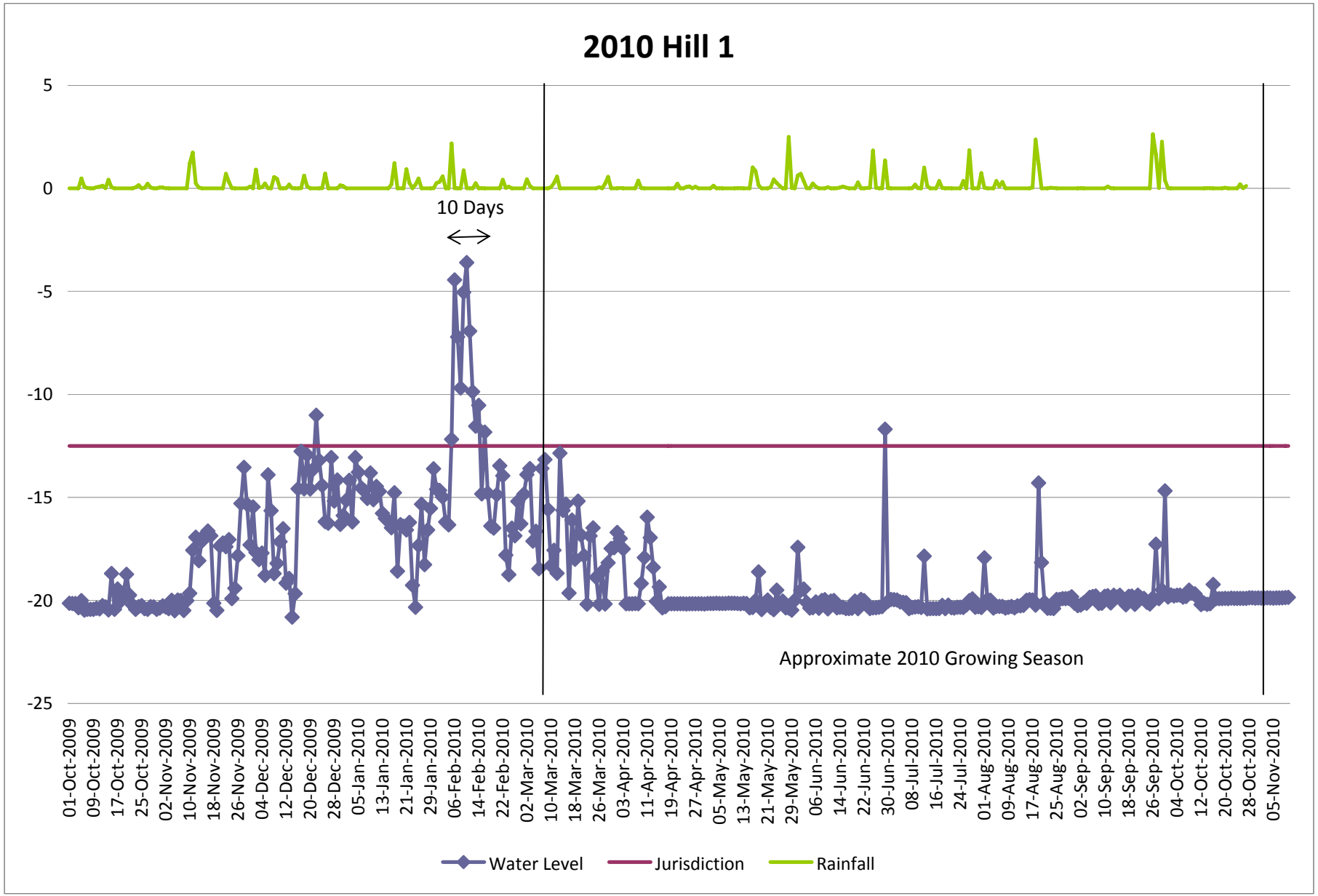
Vegetation Plot 5

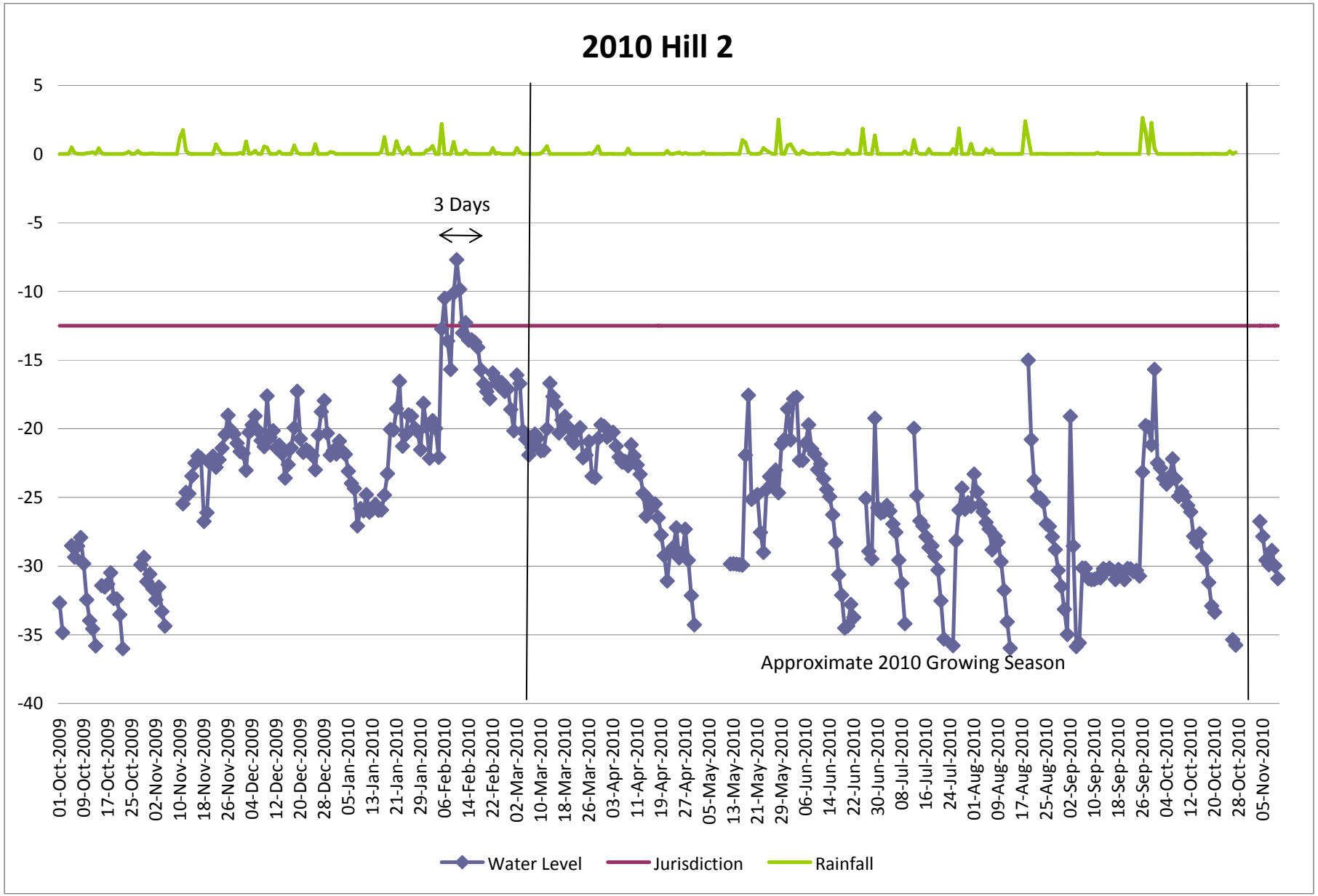
Vegetation Plot 6

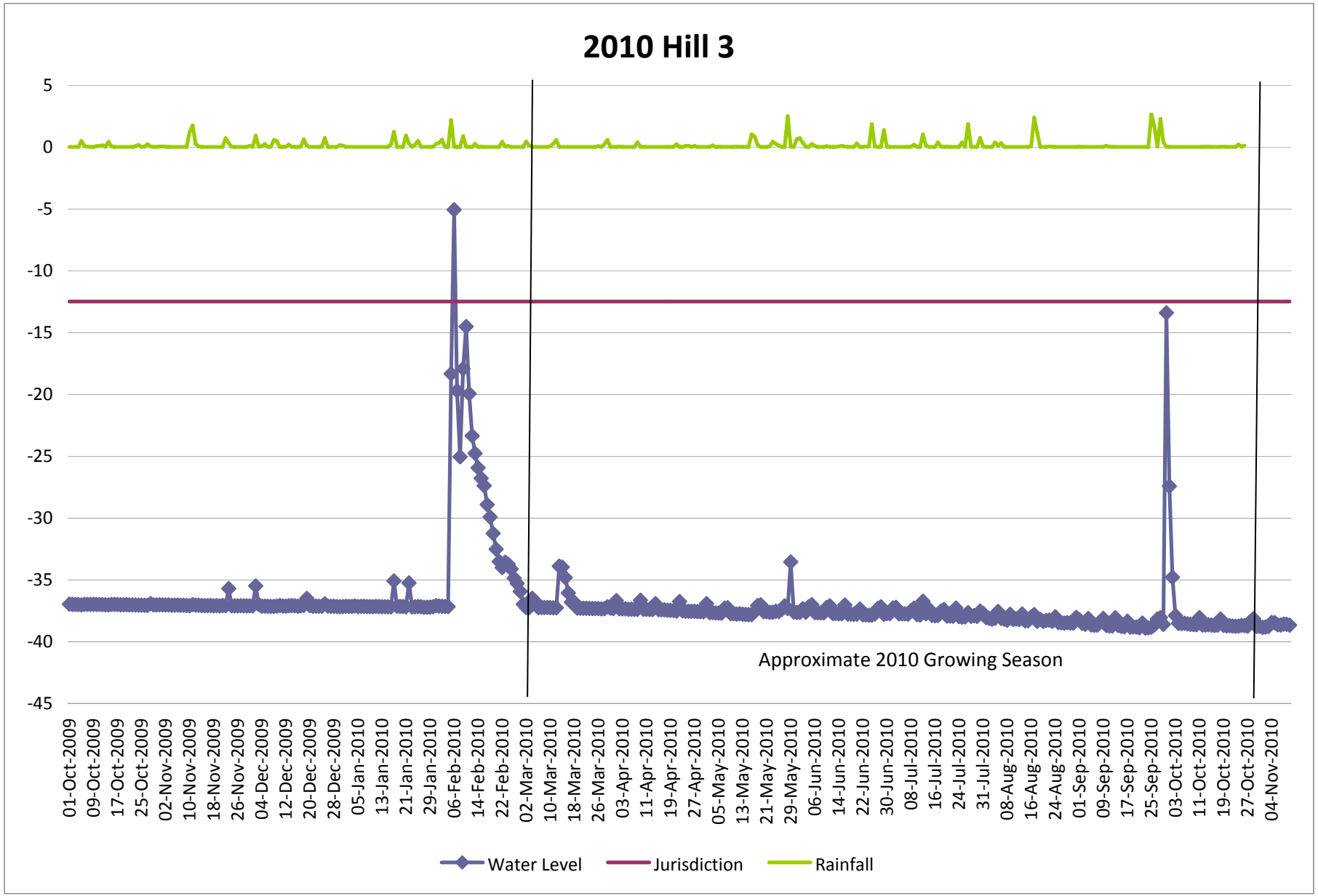
APPENDIX B. **Data Tables for Hydrological Data**

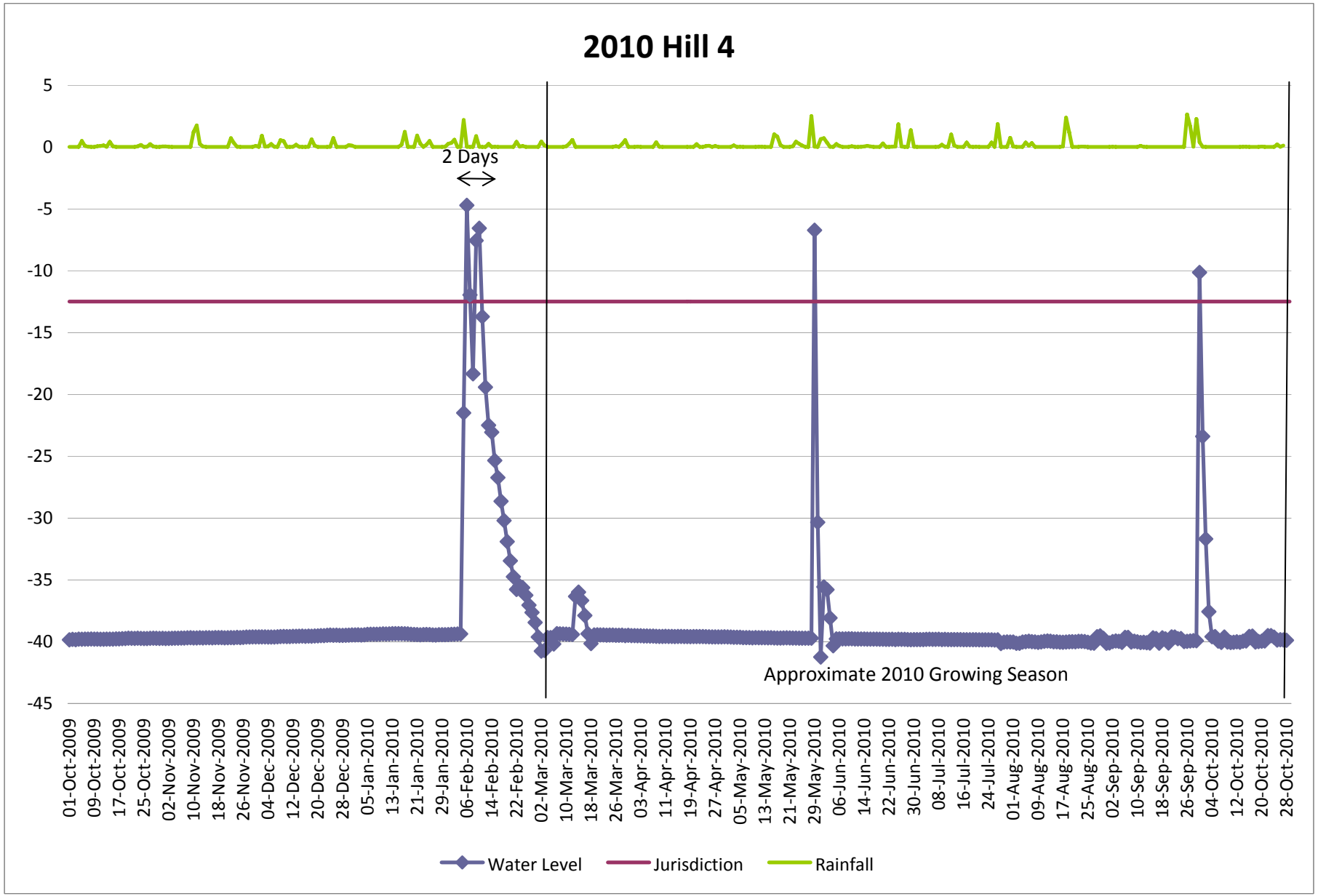
Hillcrest Bay Gauge Data (Gauges 1-10)
Goose Pond Bay Reference Data
Precipitation

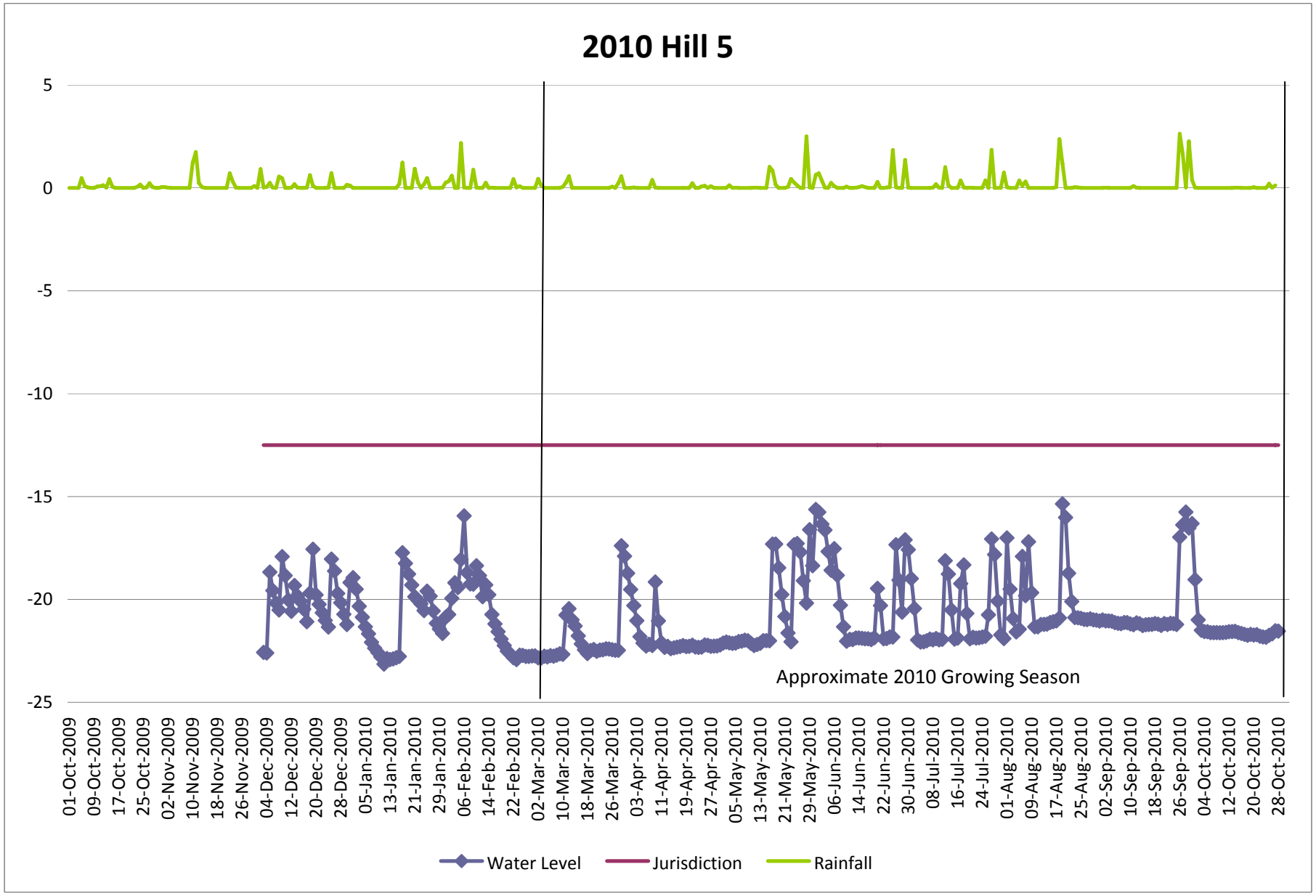

2010 Composite
10
0
-10
-20
-30
-40
-50
-60
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
Reference G
Jurisdiction
Rainfall
Hill 1
Hill 2
Hill 3
Hill 4
Hill 5
Hill 6
Hill 7
Hill 8
Hill 9
Hill 10

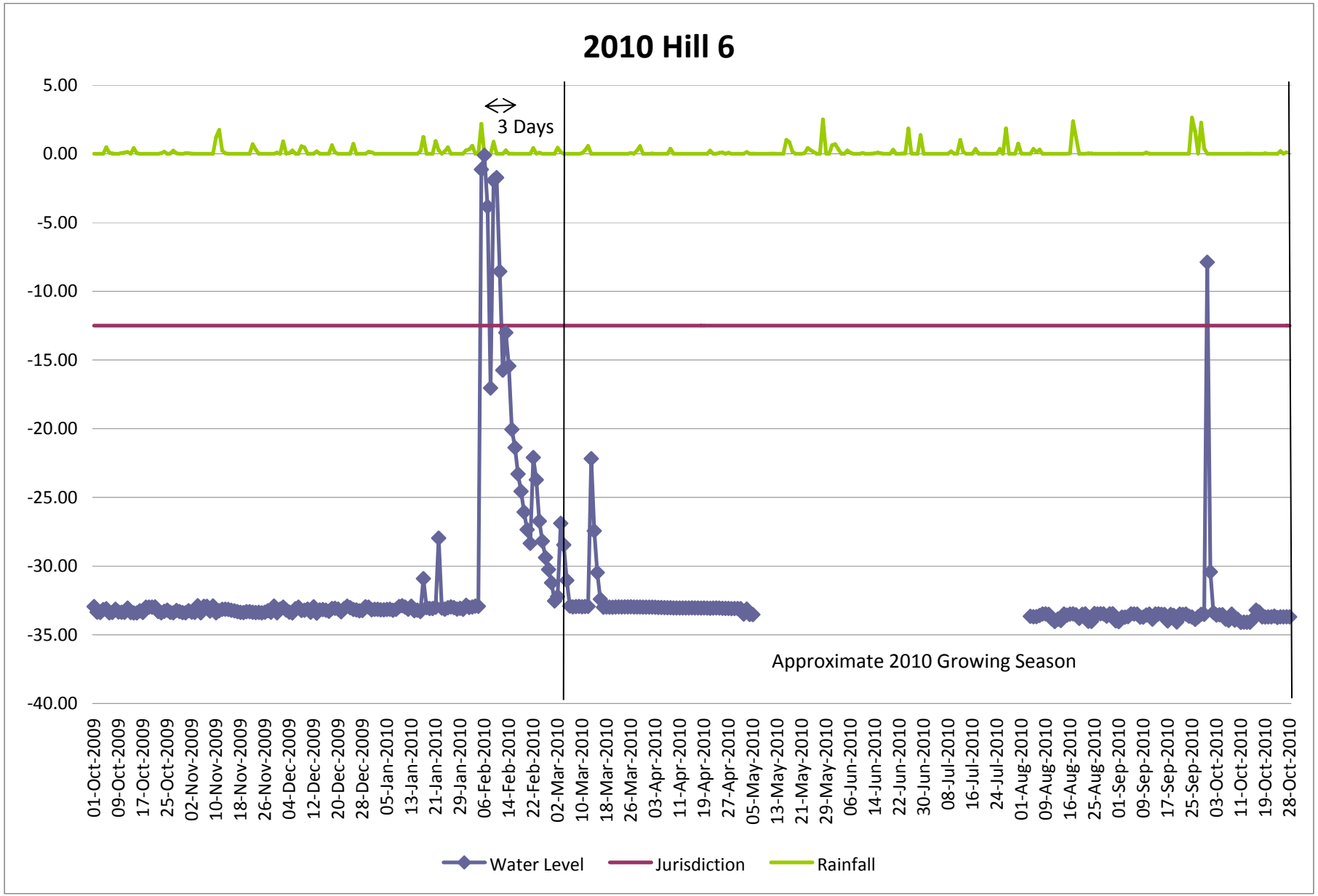

2010 Hill 1
5
0
-5
-10
-15
-20
-25
10 Days
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
05-Nov-2010
Water Level
Jurisdiction
Rainfall

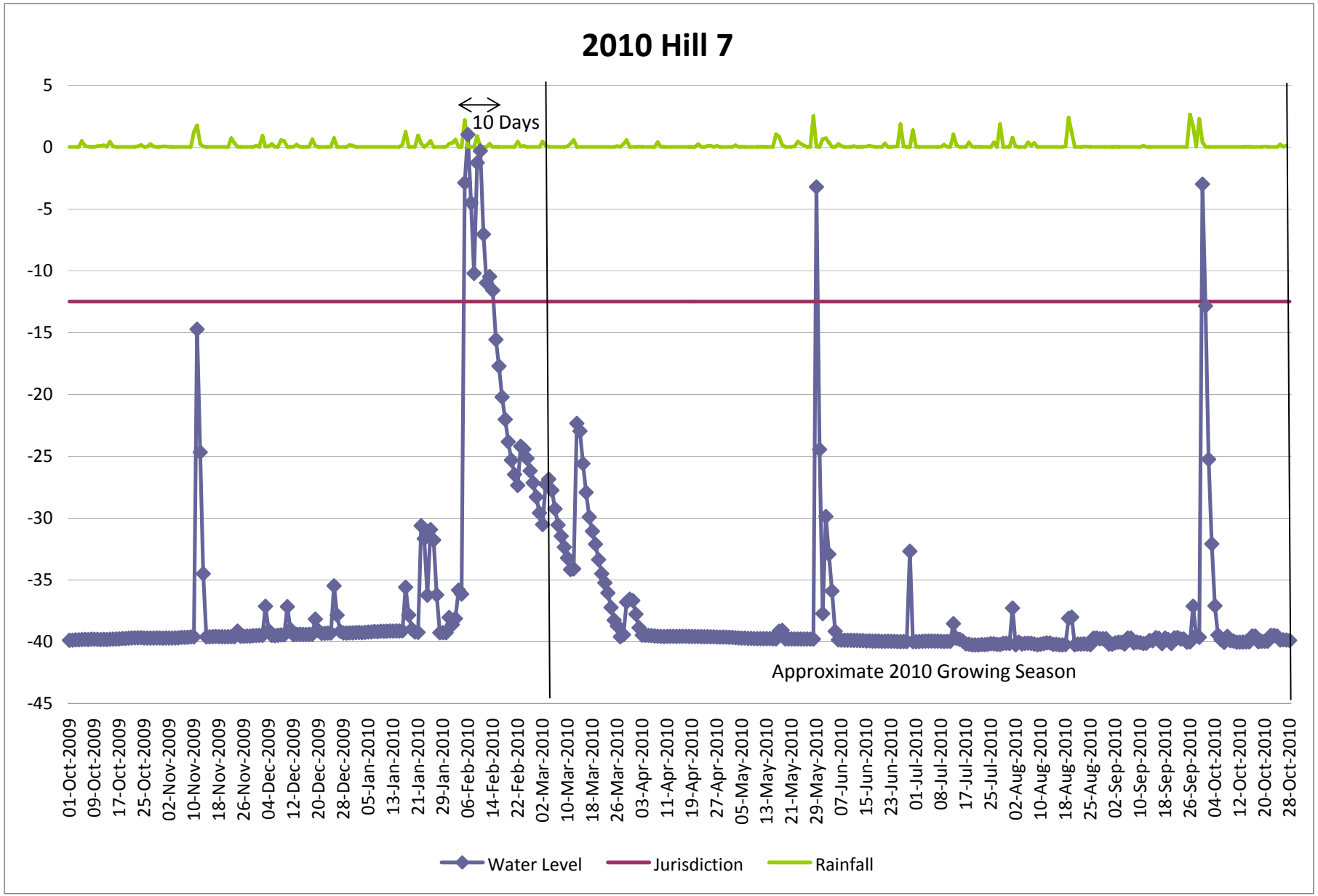

2010 Hill 2
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3 Days
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
05-Nov-2010
Water Level
Jurisdiction
Rainfall

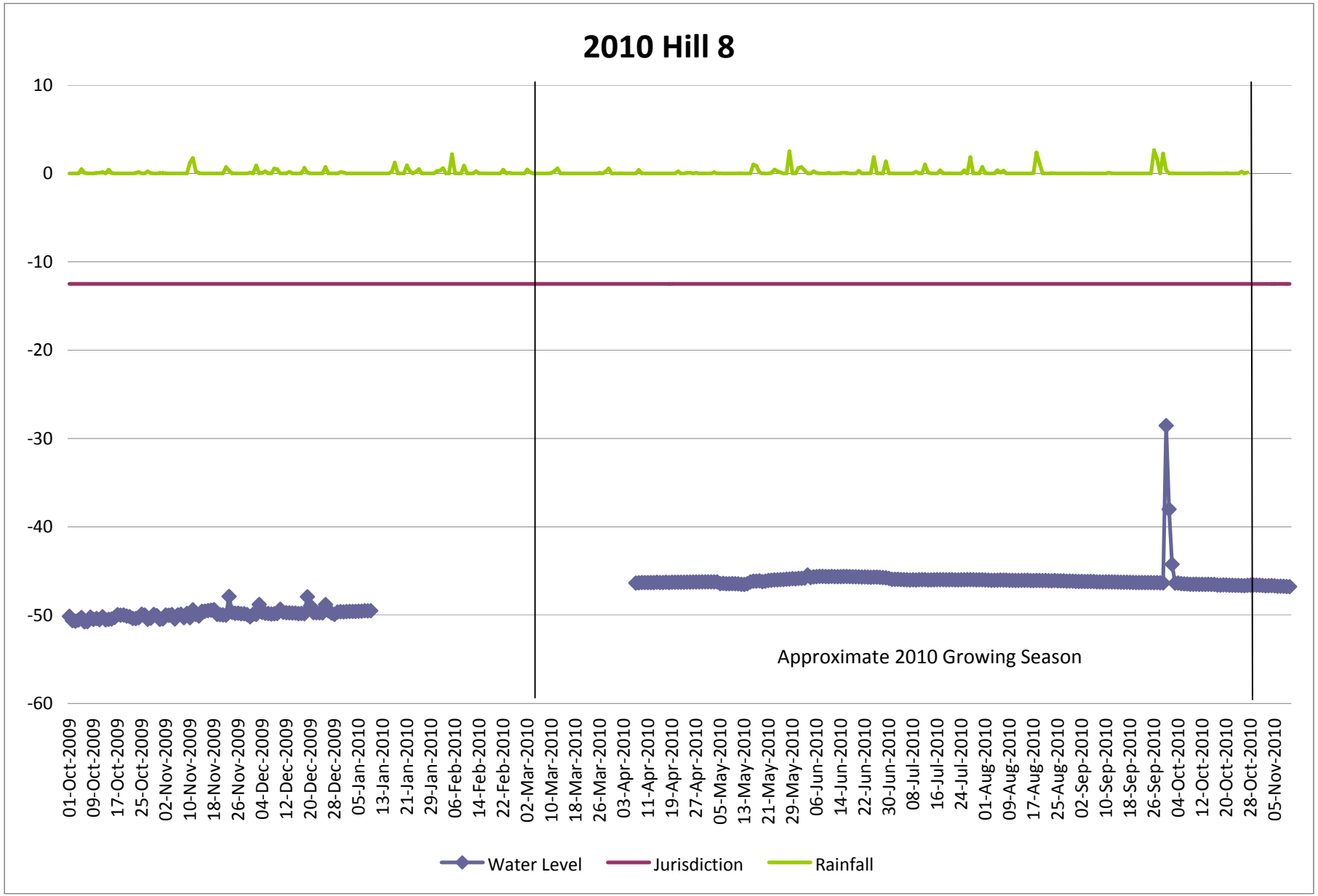

2010 Hill 3
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
31-Jul-2010
08-Aug-2010
16-Aug-2010
24-Aug-2010
01-Sep-2010
09-Sep-2010
17-Sep-2010
25-Sep-2010
03-Oct-2010
11-Oct-2010
19-Oct-2010
27-Oct-2010
04-Nov-2010
Water Level
Jurisdiction
Rainfall

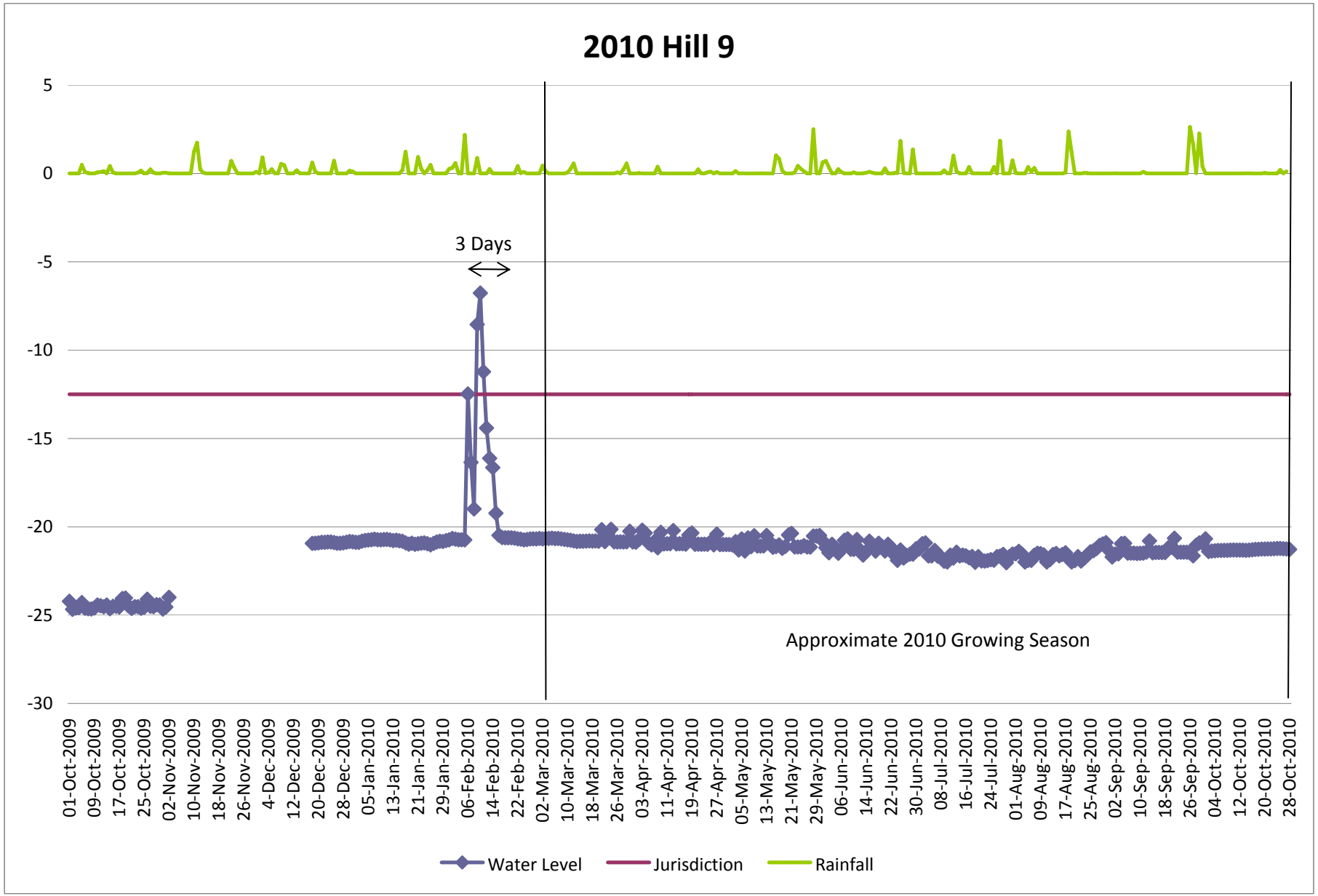

2010 Hill 4
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
2 Days
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
Water Level
Jurisdiction
Rainfall

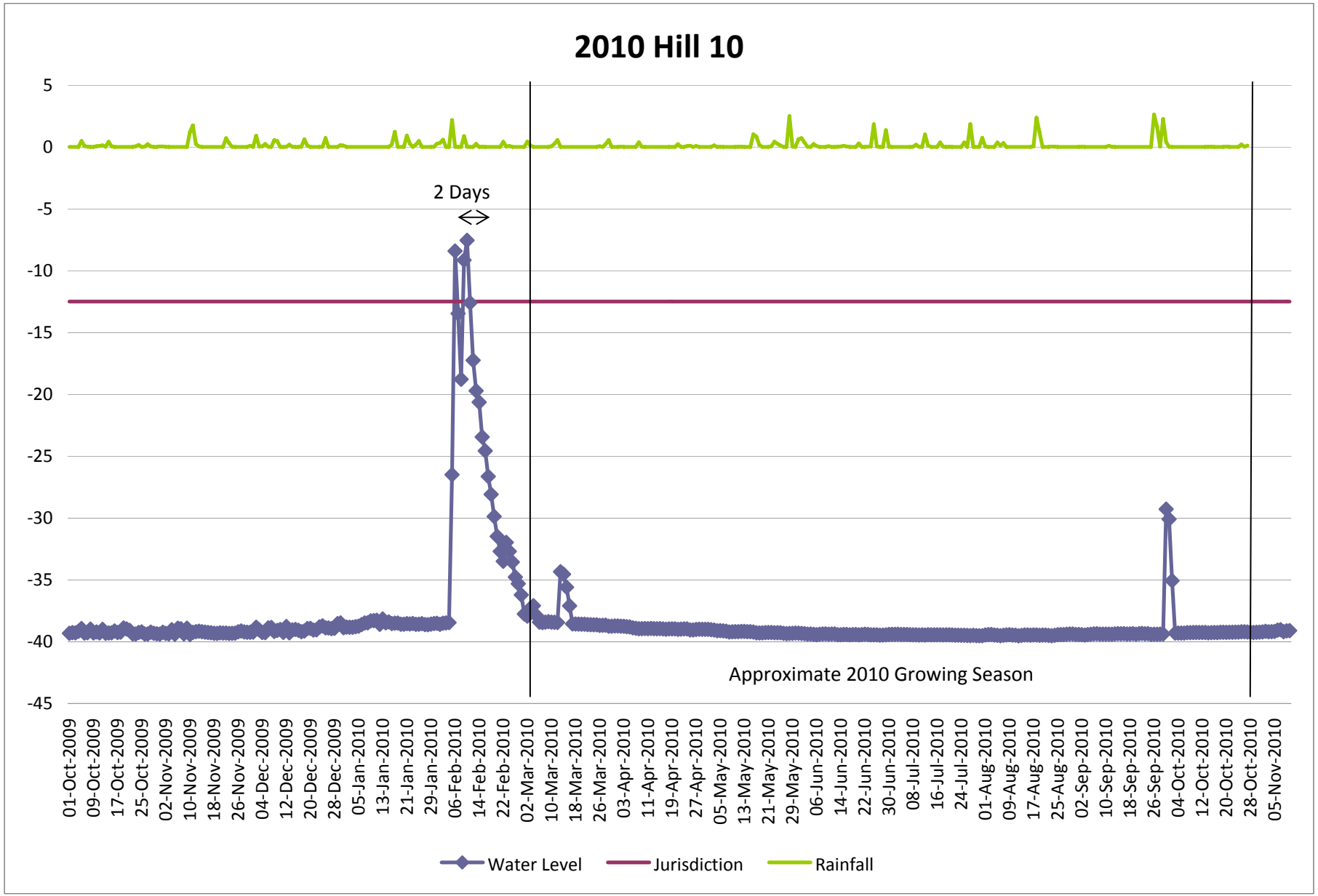

2010 Hill 5
5
0
-5
-10
-15
-20
-25
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
Water Level
Jurisdiction
Rainfall

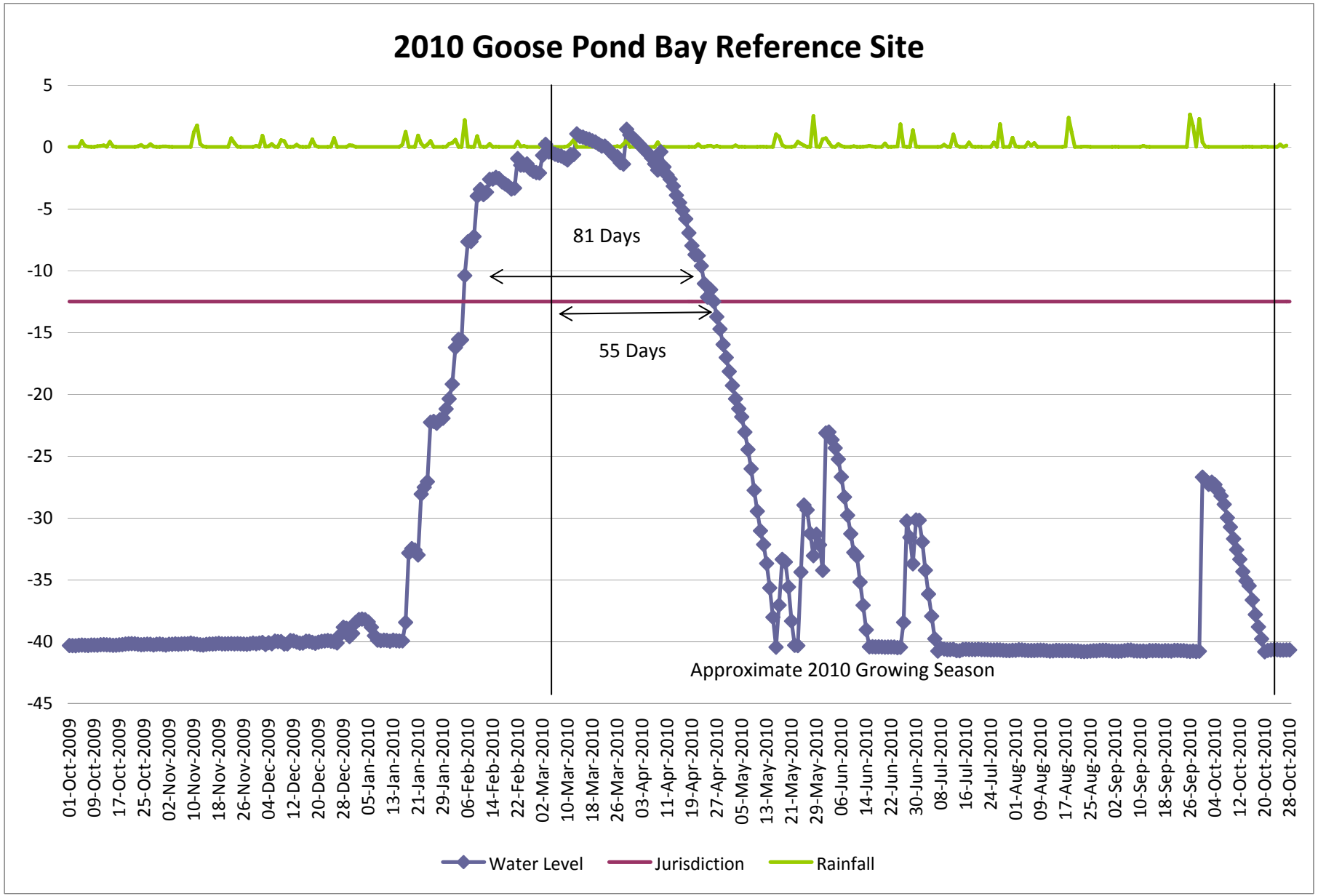

2010 Hill 6
5.00
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
3 Days
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
16-Aug-2010
25-Aug-2010
01-Sep-2010
09-Sep-2010
17-Sep-2010
25-Sep-2010
03-Oct-2010
11-Oct-2010
19-Oct-2010
28-Oct-2010
Water Level
Jurisdiction
Rainfall

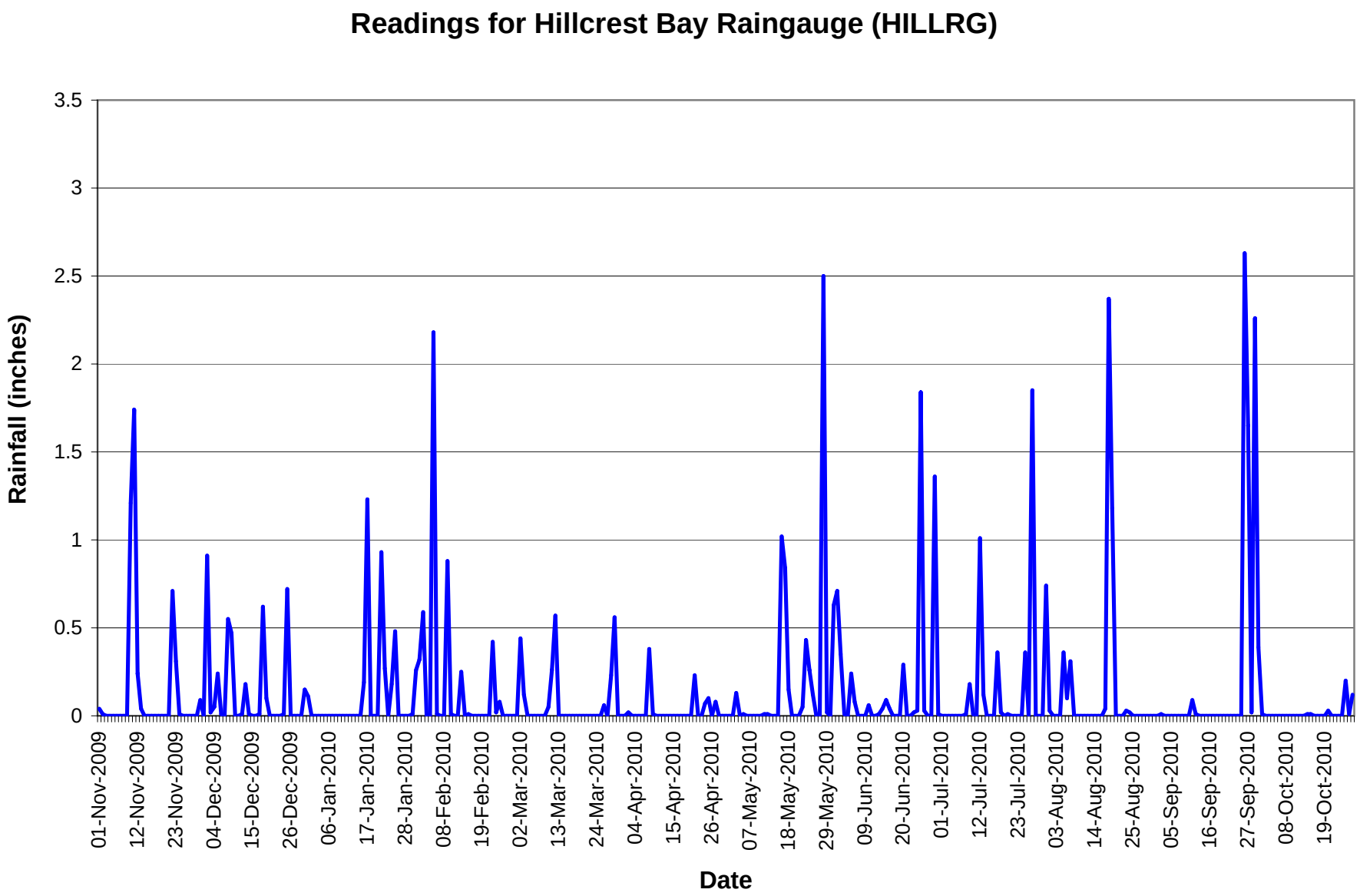

2010 Hill 7
10 Days
Approximate 2010 Growing Season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
07-Jun-2010
15-Jun-2010
23-Jun-2010
01-Jul-2010
08-Jul-2010
17-Jul-2010
25-Jul-2010
02-Aug-2010
10-Aug-2010
18-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
Water Level
Jurisdiction
Rainfall


2010 Hill 8
10
0
-10
-20
-30
-40
-50
-60
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
05-Nov-2010
Water Level
Jurisdiction
Rainfall


2010 Hill 9
5
0
-5
-10
-15
-20
-25
-30
3 Days
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
4-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
Water Level
Jurisdiction
Rainfall


2010 Hill 10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
2 Days
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
05-Nov-2010
Water Level
Jurisdiction
Rainfall


2010 Goose Pond Bay Reference Site
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
81 Days
55 Days
Approximate 2010 Growing Season
01-Oct-2009
09-Oct-2009
17-Oct-2009
25-Oct-2009
02-Nov-2009
10-Nov-2009
18-Nov-2009
26-Nov-2009
04-Dec-2009
12-Dec-2009
20-Dec-2009
28-Dec-2009
05-Jan-2010
13-Jan-2010
21-Jan-2010
29-Jan-2010
06-Feb-2010
14-Feb-2010
22-Feb-2010
02-Mar-2010
10-Mar-2010
18-Mar-2010
26-Mar-2010
03-Apr-2010
11-Apr-2010
19-Apr-2010
27-Apr-2010
05-May-2010
13-May-2010
21-May-2010
29-May-2010
06-Jun-2010
14-Jun-2010
22-Jun-2010
30-Jun-2010
08-Jul-2010
16-Jul-2010
24-Jul-2010
01-Aug-2010
09-Aug-2010
17-Aug-2010
25-Aug-2010
02-Sep-2010
10-Sep-2010
18-Sep-2010
26-Sep-2010
04-Oct-2010
12-Oct-2010
20-Oct-2010
28-Oct-2010
Water Level
Jurisdiction
Rainfall


Readings for Hillcrest Bay Raingauge (HILLRG)
Rainfall (inches)
3.5
3
2.5
2
1.5
1
0.5
0
01-Nov-2009
12-Nov-2009
23-Nov-2009
04-Dec-2009
15-Dec-2009
26-Dec-2009
06-Jan-2010
17-Jan-2010
28-Jan-2010
08-Feb-2010
19-Feb-2010
02-Mar-2010
13-Mar-2010
24-Mar-2010
04-Apr-2010
15-Apr-2010
26-Apr-2010
07-May-2010
18-May-2010
29-May-2010
09-Jun-2010
20-Jun-2010
01-Jul-2010
12-Jul-2010
23-Jul-2010
03-Aug-2010
14-Aug-2010
25-Aug-2010
05-Sep-2010
16-Sep-2010
27-Sep-2010
08-Oct-2010
19-Oct-2010
Date

2005 to 2010 Composite Project History