SUTHER STREAM & WETLAND RESTORATION SITE -- EEP #370
Cabarrus County NC -- PeeDee River HUC# 03040105-020060

MY-3 (2014) ANNUAL MONITORING REPORT (Final)

North Carolina Department of Environment & Natural Resources
Ecosystem Enhancement Program (DENR-EEP) -- Contract # 5764

Data Collected: Aug-Sep 2014 Final Report Submitted: Mar 2015

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Appendix D. Stream Geomorphology Data

Appendix E. Stream, Wetland, and Rainfall Hydrology Data

1.0. Project Summary

1.1. Goals & Objectives

The Suther Stream and Wetland Restoration Project (Suther Site, EEP # 370) lies along Dutch Buffalo Creek and an unnamed tributary in northeastern Cabarrus County NC. The site lies within the Yadkin-Pee Dee watershed (HUC #03040105-020060). This project includes restoration of ditched and drained non-riverine wetlands, restoration of a channelized ephemeral tributary, and enhancement and preservation along the main stem of Dutch Buffalo Creek. Project construction, planting, and the as-built survey were completed in late 2009, and annual monitoring was conducted in 2010 and 2011. During 2012-2013 EEP reevaluated the site with respect to project assets, necessary actions, and monitoring goals. Therefore, contracted site monitoring was temporarily suspended, and then resumed in 2014 by Robert J. Goldstein & Associates (RJG&A) and will continue through 2016 (MY5) and project close-out in 2017. The 2014 through 2016 monitoring protocol includes additional stream and wetland gauges and main channel cross-sections as shown on the CCPV. Specific **goals** for the Suther Site project include:

- Stabilize and protect degraded stream banks along the main reach of Dutch Buffalo Creek.
- Restore a natural, stable dimension, pattern, and profile along the channelized tributary.
- Improve water quality and riffle and pool habitats to support benthos and fish communities.
- Restore or enhance natural hydrology, native vegetation, and soil functions in wetlands.
- Exclude livestock and establish cattle & farm vehicle crossings along Dutch Buffalo Creek.
- Decrease in-stream sediment and improve the aesthetics of the stream.

To meet these goals, the following **objectives** have been established for the Suther Site project:

- Enhance approximately 3,004 linear feet along the upper reach of Dutch Buffalo Creek by replanting the riparian areas with native trees and shrubs.
- Preserve 3,583 linear feet along the upper and lower reaches of Dutch Buffalo Creek.
- Restore a channelized tributary to re-create 608 linear feet of a Rosgen C/E stream type.
- Preserve approximately 1.67 acres, enhance approximately 4.26 acres, and restore approximately 7.29 acres of riparian non-riverine wetland area.
- Construct access crossings for cattle and farm vehicles across the main channel and tributary.
- Create an alternative livestock watering source and install livestock exclusion fencing.

1.2. Project Success Criteria

1.2.1. Stream Morphology and Stability Success

Stream morphology monitoring during the first two years (Jacobs, 2010 to 2011) was conducted along the restored tributary (608 lin. ft) and four cross-sections on this tributary. No morphologic survey was conducted on the main channel of Dutch Buffalo Creek during MY1 or MY2. In 2013 EEP staff installed eleven sets of bank erosion pins along the main channel upstream of the restored tributary

(between stations 22+00 and 31+00). The revised monitoring scope for 2014 to 2016 includes the restored UT longitudinal profile (608 lin. ft), two of the original four cross-sections on the UT, all remaining bank pins (some were lost between 2013 and 2014), and six new cross-sections along Dutch Buffalo Creek between stations 21+00 and 45+00. The bank pins and new cross-sections were added to assess the stability of the enhancement reach.

The annual profile and cross-section measurements along the restored tributary should indicate only minor changes from the 2010 as-built data. Any future changes that occur will be evaluated to determine whether they indicate unstable conditions or whether they are within the range of expected natural channel adjustment. Substrate particle samples should generally shift towards coarser materials (based on D50 and D84 sizes at riffle cross-sections).

1.2.2. Vegetation Success

Jacobs Engineering established and monitored seven CVS vegetation plots during 2010 and 2011. No vegetation data were collected during 2012 or 2013, and in April 2014 EEP staff determined that fall 2014 vegetation data collection would not be needed due to low planted stem survival. Instead, the low stem density areas will be replanted during early 2015, new CVS vegetation plots would then be established, and annual vegetation monitoring should resume in fall 2015.

To achieve vegetative success criteria the average number of planted stems per acre must exceed or meet 320 stems/acre after the third year of monitoring, 288 stems/acre after four years, and 260 stems/acre after the fifth year of project monitoring. High threat invasive species as defined in Version 1.3 of the EEP Monitoring Template should be limited in their spatial extent and density such that survival and diversity of native woody trees and shrubs is not compromised.

1.2.3. Hydrology Success

Stream and wetland hydrology attainment will be monitored in accordance with USACE standards. A continuous stage recorder will be added to the restored tributary in 2015 in order to determine flow duration on this tributary. At the end of the five year monitoring period, two or more bankfull events must occur in separate years within the restoration reach. The target wetland hydrological success criterion is saturation or inundation for at least eight (8) percent of the growing season in the lower landscape (floodplain) positions. To achieve hydrologic success in Cabarrus County, groundwater levels must be within 12 inches of the ground surface for 18 consecutive days, which is eight (8) percent of the March 23 to November 7 growing season (229 days).

1.3. Project Setting & Pre-Restoration Conditions

The Suther Stream and Wetland Restoration Site is located in Cabarrus County, North Carolina, northeast of the City of Concord. The site is located within the Yadkin – Pee Dee River Watershed (USGS HUC 03040105, DWQ Sub-basin 30712). A Vicinity Map is included in Appendix A. The

surrounding land use is primarily agricultural with cattle grazing, row crops, and rural residential development. Dutch Buffalo Creek (DBC) is a third order stream with an approximate drainage area of 23 square miles at the farthest downstream point of the project. The restored UT to Dutch Buffalo Creek (UT) is a first order stream with an approximate drainage area of 0.3 square miles.

Prior to restoration in 2009, much of the project site was managed for cattle grazing, including dredging and straightening of two tributaries: 1) the now-restored UT that joins DBC near station 39+50, and 2) the drainageway along the south edge of the upper (western) field that joins DBC near station 18+00. Riparian vegetation along tributaries was removed during channelization and also by cattle grazing and trampling, and riparian wetlands along both sides of DBC were drained for agricultural use. The main channel of DBC is incised and over-widened due to upstream agricultural and urban development activities. Near-vertical and undercut banks are common along DBC throughout much of the project area. Cattle had unrestricted access to the stream banks prior to establishing and fencing the conservation easement. The riparian zones along the main channel of DBC are predominantly forested with mature hardwood trees and shrubs, and are now protected within the project boundaries. The project vicinity is located in a rural part of Cabarrus County, but upstream development has been encroaching for the past few decades.

1.4. Project Components and Mitigation Assets

The mitigation components are summarized in Table 1. These include:

- 3,004 lf of enhancement (mitigation ratio 2.5:1) on the main channel of DBC
- 3,583 lf of preservation (mitigation ratio 5:1) on the main channel of DBC
- 608 lf restoration (mitigation ratio 1:1) on the unnamed tributary to DBC
- 1.67 ac. of wetland preservation (mitigation ratio 5:1) at Wetland B-2
- 2.47 ac. of wetland enhancement (mitigation ratio 2:1) at Wetland Area B-1
- 1.97 ac. of wetland restoration (mitigation ratio 1:1) at Wetland Area B-1
- 1.79 ac. of wetland enhancement (mitigation ratio 2:1) at Wetland Area C
- 5.32 ac. of wetland restoration (mitigation ratio 1:1) at Wetland Area C

1.5. Project Design Approach

The stream restoration effort consisted of Enhancement Level II along the main reach of Dutch Buffalo Creek and Restoration Priority Level 1 and 2 along the UT to Dutch Buffalo Creek. The project also included wetland restoration and enhancement, the re-establishment of native riparian areas, and preservation of native vegetation, wetlands, and reaches of Dutch Buffalo Creek. The wetland restoration and enhancement area and the areas of disturbance associated with the ditch filling were planted with species similar to those found in reference wetlands to achieve a Piedmont/Mountain Bottomland Forest as described in Schafale and Weakely (1990). Similarly, the stream banks and immediately adjacent riparian areas associated with disturbance due to bank stabilization were also planted with species similar to those currently found there to maintain a Piedmont/Low Mountain

Alluvial Forest (Schafale and Weakely 1990). With the exception of the drainage ditches, minimal grading (fill or cut) occurred for the wetland restoration and enhancement areas. Top soil taken from cut areas along the stream was reserved for the top soil dressing utilized for ditch filling. The soil along the stream banks was naturally fertile due to its alluvial nature, so this top soil was well suited for planting. In addition, disking was completed to ensure adequate drainage and beneficial microtopography for planting and drainage.

The restoration plan was designed in 2007 by Jacobs Engineering (was Jordan Jones & Goulding prior to 2010), constructed and planted during Nov-Dec 2009 by River Works Inc., and monitored for two years (2010 and 2011) by Jacobs Engineering. During 2012 and 2013 no formal monitoring or reports were produced, but EEP staff conducted limited monitoring and instrument maintenance. Routine monitoring was resumed in 2014 by Robert J. Goldstein & Associates (RJG&A) and will continue through 2016 (MY5) and project close-out in 2017.

1.6. Current Conditions and Performance Summary

Based on the data collected during spring and fall of 2014 (MY-3), the Suther Project is trending toward successful restoration but has some minor concerns as described below.

1.6.1. Stream Assessment: Dutch Buffalo Creek

The condition of Dutch Buffalo Creek enhancement reach (station 17+61 to 53+72) as observed in April and Aug-Sep 2014 appears similar to the photographs and description provided in the MY-2 (2011) monitoring report (Jordan Jones & Goulding, May 2012). Most of the stream bed is dominated by shifting sand and silt, with few areas of gravel or cobble. Larger rocks appear embedded with fine sand and silt, although high turbidity and flow during the spring field inspection made this difficult to assess. During the fall site visit water was at low flow stages and no major issues were observed although erosion and undercutting appears to be active in some areas, especially at bends, and a few recently fallen large trees were observed in areas of bank undercutting. The segment between Stations 16+00 to 17+50 (at the head of the enhancement reach) is the most severely eroded, with slumping on both banks and mid-channel sand bar formation. Some smaller trees recently cut by beavers were observed along the south bank in this vicinity. Although no active beaver dams were observed. Another area of slumping banks and mid-channel sand accretion is at the temporary construction crossing near station 32+50. A few log jams were noted along the enhancement reach, similar to the 2011 description, but do not appear to be causing significant additional bank erosion. The combination of stream elevations and the fact that Dutch Buffalo Creek has a 23 square mile drainage in a mature forest made grading along the main stem impractical and inadvisable. The cross section for Dutch Buffalo is overly large and the bankfull discharge is not connected to the floodplain in many locations, particularly in the upper section, and although there are some areas of instability reach-wide stream bank integrity does not appear to be an imminent problem. Most of this channel reach still has adequate tree root density to provide bank stability. The cattle crossing areas constructed in 2009 appear to be stable, and livestock exclusion fencing appears to be effective in keeping cattle out of the stream beyond these crossings.

The DBC main stem condition is typical of many Piedmont streams in predominantly agricultural and/or urbanizing watersheds. The channel is incised and banks are actively eroding in certain places, but

appear relatively stable along most segments. Some bank pins have shown retreat since their installation in early 2013 with a mean of 0.49 feet/year retreat among the 10 remaining pin arrays (Appendix D, Table 7). A few bank pins were lost due to a tree fall and bank slump event near station 26+30. Log jams in a few areas may contribute to accelerated localized bank erosion, but are important components of aquatic habitat diversity. The visual survey of the channel identified approximately 7.5% of the reach's bank footage as active undercutting or mass wasting (i.e. 92.5% of the bank footage without significant erosions) with an additional 18% exhibiting poor vegetative cover or minor surficial scour. Overall the creek is trending toward an improved ecological condition due to cattle exclusion and vegetation recovery.

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1.6.2. Stream Assessment: Restored Tributary of DBC

The 2014 visual condition assessment in the spring and fall of the tributary appears similar to the 2011 monitoring photos. The stream pattern, profile, and dimension appear to be maintaining vertical and lateral stability over most of the restored reach, and the log cross-vane and constructed riffles are performing as designed. Stream-bank vegetation density appears adequate in most areas, although growth of planted stems remains slow as noted in 2011. In-channel vegetation growth (grasses and herbs) is abundant, but is not significantly impeding flow or causing channel over-widening. Minor wash-out of fabric was observed at some of the close-spaced step-pools along the lowermost 80 feet of this reach, and woody vegetation is sparse along the banks near the confluence with DBC, but channel grade and pattern of the tributary appear stable.

1.6.3. Wetlands & Former Pasture Area

The plugged ditch areas and steps installed in the ditches draining wetlands C, B1, and B2 appear to be stable and performing as designed, with minimal erosion. All three wetland areas show signs of extensive ponding and surface saturation during the April and September 2014 field inspections.

Survival and growth of understory vegetation planted in the forested wetland areas of B1 and B2 remains low, as noted in 2011, and is understandable considering the forest canopy in these areas. Wetland C, formerly a pasture prior to restoration, has adequate woody stem density (planted and volunteers combined) over some of the area, except for about 2.2 acres in the northwestern portion which is grass-dominated. This area is mapped as “low woody density” in CCPV Figure 2.1, and includes some non-wetland area. EEP will replant this area in early 2015, and establish new CVS monitoring plots. In 2011 the two vegetation plots in wetland C had planted stem densities of 283 and 931 stems per acre, and total stem densities over 1000 per acre. (Currently, no permanent vegetation plots are located within the area mapped as “low woody density”).

Feral hogs are living in the former pasture area, in both the wetland and non-wetland portions. A few hogs were seen by RJG&A representatives in April 2014, and several hog-wallow areas were noted

within the conservation easement in September. Moderate grazing damage was also noted along the forested stream enhancement and preservation areas downstream of the pasture, apparently from deer or feral hogs. The landowner, Mr. Suther, allows hunting of the hogs which culls 10-20 hogs per year.

1.6.4. Vegetation Assessment

The preservation areas are in good condition and do not need supplemental planting. The northwestern corner of the site which is dominated by grasses and blackberries will receive supplemental planting in early 2015 to ensure vegetative success criteria. Feral hogs and deer are present and tend to uproot newly planted vegetation so this should be considered when the supplemental planting is done. MY 4 & 5 will include vegetation data from newly established 100 m^2 CVS vegetation plots which will be added to the CCPV. Much of the streamside zone within 30 feet of the restored UT also has low planted woody stem density, but the stream channel is surrounded by mature forest.

1.6.5. Hydrology Assessment

Groundwater depth data from 16 of the 17 wetland gauges installed in April 2014 are presented in Appendix E (data period = Apr 10 to Sep 15, 2014). Fourteen gauges (#1, 3, 4, 5, 6, 7, 8, 9, 11, 14, 15, 16, 17 & 18) achieved the required hydrologic success criteria, and two gauges (#12 & 13) did not achieve hydrologic success. One gage (#2) failed to log data and was replaced. The wetland hydrologic success criterion established in the project mitigation plan is saturation within 12 inches of the ground surface for 18 consecutive days, which is eight percent of the 229-day growing season (March 23 to November 7). Gauge 10 was removed and not replaced. Overall, eighty seven percent of the functioning gauges (14 out of 16) achieved hydrologic success in 2014.

The rain gage tipping bucket apparently jammed soon after installation, and no useful on-site precipitation data were collected from April to September 2014. Data from a nearby rain gage at the Concord WWTP (9 miles SSW of Suther Site) are used as a surrogate estimate of on-site precipitation. The on-site gage was repaired and re-deployed with a new tipping bucket in November 2014, and yielded data similar to rainfall records at the Concord WWTP when downloaded a month later in mid-December 2014.

Bankfull flow events are assessed based on data from a pair of Hobo recording pressure transducers installed in April 2014 along Dutch Buffalo Creek 200 ft upstream from the restored tributary mouth. The in-stream sensor is mounted on a post 1.6 ft above the thalweg, and the reference sensor is mounted on a high ridge on the adjacent bank, with both sensors recording pressure at 30-min intervals. Creek stage rose above the sensor during eight storm events between Apr and Sep 2014, for a total of 11.4 days (Appendix E, Figure 8). The highest recorded peak stage (on Apr 19) was 5.73 ft above the in-stream sensor, or 7.33 ft above the thalweg, which is probably at or above bankfull elevation along this incised segment of Dutch Buffalo Creek.

There is no crest gage or Hobo gage along the restored tributary. However, the main channel gradient is nearly flat from the Hobo gage to the tributary confluence, allowing Hobo stage data to be useful for assessing bankfull stage events along the lower portion of the tributary. The Hobo data indicate high flow events in Dutch Buffalo Creek on Apr 15, Apr 19, and May 16 that exceeded the bankfull elevation (645 ft) along the lower segment of the tributary. The Apr 19 peak (647.7 ft) was apparently above

bankfull along 60% or more of the tributary, even without accounting for flow coming from the tributary's own watershed. Matted vegetation and wrack lines were observed in multiple locations along the tributary floodplain during the April site visit.

2.0. Monitoring Methods

Monitoring methodologies follow the CVS-EEP Level 2 Vegetation Monitoring Protocol for Recording Vegetation (Lee *et al.* 2008). Photos were taken with digital cameras and are available electronically. A Trimble Hand Held GPS unit was used to locate groundwater gauges, stream cross-sections, other monitoring features and problem areas.

An HP 48G+ calculator was used to download the Infinity rain gauge, an Aceeca Meazura PDA was used to download the RDS groundwater gauges, and an Onset Hobo Data Shuttle was used to download the Onset Hobo pressure transducers. CCPV graphics were prepared using ESRI ArcGIS.

2.1. Vegetation Methodologies

In the winter/spring of 2015, new 10 x 10 square meter veg. plots will be installed and monitored according to the CVS-EEP Level 2 Vegetation Monitoring Protocol Version 4.2 (Lee *et al.* 2008) starting in MY 4. All plot corners will be marked with 1" Aluminum pipe and flagged with bright red flagging tape. Data collected from each plot will be included in Appendix C. Monitoring plot locations will be shown on the maps in Appendix B.

2.2. Wetland Methodologies

All seventeen (17) RDS groundwater Monitoring Gauges were downloaded most recently in September, 2014, and have been downloaded quarterly throughout the growing season to ensure that the gauges are functioning properly. Data are provided in an Excel spreadsheet.

2.3. Stream Methodologies

The UT longitudinal profile was surveyed using a Trimble RDK survey-grade GPS unit, and cross-sections along the UT and DBC were surveyed with an automatic level and rod. The survey data locations were plotted using ARC GIS 10.0 and Excel. Cross-sectional data was based on a linear alignment between end points marked by metal pins. Measurements at each cross-section include points at point of origin, bankfull, top of bank, toe of slope and thalweg for each stream side supplemented with photo's. Long-pro measurements include thalweg, and water surface taken at the head of feature (i.e. riffle, run, pool glide) in addition to pool depths. In addition, visual and photographic assessment of in-stream structures was conducted to determine overall project success. Stream assessment data are included in Appendix D with cross-sections and monitored stream reaches indicated on maps in Appendix B. In addition, MMI used manual crest stage gauges to verify bankfull events.

3.0. References

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Jacobs Engineering (was Jordan Jones & Goulding) (2010). *Mitigation Plan: Suther Stream and Wetland Restoration Project, December 2010*. Prepared for NC Ecosystem Enhancement Program, Raleigh, NC.

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NC Ecosystem Enhancement Program. (2010). *Neuse River Basin Restoration Priority Plan, Draft 2010*. http://www.nceep.net/services/restplans/DRAFT_RBRP_Neuse_201007.pdf

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US Army Corps of Engineers (2003) *Stream Mitigation Guidelines*. US Army Corps of Engineers, US Environmental Protection Agenmcy Region 4, USDA Natural Resources Conservation Service, NC Wildlife Resources Commission, and NC Dept. Environment & Natural Resources.

Weakley, Alan (2012). *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas*. http://www.herbarium.unc.edu/flora.htm.

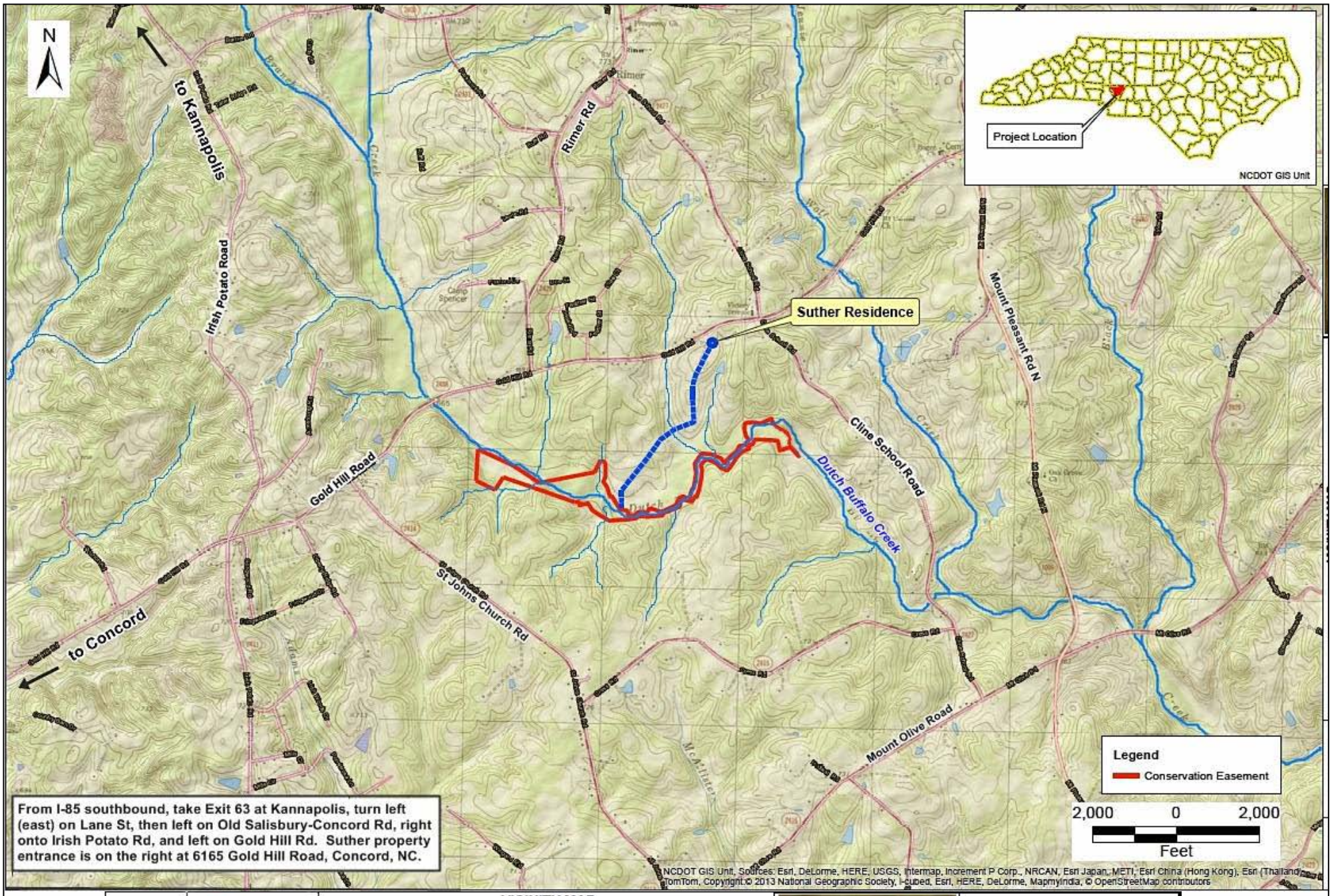


Figure 1
January 2015

Ecosystem Enhancement Program

VICINITY MAP
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP #370)

CABARRUS COUNTY
NORTH CAROLINA

RJG&A ENVIRONMENTAL CONSULTANTS Since 1985

Robert J Goldstein & Associates, Inc.
1221 Corporation Parkway
Raleigh, North Carolina 27610

Appendix A: Project Background Data

Table 1. Project Components and Mitigation Credits Suther Site (Dutch Buffalo Cr) EEP # 370: Stream and Wetland Restoration Project						
Mitigation Credits						
	Stream (SMU)	**Riparian Wetland (WMU)**	**Non-riparian Wetland**	**Buffer**	**Nitrogen Nutrient Offset**	**Phosphorous Nutrient Offset**
Type	**EII/ P/ R**	**P/ E/ R**	**N/A**	**N/A**	**N/A**	**N/A**
Totals	1,201.6/ 716.6/ 608	0.33/ 2.13/ 7.29	**N/A**	**N/A**	**N/A**	**N/A**
Project Components						
Project Component/Reach ID	**Stationing (ft)**	**Existing Footage/ Acreage**	**Approach**	**Restoration or Restoration Equivalent**	**Restoration Footage or Acres**	**Mitigation Ratio and Credits**
Dutch Buffalo Creek-Upper Reach	0+00 – 17+61	N/A	N/A	N/A	N/A	N/A
	17+61 - 53+72 *	3,611 lf	Enhance	RE	3,004 lf	2.5:1 = 1201.6
Dutch Buffalo Creek-Lower Reach	53+72 – 100+50 *	4,678 lf	Preserve	RE	3,583 lf	5:1 = 716.6
UT to Dutch Buffalo	0+00 – 6+08	527 lf	Restor P1, P2	R	608 lf	1:1 = 608.0
Wetland Area B-2	N/A	1.67 ac	Preserve	RE	1.67 ac	5:1 = 0.334
Wetland Area B-1	N/A	4.44 ac	Enhance	RE	2.47 ac	2:1 = 1.235
			Restore	R	1.97 ac	1:1 = 1.97
Wetland Area C	N/A	4.64 ac	Enhance	RE	1.79 ac	2:1 = 0.895
			Restore	R	5.32 ac	1:1 = 5.32
Component Summations						
Restoration Level	**Stream (linear feet)**	**Riparian Wetland (acres)**		**Non-riparian Wetland (acres)**	**Buffer (square feet)**	**Upland (acres)**
		Riverine	**Non-Riverine**			
Restoration (R)	608	N/A	7.29	N/A	N/A	N/A
Enhancement (E)		N/A	4.26	N/A	N/A	N/A
Enhancement I (E)	N/A					
Enhancement II (E)	3,004					
Creation (C)		N/A	N/A	N/A		
Preservation (P)	3,583	N/A	1.67	N/A		N/A
HQ Preservation (P)	N/A	N/A	N/A	N/A		N/A
Totals	**7,195**	**N/A**	**13.22**	**N/A**	**N/A**	**N/A**
BMP Elements						

Table 2. Project Activity and Reporting History Suther Site (Dutch Buffalo Cr) EEP # 370: Stream and Wetland Restoration Project		
Activity or Report	**Data Collection Completed**	**Actual Completion or Delivery**
Restoration Plan	Jan-06	Sep-07
Final Design-90%	Nov-08	Nov-08
Construction	Nov-09	Dec-09
Temporary S&E mix applied to entire project area*	Nov-09	Nov-09
Permanent seed mix applied to reach	Nov-09	Nov-09
Bare root and livestake plantings for reach	Dec-09	Dec-09
Mitigation Plan/ As-Built (Year 0 Monitoring)	Dec-09	Jan-09
Year 1 Monitoring (2010)	Oct-10	Jun-11
Year 2 Monitoring (2011)	Aug-11	May-12
Year 3 Monitoring (2014)	Oct-14	Feb-15
Year 4 Monitoring (2015)		
Year 5 Monitoring (2016)		

*Seed and mulch is added as each section of construction is completed.

Table 3. Project Contacts Table Suther Site (Dutch Buffalo Cr) EEP # 370: Stream and Wetland Restoration	
Designer Matthew Clabaugh, PE*	Jacobs Engineering Group 6801 Governors Lake Parkway Norcross, GA 30071 770-455-8555
Construction Will Pedersen	River Works, Inc. 8000 Regency Parkway, Suite 200 Cary, NC 27511 919-459-9001
Planting Contractor	River Works, Inc.
Seeding Contractor	River Works, Inc.
Monitoring Performers: **Baseline Year 0 to Year 2**	Jacobs Engineering Group 6801 Governors Lake Parkway Norcross, GA 30071
Stream Monitoring, POC	Alison Nichols, 704-247-9065
Vegetation Monitoring, POC	
Wetland Monitoring, POC	
Monitoring Performers: **Year 3 to Closeout**	Robert J Goldstein & Associates (RJGA) 1221 Corporation Parkway Norcross, GA 30071
Stream Monitoring, POC	Gerald Pottern, 919-872-1174 Gpottern@RJGAcarolina.com
Vegetation Monitoring, POC	
Wetland Monitoring, POC	

Suther Site (Dutch Buffalo Cr) EEP # 370: Stream and Wetland Restoration Project			
Project Information			
Project Name	Suther Site, Dutch Buffalo Cr Stream and Wetland Restoration Project		
County	Cabarrus County, North Carolina		
Project Area (acres)	66		
Project Coordinates (latitude and longitude)	35° 27' 05" N, 80° 29' 32" W		
Project Watershed Summary Information			
Physiographic Province	Piedmont		
River Basin	Yadkin PeeDee		
USGS Hydrologic Unit 8-digit 3040105		USGS Hydrologic Unit 14-digit	03040105020060
DWQ Sub-basin	03-07-12		
Project Drainage Area (sq mi)	21.3		
Project Drainage Area Percentage of Impervious Area	3%		
CGIA Land Use Classification	Cultivated (3.00); Mixed Upland Hardwoods (10.00)		
Reach Summary Information			
Parameters	**Main Channel**	**UT**	
Length of Reach (linear feet)	10,050	608	
Valley Classification	VIII		
Drainage Area (sq.mi.)	21.3	0.31	
NCDWQ stream identification score	13-17-11-(4.5)		
NCDWQ Water Quality Classification	WS-II; HQW,CA		
Morphological Description (stream type)	Perennial	Intermittent	
Evolutionary trend	C→G→F→C	E→Gc→F→C→E	
Underlying mapped soils	Altavista, Cecil, Chewacala, Cullen, Enon, Pacolet, Mecklenburg		
Drainage class**	MWD, WD, SPD, WD, WD, WD, WD		
Soil Hydric status	Class B (Chewacla and Altavista)		
Slope	0.0011	0.0093	
FEMA Classification	100-year floodplain		
Native vegetation community	Piedmont/Mountain Bottomland Forest; Piedmont/Low Mountain Alluvial Forest		
Percent composition of exotic invasive vegetation	10	80	
Wetland Summary Information			
Parameters	**Main Channel**	**UT**	
Size of Wetland (acres)	11.55	1.67	
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	riparian riverine	riparian riverine	
Mapped Soil Series	Chewacla		
Drainage class	SPD	SPD	
Soil Hydric Status	B	B	
Source of Hydrology	streamflow, groundwater	streamflow, stormwater	
Hydrologic Impairment	ditching	ditching	
Native vegetation community	Piedmont/Mountain Bottomland Forest; Piedmont/Low Mountain Alluvial Forest; Piedmont/Low Mountain Bottomland Forest	Piedmont/Low Mountain Alluvial Forest	
Percent composition of exotic invasive vegetation	5	5	

Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States - Section 404	Yes	Yes	Approved JD, NWP 27
Waters of the United States - Section 401	Yes	Yes	Approved 401 Certification
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

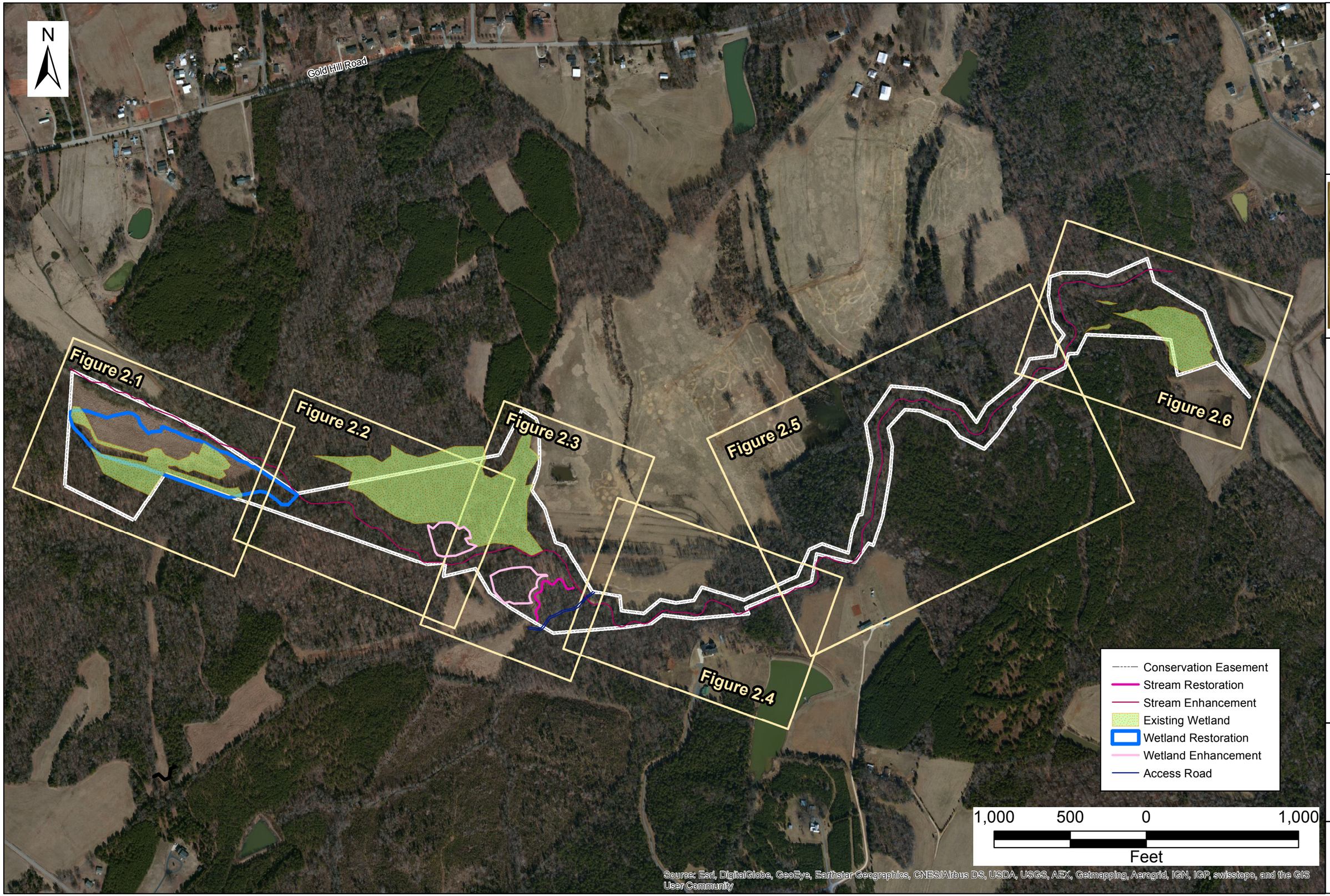
*Beaver activity was observed along the main channel of Dutch Buffalo Creek during the early stages of the design phase and has not impacted the UT. No beaver activity was observed during 2009-2012 post-construction monitoring.

"N/A": items do not apply / "-": items are unavailable / "U": items are unknown

SPD: Somewhat Poorly Drained; MWD: Moderately Well Drained; WD: Well Drained

**Drainage classes correspond to the underlying mapped soils listed.

Appendix B: Visual Assessment Data



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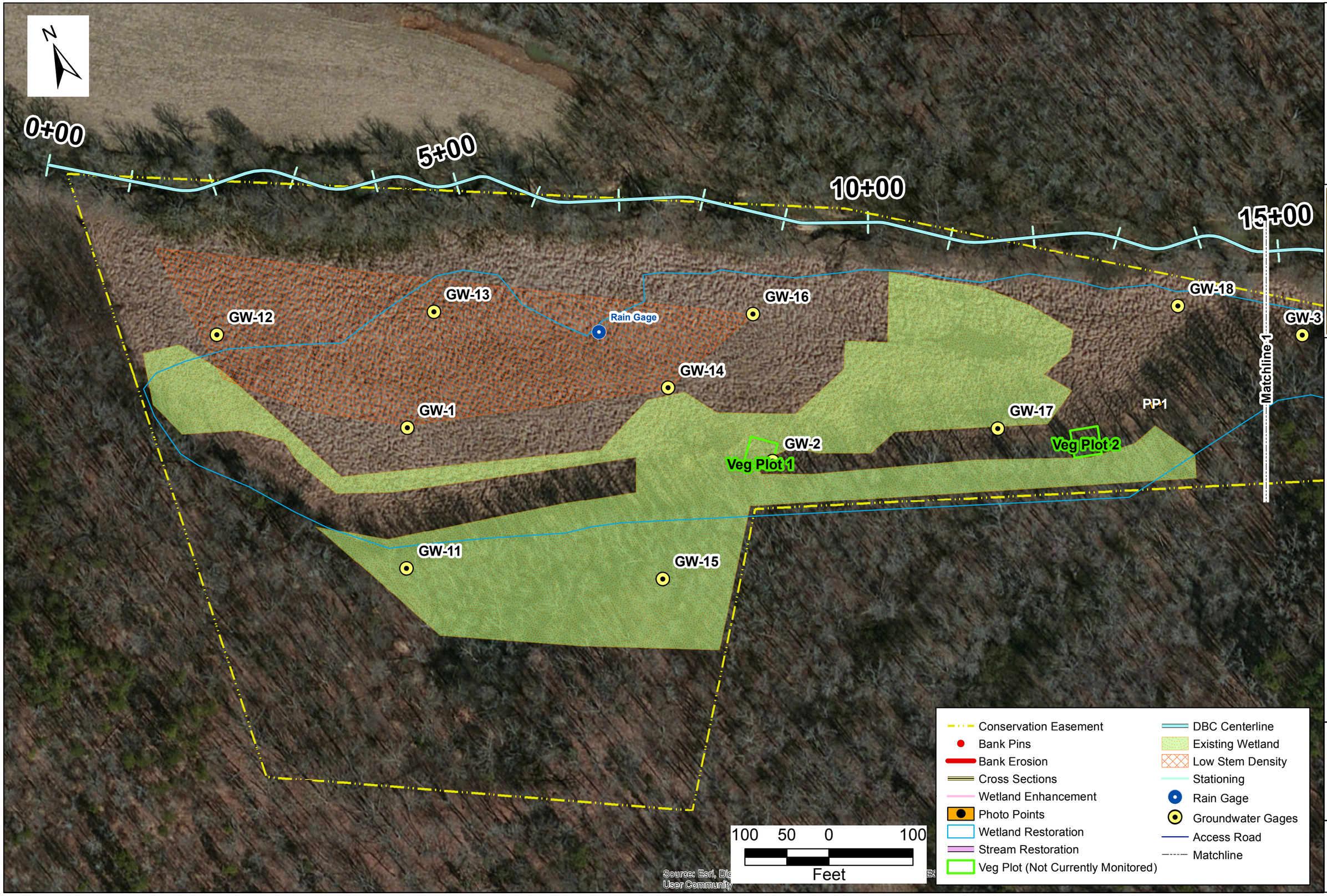
CURRENT CONDITIONS PLAN VIEW OVERVIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
NORTH CAROLINA

Ecosystem Enhancement Program

Figure 2

January 2015



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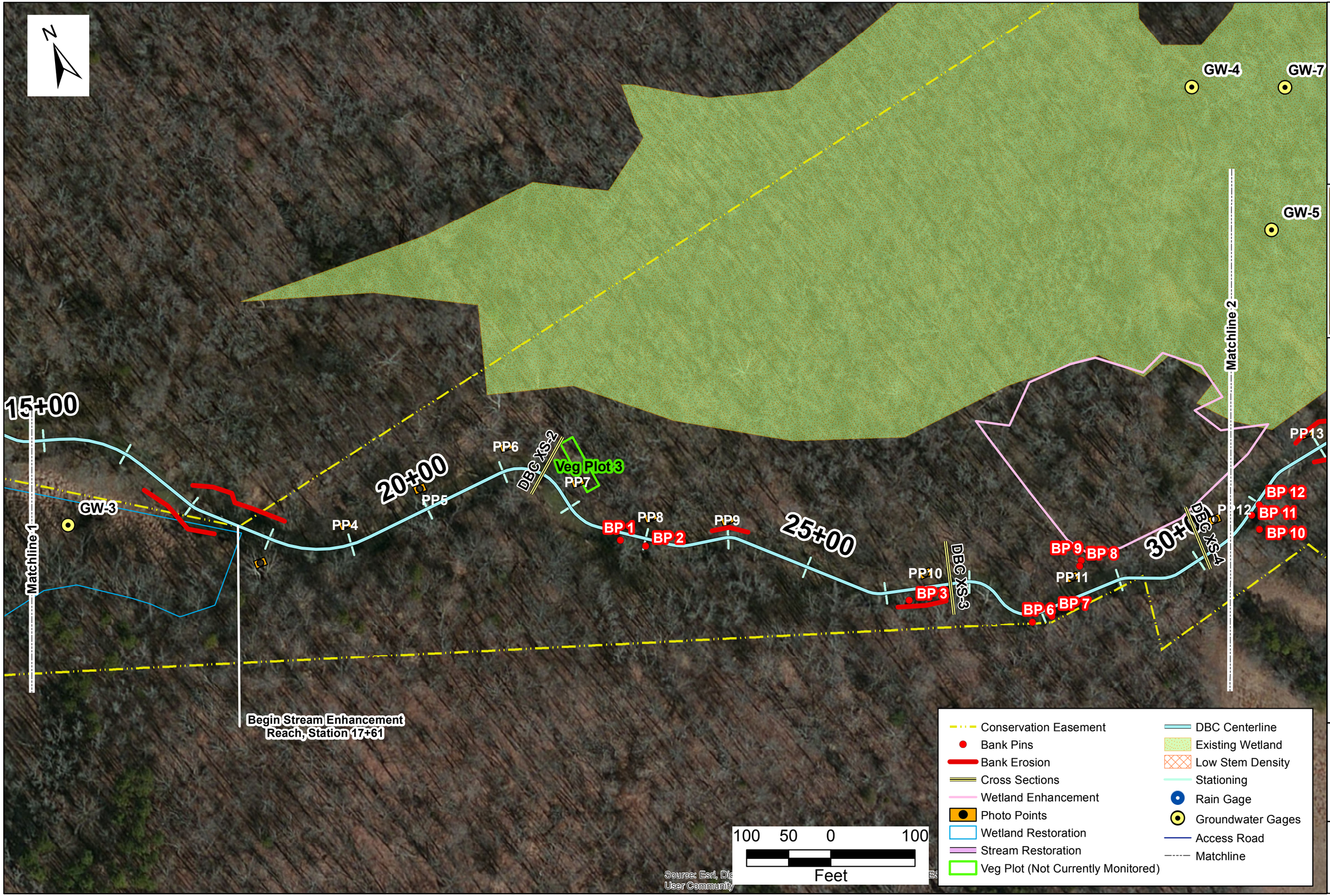
CURRENT C ONDITIONS PLAN VIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
NORTH CAROLINA

Ecosystem Enhancement Program

Figure 2.1

January 2015



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CURRENT CONDITIONS PLAN VIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
NORTH CAROLINA

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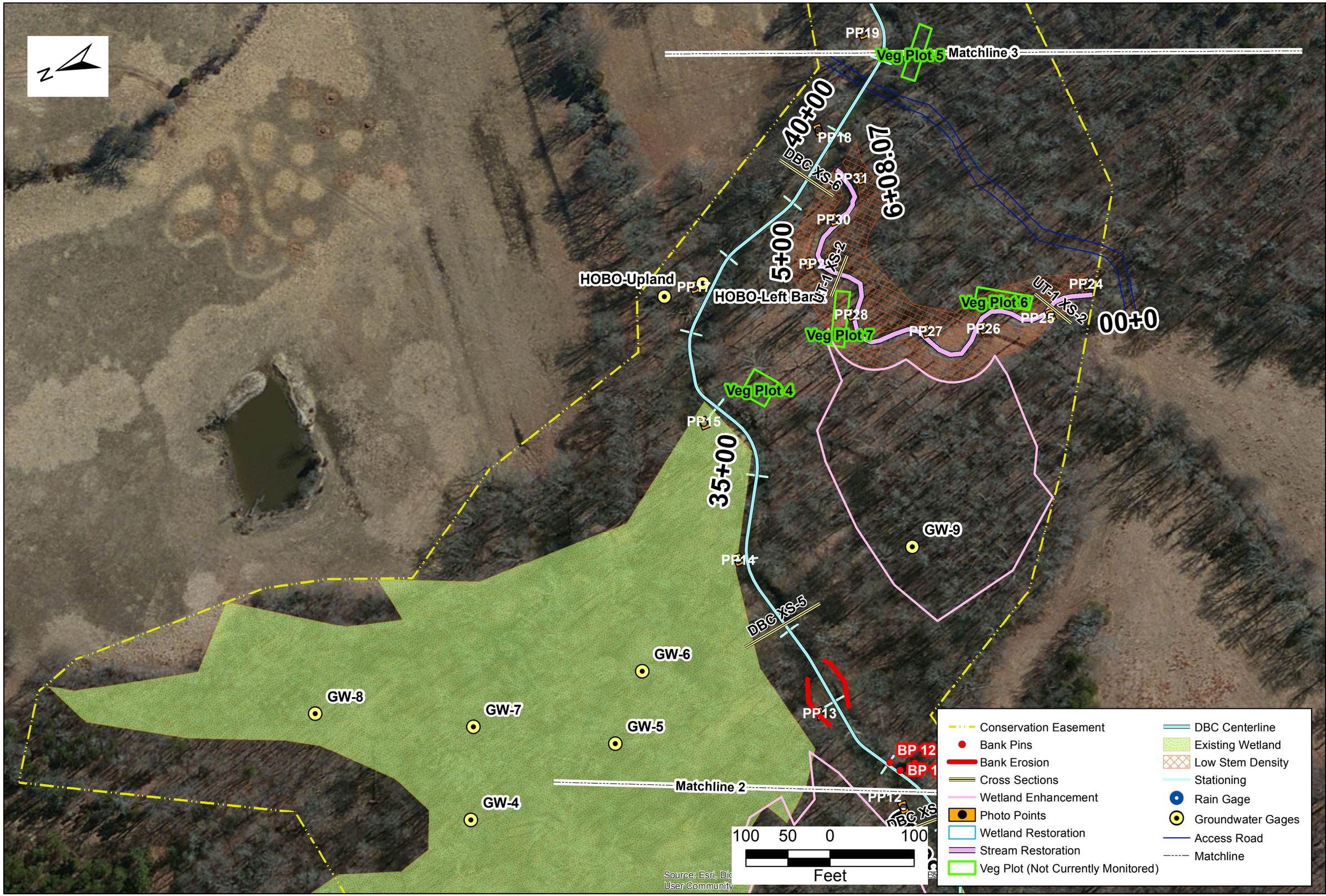
Figure 2.2

January 2015



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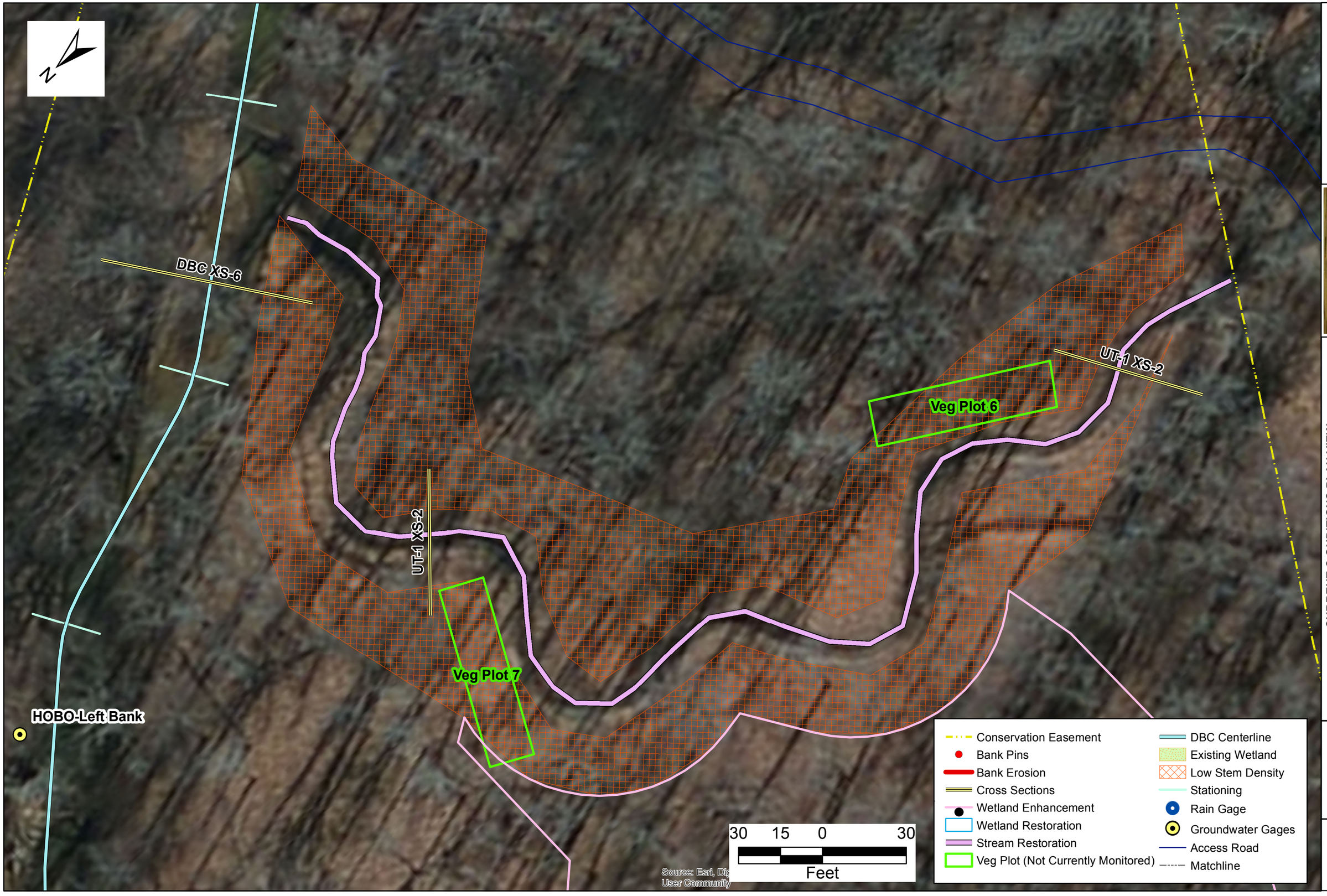
CURRENT C ONDITIONS PLAN VIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
NORTH CAROLINA

Ecosystem Enhancement Program

Figure 2.3

January 2015



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CURRENT C ONDITIONS PLAN VIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
NORTH CAROLINA

Ecosystem Enhancement Program

Figure 2.3A

January 2015

N

Matchline 3

Matchline 4

55+00

50+00

45+00

End Stream Enhancement
Reach, Begin Stream
Preservation Reach Station 53+71

PP22

PP19

PP20

PP21

DBC XS-7

Veg Plot 5

100 50 0 100

Feet

Source: Esri, Di
User Community

- Conservation Easement
- Bank Pins
- Bank Erosion
- Cross Sections
- Wetland Enhancement
- Photo Points
- Wetland Restoration
- Stream Restoration
- Veg Plot (Not Currently Monitored)
- DBC Centerline
- Existing Wetland
- Low Stem Density
- Stationing
- Rain Gage
- Groundwater Gages
- Access Road
- Matchline

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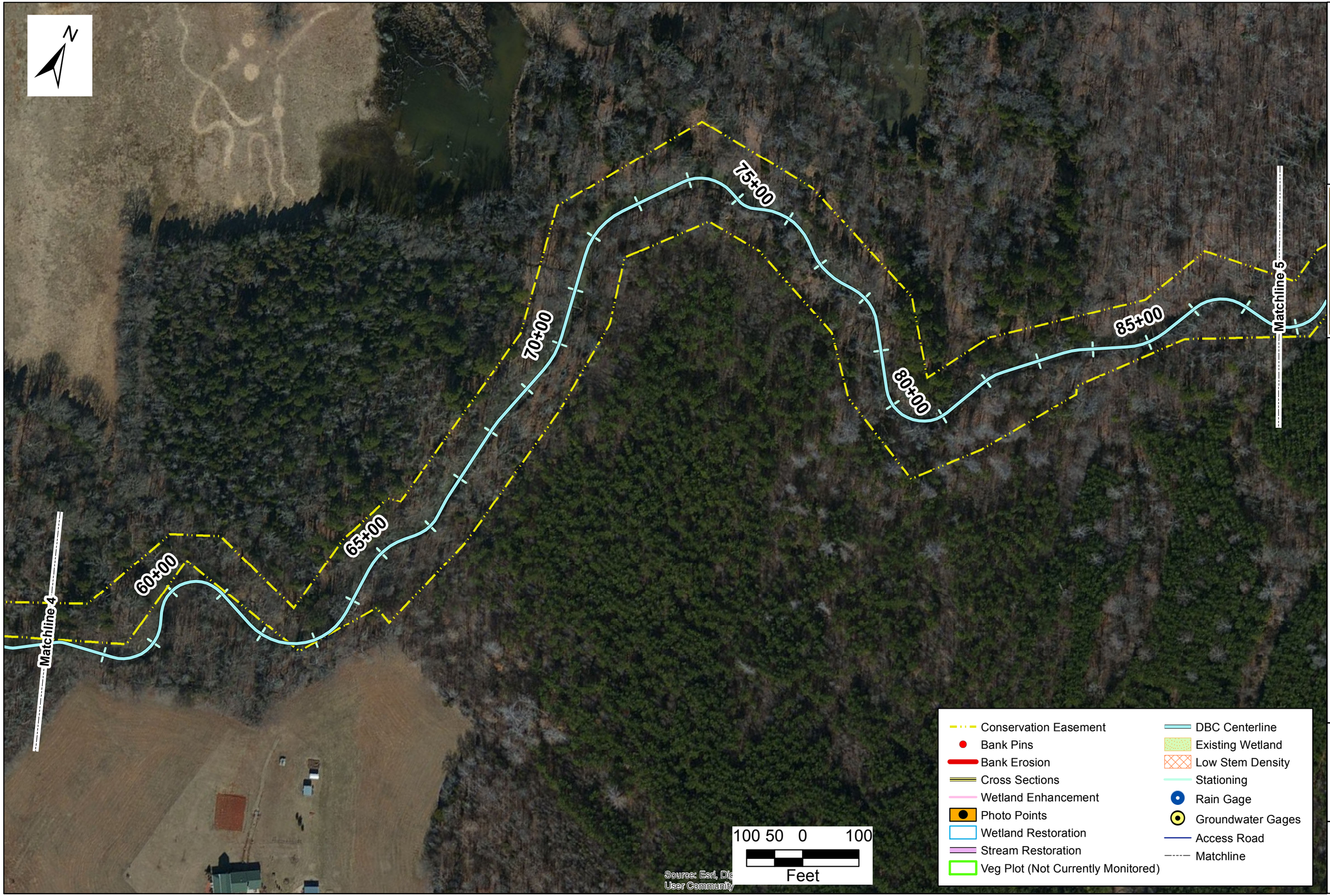
CURRENT C ONDITIONS PLAN VIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
NORTH CAROLINA

Ecosystem Enhancement Program

Figure 2.4

January 2015



CURRENT C ONDITIONS PLAN VIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
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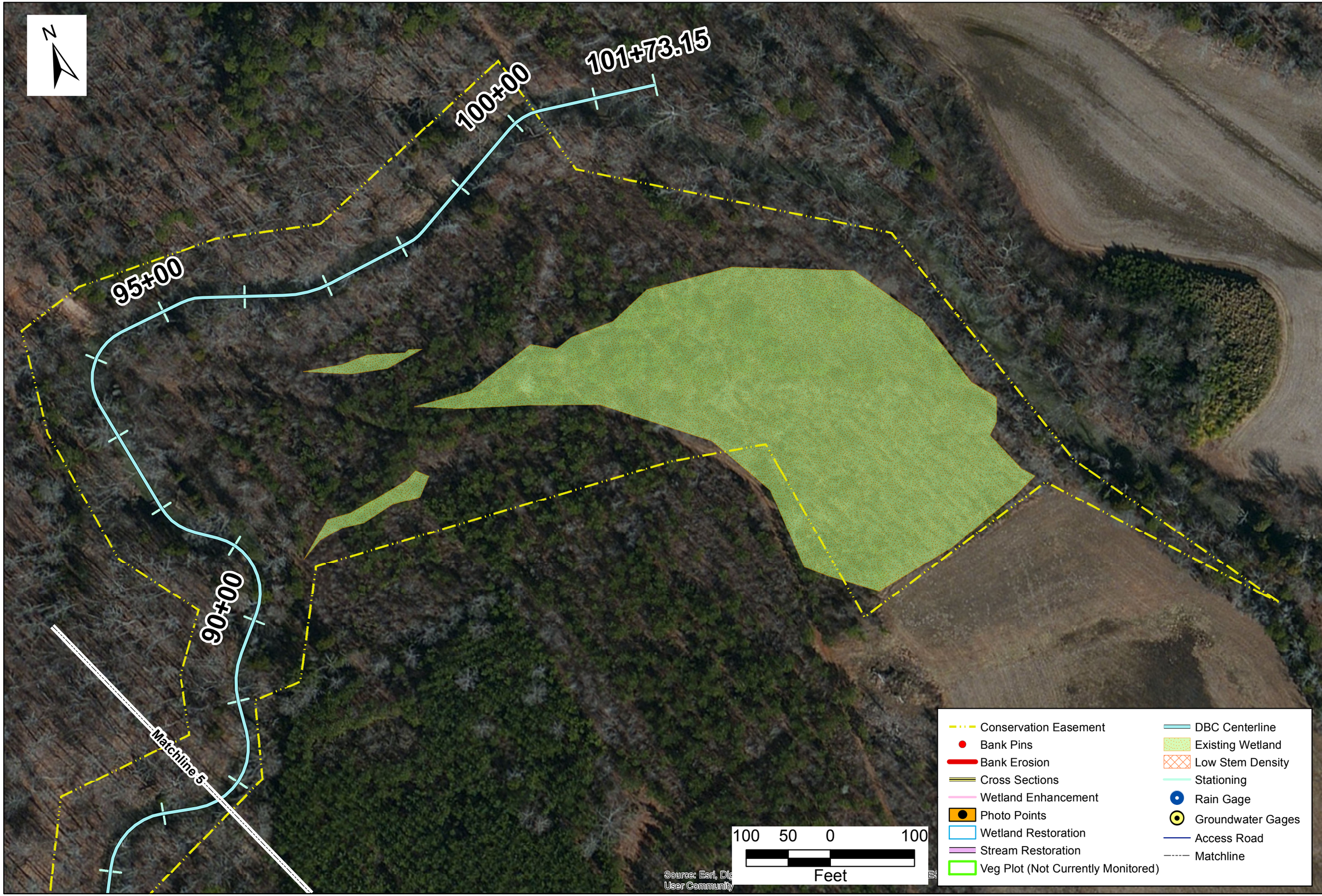
Figure 2.5

January 2015



CURRENT C ONDITIONS PLAN VIEW
SUTHER SITE, DUTCH BUFFALO CREEK
MONITORING YEAR 3 OF 5 (EEP#370)

CABARRUS COUNTY
NORTH CAROLINA

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Ecosystem Enhancement Program

Figure 2.6

January 2015

Table 5a. Visual Stream Stability Assessment -- Main Stem Dutch Buffalo Creek Enhancement (3,611 lin.ft = 7,222 bank ft)
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration: EEP Project # 370
Monitoring Year 3 of 5 (2014)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	N/A*	N/A*			N/A*			
	3. Meander Pool Condition	Depth Sufficient	N/A*	N/A*			N/A*			
		Length Appropriate	N/A*	N/A*			N/A*			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	N/A*	N/A*			N/A*			
		Thalweg centering at downstream of meander bend (Glide)	N/A*	N/A*			N/A*			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			18	1303	82%	14	1031	96%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely Does NOT include undercuts that are modest, appear sustainable and are providing habitat			3	160	98%	0	0	98%
	3. Mass Wasting	Bank slumping, calving, or collapse			2	110	98%	0	0	98%
				Totals	23	1573	78%	14	1031	92%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	N/A*	N/A*			N/A*			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	N/A*	N/A*			N/A*			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms	N/A*	N/A*			N/A*			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%	N/A*	N/A*			N/A*			
	4. Habitat	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow	N/A*	N/A*			N/A*			

The Dutch Buffalo Creek Enhancement II channel is incised and eroded. No channel restoration was performed on this reach.

*No engineered structures were installed within the Dutch Buffalo Creek Enhancement II segment.

Table 5b. Visual Stream Stability Assessment -- UT Dutch Buffalo Creek Restoration (608 lin.ft = 1,216 bank feet)
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration: EEP Project # 370
Monitoring Year 3 of 5 (2014)

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-Built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjust % for Stabilizing Woody Vegetation
1. Bed	**1. Vertical Stability (Riffle and Run units)**	Aggradation			0	0	100%			
		Degradation			0	0	100%			
	2. Riffle Condition	Texture/Substrate	7	7			100%			
	3. Meander Pool Condition*	Depth Sufficient *	-	-			N/A			
		Length Appropriate	8	8			100%			
	4. Thalweg Position	Thalweg centering at upstream of meander bend (Run)	7	7			100%			
		Thalweg centering at downstream of meander bend (Glide)	7	7			100%			
2. Bank	**1. Scoured/Eroded**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely Does NOT include undercuts that are modest, appear sustainable and are providing habitat			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	7	8			88%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms	6	8			75%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%	8	8			100%			
	4. Habitat*	Pool forming structures maintaining ~Max Pool Depth : Bankfull Depth ≥ 1.6 Rootwads/logs providing some cover at baseflow	-	-			N/A			

* Survey performed during dry conditions in channel. Parameter not assessed due to lack of water.
Piping: Two step-pools near the lower end of this reach have minor fabric washout and piping.

Table 6: Vegetation Condition Assessment Table
Suther Site (Dutch Buffalo Creek) Stream and Wetland Restoration: EEP Project # 370
Monitoring Year 3 of 5 (2014)

Planted Acreage **25.14**

Vegetation Category	Definitions	Mapping Threshold (acres)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
Bare Areas	Very limited cover of both woody and herbaceous material	0.1	N/A	0	0	0%
Low Stem Density Areas*	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1	N/A	3	3.2	13%
			Total	**3**	**0**	**13%**
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	N/A	0	0	0%
			Cumulative Total	0	0	**13%**

Easement Acreage **67.32**

Vegetation Category	Definitions	Mapping Threshold (SF)	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
Invasive Areas of Concern**	Areas of points (if too small to render as polygons at map scale).	1000	N/A	0	0	0%
Easement Encroachment Areas	Areas of points (if too small to render as polygons at map scale).	none	N/A	0	0	0%

Tabulated data are based on observations made between April and October 2014.
Competition from tall grasses, herbs, and Rubus may be limiting planted tree survival and growth in Area C-1. Shading from adjacent forest plus competion from grasses and herbs may be limiting planted tree survival and growth in the streamside zones adjacent to the restored tributary.

** Many forested areas on the site contain invasive groundover and shrub vegetation (*Microstegium, Lonicera, Ligustrum, Rosa*) but these are mostly beneath existing forest canopy and are not of concern.

Problem Areas Inventory Table -- Suther Site (Dutch Buffalo Cr): EEP Project # 370
Monitoring Year 3 of 5 (2014)

Stream: Dutch Buffalo Creek Enhancement Reach (Station 17+61 to 53+72 = 3,611 lin.ft)			
Feature Issue	**Station & Bank**	**Length (ft)**	**Suspected Cause**
Bank Erosion	17+60 - 18+20 LB	60	Poor tree survival at former construction crossing
Bank Erosion	23+80 - 24+30 LB	50	Log jam at stream bend
Bank Erosion	26+10 - 26+70 RB	60	Fallen tree, bank slump
Bank Eros + Mid-Bar	31+80 - 32+30 LB	50	Poor tree survival at former construction crossing
Bank Eros + Mid-Bar	31+80 - 32+30 LB	50	Poor tree survival at former construction crossing

Stream: UT Dutch Buffalo Creek Restoration Reach (Station 00+00 to 06+08 = 608 lin.ft)			
Feature Issue	**Station & Bank**	**Length (ft)**	**Suspected Cause**
Minor piping under step	5+65	2	Fabric & gravel/soil wash-out under structure
Minor piping under step	5+80	2	Fabric & gravel/soil wash-out under structure
Dense terrestrial vegetation in channel	0+00 - 5+30	2	Frequent periods with minimal stream flow and high survival of groundcover seed mix in channel bed.

Vegetation: Along Dutch Buffalo Creek Main Stem and Adjacent Wetlands			
Feature Issue	**Station & Bank**	**Area (ac)**	**Suspected Cause**
Low woody stem density in wetland restor area C1	South of DBC Sta 2+00 - 9+00	2.2	Low survival of planted trees; competition from dense tall grasses, herbs, and Rubus

Vegetation: Along Restored UT to Dutch Buffalo Creek			
Feature Issue	**Station & Bank**	**Area (ac)**	**Suspected Cause**
Low woody stem density in streamside zones	UT Sta 0+00 - 6+08	1.0	Low survival of planted trees; competition from dense tall grasses, herbs, and Rubus

STREAM PHOTO STATIONS

Restored Tributary to Dutch Buffalo Creek: Photo Points 24 to 31
Wetland Enhancement Area C1 & Filled Ditch: Photo Points 1 to 3A
Dutch Buffalo Creek Main Stem: Photo Points 3 to 20

Restored Tributary station 00+40, Photo Point #24, facing S (upstream). 10Apr2014.

Restored Tributary station 00+40, Photo Point #24 (downstream). 10Apr2014.

Restored Tributary station 01+20, Photo Point #25, facing S (upstream). 10Apr2014.

Restored Tributary station 01+20, Photo Point #25, facing N (downstream). 10Apr2014.

Restored Tributary station 02+00, Photo Point #26, facing S (upstream). 10Apr2014.

Restored Tributary station 02+00, Photo Point #26, (downstream). 10Apr2014.

Restored Tributary station 03+00, Photo Point #27, (upstream). 10Apr2014.

Restored Tributary station 03+00, Photo Point #27, (downstream). 10Apr2014.

Restored Tributary station 04+00, Photo Point #28, (upstream). 10Apr2014.

Restored Tributary station 04+00, Photo Point #28, facing E (downstream). 10Apr2014.

Restored Tributary station 04+80, Photo Point #29, (upstream). 10Apr2014.

Restored Tributary station 04+80, Photo Point #29, facing E (downstream). 10Apr2014.

Restored Tributary station 05+40, Photo Point #30, facing NW (upstream). 10Apr2014.

Restored Tributary station 05+40, Photo Point #30, (downstream). 10Apr2014.

Restored Tributary station 05+80, Photo Point #31, facing NW (upstream). Sparse bank vegetation. 10Apr2014.

Restored Tributary station 05+80, Photo Point #31, facing E (downstream). Sparse bank vegetation. 10Apr2014.

Photo Point # 1. Eastern portion of field, north of DBC tributary draining south edge of field; facing upstream (west).

Photo Point # 2. DBC. Upstream. 10Apr2014.

Photo Point #3. DBC.Upstream. 10Apr2014.

Photo Point # 3A. DBC tributary draining south edge of field; facing upstream from DBC confluence. 10Apr2014.

Photo Point #4. DBC.Downstream. 10Apr2014

Photo Point #6. DBC. Upstream. 10Apr2014

Photo Point # 9. DBC.Upstream. 10Apr2014.

Photo Point #10. DBC.Downstream. 10Apr2014

Photo Point # 12. DBC. Upstream. 10Apr2014.

Photo Point # 13. DBC. Upstream. 10Apr2014.

Photo Point #14. DBC. Downstream. 10Apr2014.

Photo Point #17. DBC.Upstream. 10Apr2014

Photo Point #17. DBC. Downstream 10Apr2014 – HOBO Gauge Location

Photo Point # 18. DBC.Downstream. 10Apr2014. Cattle Crossing.

Photo Point #20. DBC.Downstream. 10Apr2014

PROBLEM AREA PHOTOS

Low Woody Stem Density in Old Pasture Area C-1 (Replanted in 2015)
Dutch Buffalo Creek Station 16+50, Beaver-Cut Tree Stumps
Dutch Buffalo Cr Station 16+50 to 18+00, Bank Erosion & Slumping
Dutch Buffalo Cr Station 23+50 to 26+50, Bank Slump, Fallen Tree
Dutch Buffalo Cr Sta 32+50, Mid-Channel Bar at Construction Crossing

Vegetation Problem Area 1: Low woody density area in field west of well #16. The low stem density area mapped for replanting this winter extends ~ 650 feet west from this photo and is approximately 120 to 200 feet wide, or about 2.3 acres. 10Apr2014.

Vegetation Problem Area 2: Beaver-cut trees and low stem density along DBC right bank, station 16+50. 10Apr2014.

Station 16+50, south bank downstream.

Station 18+00, north bank upstream.

Station 17+00, south bank upstream.

Stream Problem Area 1: DBC bank erosion at stations 16+50 to 18+00. 10Apr2014.

Stream Problem Area 2: DBC bank erosion at sta 24+00, possibly from log jam at sta 23+50. Also fallen oak & slumped bank at sta 26+40 (where missing bank pins A4 should have been). 10Apr2014.

Stream Problem Area 3: DBC mid-channel bar at sta 32+50, construction access crossing. 10Apr2014.

Appendix C: Vegetation Plot Data

No CVS vegetation plot data were collected in 2014. Supplementary planting is scheduled to occur during the winter/spring of 2015, and new CVS plots will be established in 2015.

Appendix D:

Stream Survey & Geomorphology Data

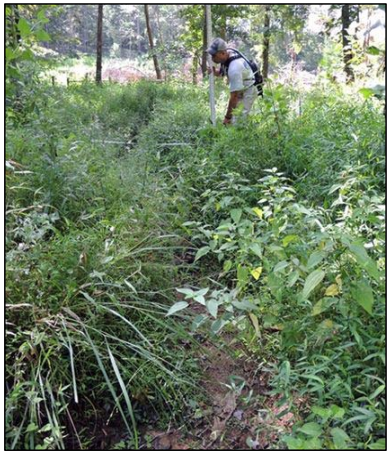
Figures 3.1 - 3.8. Stream Cross-Section Survey Data & Plots
Figure 4.0. Stream Longitudinal Survey Data & Plot
Figures 5.1 - 5.4. Substrate Pebble Count Data & Plots

e-Table: Raw Survey Data & Pebble Count Data

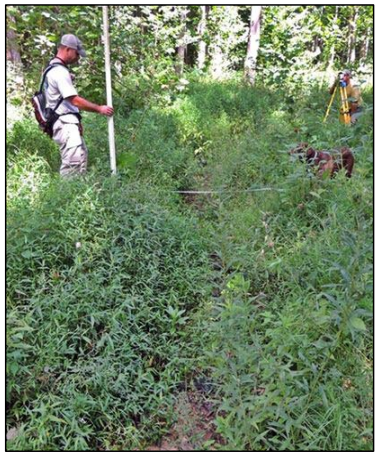
Table 7. Bank Erosion Pin Exposure Data
Table 8.1 – 8.2. Baseline Stream Data Summary
Table 9.1. Cross Section Morphology Monitoring Data Summary
Table 9.2. Stream Reach Longitudinal Morphology Data Summary

Figure 3.1. Cross Section Trib XS-1

Project Name	DBC (Suther)	
EEP Project Number	370	
Cross-Section ID	UT-1, XS-1, Riffle	
Survey Date	8/2014	
SUMMARY DATA		
Bankfull Elevation (ft)		648.81
Bankfull Cross-Sectional Area (ft^2)		13.90
Bankfull Width (ft)		9.00
Flood Prone Area Elevation (ft)		650.53
Flood Prone Width (ft)		56.00
Bankfull Mean Depth (ft)		1.10
Bankfull Max Depth (ft)		1.87
W/D Ratio		8.18
Entrenchment Ratio		6.22
Bank Height Ratio		1.01



Trib XS-1: Upstream



Trib XS-1: Downstream

Station	Elevation	Notes
0	650.11	TLP
0.1	650.01	BLP
2.5	649.96	xs1
7.5	649.77	xs1
12.5	649.34	xs1
17.5	649.1	xs1
22.5	648.95	xs1
26.5	648.84	xs1
27.5	648.71	TLB
28.5	648.4	xs1
29.5	647.75	xs1
30.5	647.32	xs1
31.2	646.89	xs1
32.4	646.84	xs1
33.6	646.79	THW
33.7	646.79	xs1
34.5	647.79	xs1
35.5	648.3	xs1
36.5	648.66	TRB
37.5	648.81	xs1
39.5	648.88	xs1
42.5	648.72	xs1
45.5	648.64	xs1
48.5	648.57	xs1
51.5	648.54	xs1
56	648.46	BRP
56	648.54	TRP

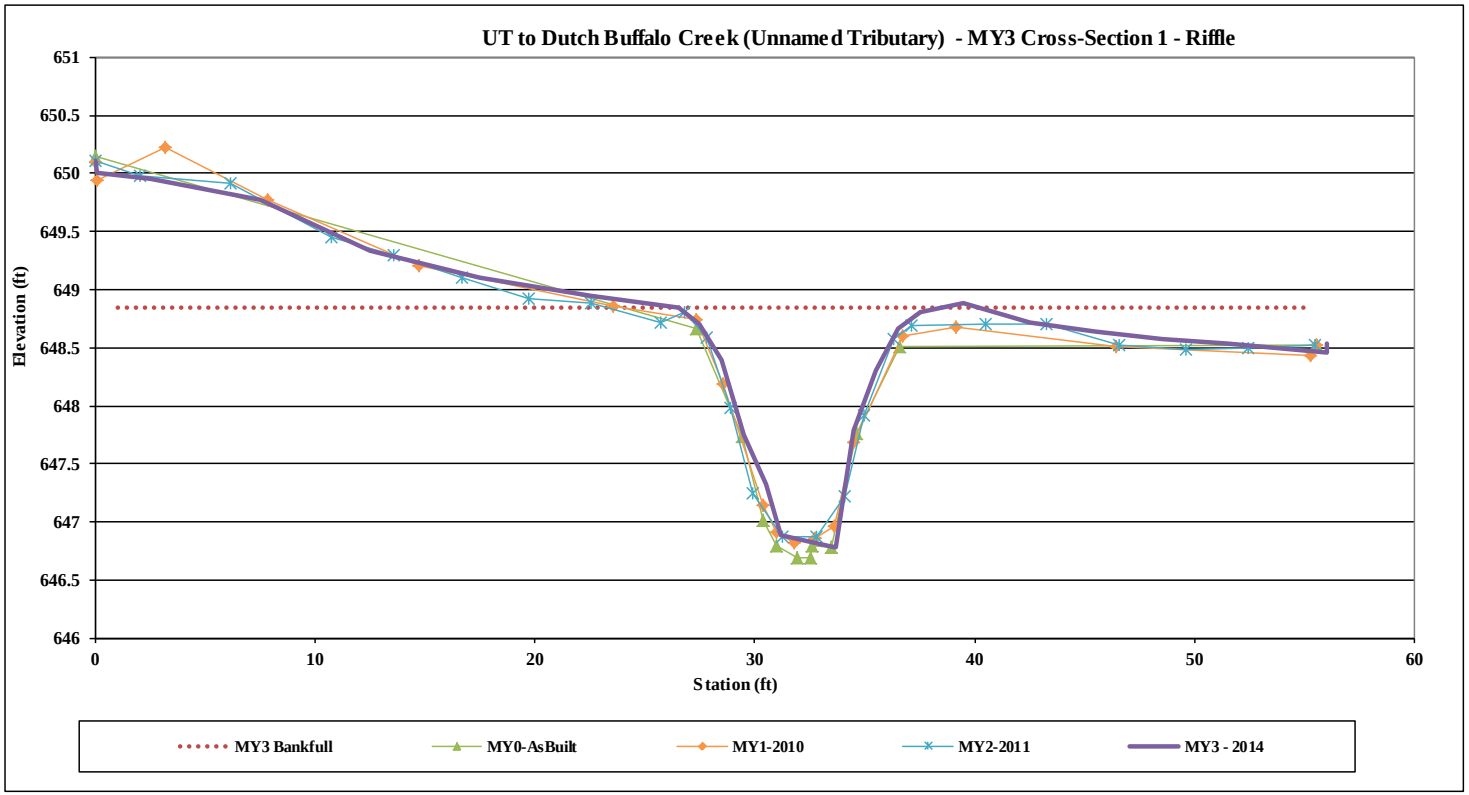


Figure 3.2. Cross Section Trib XS-4

Project Name	DBC (Suther)	
EEP Project Number	370	
Cross-Section ID	UT-1, XS-4, Riffle	
Survey Date	8/2014	
SUMMARY DATA		
Bankfull Elevation (ft)		646.52
Bankfull Cross-Sectional Area (ft^2)		9.54
Bankfull Width (ft)		8.50
Flood Prone Area Elevation (ft)		648.31
Flood Prone Width (ft)		55.00
Bankfull Mean Depth (ft)		1.10
Bankfull Max Depth (ft)		1.79
W/D Ratio		7.73
Entrenchment Ratio		6.47
Bank Height Ratio		1.03

Station	Elevation	Notes
0	647.37	TLP
0.1	647.26	BLP
0.7	647.31	xs4
3.7	647.42	xs4
9.7	647.31	xs4
12.7	647.06	xs4
14.7	646.69	xs4
16.7	646.56	xs4
19.7	646.55	xs4
23.7	646.58	TLB
24.7	646.21	xs4
25.7	645.89	xs4
26.5	644.88	xs4
28.4	644.73	THW
30.1	644.97	xs4
30.7	645.71	xs4
32.2	646.52	TRB
35.7	646.45	xs4
38.7	646.39	xs4
41.7	646.52	xs4
45.7	646.9	xs4
49.7	647.05	xs4
55	647.04	BRP
55	647.17	TRP

Trib XS-4: Upstream

Trib XS-4: Downstream

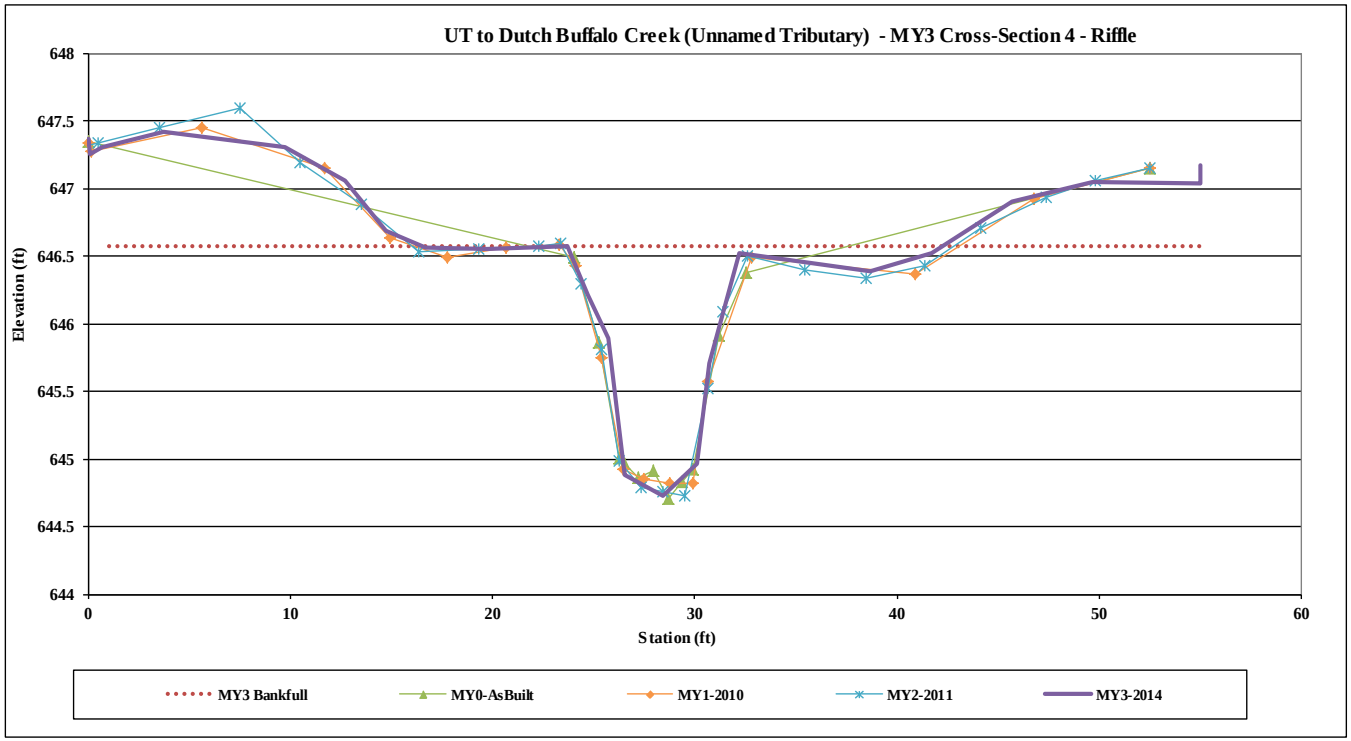


Figure 3.3. Cross Section DBC XS-2

Project Name	DBC (Suther)	
EEP Project Number	370	
Cross-Section ID	DBCr, XS-2, Pool	
Survey Date	8/2014	
SUMMARY DATA		
Bankfull Elevation (ft)		99.27
Bankfull Cross-Sectional Area (ft^2)		266.30
Bankfull Width (ft)		48.10
Flood Prone Area Elevation (ft)		106.60
Flood Prone Width (ft)		77.30
Bankfull Mean Depth (ft)		5.53
Bankfull Max Depth (ft)		7.33
W/D Ratio		8.70
Entrenchment Ratio		1.61
Bank Height Ratio		1.05

XS-2: Upstream

XS-2: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.1	99.95	BRP
5	100.18	xs2
9	100.41	xs2
12	100.49	xs2
14.4	99.64	TLB
15.2	95.90	xs2
16.2	93.81	xs2
18.8	92.29	LEW
21	91.94	THW
26	91.96	xs2
30	92.10	xs2
35	92.19	xs2
36.2	92.25	REW
40	92.86	xs2
44	93.35	xs2
48	94.07	xs2
51.4	94.56	xs2
55	95.68	xs2
58.3	97.04	xs2
61	98.18	xs2
62.6	99.27	TRB
66	99.88	xs2
71	99.96	xs2
74	99.74	xs2
77.3	99.69	BRP
77.3	99.72	TRP

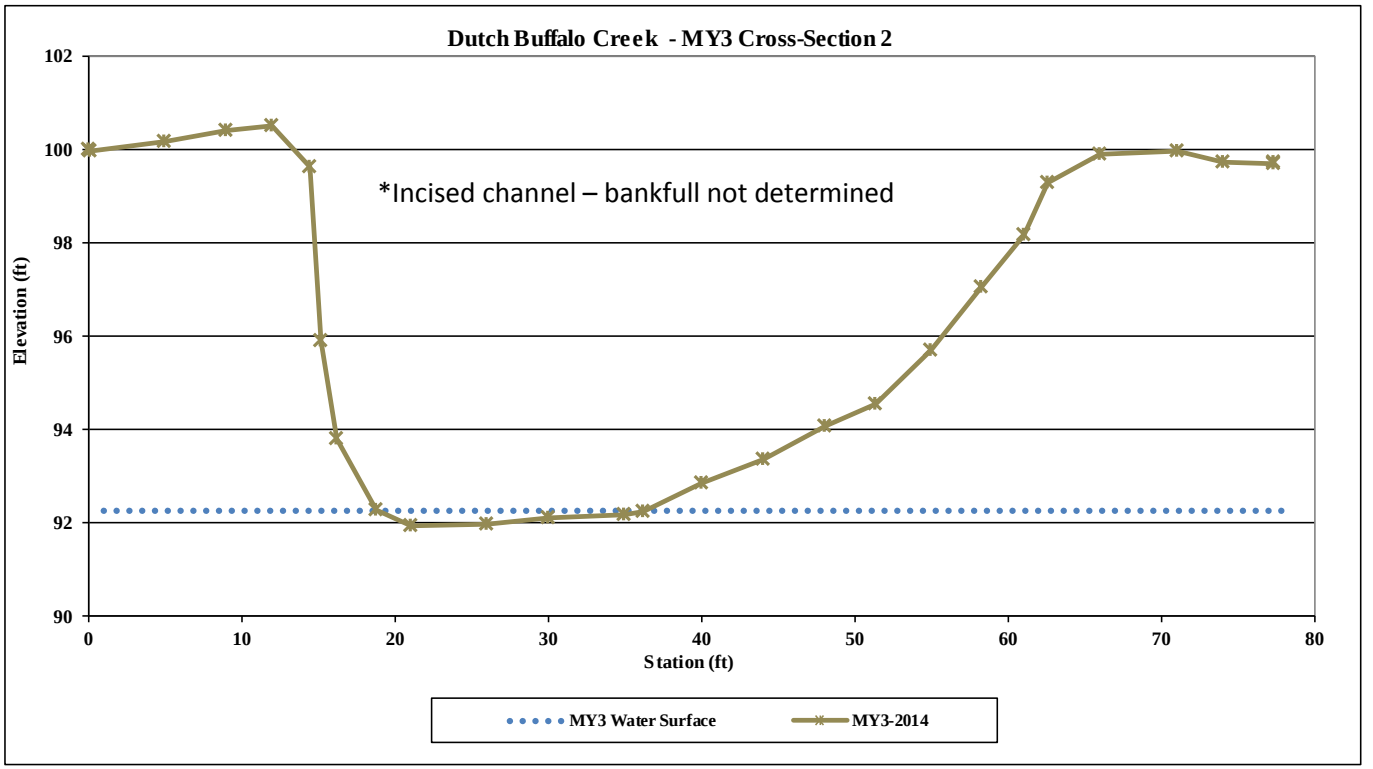


Figure 3.4. Cross Section DBC XS-3

Project Name	DBC (Suther)
EEP Project Number	370
Cross-Section ID	DBCr, XS-3, Pool
Survey Date	8/2014
SUMMARY DATA	
Bankfull Elevation (ft)	99.27
Bankfull Cross-Sectional Area (ft^2)	254.30
Bankfull Width (ft)	64.40
Flood Prone Area Elevation (ft)	107.23
Flood Prone Width (ft)	82.00
Bankfull Mean Depth (ft)	3.95
Bankfull Max Depth (ft)	7.96
W/D Ratio	16.30
Entrenchment Ratio	1.27
Bank Height Ratio	1.00

XS-3: Upstream

XS-3: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.1	99.93	BLP
4	100.14	xs3
8	99.14	xs3
13	98.82	xs3
17	98.21	xs3
20	97.06	xs3
22	95.82	xs3
23.5	94.73	xs3
24.2	93.03	xs3
25.5	92.63	LEW
28	92.37	xs3
32	91.81	xs3
35	91.57	xs3
37	91.86	xs3
39	91.52	xs3
41.5	91.31	THW
44	91.33	xs3
46.5	91.31	xs3
49	91.47	xs3
52	92.64	REW
53	94.61	xs3
54.8	96.02	xs3
56.2	96.78	xs3
57	98.78	xs3
59	99.27	RTB
63	99.49	xs3
67	99.14	xs3
70	99.48	xs3

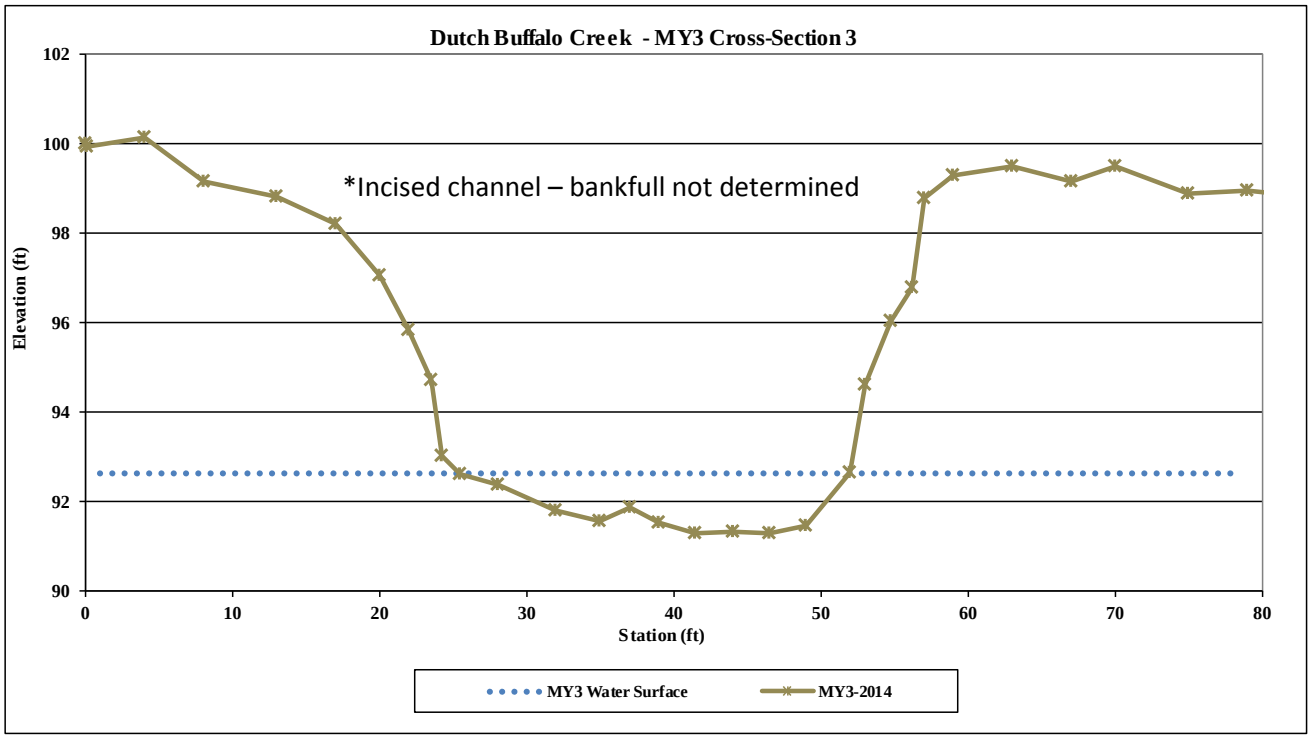


Figure 3.5. Cross Section DBC XS-4

Project Name	DBC (Suther)
EEP Project Number	370
Cross-Section ID	DBCr, XS-4, Riffle
Survey Date	8/2014
SUMMARY DATA	
Bankfull Elevation (ft)	100.11
Bankfull Cross-Sectional Area (ft^2)	222.70
Bankfull Width (ft)	47.90
Flood Prone Area Elevation (ft)	107.26
Flood Prone Width (ft)	67.40
Bankfull Mean Depth (ft)	4.65
Bankfull Max Depth (ft)	7.15
W/D Ratio	10.30
Entrenchment Ratio	1.41
Bank Height Ratio	1.29

XS-4: Upstream

XS-4: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.1	99.90	BLP
5	99.99	xs4
10	100.14	xs4
15	100.14	xs4
18	100.11	TLB
21.6	97.12	xs4
24.5	92.99	LEW
32	92.96	THW
39	93.20	REW
43.4	93.19	xs4
49	93.87	xs4
53.5	95.66	xs4
58.5	102.20	TRB
63.5	103.11	xs4
67.4	103.97	BRP
67.4	104.01	TRP

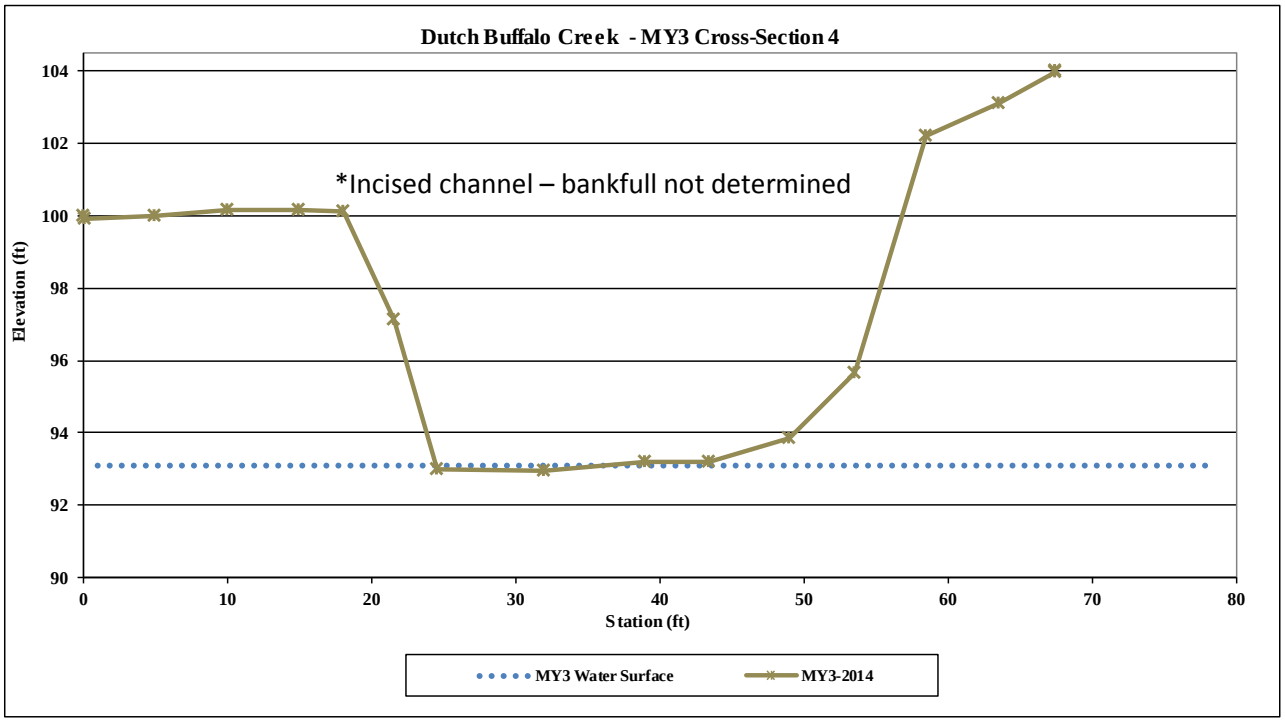


Figure 3.6. Cross Section DBC XS-5

Project Name	DBC (Suther)	
EEP Project Number	370	
Cross-Section ID	DBCr, XS-5, Riffle	
Survey Date	8/2014	
SUMMARY DATA		
Bankfull Elevation (ft)		100.23
Bankfull Cross-Sectional Area (ft^2)		258.50
Bankfull Width (ft)		73.40
Flood Prone Area Elevation (ft)		107.35
Flood Prone Width (ft)		92.20
Bankfull Mean Depth (ft)		3.52
Bankfull Max Depth (ft)		7.12
W/D Ratio		20.85
Entrenchment Ratio		1.26
Bank Height Ratio		1.00

XS-5: Upstream

XS-5: Downstream

Station	Elevation	Notes
0.0	100.00	TLP
0.1	99.95	BLP
5.0	100.24	xs5
10.0	100.38	xs5
15.0	100.15	xs5
20.0	99.62	xs5
24.0	98.73	xs5
26.0	97.71	xs5
28.0	96.14	xs5
29.0	95.62	xs5
32.3	94.80	xs5
33.3	94.45	xs5
34.6	93.57	xs5
35.6	93.27	LEW
40.0	93.11	THW
44.2	93.25	REW
47.5	92.55	xs5
54.4	93.53	xs5
57.5	93.64	xs5
61.4	95.95	xs5
66.6	100.23	TRB
73.0	100.27	xs5
78.0	100.22	xs5
84.0	100.03	xs5
88.5	98.37	xs5
92.2	98.19	BRP
92.2	98.24	TRP

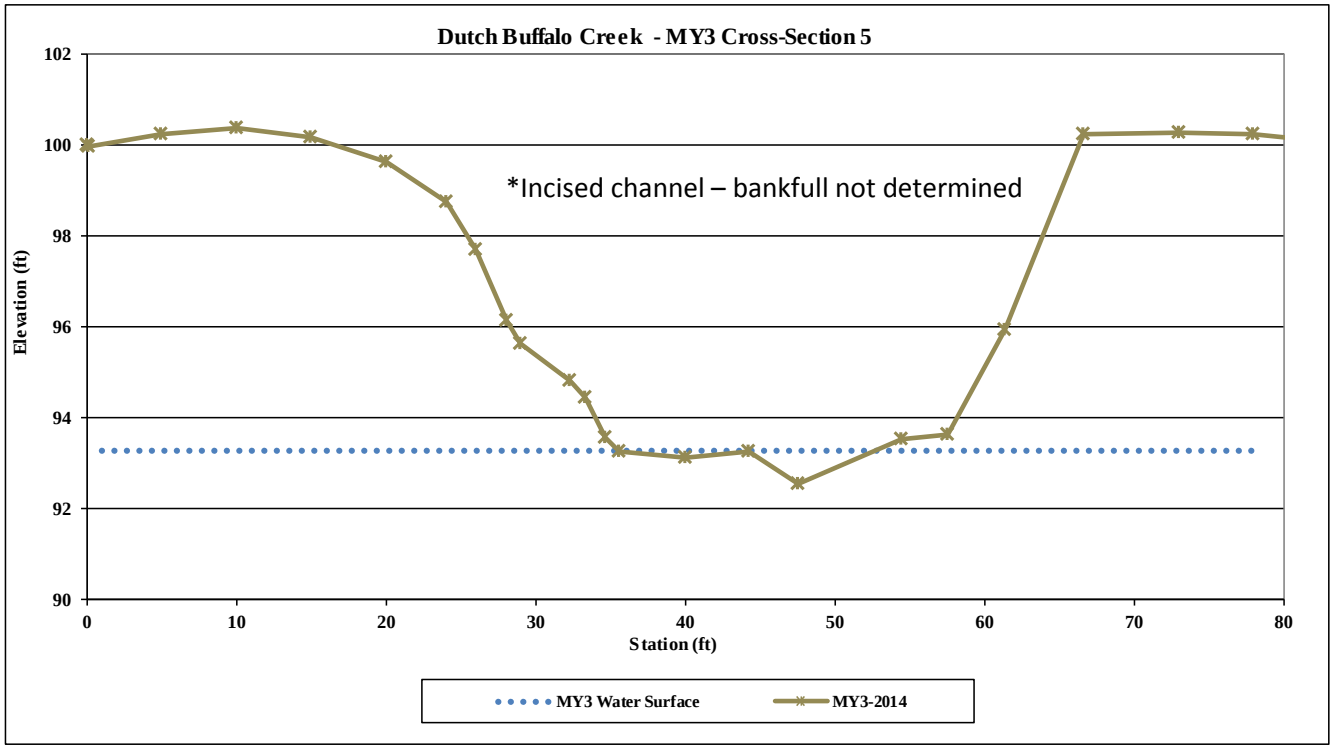


Figure 3.7. Cross Section DBC XS-6

Project Name	DBC (Suther)	
EEP Project Number	370	
Cross-Section ID	DBCr, XS-6, Riffle	
Survey Date	8/2014	
SUMMARY DATA		
Bankfull Elevation (ft)		98.24
Bankfull Cross-Sectional Area (ft^2)		161.80
Bankfull Width (ft)		38.00
Flood Prone Area Elevation (ft)		104.30
Flood Prone Width (ft)		66.70
Bankfull Mean Depth (ft)		4.26
Bankfull Max Depth (ft)		6.06
W/D Ratio		8.92
Entrenchment Ratio		1.76
Bank Height Ratio		1.33

XS-6: Upstream

XS-6: Downstream

Station	Elevation	Notes
0.0	100	TLP
0.1	99.94	BLP
4.0	100.06	xs6
8.0	100.14	xs6
12.0	100.24	xs6
13.1	100.26	TLB
14.7	99.47	xs6
16.7	97.3	xs6
19.3	95.38	xs6
21.1	94.49	xs6
26.5	94.26	xs6
31.7	93.64	xs6
34.0	92.92	xs
36.5	92.59	LEW
40.7	92.18	THW
45.8	92.55	REW
47.9	93	xs6
49.9	94.62	xs6
51.8	96.25	xs6
53.8	98.24	TRB
57.3	99.28	xs6
61.4	99.25	xs6
66.7	99.05	BRP
66.7	99.13	TRP

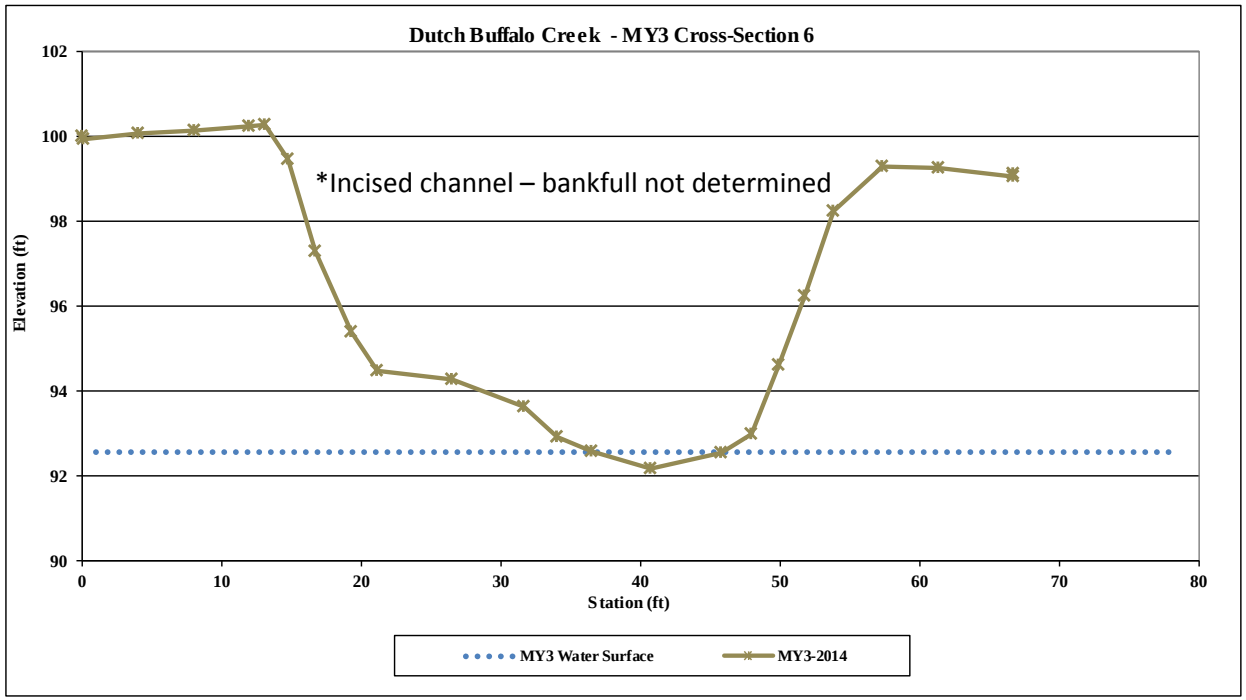


Figure 3.8. Cross Section DBC XS-7

Project Name	DBC (Suther)	
EEP Project Number	370	
Cross-Section ID	DBCr, XS-7, Pool	
Survey Date	8/2014	
SUMMARY DATA		
Bankfull Elevation (ft)		99.90
Bankfull Cross-Sectional Area (ft^2)		247.90
Bankfull Width (ft)		67.90
Flood Prone Area Elevation (ft)		108.95
Flood Prone Width (ft)		82.70
Bankfull Mean Depth (ft)		3.65
Bankfull Max Depth (ft)		9.05
W/D Ratio		18.60
Entrenchment Ratio		1.22
Bank Height Ratio		1.00

XS-7: Upstream

XS-7: Downstream

Station	Elevation	Notes
0.0	100	TRP
0.1	99.93	BRP
5.0	99.92	xs7
10.0	100.06	xs7
14.8	99.99	TLB
16.8	92.4	LEW
19.5	91.56	xs7
23.0	90.96	xs7
26.5	90.85	THW
28.0	91.27	xs7
31.0	91.77	xs7
33.2	92.41	REW
35.5	92.75	xs7
37.0	93.36	xs7
40.2	94.64	xs7
43.5	95.12	xs7
46.0	96.21	xs7
48.0	97.48	xs7
51.2	99.36	xs7
56.5	99.86	xs7
62.0	99.34	xs7
68.0	99.23	xs7
75.0	98.9	xs7
82.7	99.57	BRP
82.7	99.63	TRP

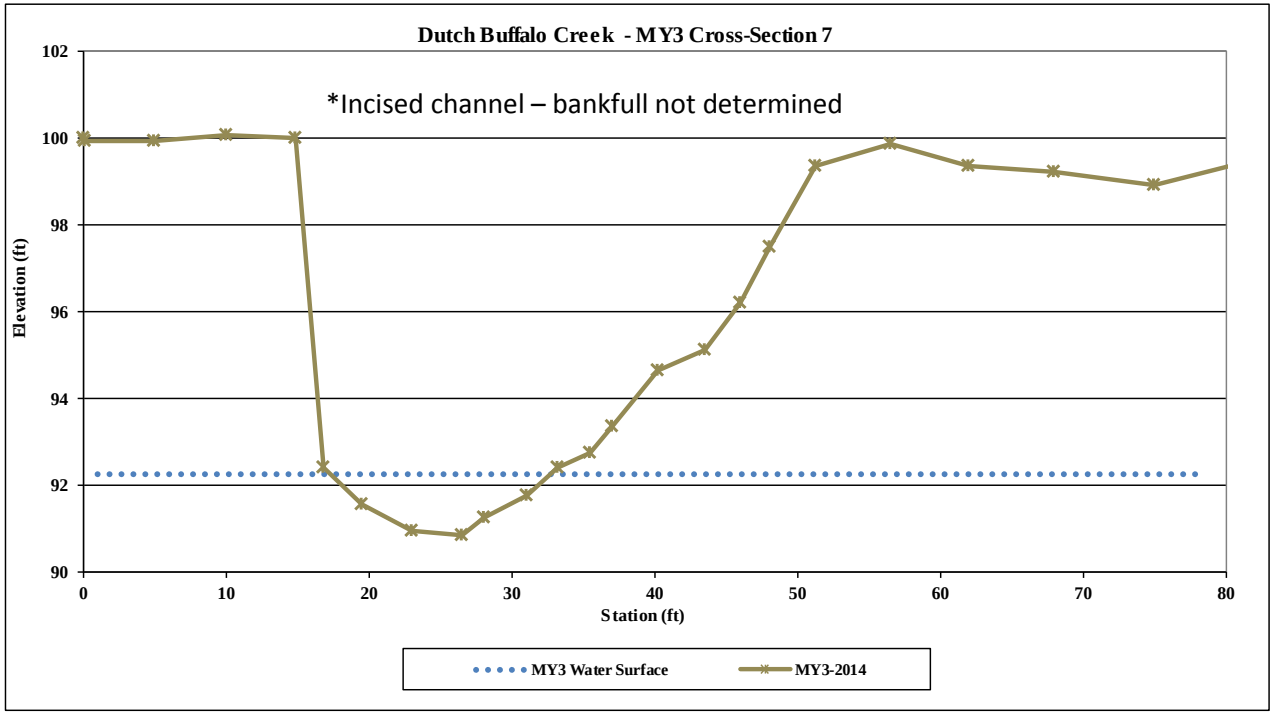


Figure 4. Longitudinal Profile Plot, Restored Tributary

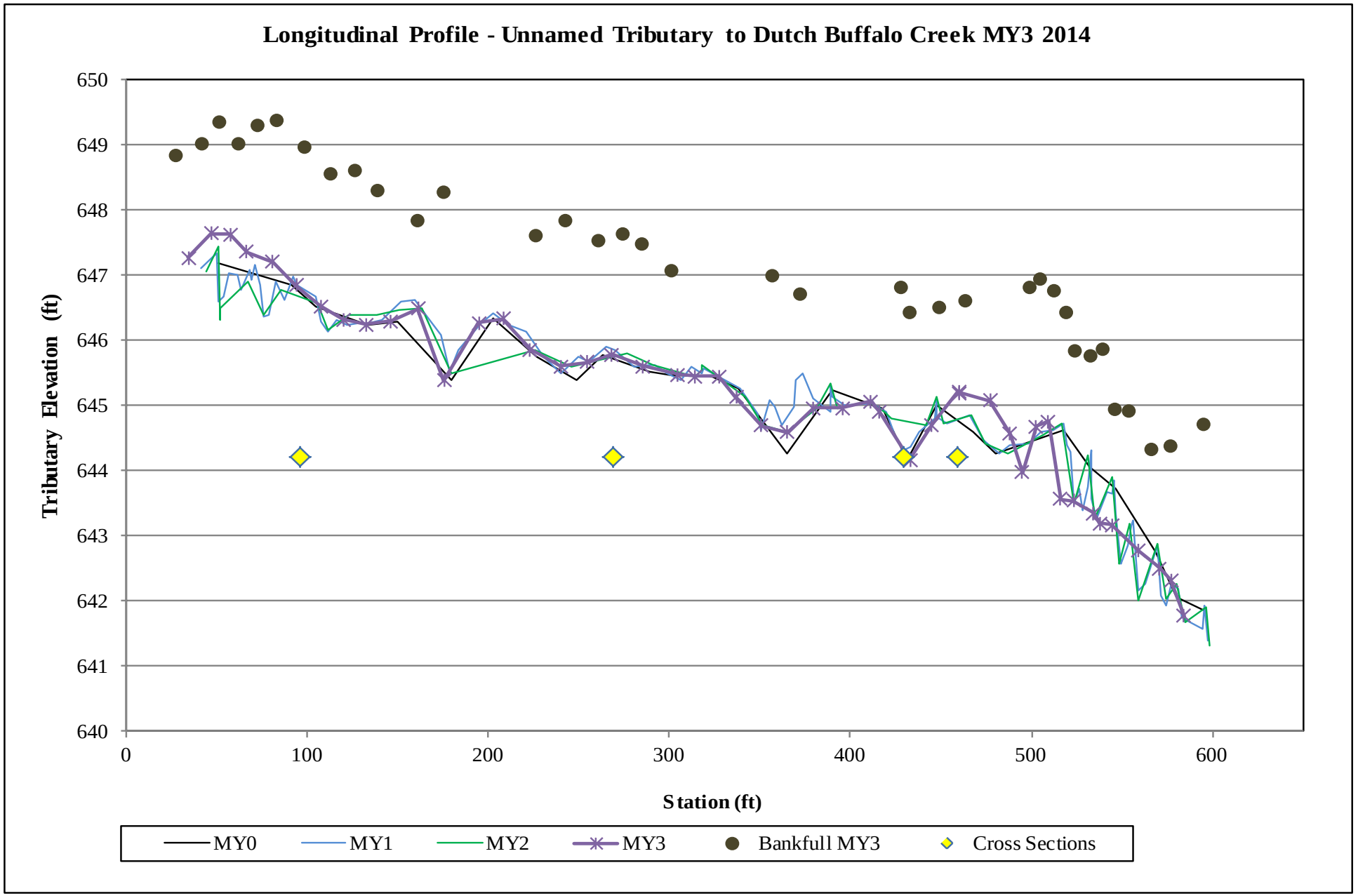
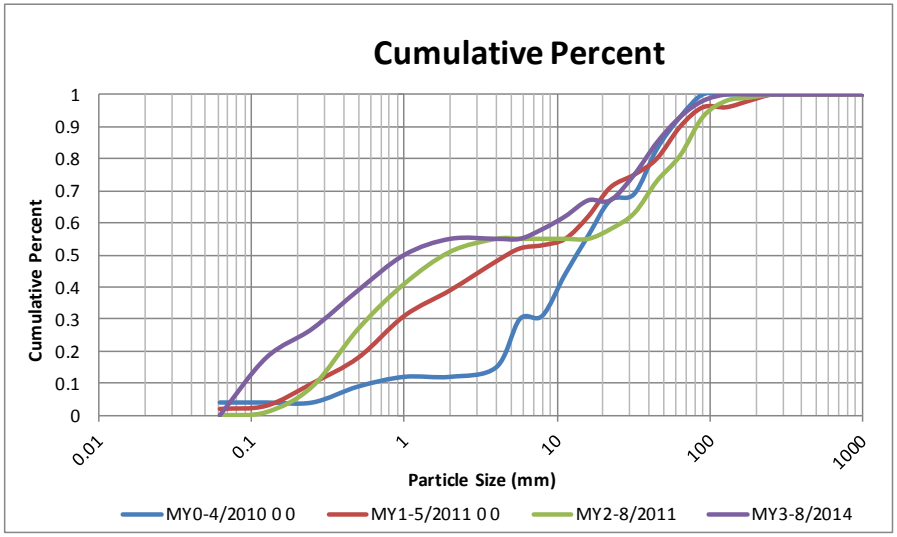


Figure 5.1. Substrate Pebble Count Data, Trib XS-1

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 1					
Feature: Riffle					
			MY3-8/2014		
Description	**Material**	**Size (mm)**	**Total #**	**Item %**	**Cum %**
Silt/Clay	silt/clay	0.062	0	0%	0%
Sand	very fine sand	0.125	18	18%	18%
	fine sand	0.250	9	9%	27%
	medium sand	0.50	12	12%	39%
	coarse sand	1.00	11	11%	50%
	very coarse sand	2.0	5	5%	55%
Gravel	very fine gravel	4.0	0	0%	55%
	fine gravel	5.7	0	0%	55%
	fine gravel	8.0	3	3%	58%
	medium gravel	11.3	4	4%	62%
	medium gravel	16.0	5	5%	67%
	course gravel	22.3	0	0%	67%
	course gravel	32.0	8	8%	75%
	very coarse gravel	45	10	10%	85%
	very coarse gravel	64	8	8%	93%
Cobble	small cobble	90	5	5%	98%
	medium cobble	128	2	2%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	2.0
D84	62.1
D95	105.2



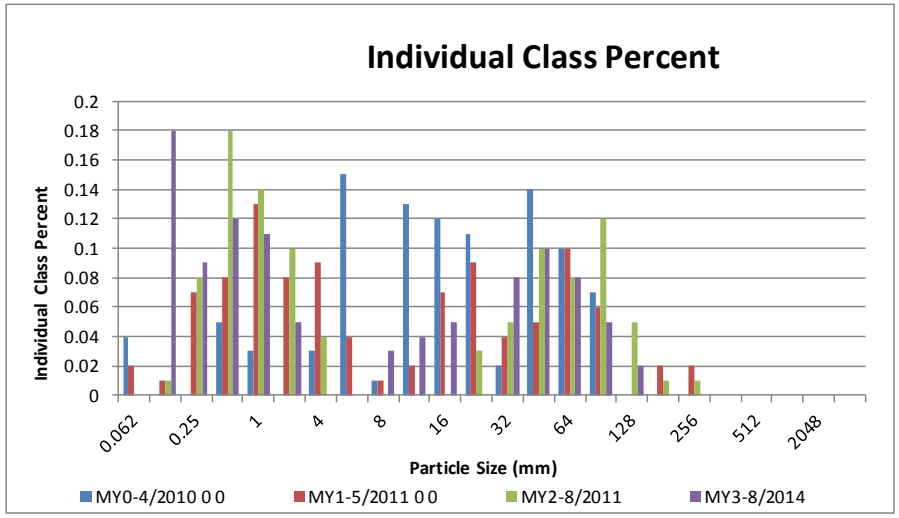
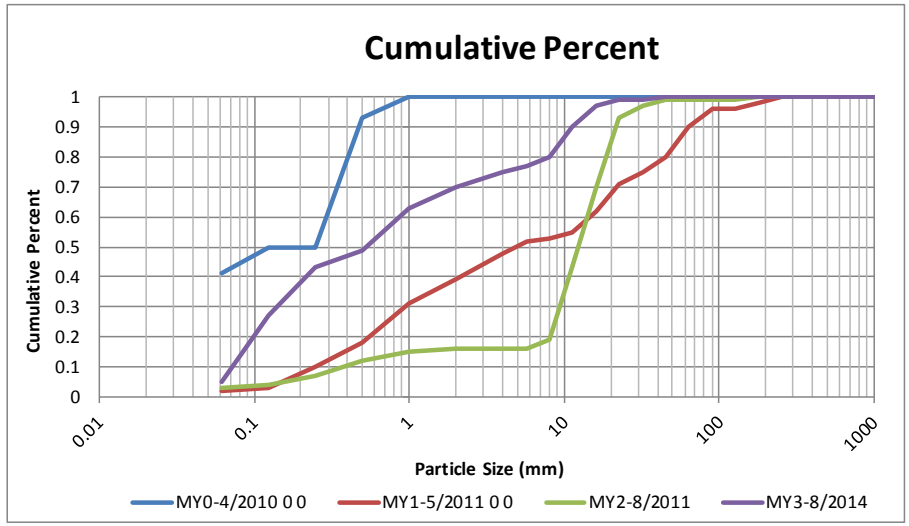


Figure 5.2. Substrate Pebble Count Data, Trib XS-2

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 2					
Feature: Pool					
			MY3-8/2014		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	5	5%	5%
Sand	very fine sand	0.125	22	22%	27%
	fine sand	0.250	16	16%	43%
	medium sand	0.50	6	6%	49%
	coarse sand	1.00	14	14%	63%
	very coarse sand	2.0	7	7%	70%
Gravel	very fine gravel	4.0	5	5%	75%
	fine gravel	5.7	2	2%	77%
	fine gravel	8.0	3	3%	80%
	medium gravel	11.3	10	10%	90%
	medium gravel	16.0	7	7%	97%
	course gravel	22.3	2	2%	99%
	course gravel	32.0	0	0%	99%
	very coarse gravel	45	1	1%	100%
	very coarse gravel	64	0	0%	100%
Cobble	small cobble	90	0	0%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	1.2
D84	13.0
D95	20.4



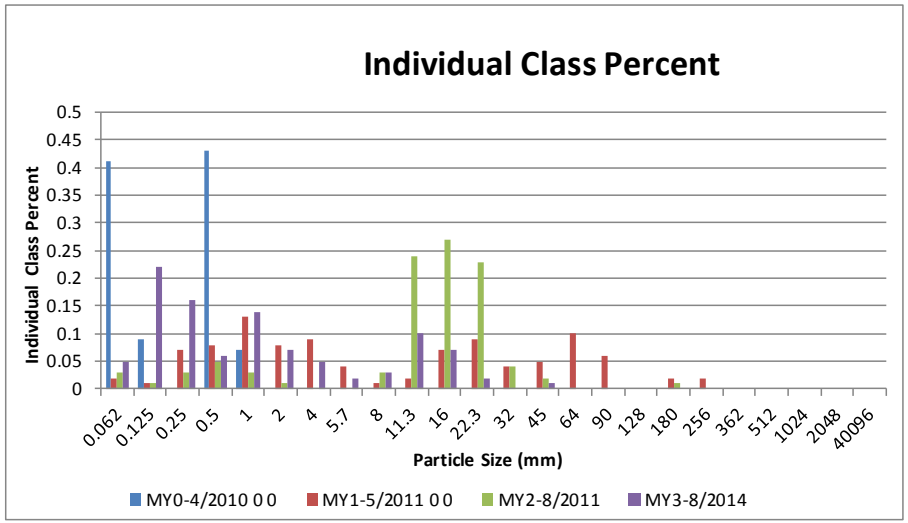
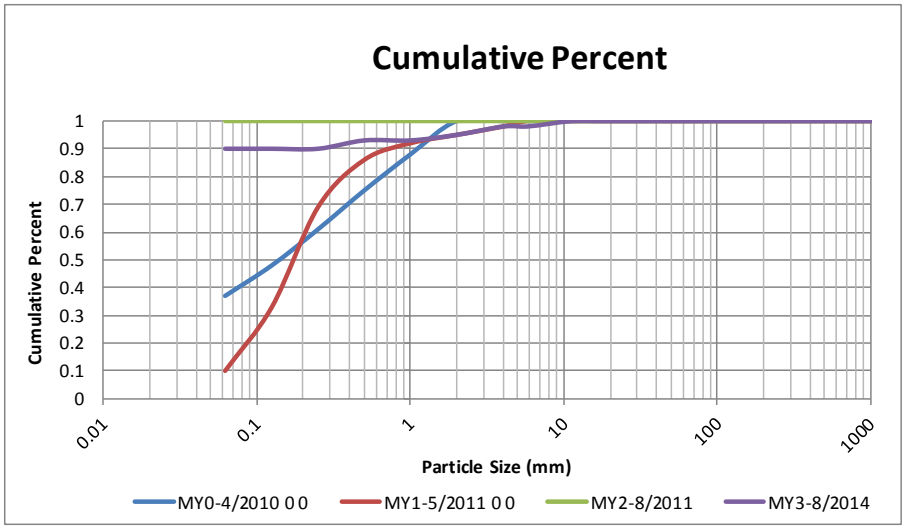


Figure 5.3. Substrate Pebble Count Data, Trib XS-3

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 3					
Feature: Pool					
			MY3-8/2014		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	90	90%	90%
Sand	very fine sand	0.125	0	0%	90%
	fine sand	0.250	0	0%	90%
	medium sand	0.50	3	3%	93%
	coarse sand	1.00	0	0%	93%
	very coarse sand	2.0	2	2%	95%
Gravel	very fine gravel	4.0	3	3%	98%
	fine gravel	5.7	0	0%	98%
	fine gravel	8.0	1	1%	99%
	medium gravel	11.3	1	1%	100%
	medium gravel	16.0	0	0%	100%
	course gravel	22.3	0	0%	100%
	course gravel	32.0	0	0%	100%
	very coarse gravel	45	0	0%	100%
	very coarse gravel	64	0	0%	100%
Cobble	small cobble	90	0	0%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	0.03
D84	0.06
D95	4.00



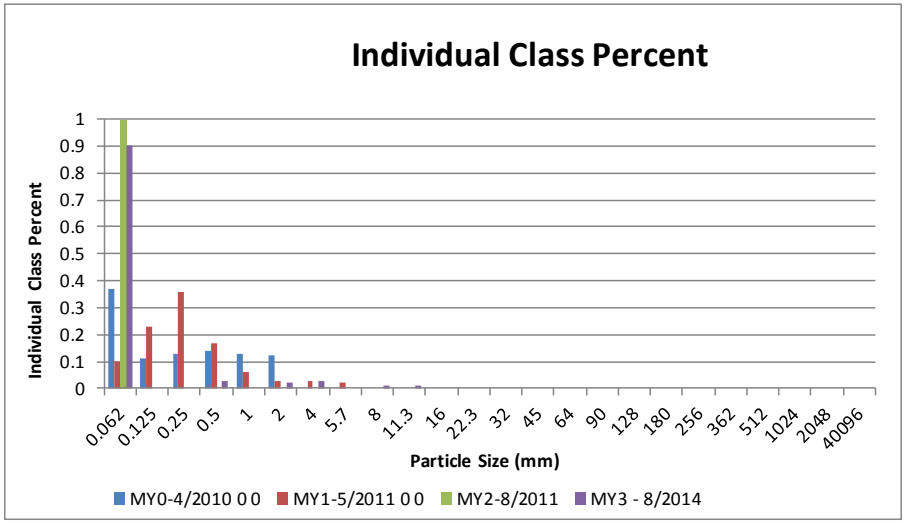
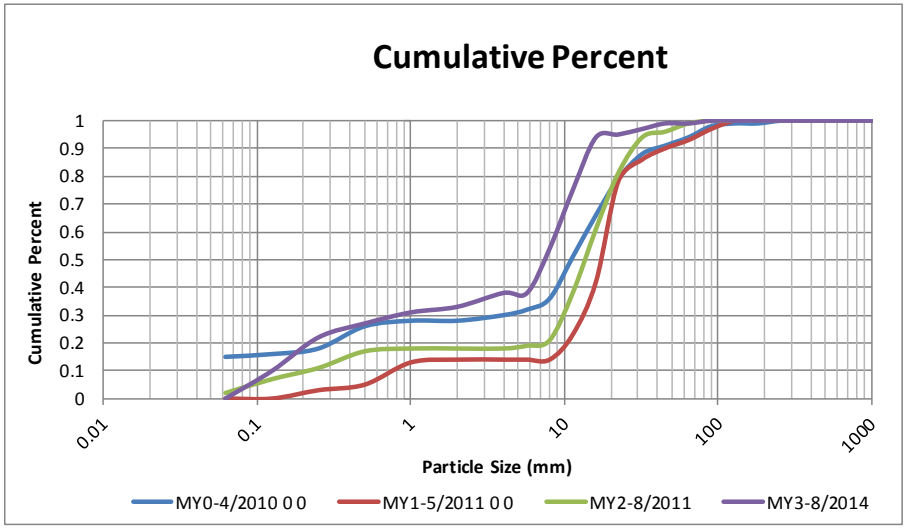


Figure 5.4. Substrate Pebble Count Data, Trib XS-4

Project Name: Dutch Buffalo Creek (Unnamed Tributary)					
Cross-Section: 4					
Feature: Riffle					
			MY3-8/2014		
Description	Material	Size (mm)	Total #	Item %	Cum %
Silt/Clay	silt/clay	0.062	0	0%	0%
Sand	very fine sand	0.125	10	10%	10%
	fine sand	0.250	12	12%	22%
	medium sand	0.50	5	5%	27%
	coarse sand	1.00	4	4%	31%
	very coarse sand	2.0	2	2%	33%
Gravel	very fine gravel	4.0	5	5%	38%
	fine gravel	5.7	0	0%	38%
	fine gravel	8.0	16	16%	54%
	medium gravel	11.3	21	21%	75%
	medium gravel	16.0	19	19%	94%
	course gravel	22.3	1	1%	95%
	course gravel	32.0	2	2%	97%
	very coarse gravel	45	2	2%	99%
	very coarse gravel	64	0	0%	99%
Cobble	small cobble	90	1	1%	100%
	medium cobble	128	0	0%	100%
	large cobble	180	0	0%	100%
	very large cobble	256	0	0%	100%
Boulder	small boulder	362	0	0%	100%
	small boulder	512	0	0%	100%
	medium boulder	1024	0	0%	100%
	large boulder	2048	0	0%	100%
Bedrock	bedrock	40096	0	0%	100%
TOTAL % of whole count			100	100%	100%

Summary Data	
D50	10.20
D84	18.80
D95	32.00



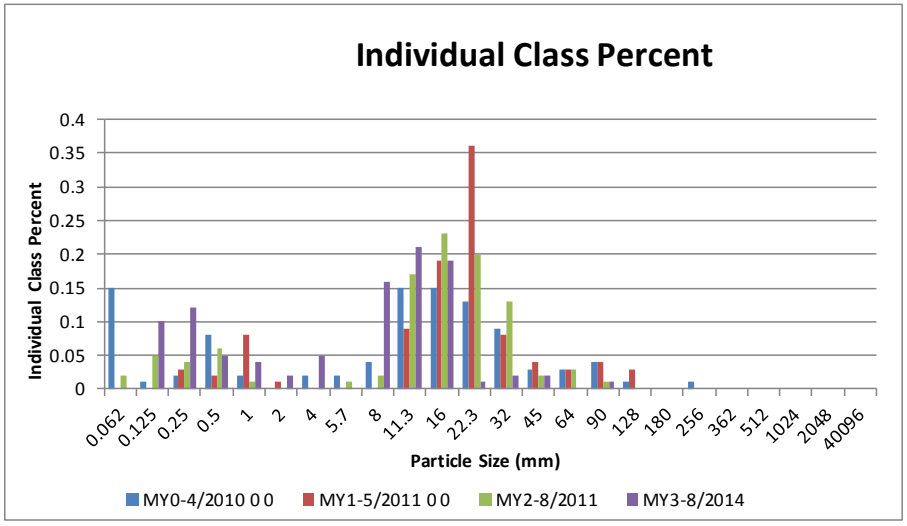


Table 7. Suther Site (Dutch Buffalo Cr) stream-bank erosion pins, length (feet) of exposed pins by date.

NF = Pin Not Found on monitoring survey date. See additional notes below.

			13-Nov-13			10-Apr-14 (high flow)			22-Aug-14				Cumulative Retreat	Annualized Rate
Pins	**Sta+Bank**	**Height**	**Exposed**	**New Eros**	**RemEx**	**Exposed**	**New Eros**	**RemEx**	**Exposed**	**New Eros**	**RemEx**		(Feet)	(Feet/Yr)
A1	**22+70-R**	Upper, 4'	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.15		0.25	0.18
inst: 02-18-2013		Middle, 2'	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.15	0.00		0.15	0.11
		Lower, 0'	0.00	0.00	0.00	NF	NF	NF	0.90	0.90	0.00		0.90	0.63
												A1 ave	**0.43**	**0.31**
A2	**23+00-R**	Upper, 4'	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.40	0.00		0.40	0.28
inst: 02-18-2013		Middle, 2'	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
		Lower, 0'	0.00	0.00	0.00	NF	NF	NF	0.10	0.10	0.00		0.10	0.07
												A2 ave	**0.17**	**0.12**
A3	**26+00-R**	Upper, 4'	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00		0.50	0.35
inst: 03-19-2013		Middle, 2'	0.00	0.00	0.00	0.50	0.50	0.00	NF	NF	NF		0.50	0.35
		Lower, 0'	0.50	0.50	0.00	0.50	0.50	0.00	0.25	0.25	0.00		1.25	0.88
												A3 ave	**0.75**	**0.53**
A4	**26+30-R**	Upper, 4'	0.00	0.00	0.00	NF	NF	NF	NF	NF	NF		unk	unk
inst: 03-19-2013		Middle, 2'	0.33	0.33	0.33	NF	NF	NF	NF	NF	NF		unk	unk
		Lower, 0'	NF	NF	NF	NF	NF	NF	NF	NF	NF		unk	unk
												A4 ave	**pins lost (b)**	
A6	**27+90-R**	Upper, 4'	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00		0.10	0.07
inst: 03-19-2013		Middle, 2'	0.00	0.00	0.00	0.20	0.20	0.00	0.10	0.10	0.00		0.30	0.21
		Lower **(a)**	0.30	0.00	0.30	0.30	0.00	0.30	0.30	0.00	0.30		0.00	0.00
												A6 ave	**0.13**	**0.09**
A7	**28+20-R**	Upper, 4'	0.50	0.50	0.00	0.92	0.92	0.00	0.00	0.00	0.00		1.42	1.00
inst: 03-19-2013		Middle, 2'	0.50	0.50	0.00	0.98	0.98	0.00	0.10	0.10	0.00		1.58	1.11
		Lower, 0'	0.50	0.50	0.00	1.30	1.30	0.00	0.20	0.20	0.00		2.00	1.41
												A7 ave	**1.67**	**1.17**
A8	**28+50-L**	Upper, 5'	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00		0.10	0.07
inst: 02-18-2013		Middle, 3'	0.00	0.00	0.00	0.09	0.09	0.00	0.05	0.05	0.00		0.14	0.10
		Lower, 1'	0.00	0.00	0.00	0.30	0.30	0.00	0.00	0.00	0.00		0.30	0.21
												A8 ave	**0.18**	**0.13**

Pins	Sta+Bank	Height	13-Nov-13 Exposed	13-Nov-13 New Eros	13-Nov-13 RemEx	10-Apr-14 (high flow) Exposed	10-Apr-14 (high flow) New Eros	10-Apr-14 (high flow) RemEx	22-Aug-14 Exposed	22-Aug-14 New Eros	22-Aug-14 RemEx		Cumulative Retreat (Feet)	Annualized Rate (Feet/Yr)
A9	**28+80-L**	Upper, 5'	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00		0.05	0.04
inst: 02-18-2013		Middle, 3'	0.00	0.00	0.00	0.18	0.18	0.00	0.00	0.00	0.00		0.18	0.13
		Lower, 1'	0.00	0.00	0.00	0.15	0.15	0.00	0.10	0.10	0.00		0.25	0.18
												A9 ave	**0.16**	**0.11**
A10	**30+30-R**	Upper, 5'	0.00	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00		0.10	0.07
inst: 03-19-2013		Middle, 3'	0.00	0.00	0.00	0.21	0.21	0.00	0.00	0.00	0.00		0.21	0.15
		(No Lower Pin Installed; Bedrock)										**A10 ave**	**0.16**	**0.11**
A11	**30+60-R**	Upper, 4'	0.25	0.25	0.00	0.27	0.27	0.00	0.00	0.00	0.00		0.52	0.37
inst: 03-19-2013		Middle, 2'	0.10	0.10	0.00	0.25	0.25	0.00	0.00	0.00	0.00		0.35	0.25
		Lower, 0'	0.10	0.10	0.00	0.48	0.48	0.00	0.00	0.00	0.00		0.58	0.41
												A11 ave	**0.48**	**0.34**
A12	**30+90-R**	Upper, 4'	0.83	0.83	0.00	0.37	0.37	0.00	0.00	0.00	0.00		1.20	0.84
inst: 03-19-2013		Middle, 2'	0.25	0.25	0.00	0.97	0.97	0.00	0.00	0.00	0.00		1.22	0.86
		Lower, 0'	0.00	0.00	0.00	NF	NF	NF	NF	NF	NF		0.00	0.00
												A12 ave	**0.81**	**0.57**
months / years from Mar 2013			8 months = 0.67 year			13 months = 1.08 year			17 months = 1.42 year					
												Reach ave	**0.49**	**0.35**

NOTES

RemEx = Remaining exposed pin (ft) after measuring and pounding in, if possible.

(a) A6 Lower Pin installed with 0.33 ft exposed due to bedrock

(b) A4 Pins all lost due to fallen tree with bank slump during winter 2013-14

Table 8.1. Baseline Stream Data Summary: Pre-Restoration Reach and Reference Reach Data

Baseline Stream Data Summary																									
Dutch Buffalo Creek Stream and Wetland Restoration/EEP Project Number 370																									
Unnammed Tributary to Dutch Buffalo (608 linear feet)																									
Parameter	**Gauge**	**Regional Curve**			Pre-Existing Condition						Reference Reach Data						Design			Monitoring Baseline					
Dimension and Substrate - Riffle	-	**LL**	**UL**	**Eq.**	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Med	Max	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	-	6.83	7.55	7.19	-	8.68	-	-	-	10	-	8.3	-	-	-	-	-	9	-	8.34	8.60	8.60	8.85	-	2
Floodprone Width (ft)					-	9.8	-	-	-	10	-	130	-	-	-	-	-	150	-	52.52	54.05	54.05	55.57	-	2
Bankfull Mean Depth (ft)	-	0.98	1.08	1.03	-	1.17	-	-	-	10	-	1.3	-	-	-	-	-	1	-	1.00	1.02	1.02	1.04	-	2
Bankfull Max Depth (ft)	-				-	1.49	-	-	-	10	-	1.9	-	-	-	-	-	1.5	-	1.67	1.74	1.74	1.81	-	2
Bankfull Cross-Sectional Area (ft^2)	-	9.18	10.14	9.66	-	10.17	-	-	-	10	-	10.95	-	-	-	-	-	9	-	8.30	8.77	8.77	9.24	-	2
Width/Depth Ratio	-				-	7.42	-	-	-	10	-	6.4	-	-	-	-	-	9	-	8.34	8.43	8.43	8.51	-	2
Entrenchment Ratio	-				-	1.13	-	-	-	10	-	15.66	-	-	-	-	-	16.67	-	6.28	6.29	6.29	6.30	-	2
Bank Height Ratio	-				-	2.53	-	-	-	10	-	1.2	-	-	-	-	-	1.0	-	1.0	1.0	1.0	1.0	-	2
Pattern																									
Channel Beltwidth (ft)					2.5	-	-	19.4	-	46	33	51	-	69	-	2	33.3	57.15	81	33.3	57.15	57.15	81	-	-
Radius of Curvature (ft)					10.38	-	-	37.99	-	76	12	15.5	-	19	-	2	22.5	24.75	27	22.5	24.75	24.75	27	-	-
Rc:Bankfull width (ft/ft)					1.2	-	-	4.38	-	76		8.3	-		-	1	2.5	2.75	3	2.5	2.75	3	-	-	-
Meander Wavelength (ft)					43	-	-	109	-	50	60	64.5	-	69	-	2	57.6	91.80	126	57.6	91.8	91.8	126	-	-
Meander Width Ratio					0.29	-	-	2.24	-	46	4	6.15	-	8.3	-	2	3.7	6.35	9	3.7	6.35	6.35	9	-	-
Profile																									
Riffle Length (ft)					6.76	-	-	41.57	-	4	5.4	-	-	23	-	2	14.4	33.40	52.4	13.76	-	-	19.36	-	-
Riffle Slope (ft/ft)					0.0031	-	-	0.0386	-	4	0.016	-	-	0.024	-		0.014	0.02	0.024	0.00142	-	-	0.01113	-	-
Pool Length (ft)					5.89	-	-	37.56	-	7	7.8	-	-	35	-	2	54.12	64.72	75.32	10.32	-	-	31.4	-	-
Pool Max Depth (ft)						1.79	-	-	-	7		2.4	-	-	-	-	1	1.40	1.8	-	-	-	-	-	-
Pool Spacing (ft)					17.35	-	-	125.66	-	7	40.3	-	-	60	-	-	44.1	54.45	64.8	10.32	-	-	52.04	-	-
Transport Parameters																									
Reach Shear Stress (competency) lb/ft^2					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankful					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m^2					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																									
Rosgen Classification	-				G5c						E4						C/E4			E4					
Bankful Velocity (fps)	-	-	-	-	3.8						3.5						3.65			3.65					
Bankful Discharge (cfs)	-	-	-	-	39.04*						38						39.04*			39.04*					
Valley Length (ft)					-						-						-			-					
Channel Thalweg Length (ft)					608						608						608			608					
Sinuosity (ft)					1.24						1.8						1.13			1.16					
Water Surface Slope (ft/ft)	-				0.008						0.005						0.006			0.008					
BF slope (ft/ft)	-				0.008						0.005						0.006			0.008					
Bankful Floodplain Area (acres)					0.14						1.81						2.09			0.75					
% of Reach with Eroding Banks					-						-						-			0					
Channel Stability or Habitat Metric					-						-						-			-					
Biological or Other					-						-						-			-					

*Calculated using Flowmaster

Table 8.2. Baseline Stream Data Summary: Pre-Restoration Reach and Reference Reach Data

Baseline Stream Data Summary (Substrate, Bed, Bank and Hydrologic Containment Parameter Distributions)				
Dutch Buffalo Creek Stream and Wetland Restoration/EEP Project No. 370				
Unnammed Tributary to Dutch Buffalo (608 linear feet)				
Parameter	**Pre-Existing Condition**	**Reference Reach Data**	**Design**	**As-built/Baseline**
Ri%/Ru%/P%/G%/S%	-	-	-	-
SC% / Sa% / G% / C% / B% / Be%	-	-	-	24.5/35.75/36.75/3.25/0/0
d16 / d35 / d50 / d84 / d95 (mm)	0.12/0.83/2.36/11.03/22.6	-	-	1.45/5.85/8.29/25.06/47.52
Entrenchment Class<1.5/1.5-1.99/2.0-4.9/5.0-9.9/>10	100% <1.5 (1.13)	100% > 10 (15.66)	100% > 10 (16.67)	5.0 < 100% < 9.9 (5.35, 6.30)
Incision Class <1.2/1.2-1.49/1.5-1.99/>2.0	(2.53) 100% > 2.0	1.2=(1.2) 100% <1.49	(1.0) 100%< 1.2	(1.0) 100%< 1.2

Table 9.1. Cross Section Morphology Monitoring Data Summary, MY0 – MY3

Morphologic and Hydraulic Monitoring Summary												
Dutch Buffalo Creek Stream and Wetland Restoration Project/SCO #06-06752-01												
Unnammed Tributary to Dutch Buffalo (608 linear feet)												
PARAMETER		**Cross-Section 1 (Riffle)**						**Cross-Section 2 (Riffle)**				
DIMENSION	**Baseline**	**MY1-2010**	**MY2-2011**	**MY3-2014**	**MY4-2015**	**MY5-2016**	**Baseline**	**MY1-2010**	**MY2-2011**	**MY3-2014**	**MY4-2015**	**MY5-2016**
Bankfull Width (ft)	8.9	8.7	8.3	9.00			9.6	9.7	9.4	NA		
Floodprone Width (ft)	55.6	55.6	55.8	56.00			53.3	53.2	53.3	NA		
Bankfull Mean Depth	1.0	1.1	1.1	1.1			1.1	1.0	1.0	NA		
Bankfull Max Depth (ft)	1.8	1.7	1.6	1.9			1.7	1.6	1.6	NA		
Bankfull Cross-sectional Area (ft^2)	9.2	8.8	8.8	9.8			10.2	9.4	9.4	NA		
Bankfull Width/Depth Ratio	8.5	8.6	7.8	8.2			9.1	10.0	9.3	NA		
Bankfull Entrenchment Ratio	6.3	6.4	6.7	6.2			5.6	5.5	5.7	NA		
Bankfull Bankheight Ratio	1.0	1.0	1.0	1.0			1.0	1.0	1.0	NA		
Cross Sectional Area between end pins (ft^2)	75.0	69.6	75.5	71.3			12.0	9.8	19.1	NA		
d50 (mm)	13.7	4.9	1.9	2.0			0.1	11.6	12.5	NA		
PARAMETER		**Cross-Section 3 (Pool)**						**Cross-Section 4 (Riffle)**				
DIMENSION	**Baseline**	**MY1-2010**	**MY2-2011**	**MY3-2014**	**MY4-2015**	**MY5-2016**	**Baseline**	**MY1-2010**	**MY2-2011**	**MY3-2014**	**MY4-2015**	**MY5-2016**
Bankfull Width (ft)	11.0	10.5	10.4	NA			8.3	8.3	8.2	8.5		
Floodprone Width (ft)	59.0	58.0	55.3	NA			52.5	52.5	55.1	55.00		
Bankfull Mean Depth	0.8	0.7	0.7	NA			1.0	1.0	1.0	1.1		
Bankfull Max Depth (ft)	8.9	8.7	1.6	NA			8.9	8.7	1.7	1.8		
Bankfull Cross-sectional Area (ft^2)	9.3	7.5	7.6	NA			8.3	8.4	8.3	8.7		
Bankfull Width/Depth Ratio	13.1	14.8	14.3	NA			8.3	8.2	8.1	7.7		
Bankfull Entrenchment Ratio	5.4	5.5	5.3	NA			6.3	6.3	6.8	6.5		
Bankfull Bankheight Ratio	1.0	1.0	1.0	NA			1.0	1.0	1.0	1.0		
Cross Sectional Area between end pins (ft^2)	49.8	35.4	53.4	NA			39.6	36.3	41.3	39.7		
d50 (mm)	0.1	0.2	0.03	NA			11.1	17.5	13.8	10.2		

Table 9.2. Stream Reach Morphology Monitoring Data Summary, MY0 – MY3

Monitoring Data - Stream Reach Data Summary Dutch Buffalo Creek Stream and Wetland Restoration Project/SCO #06-06752-01 Unnammed Tributary to Dutch Buffalo (608 linear feet)																								
Parameter	Baseline						MY 1 2010						MY 2 2011						MY3 2014					
DIMENSION	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	8.34	8.60	8.60	8.85	-	3	8.31	8.52	8.52	8.72	-	3	8.16	8.59	8.28	9.34	0.65	3	8.50	8.75	8.75	9.00	0.35	2
Floodprone Width (ft)	52.52	54.05	54.05	55.57	-	3	52.49	54.07	54.07	55.64	-	3	53.33	54.73	55.09	55.77	1.26	3	55.00	55.50	55.50	56.00	0.71	2
Bankfull Mean Depth (ft)	1.00	1.02	1.02	1.04	-	3	1.01	1.01	1.01	1.01	-	3	1.01	1.03	1.01	1.06	0.03	3	1.10	1.10	1.10	1.10	0.00	2
Bankfull Max Depth (ft)	1.67	1.74	1.74	1.81	-	3	1.56	1.63	1.63	1.70	-	3	1.62	1.64	1.64	1.65	0.02	3	1.79	1.83	1.83	1.87	0.06	2
Bankfull Cross Sectional Area (ft2)	8.30	8.77	8.77	9.24	-	3	8.42	8.62	8.62	8.82	-	3	8.27	8.82	8.77	9.42	0.58	3	8.70	9.26	9.26	9.81	0.78	2
Width/Depth Ratio	8.34	8.43	8.43	8.51	-	3	8.23	8.43	8.43	8.63	-	3	7.81	8.38	8.08	9.25	0.77	3	7.73	7.95	7.95	8.18	0.32	2
Entrenchment Ratio	6.28	6.29	6.29	6.30	-	3	6.32	6.35	6.35	6.38	-	3	5.71	6.40	6.74	6.75	0.60	3	6.22	6.35	6.35	6.47	0.18	2
Bank Height Ratio	1.0	1.0	1.0	1.0	-	3	1.0	1.0	1.0	1.0	-	3	1.0	1.0	1.0	1.0	0.00	3	1.01	1.02	1.02	1.03	0.01	2
Bankfull Velocity (fps)	4.70	4.45	4.45	4.23	-	3	4.64	4.53	4.53	4.43	-	3	4.14	4.44	4.45	4.72	0.29	3	4.14	4.47	4.45	4.72	0.30	2
PROFILE	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Riffle Length (ft)	13.76	21.29	21.29	28.82	-	2	16.07	22.09	22.09	28.11	-	3	9.01	16.90	17.46	22.53	5.05	6	12.95	20.09	20.28	26.49	5.05	3
Riffle Slope (ft/ft)	0.00142	0.01	0.01	0.01856	-	2	0.00916	0.01006	0.01006	0.01096	-	3	0.0093	0.0203	0.0158	0.0472	0.0140	6	0.01	0.01	0.01	0.03	0.01	3
Pool Length (ft)	10.32	31.83	31.83	53.33	-	2	18.30	27.90	27.90	37.49	-	3	15.77	38.02	40.93	61.57	15.69	8	14.80	32.58	33.55	50.80	15.69	4
Pool Max depth	1.72	1.82	1.82	1.91	-	2	1.62	1.63	1.63	1.63	-	2	1.95	2.29	2.17	2.8	0.30	9	1.76	1.91	1.87	2.11	0.30	4
Pool Spacing (ft)	10.32	42.80	42.80	75.27	-	2	19.98	23.64	23.64	27.29	-	3	25.45	54.46	58.32	77.41	18.41	8	18.58	40.30	41.58	59.99	18.41	4
PATTERN	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Channel Beltwidth (ft)	33.30	57.15	57.15	81.00	-	5	33.30	57.15	57.15	81.00	-	5	33.30	57.15	57.15	81.00	-	5	33.30	57.15	57.15	81.00	-	5
Radius of Curvature (ft)	22.50	24.75	24.75	27.00	-	9	22.50	24.75	24.75	27.00	-	9	22.50	24.75	24.75	27.00	-	9	22.50	24.75	24.75	27.00	-	9
Meander Wavelength (ft)	57.60	91.80	91.80	126.00	-	7	57.60	91.80	91.80	126.00	-	7	57.60	91.80	91.80	126.00	-	7	57.60	91.80	91.80	126.00	-	7
Meander Width Ratio	3.70	6.35	6.35	9.00	-	-	3.70	6.35	6.35	9.00	-	-	3.70	6.35	6.35	9.00	-	-	3.70	6.35	6.35	9.00	-	-
ADDITIONAL REACH PARAMETERS																								
Rosgen Classification	E4						E4						E4						E4					
BF slope (ft/ft)	0						0.008						0.006						0.007					
Ri%/Ru%/P%/G%/S%	-	-	-	-	-		29.00	1.20	38.10	-	0.2		17.00	-	50.00	-	0.2		-	-	-	-	-	
SC%/Sa%/G%/C%/B%/Be																								
d16 / d35 / d50 / d84 / d95																								
% of reach with eroding banks	0						4						0						0					
Channel Stability or Habitat Metric	-						-						-						-					
Biological or Other	-						-						-						-					

*Insufficient water in channel to estimate an approximate value

Appendix E - Hydrologic Data

Table 10. Verification of Bankfull Events: Restored Tributary UT-1

Data Collected	Event Date	Method	Photo # (if available)	Feet Above Bankfull Elevation
5/19/2011	Unknown	Crest Gauge	N/A	UNK
6/23/2011	Unknown	Crest Gauge	N/A	UNK
4/10/2014	Past few days	Matted vegetation	below	UNK
9/15/2014	4/15/2014	Hobo Gage = 4.9 ft	N/A	0.9
9/15/2014	4/19/2014	Hobo Gage = 5.7 ft	N/A	1.7

Table 10.2. Verification of Bankfull Events: Main Stem Dutch Buffalo Creek **

Data Collected	Event Date	Method	Photo # (if available)	Feet Above Thalweg Elevation
9/15/2014	4/15/2014	Hobo Gage = 4.9 ft	N/A	6.5
9/15/2014	4/19/2014	Hobo Gage = 5.7 ft	N/A	7.3

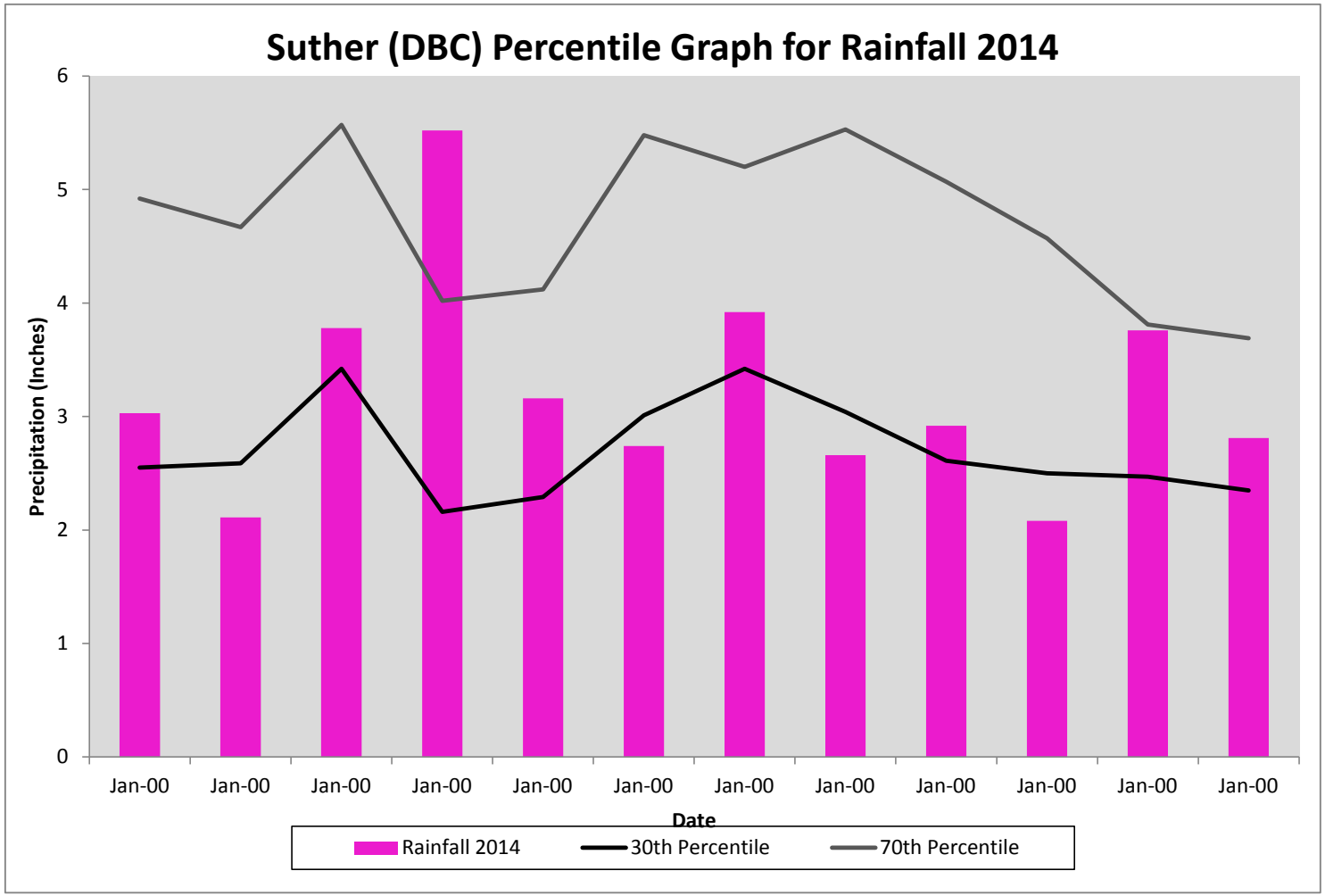
** Dutch Buffalo Creek is severely incised and bankfull indicators are unclear. Hobo Gage height > 4.0 ft (about 5.6 ft above THW) is used as estimate of bankfull.

Bankfull elevation at the uppermost step-pool on the tributary (station 5+20) ~ 646 ft
Hobo sensor elevation in Dutch Buffalo Cr is approx 642 ft.
Readings above 4 ft at the Hobo gage suggest probable bankfull flow in the tributary.

Matted vegetation and wrack lines, between Trib stations 3+00 to 5+00, Apr 9-10, 2014.

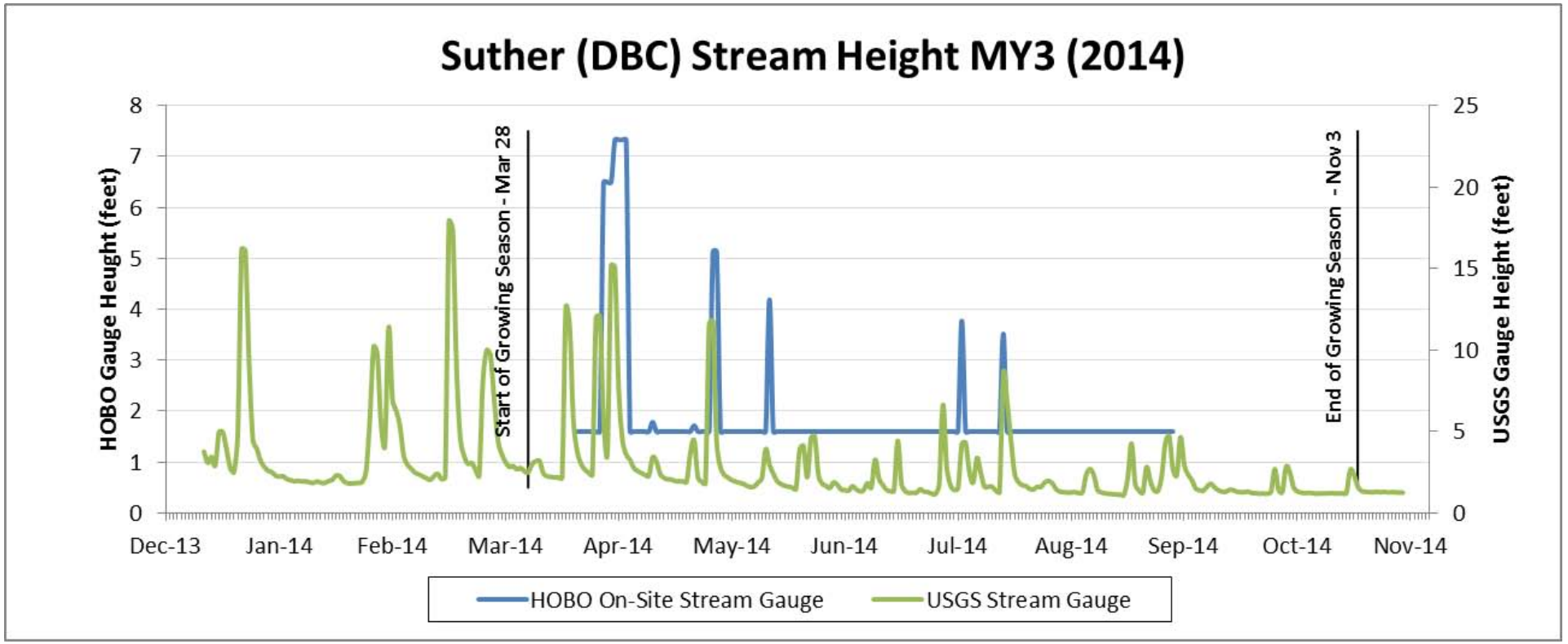
Figure 7. Monthly Rainfall Totals for 2014 and 30th and 70th Percentiles for Climate Normals, Concord, NC

Month	Total 2014	30th Perc*	70th Perc*
Jan-14	3.03	2.55	4.92
Feb-14	2.11	2.587	4.668
Mar-14	3.78	3.42	5.57
Apr-14	5.52	2.16	4.02
May-14	3.16	2.29	4.12
Jun-14	2.74	3.01	5.48
Jul-14	3.92	3.42	5.2
Aug-14	2.66	3.04	5.53
Sep-14	2.92	2.61	5.07
Oct-14	2.08	2.5	4.57
Nov-14	3.76	2.47	3.81
Dec-14	2.81	2.35	3.69



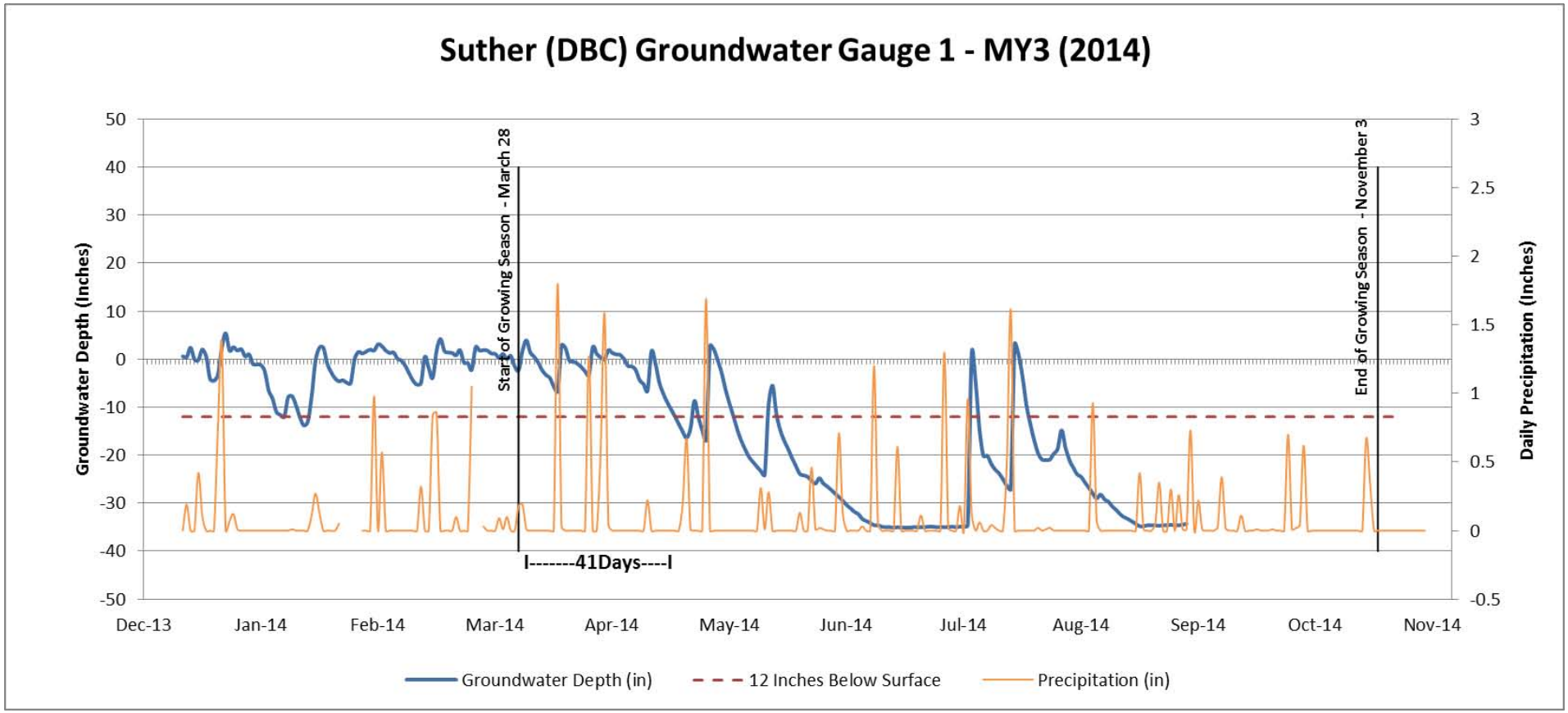
30th and 70th Percentiles are based on monthly totals for the 30 year period from 1981 to 2010 at Concord Airport, Cabarrus Co.

Figure 8. HOBO On-site stream Gauge Data



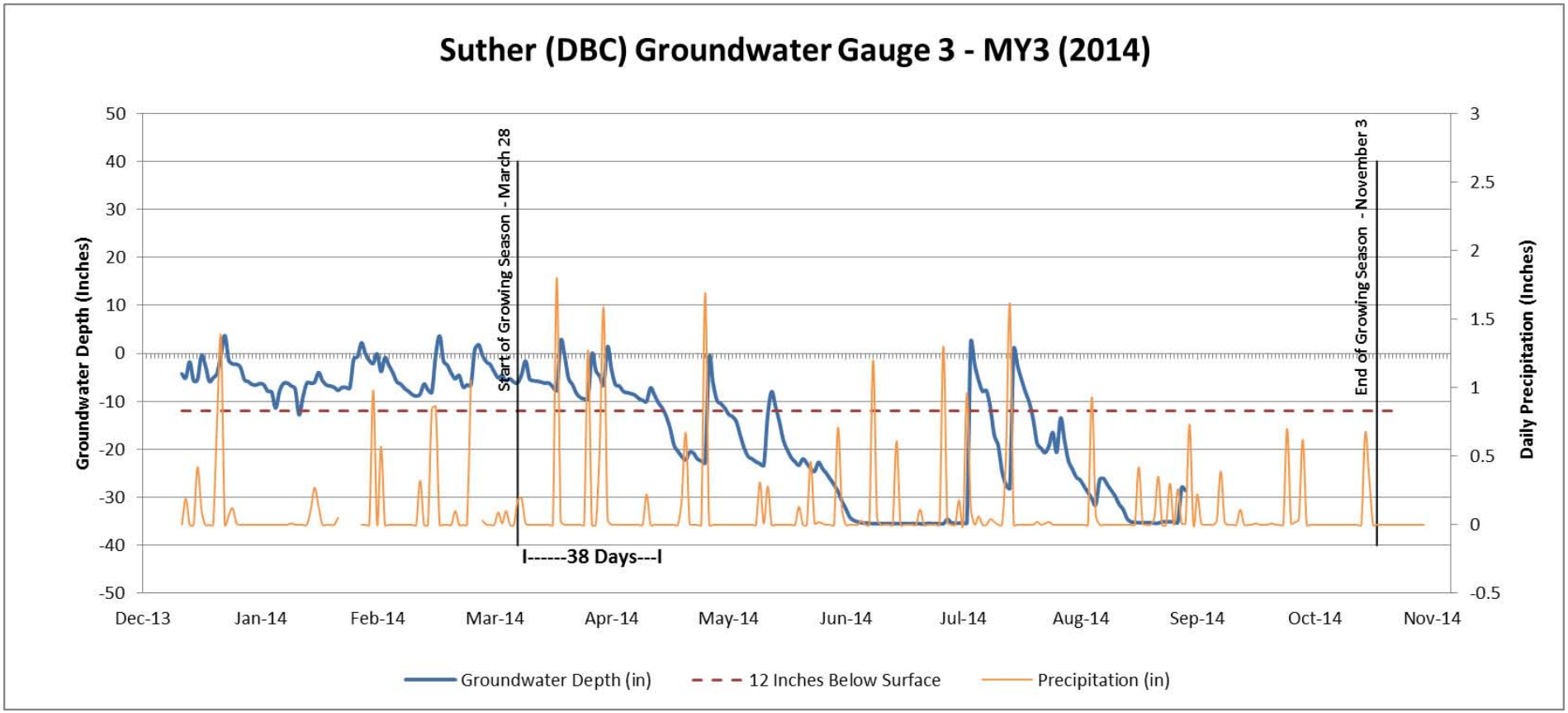
- USGS Stream Data referenced from Gage # 0212433550, Rocky River – 9 miles SSW of Suther Site

Figure 9.1. Groundwater Data



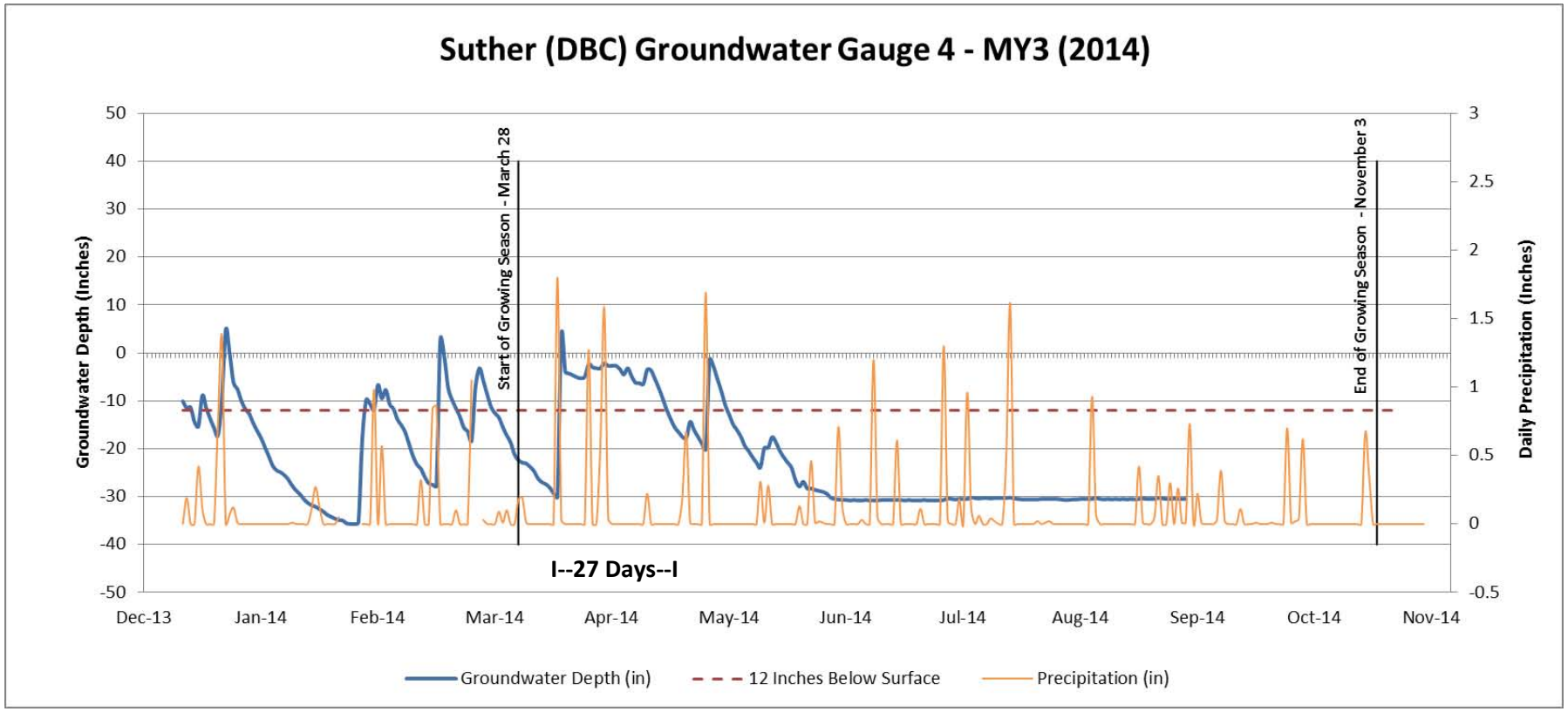
- Replaced in original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.2. Groundwater Data



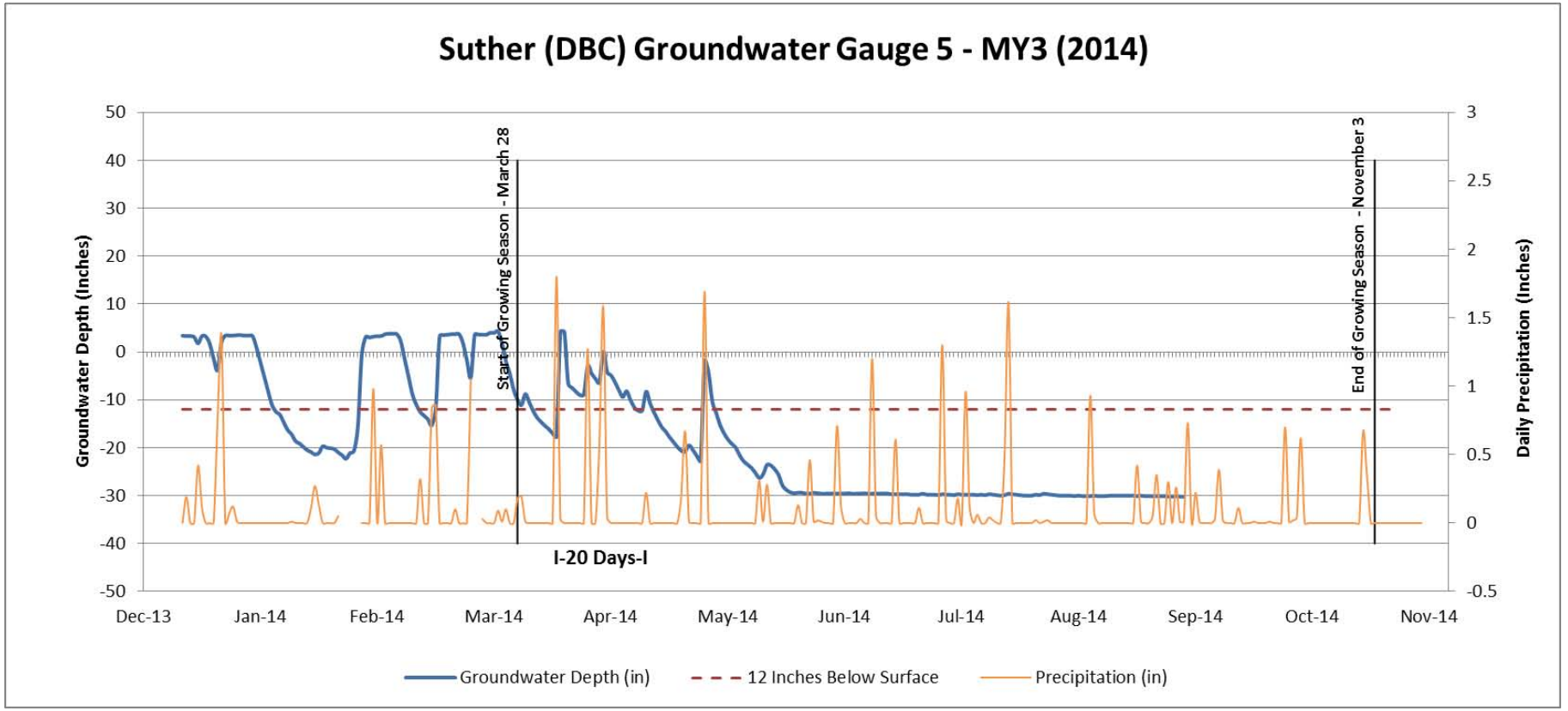
- Replaced in original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.3. Groundwater Data



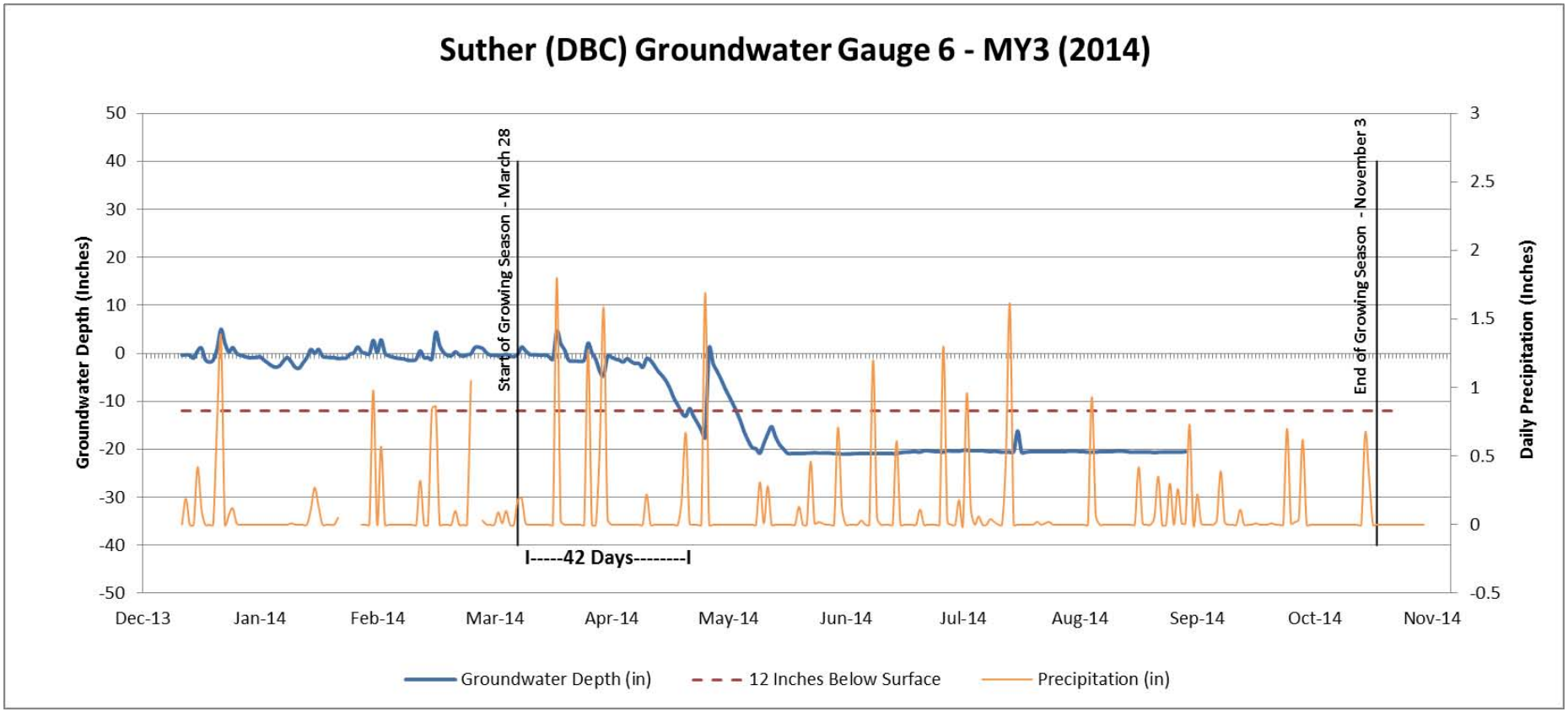
- Replaced Gauge 450 ft NNE of original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.4. Groundwater Data



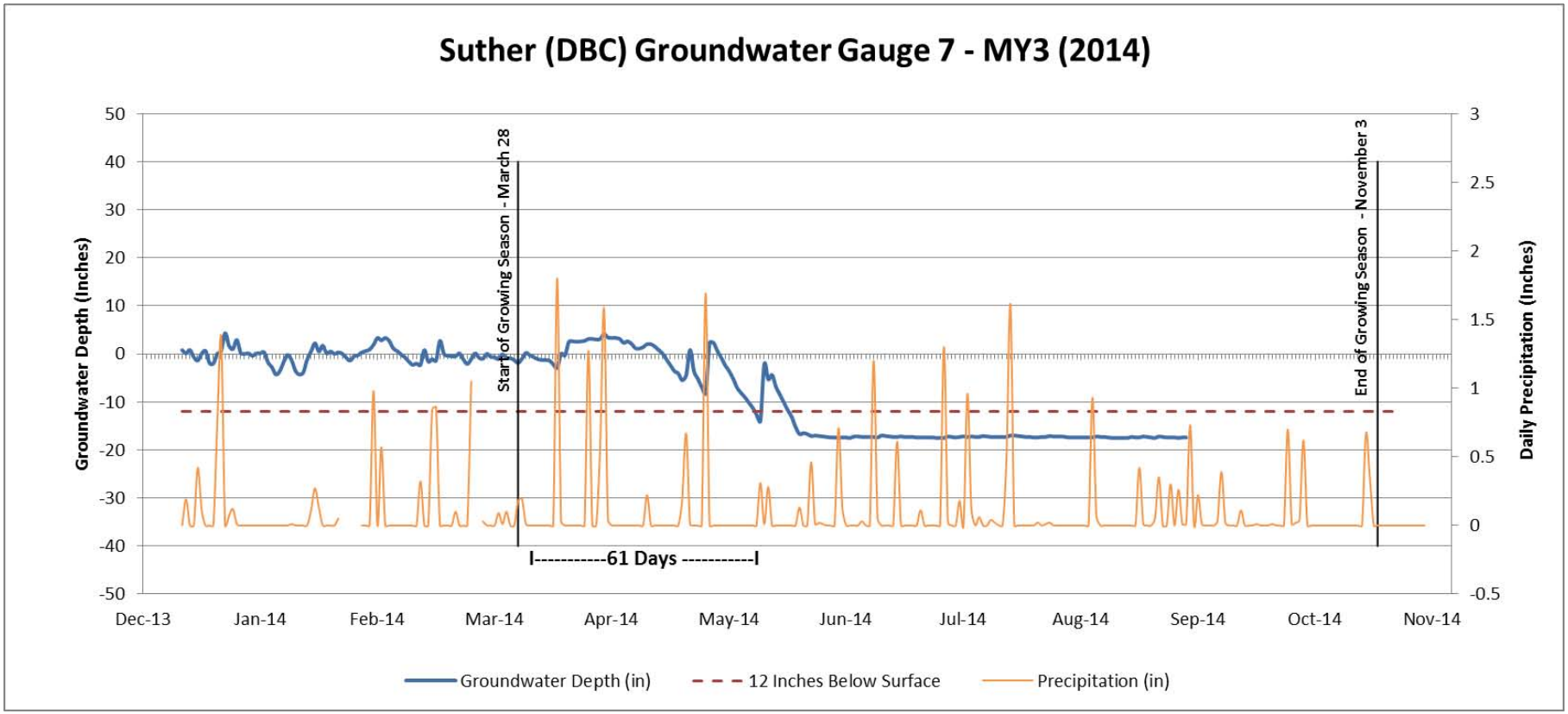
- Replaced Gauge 250 ft NNE of original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.5. Groundwater Data



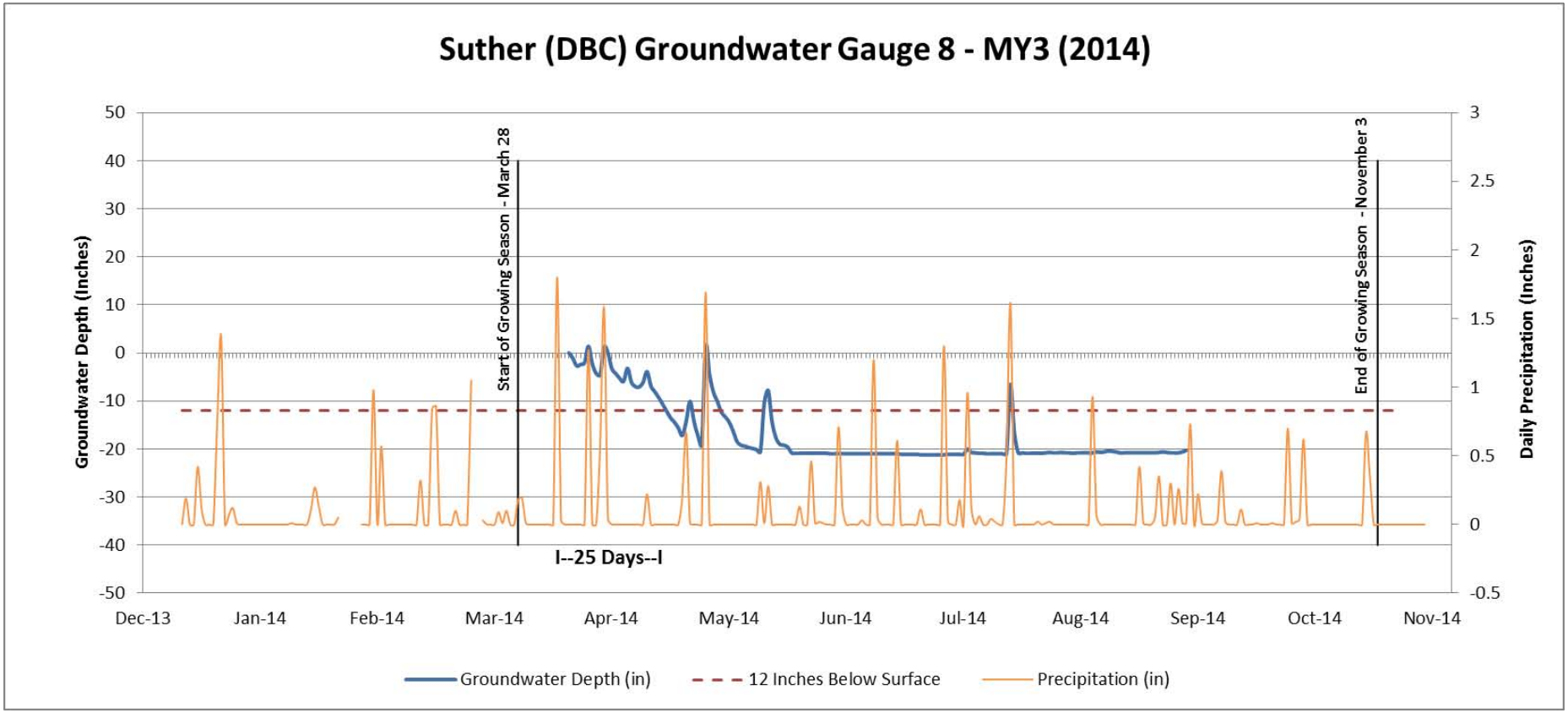
- Replaced in original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.6. Groundwater Data



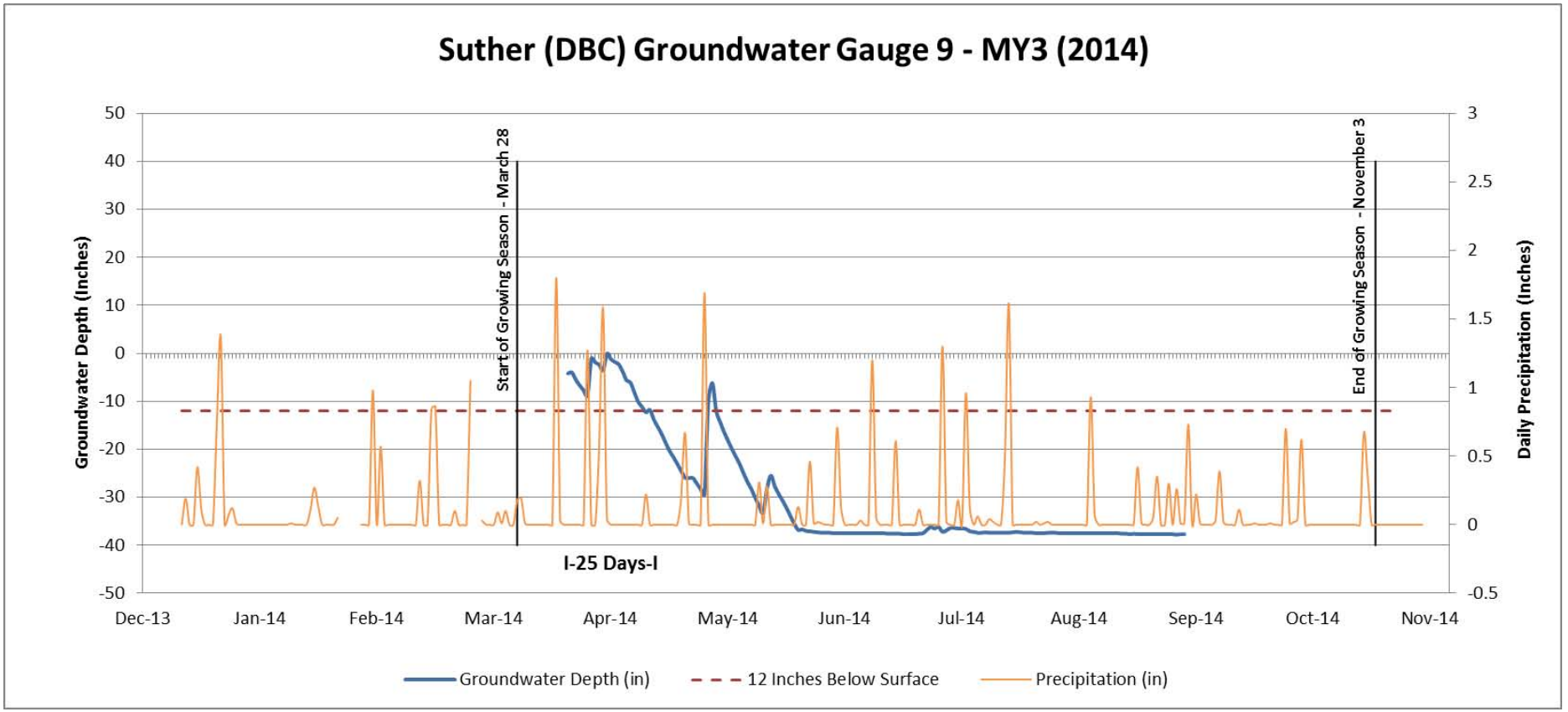
- Replaced in original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.7. Groundwater Data



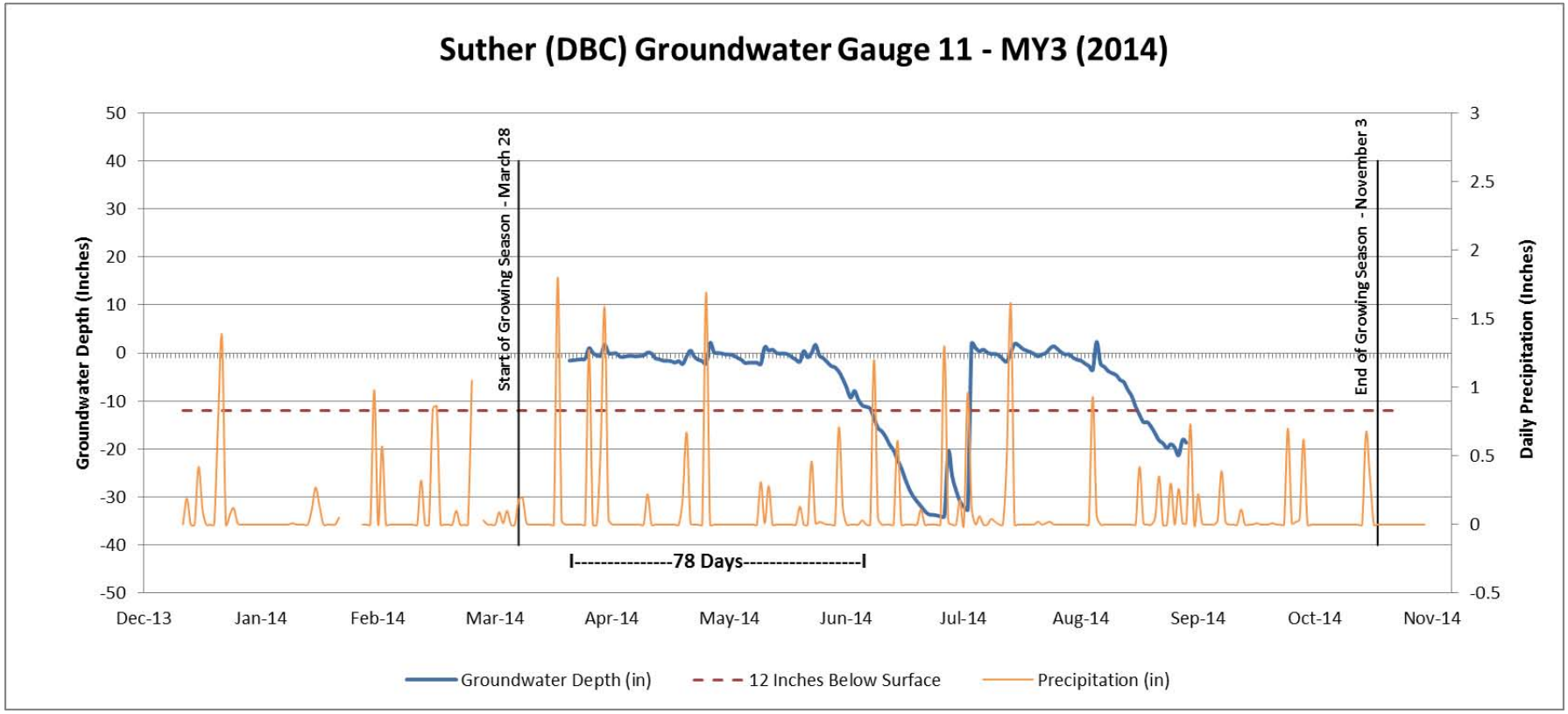
- Replaced in original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.8. Groundwater Data



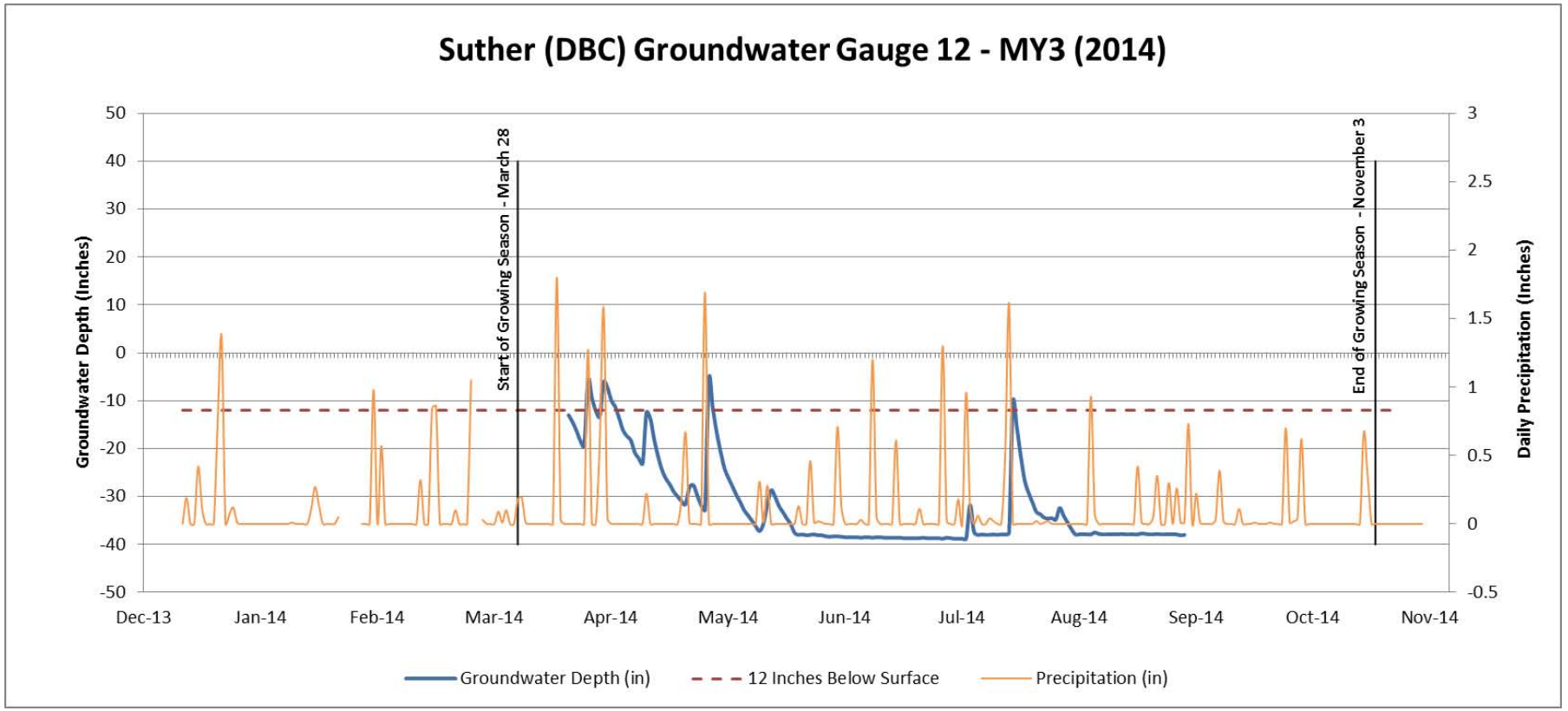
- Replaced in original location on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.9. Groundwater Data



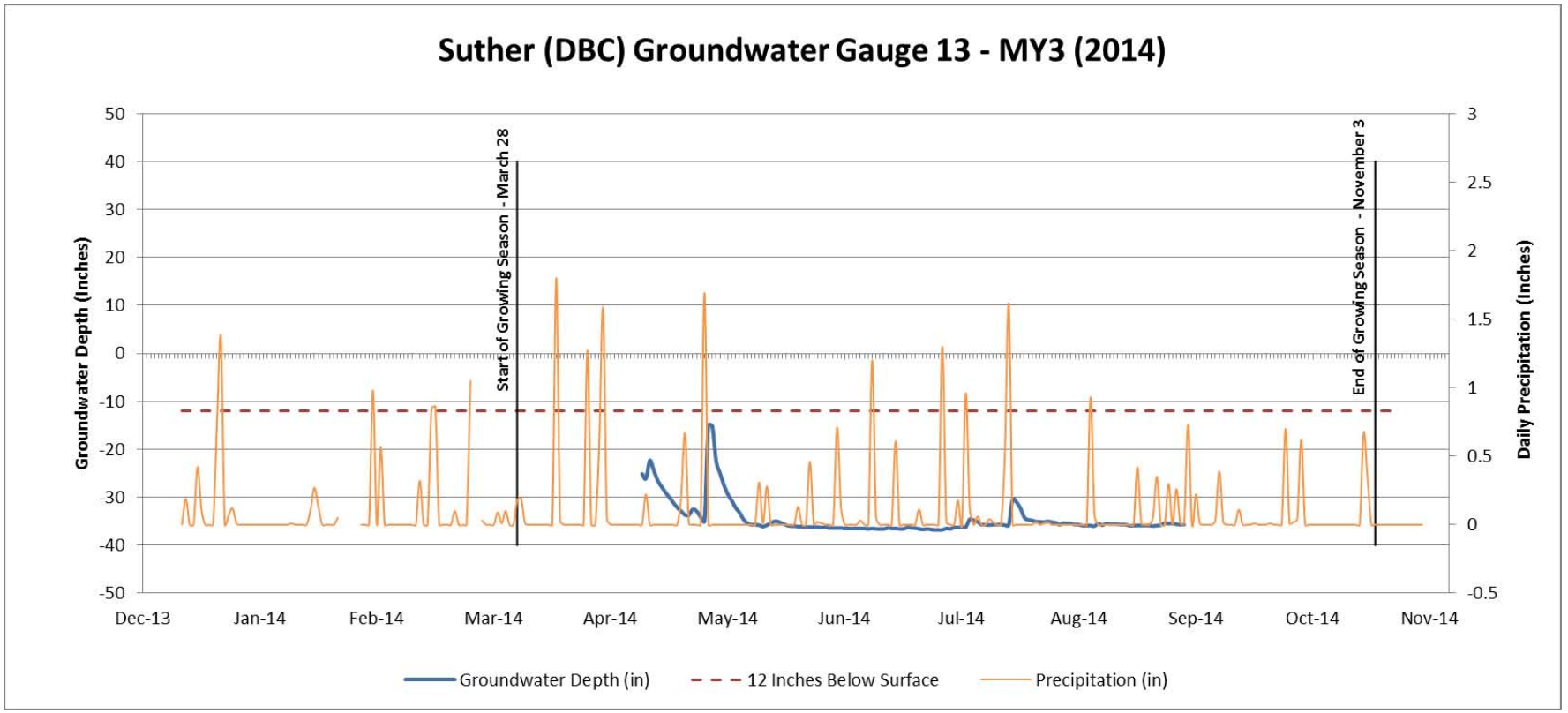
- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.10. Groundwater Data



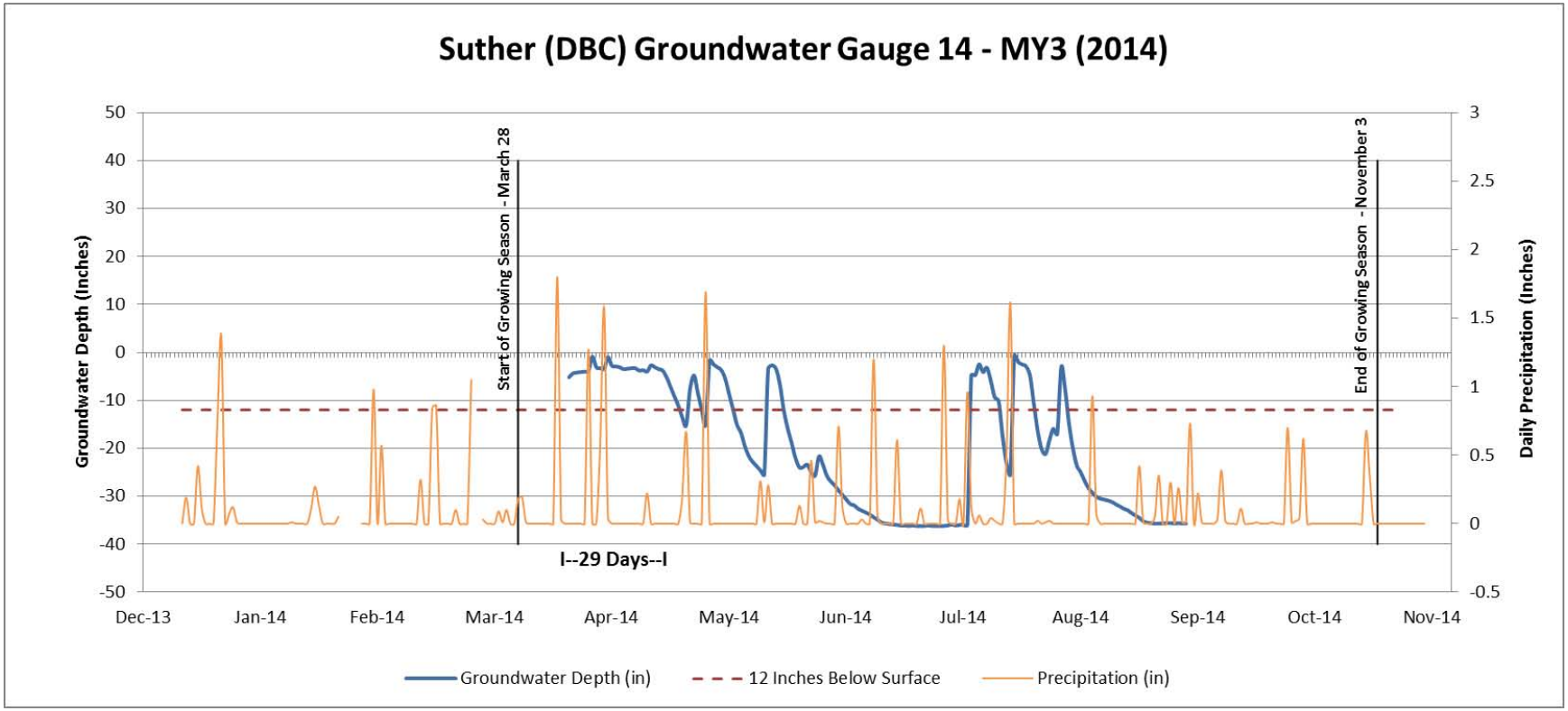
- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.11. Groundwater Data



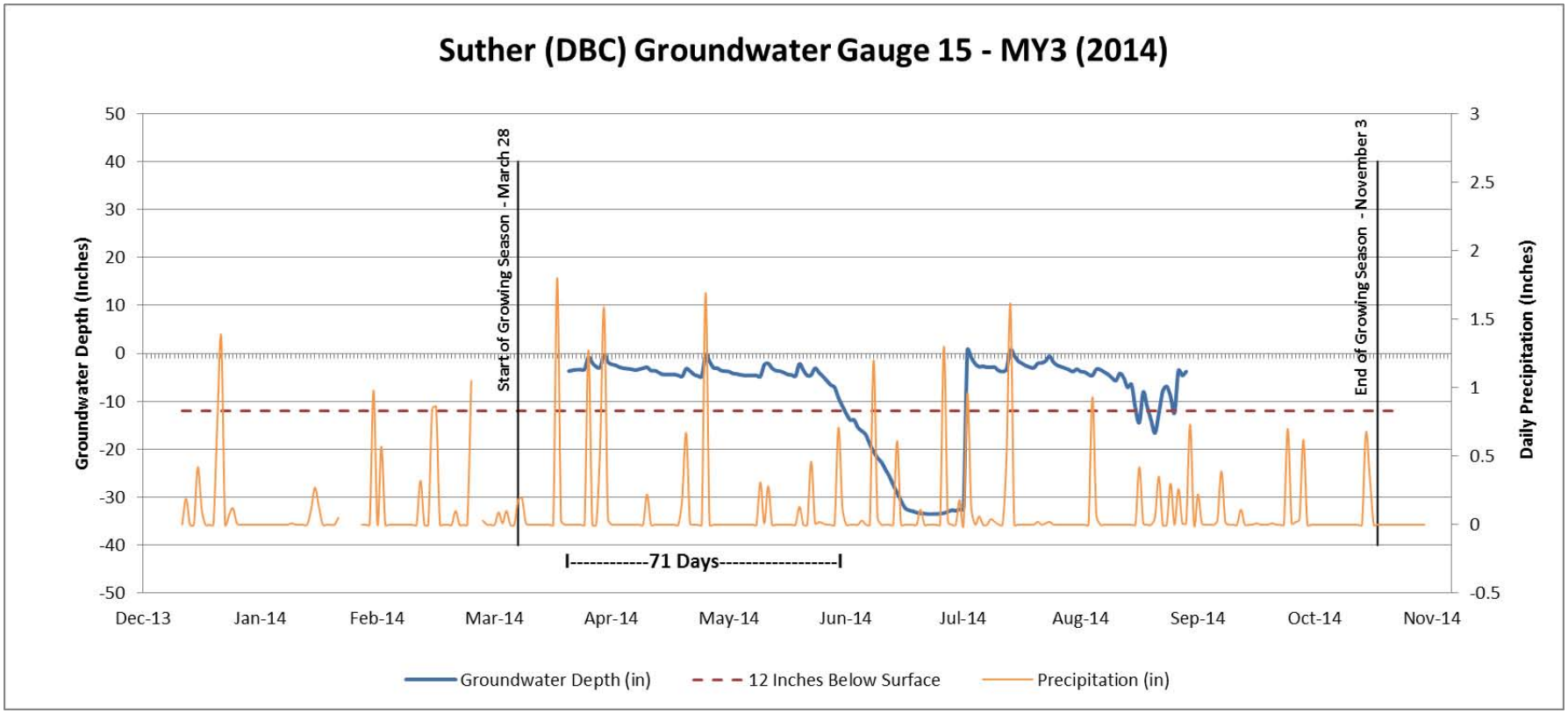
- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.12. Groundwater Data



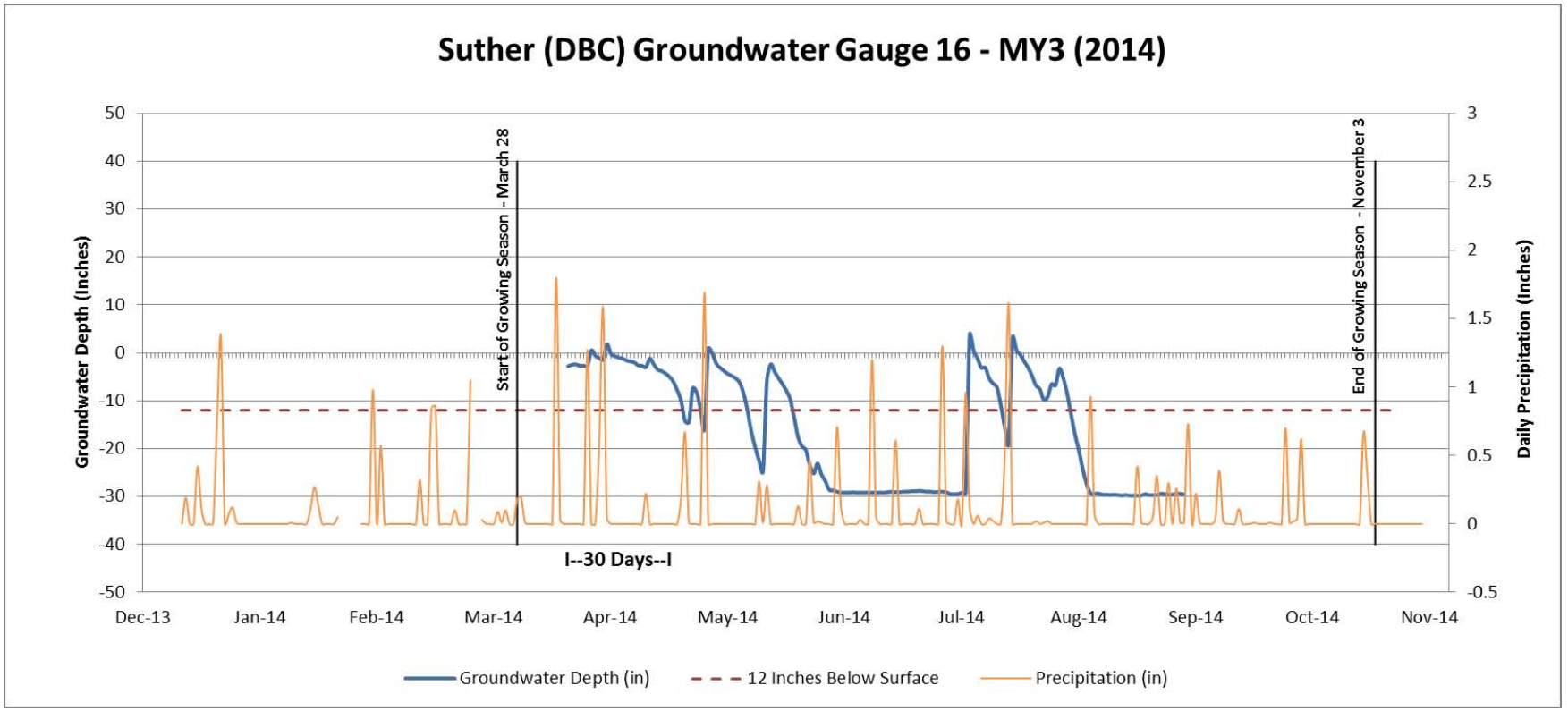
- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.13. Groundwater Data



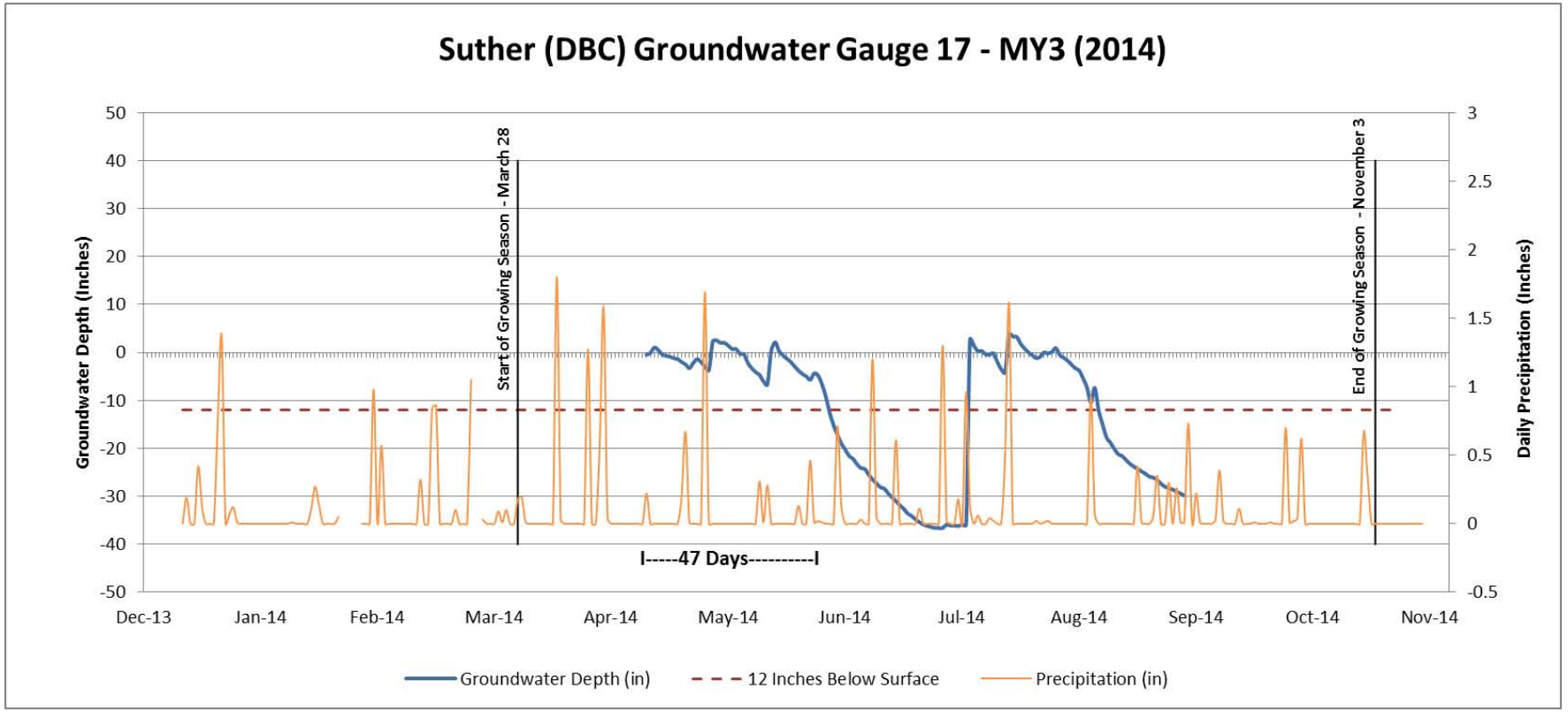
- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.14. Groundwater Data



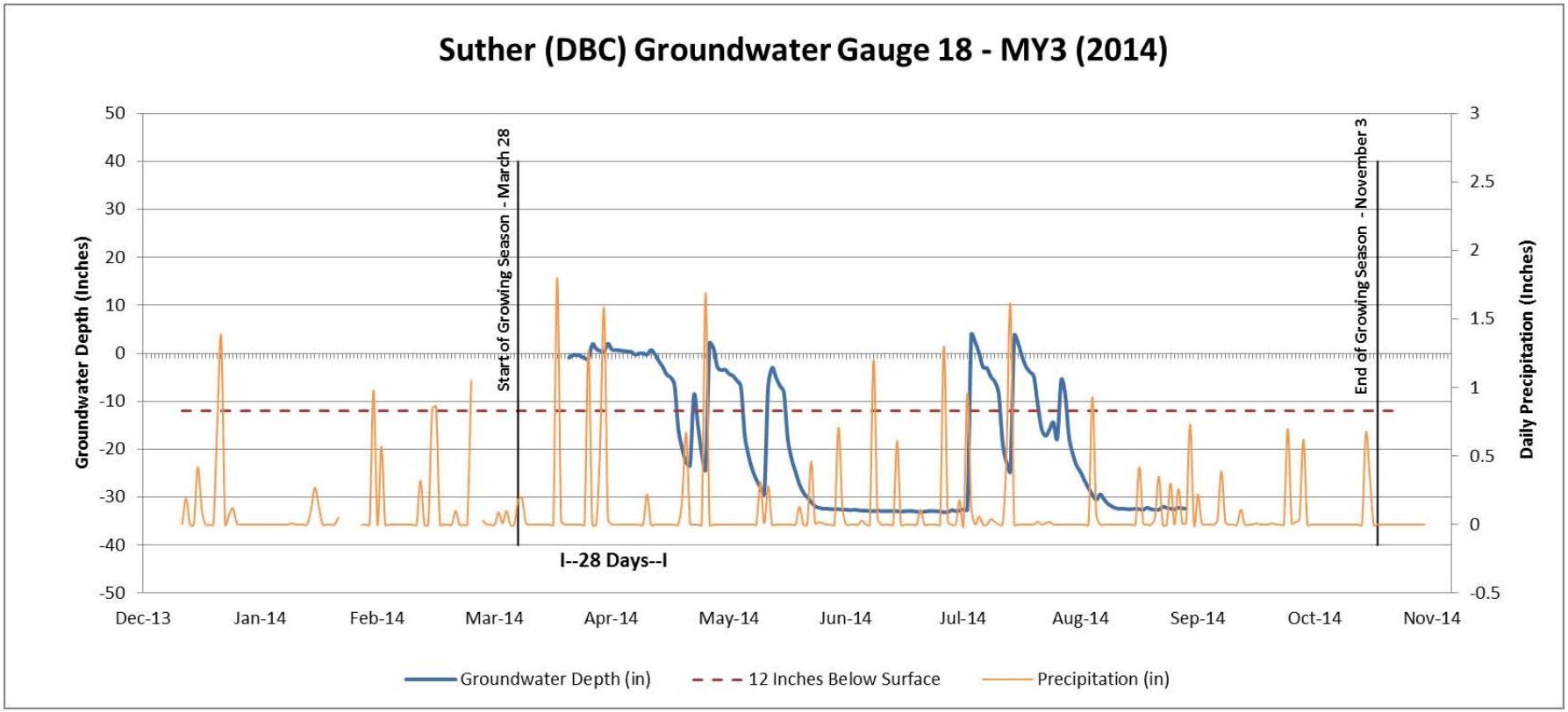
- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.15. Groundwater Data



- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Figure 9.16. Groundwater Data



- New gauge location established on 10 Apr 2014 with reconditioned RDS well provided by EEP

Appendix E - Hydrologic Data: Suther Site

Table 11. Wetland GW Gage Success Attainment, 2010-2014

Gage Site #	MY-01 (2010)			MY-02 (2011)			MY-xx (2012)			MY-xx (2013)			MY-03 (2014)			MY-04 (2015)			MY-05 (2016)		
	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit	Days	% Gro	Crit
1	20	9	YES	63	28	YES	43	19	YES	66	29	YES	39	17	YES						
2	52	23	YES	71	31	YES	44	19	YES	*MAL*	-	*Unk*	*MAL*	-	*Unk*						
3	19	8	YES	12	5	NO	17	7	NO	26	11	YES	38	17	YES						
4-O	4	2	NO	0	0	NO	3	1	NO	9	4	NO	--	--	--	--	--	--	--	--	--
4-N	--	--	--	--	--	--	--	--	--	--	--	--	28	12	YES						
5-O	0	0	NO	3	1	NO	7	3	NO	15	7	NO	--	--	--	--	--	--	--	--	--
5-N	--	--	--	--	--	--	--	--	--	--	--	--	25	11	YES						
6	46	20	YES	64	28	YES	32	14	YES	56	24	YES	40	17	YES						
7	--	--	--	41	18	YES	39	17	YES	57	25	YES	59	26	YES						
8	--	--	--	18	8	YES	3	1	NO	*MAL*	-	*Unk*	24	10	YES						
9	10	4	NO	3	1	NO	6	3	NO	13	6	NO	23	10	YES						
10	53	23	YES	9	4	NO	9	4	NO	*MAL*	--	*Unk*	--	--	--	--	--	--	--	--	--
11													78	34	YES						
12													11	5	NO						
13													*MAL*	-	*Unk*						
14													29	13	YES						
15													71	31	YES						
16													30	13	YES						
17													46	20	YES						
18													28	12	YES						

Growing season = Mar 23 to Nov 7 = 229 days. Wetland Success Criterion = 8% of growing season = 18 consecutive days (Yes or No)
MAL = GW gage malfunction; data not usable. 2010 and 2011 data and success copied from Jacobs MY2 report (2012).

GW Well History: Nov 2009 original wells 1 thru 10 installed by JJG/Jacobs, maintained thru fall 2011.
No data downloaded during 2012 to 2013; some wells stopped recording during this period.
10 Apr 2014 - RJGA + MMI replaced 9 old wells and installed 8 new well locations selected by EEP.

Gages 1,2,3,6,7,8,9 - Replaced in original locations with reconditioned RDS GW gages
Gage 4 – Replaced 450 ft NNE of original location with reconditioned RDS GW gage [O =old; N= new]
Gage 5 – Replaced 250 ft NNE of original location with reconditioned RDS GW gage [O =old; N= new]
Gage 10 – Removed permanently; not replaced.
Gages 11 to 18 – New well locations installed with reconditioned RDS GW gages