# Tarlton Stream and Wetland Restoration Project

| | |
|---|---|
| Contract #: | D05013-1 |
| County: | Cumberland |
| Cataloging Unit: | Cape Fear 03030004 |
| Monitoring Firm POC: | Mid-Atlantic Mitigation, LLC<br>Rich Mogensen (704) 782-4133<br>Kimley-Horn Associates, Inc.<br>Will Wilhelm (704) 333-5131 |
| Prepared For: | EEP Project Manager, Guy Pearce |

# Year 3 (2008) Monitoring Report

Kimley-Horn
and Associates, Inc.

Mid-Atlantic
Mitigation, LLC
AN EARTHMARK COMPANY

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## 1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

On behalf of the North Carolina Ecosystem Enhancement Program (NCEEP), Mid-Atlantic Mitigation, LLC (MAM) with technical assistance from Kimley-Horn and Associates (KHA) restored, enhanced and preserved 4,402 linear feet of stream, restored 6.6 acres of riverine wetlands and enhanced 2.7 acres of riverine wetlands. Construction of the project began in November 2005 with beaver dam removal and grade-control structure installation, continued into March 2006 with final planting completed in June 2006. The Tarlton Stream and Wetland Restoration Project (Project) will provide NCEEP with 3,930 Stream Mitigation Units (SMUs) and 8.0 Wetland Mitigation Units (WMUs).

The objective of the restoration approach is to plan, design, and construct a dynamically stable stream/riparian floodplain and bottomland hardwood riverine wetland community providing an ecological improvement for the entire site and watershed. This project is designed to provide a stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport the surface water and sediment load. Also, the Project aims to reestablish the primary stream and wetland functions associated with nutrient removal and transport, sediment retention, wildlife (both aquatic and terrestrial) habitat, and to provide restoration of riparian zones that historically were an impounded lakebed. The restoration approach, due to the existing condition (fluctuating open water levels caused by beaver activity) and varied historical conditions of the site (lake, dry lake bed, beaver impoundments, etc.), involved an "adaptive" management phased process.

The project was constructed in two phases. The restoration approach established a stable grade control stream section, which maintains the elevation of the entire stream thalweg and the floodplain by controlling the downstream end of the project area. The floodplain elevation below the removed dam was set by installing several rock-cross vanes and a constructed riffle to hold the grade of the existing lake bottom area which is now the floodplain area above the former dam. This design provides both secondary water quality and primary flood storage benefits. The Project (both streams and wetlands) underwent a natural adjustment to a more stable aquatic ecosystem. The streams continued to re-establish natural channel function. This adaptive management approach allowed the streams to naturally seek equilibrium and appropriate dimension, pattern, and profile as the Project stabilizes. The primary restoration approach is to determine whether the stream adjustments trend towards the design criteria and restoration goals based on up-stream reference morphology and vegetation communities.

The riverine wetland and buffer vegetation community will transition as the system seeks hydrologic and biologic equilibrium. After removing the dam sediments were unconsolidated and mucky with saturation. It was anticipated that settling and subsidence would occur throughout the initial growing season, first through evaporation and then through transpiration as the herbaceous cover (seeded and natural propagation) established. This did occur and continues to progress. Areas that were not

saturated/ponded (i.e. fringe areas and/or headwater wetlands) were initially planted with bare root seedlings and containerized plants to establish a bottomland hardwood riparian wetland community. Later as the site dewatered, thousands of containerized, bottomland hardwood trees & shrubs were planted throughout the stream and wetland areas.

The stream(s) will be monitored for stability of dimension, pattern, and profile using standard practices including permanent cross sections, riffle-run-pool analysis, and pebble counts. Wetland hydrology and vegetation success will be monitored using self-reading ground water monitoring gages and standardized, randomly placed permanent vegetation plots which will be monitored for species diversity and survival. Monitoring data will be analyzed to determine what remedial actions if any are required and any remedial actions proposed will be detailed in the annual monitoring reports.

The third year monitoring began with plant counts and photos on July 30th, 2008, and was completed with survey work on November 20th. The vegetation in all of the plots currently meets and/or exceeds the requirements while profiles and cross sections continue to indicate increased stability and function. Monitoring success will be discussed in detail in Section 3.

# 2.0 PROJECT BACKGROUND

## 2.1 LOCATION AND SETTING

The Project is located in the City of Fayetteville, Cumberland County, North Carolina on the corner of Clearwater Drive and US 401 Bypass (Country Club Drive). A location map is included in Figure 1. The project site is located in the Upper Cape Fear River Watershed (USGS 8-digit Hydrologic Unit 03030004, and NCDWQ River Basin 03-06-15), and is within the NC Ecosystem Enhancement Program (EEP) Cross Creek Targeted Local Watershed (00050). The project site was historically impounded by a dam built in the 1970s, creating Country Club Lake which impounded about 4,500 feet of two perennial prongs of a tributary to Cross Creek. The project drainage area is approximately 2.6 sq. mi. flowing into Cross Creek, a 303(d)-listed stream for impaired biological activity. The eastern prong of the project which is named UT to Cross Creek East has a drainage area of 1.0 square miles. The western prong named UT to Cross Creek West has a drainage area of 1.6 square miles. The project area conservation easement consists of 17.8 acres. The restoration project is being managed and monitored by Mid-Atlantic Mitigation, LLC but the property is owned by Greg and Patricia Tarlton and the conservation easement is held by the State of North Carolina.

## 2.2 STRUCTURE AND OBJECTIVES

The goals and objectives of the Project are to restore a naturally stable stream and riparian wetland community; to restore a bottomland hardwood wetland community; and to provide stormwater management for downstream development. In addition, water quality will be improved, flood storage will be increased, wildlife and aquatic habitat will be restored and the threat of flooding of downstream areas will be significantly reduced.

Phase I (completed Fall 2005): A beaver management plan was implemented to remove all the beavers from the project site. The removal of the old dam debris and spillway was completed in November and December 2005 making it more difficult for the beavers to re-establish a dam at its existing location. A beaver control program which includes regular site visits to the former dam area has been implemented and will continue throughout the monitoring period. In mid-November 2005, the lake water level was lowered over a 3-5 day period slowly releasing the water downstream to prevent flooding and erosion. In conjunction with removing the beaver dams, the stream section through the area of the historical dam and beaver dams was restored. The channel in this section (approximately 175 feet) was restored using a Priority I (Rosgen) restoration approach. The stream restoration included establishing a bankfull channel and active floodway through the relic spillway/dam and providing a variety of in-stream structures (rock vanes, constructed riffle, and step pool structures) to provide grade control, stability, and improve aquatic habitat diversity. The natural channel design was based on the upstream reference reach. The restoration project was constructed through and under an existing aerial sanitary sewer crossing that is cut out of the easement limit. In addition to the stream restoration, a BMP (level spreader / pre-formed scour hole) was constructed in this area at the outlet of a stormwater drainage pipe. This restoration establishes a stable grade control, which maintains the elevation of the entire stream thalweg and the floodplain by controlling downstream end of the project area. The floodplain elevation below the dam was set to hold the grade of the existing lake bottom which is now the floodplain area above the former dam area. This also prevented any sediment that was in the old lake from being washed downstream and to provide a natural "pinch-point" corresponding with existing topography. This pinch-point will help re-establish and control natural hydrology in the proposed riparian wetland during events above bankfull and act as a large detention area.

Phase II (completed in July 2006): Once the beavers, beaver dams, and impounded water were removed, and the downstream grade control established, the Project (both streams and wetlands) underwent a natural adjustment to a more stable aquatic ecosystem. The stream segments found their hydrologic equilibrium and re-established bed and bank features. In addition, the site soils gradually dewatered allowing the deposited sediments to consolidate and subside. During the first growing season the Project soils stabilized through evapotranspiration and subsidence processes. The streams continued to re-establish natural channel function, and were evaluated for necessary adjustments. This adaptive management approach allowed the streams to naturally seek equilibrium and appropriate dimension, pattern, and profile as compared to the upstream reference reach. The primary restoration approach is to determine whether the stream adjustments trend towards the design criteria and restoration goals based on reference morphology and vegetation communities. The eastern and western prongs are designed as Rosgen C5->E5 channels. During each monitoring year, where the channel slope and/or dimension are found to be unstable, structures such as rock cross vanes, log cross vanes, log vanes, log sills, and constructed riffles may be utilized to help maintain the channel compared to the reference morphology.

The riparian wetland and buffer vegetation community will transition and stabilize as the system seeks hydrologic equilibrium. The initial planting/seeding of the site was completed in March-April 2006 to establish herbaceous cover of exposed bare soils with the expectation that the initial growing season would allow for evapotranspiration to dewater lake bottom sediments. These sediments were initially unconsolidated and mucky with saturation. It was anticipated that settling and subsidence would occur throughout the initial growing season, first through evaporation and then through transpiration as the herbaceous cover (seeded and natural propagation) established. This has occurred as proposed. Areas that are not saturated/ponded (i.e. fringe areas and/or floodplain wetlands) were planted with bare root seedlings and containerized plants to establish a bottomland hardwood riparian wetland community. Additional plantings may occur as needed as the site continues to consolidate and settle.

In order to stabilize the newly constructed stream channel and flood plain areas both temporary and permanent grass seed as well as wetland herbaceous seed were applied to all restored areas. The types of seeds used were: *Leersia oryzoides* (Rice Cut grass); *Panicum clandestinum* (Deertongue grass); *Panicum virgatum* (Switchgrass): *Trisacum dactyloides* (Gama grass), and *Secale cereale* (Annual rye). Also, a Southeast Wildflower mix was applied throughout the project. Five hardwood planting zones were established as follows: Zone 1 – Stream Channel, Zone 2- Stream Bank, Zone 3 – Bottomland Hardwood wetland, Zone 4 – Swamp Wetland, and Zone 5- Upland fringe. Livestakes were installed along the newly constructed channel (approx. 175') within Zone 2. They were planted randomly spaced approximately 3 feet apart and differed in sizes ranging from .25" to 2" in diameter and 2' to 3' in length. Further livestaking may be necessary as the new stream channels stabilize. Zone 3 –5 consists of bareroot seedlings and 1 gallon containerized plants, which were planted randomly 3' to 12' apart throughout the project.

**Table I. Project Mitigation Structure and Objectives Table**

| Project Segment | Mitigation Type | Approach | Linear Footage or Acerage | Stationing | Comment |
|---|---|---|---|---|---|
| Stream W Prong | P | - | 341 | 10 + 00 - 14 + 00 | Western Prong as it enters the site |
| Stream W Prong | E1 | | 596 | 14 + 00 - 19 + 00 | Western Prong between Preservation Area and Restoration Area |
| Stream | R | P1 | 3465 | | Remainder of Site is Restoration (88%) |
| Wetland | R | - | 6.6 | | Project is 83% restoration |
| Wetland | E | - | 2.7 | | Stream Enhancement Area is bordered by Wetland Enhancement, Several other enhancement areas exist |

**Table II. Project Activity and Reporting History**

| Activity or Report | Calendar Year of Completion or Planned Completion | Actual Completion Date |
|---|---|---|
| Restoration Plan | October 2005 | March 2006 |
| Construction | October 2006 | March 2006 |
| Temporary /Permanent seeding | October 2006 | March 2006 |
| Bareroot Plantings | November 2006 | March 2006 |
| Containerized Plantings | November 2006 | June 2006 |
| Mitigation Plan | December 2006 | August 2006 |
| Year 1 Monitoring | December 2007 | October 2006 |
| Year 2 Monitoring | December 2008 | December 2007 |
| Year 3 Monitoring | December 2009 | November 2008 |
| Year 4 Monitoring | December 2010 | |
| Year 5 Monitoring | December 2011 | |

**Table III. Project Contacts**

| | |
|---|---|
| **Project Manager**<br>Mid-Atlantic Mitigation, LLC | 1960 Derita Road<br>Concord, NC 28027<br>Rich Mogensen (704) 782-4133 |
| **Designer**<br>Kimley-Horn and Associates Inc. | 4651 Charlotte Park Dr<br>Suite 300<br>Charlotte, NC 28217<br>Will Wilhelm (704) 333-5131 |
| **Construction Contractor**<br>Earthwork Inc. | 343 Chapman Drive<br>Sanford, NC 27330<br>Dan Wood (919) 718-6812 |
| **Planting & Seeding Contractor**<br>Carolina Silvics<br><br>Seed mixes provided by IKEX<br>Nursery Stock provided by Native Roots Nursery (Formerly Southern Shade) | 908 Indian Trail Road<br>Edenton, North Carolina 27932<br>Dwight McKinney (252) 482-8491 |
| **Monitoring Performers**<br>Mid-Atlantic Mitigation, LLC | 1960 Derita Road<br>Concord, North Carolina 28027<br>Christine Cook (704) 782-4140 |

**Table IV. Project Background**

| **Project Background Table** | |
|---|---|
| Project County | Cumberland |
| Drainage Area | 2.6 square miles |
| Drainage Cover Estimate (%) | 10% |
| Physiographic Region | Coastal Plain |
| Ecoregion | 45a Southern Inner Piedmont |
| Wetland Type | Palustrine, Forested, Broad-leaved Deciduous |
| Cowardin Classification | PFO1Fh |
| Dominant soil types | Johnston Loam |
| Reference site ID | UT to Cross Creek |
| USGS HUC for Project and Reference | 03030004 |
| NCDWQ Sub-basin for Project and Reference | 03-06-15 |
| % of project easement fenced | 0 – Urban site surrounded by private residence |

# 3.0 PROJECT CONDITION AND MONITORING RESULTS

## 3.1 VEGETATION ASSESSMENT

### 3.1.1 Soil Data

**Table V. Preliminary Soil Data**

| **Series** | **Max Depth (in)** | **% Clay on Surface** | **K** | **T** | **OM %** |
|---|---|---|---|---|---|
| Johnston Loam | 80 | 25 - 49 | .20 - .17 | 5 | 3 - 8 |

### 3.1.2 Vegetative Problem Areas

At this time, no vegetative problem areas have been noted or invasive species problems. The site has been stabilized and vegetated with native woody and herbaceous species.

### 3.1.3 Stem Counts

Zones 1 – 3 of the five planting zones were sampled in three 75 ft by 75 ft plots. The prevalent vegetation should consist of macrophytes that typically are adapted for life in saturated soil conditions. These species should have the ability to grow, compete, reproduce, and persist in anaerobic soil conditions. A reduction in the percentage of nuisance vegetation in wetlands areas with existing vegetation to less than 15% will indicate enhancement of wetland vegetation. For the restoration areas, study plots showing that the composition and density of vegetation in the restoration areas that compares closely to the reference areas will indicate restoration success for vegetation.

The initial success of riparian and wetland vegetation planting will be evaluated based on herbaceous cover as the site is stabilized in the initial growing season. After the year-two growing season, success will be gauged by stem counts of planted species and desirable volunteer species. Stem counts of over 320 trees per acre after 3 years, 288 trees per acre after 4 years, and 260 trees per acre after 5 year will be considered successful. Photos taken at established photo points should indicate maturation of riparian vegetation community.

On July 30th, 2008, the third year-vegetative monitoring was performed on the established vegetative plots.

**Exhibit Table VI: Stem Counts for Each Species Arranged by Plot**

| Species | Plots 1 | 2 | 3 | Initial Totals | Year 1 Totals | Year 2 Totals | 2008 Initial | Year 3 Totals | Survival % |
|---|---|---|---|---|---|---|---|---|---|
| *Betula nigra* | 4 | 12 | | 18 | 18 | 15 | 18 | 16 | 89% |
| *Chamaecyparis thyoides* | | | | 8 | 2 | | 8 | | 0% |
| *Cornus ammomum* | | 2 | 1 | 10 | 9 | 2 | 10 | 3 | 30% |
| *Fraxinus pennsylvanica* | 20 | | 14 | 35 | 35 | 43 | 35 | 34 | 97% |
| *Liriodendron tulipifera* | | | | 1 | | | 1 | | 0% |
| *Magnolia virginiana* | | 3 | | | | | 3 | 3 | 100% |
| *Nyssa aquatica* | 5 | 1 | | 6 | 6 | 8 | 6 | 6 | 100% |
| *Nyssa biflora* | 5 | | | 8 | 8 | 6 | 8 | 5 | 63% |
| *Nyssa slyvantica* | 5 | 4 | 1 | 10 | 10 | 10 | 10 | 10 | 100% |
| *Quercus bicolor* | | 3 | | | | | 3 | 3 | 100% |
| *Quercus nigra* | | | | 2 | | | 2 | | 0% |
| *Quercus phellos* | | | 1 | 1 | 1 | 1 | 1 | 1 | 100% |
| *Quercus shumardii* | | | | 1 | 1 | | 1 | | |
| *Taxodium distichium* | 7 | 10 | 8 | 25 | 21 | 24 | 25 | 25 | 100% |
| **Totals** | **46** | **35** | **25** | **125** | **111** | **109** | **131** | **106** | 85% |

| **Table VII. Stems Per Acre** | **SPA** | **SPA w/ volunteers** |
|---|---|---|
| Plot 1 | 356 | 441 |
| Plot 2 | 271 | 332 |
| Plot 3 | 194 | 309 |
| **Total** | 274 | 361 |

### 3.1.4 Vegetation Assessment Summary

Vegetation success will be defined as tree survival to meet 320 stems per acre after 3 years and 260 stems per acre after 5 years inside the permanent vegetative plots and herbaceous cover evaluated with photos showing 75% coverage, after 5 years.

Survival of many species is 100% after 3 years with additional volunteers of many desirable species. Volunteer species include *Alnus serrulata, Cephalanthus occidentalis, Platanus occidentalis, and Salix nigra,* none of these species were planted because of the large available seed source and excellent growing conditions of the site. Volunters of planted species include *Betula nigra* and *Fraxinus pennsylvanica*. A large colony of Alders still exists in Plot 3, this dense community is typical of Alders and will be managed and thinned to a manageable number of individuals, approximately 10 to 15. On March 24th, 2008 a small replant, as requested by EEP after the 2007 monitoring report, was done. 55 *Magnolia virginiana*, 45 *Quercus bicolor*, and 35 *Taxodium distichum*, for a total of 135 plants were installed in the areas around and between Plots 2 and 3. Based on sampling, the site as a whole shows an average of 274 stems per acre of planted stems and 361 stems per acre when healthy, desirable volunteers are included, only 10 Alder individuals in plot 3 were used in this calculation. The site demonstrates 85 percent survival of planted stems. The community is diverse and rich with healthy volunteers. Using the adaptive management approach for this site; the contribution of healthy, desirable volunteers will be considered before any decisions are made on additional plantings. This site was not over planted during initial planting as would typically be done due to a predicted high rate of colonization of desirable volunteer species. While the planted stem count is still below the 3 year goal of 320 stems the contribution of desirable volunteers is significant and places the stems per acre calculation well above the 320 goal. The high survival of volunteers species and individuals indicates that the adaptive management approach is working.

In Appendix A, the vegetative survey data tables show the actual counts of each species found per plot. The herbaceous cover plant community was monitored in a 1 m by 1 m square at one corner of each plot. Herbaceous cover for the site is at or close to 100%.

## 3.2 CHANNEL STABILITY ASSESSMENT

### 3.2.1 Cross Sections

The site as a whole has shown no significant change since as-built documents were submitted. The Cross Section plots are located in Appendix B. The small problem area where there was minor settling occurring on the left bank of the run between Cross Sections 1 and 2 appears to be stabilizing. Vegetation has finally gotten a foothold in this area. Cross Section 2 was built as a constructed riffle using stone debris from the removal of the dam. The stream bank sub-surfaces and stream bed were formed with some stone debris. The banks were graded to the typical designed cross sections. The

stream bed is made of stone to stabilize the riffle and to increase bed form diversity/ habitat of the riffle for this section as well as acting as grade control. The stream channels at Cross Sections 3 through 10 are less defined then Cross Sections 1 and 2. MAM and KHA tried to select deep still areas for pools and chose shallower areas of swift running water for the riffle cross sections. Observations for each Cross Section follow.

Cross Section 1 – No significant changes, Thalweg right of center.
Cross Section 2 – There may be some scouring present along the left bank and a small sand bar may be developing, thalweg right of center.
Cross Section 3 – Channel appears to be narrowing, thalweg right of center.
Cross Section 4 – Channel has deepened slightly, thalweg left of center.
Cross Section 5 – Channel shows narrowing and deepening trend, thalweg left of center.
Cross Section 6 - Channel has deepened slightly, thalweg right of center.
Cross Section 7 - Channel has deepened slightly, thalweg left of center.
Cross Section 8 – Deposition appears to have occurred in this pool along left bank, thalweg right of center.
Cross Section 9 – Channel shows deepening and widening trend, thalweg left of center, scouring may be present along right bank.
Cross Section 10 – Channel indicates a potential right bank failure may have sloughed into the channel, thalweg left of center.

### 3.2.2 Bank Full Events

The Crest Stage Gage (CSG) located at the southern end of the site below the confluence of the East and West Prongs was reset and indicated bankfull conditions on January 24th, 2008 and July 29th, 2008. In order for the CSG to indicate bankfull conditions the stream gage north of the site in the reference area must register a peak of approximately 24 inches or higher and rainfall onsite as recorded by the raingage near the CSG must be significant (exceeding one inch combined) for two consecutive days. The most likely event preceding the January reading was December 15 and 16, 2007 and for the July reading, June 14 and 15, 2008. Rainfall amounts and stream gage peaks are shown in the table below. On November 20th at the time of the 2008 monitoring survey work the CSG was inspected and the cork was found to be waterlogged without a clear bankfull indicator line, however indicating a bankfull event and qualifying storm event occurred on November 14th and 15th as shown below.

Table VII. Potential Bankfull Events

| Date | Stream Gage | Onsite Rainfall | Comments |
|---|---|---|---|
| 12/15/2007 | 16.21 | 0.98 | |
| 12/16/2007 | 23.92 | 0.42 | Most likely bank full event CSG |
| 2/18/2008 | 22.46 | 1.33 | |
| 3/7/2008 | 24.62 | 0.87 | |
| 3/15/2008 | 31.45 | 1.08 | |
| 4/5/2008 | 23.29 | 1.78 | |
| 6/14/2008 | 18.95 | 0.7 | |
| 6/15/2008 | 24.08 | 0.76 | Most likely bank full event CSG |
| 7/8/2008 | 29.24 | 0.03 | |
| 7/9/2008 | 21.23 | 0.02 | |
| 7/10/2008 | 24.86 | 0.01 | Rainfall offsite, upstream |
| 8/27/2008 | 35.23 | 0 | Rainfall offsite, upstream |
| 9/6/2008 | 36.83 | 0 | Rainfall offsite, upstream |
| 11/14/2008 | 20.93 | 0.86 | |
| 11/15/2008 | 27.73 | 0.56 | Most likely bank full event CSG |

### 3.2.3 Longitudinal Profiles

There is currently only one constructed riffle on the project, which is located at the site of the original dam and corresponds with Cross Section 2. This riffle was constructed with large cobbles and small boulders found on site. A pebble count was done in 2006 which demonstrates the substantial size of the bed material, and has not been repeated. There is currently no smaller bed material present and only a small representative sample was taken in 2006. The site has shown no significant change since as-built documents were submitted. Profiles of the Eastern and Western Prongs show similar trends. Several obvious pools (profile graphs in Appendix C) have formed and many continue to deepen particularly on the upper portion of the Eastern Prong. Riffle areas appear to be becoming more defined with longer stretches of similar elevation followed by pools or series of pools. The current stream morphology is common and typically stable in low-gradient coastal plain systems.

### 3.2.4 Wetland Assessment

Seven ground water gages are distributed around the project along with one reference gage off site, but not far upstream on the Western Prong. Graphs showing the 2008 data have been prepared and are included in Appendix E. Gage CEC10 showed borderline hydrology and was the only gage on site not to indicate unquestionable jurisdictional hydrology. Gage CEC10 is the northern most gage on the Eastern Prong. Last year, 2007, Gage CC2 showed similar borderline hydrology, but this year easily satisfied wetland requirements. The average growing season for Cumberland County and the Fayetteville area is 213 days between March and October. Therefore, ten percent of the growing season is approximately 21 days. The site as a whole did not seem to be overly affected by drought conditions experienced in this part of the state.

Table IX. Success Criteria Attainment

| Well ID | Well Hydrology Threshold Met? | Mean | Vegetation Plot ID | Vegetation Survival Threshold Met? | Mean |
|---|---|---|---|---|---|
| CC2 | Y | 86% | Plot 1 | Y | 33%<br>100% w/ vols |
| CC3 | Y | | Plot 2 | N (Y w/ vols) | |
| CEC6 | Y | | Plot 3 | N (Y w/ vols) | |
| CE2 | Y | | | | |
| CE5 | Y | | | | |
| CEC10 | N | | | | |
| Tarlton 4 | Y | | | | |
| | | | | | |
| CC6 | Y | | | | |

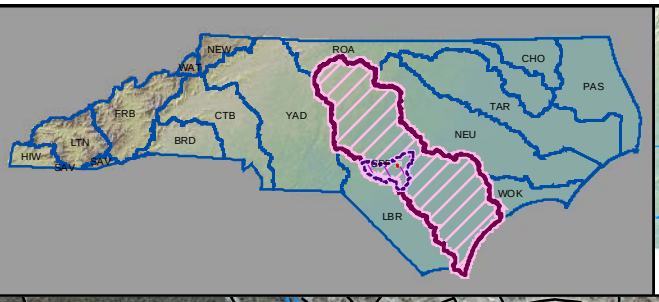
Table X. Wetland Criteria Attainment

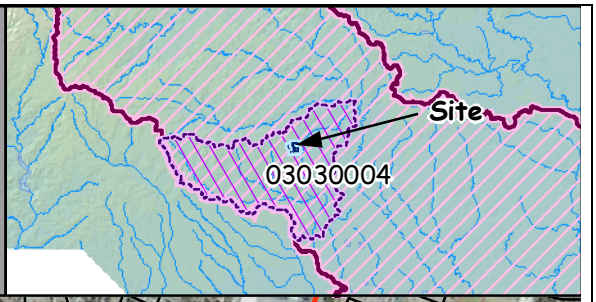
| Well ID | Well Hydrology Threshold Met? | Total days w/ Jurisdictional Hydrology | Percent of Growing Season w/ Jurisdictional Hydrology |
|---|---|---|---|
| CC2 | Y | 31 | 14% |
| CC3 | Y | 70 | 32% |
| CEC6 | Y | 39 | 18% |
| CE2 | Y | 70 | 32% |
| CE5 | Y | 360 | 100% |
| CEC10 | | 10 | 5% |
| Tarlton 4 | Y | 53 | 24% |
| | | | |
| CC6 | Y | 360 | 100% |
| | | | |

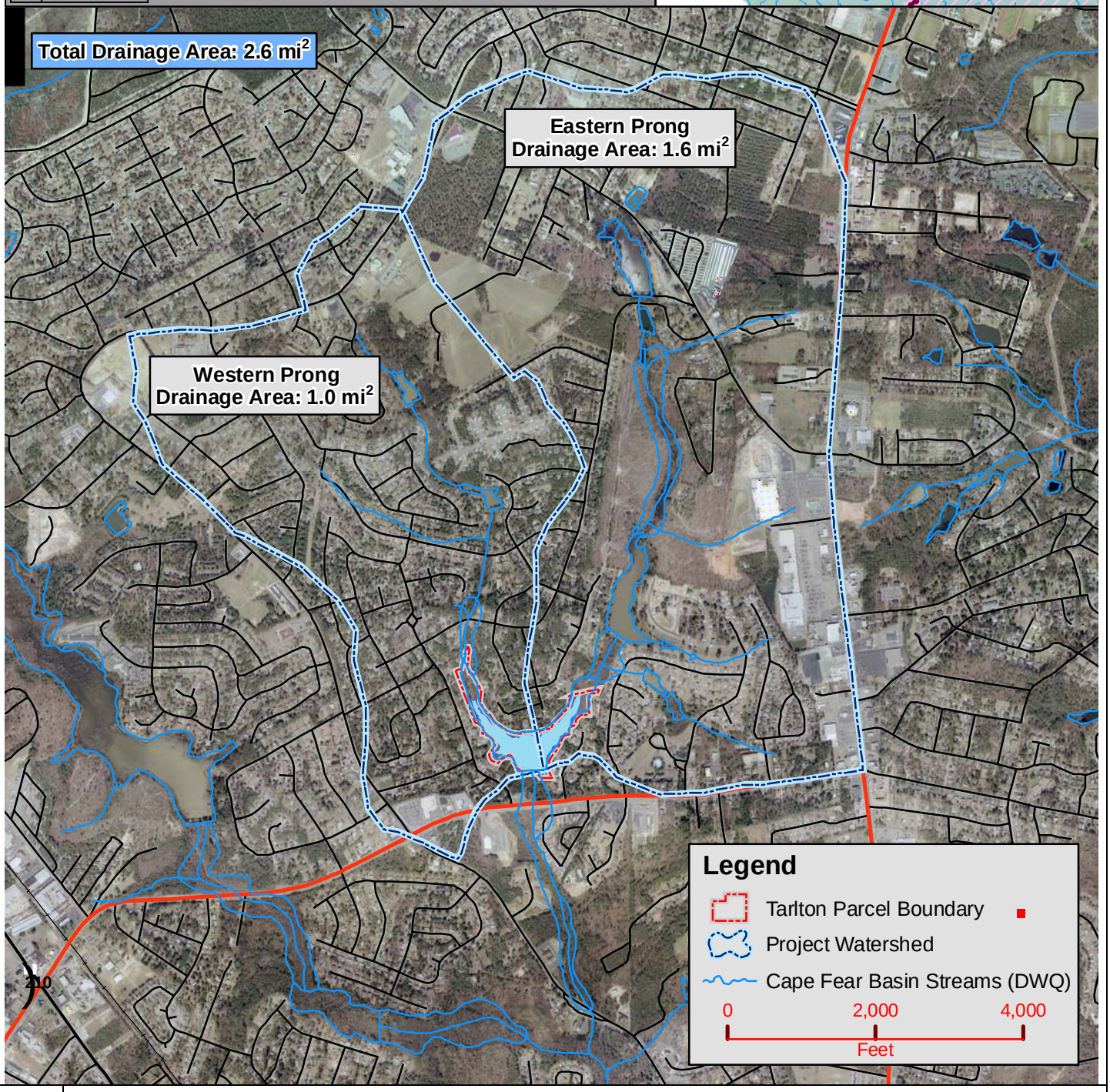
### 3.2.5 Site Stability Assessment Summary

Overall, the stream channel has developed and stabilized well. The herbaceous vegetative cover has also developed a healthy and diverse community. The planted trees and shrubs have also done very well and are supplemented by a robust existing buffer community which provides seed source for volunteers well suited to the current site conditions. Ground water wells demonstrate favorable trends and jurisdictional wetland hydrology. A small beaver dam was removed in November. Beaver activity on site seems to pick up in the fall each year. A beaver contractor is actively monitoring the site on a quarterly basis.

| | |
|---|---|
| NEW | NEW |
| PAS | PASQUOTANK |
| YAD | YADKIN |
| CHO | CHOWAN |
| ROA | ROANOKE |
| TAR | TAR-PAMLICO |
| NEU | NEUSE |
| WAT | WATAUGA |
| CPF | CAPE FEAR |
| FRB | FRENCH BROAD |
| CTB | CATAWBA |
| LTN | LITTLE TENNESSEE |
| BRD | BROAD |
| HIW | HIWASSEE |
| LBR | LUMBER |
| SAV | SAVANNAH |
| WOK | WHITE OAK |




| | |
|---|---|
| **Title** | Project Site Watershed Map (Cumberland County 2001 Aerial) |

| | | | |
|---|---|---|---|
| Prepared For:<br>Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration<br>Cumberland County, North Carolina | |
| | **Date** | **Project Number** | **Figure** |
| | 11/28/07 | 012857003 | 1 |

CU: 03030004

35.10975 N
-78.89638 W

REFERENCE STREAM AND WETLAND GAGES

CONSERVATION EASEMENT BOUNDARY

CE2

35.10808 N
-78.89136 W

CEC10

CEC6

CC3

ORIGINAL POND BOUNDARY

35.10555 N
-78.89530 W

TARLTON4

CE5

RIVERBEND ROAD

PERMANENT ACCESS

REMNANT DOCK EASEMENT ENCROACHMENT (REMOVED IN PHASE I)

35.10489 N
-78.89292 W

CC2

PHASE I ACTIVE PRIORITY I RESTORATION (COMPLETED FALL 2005)

CC6
REFERENCE WETLAND GAGE

CEC4
REFERENCE STREAM GAGE

WESTERN PRONG

## SITE LEGEND

- MAJOR CONTOUR
- MINOR CONTOUR
- PROPERTY BOUNDARY
- WETLAND ENHANCEMENT
- WETLAND RESTORATION
- STREAM RESTORATION
- STREAM ENHANCEMENT
- STREAM PRESERVATION
- PERMANENT RIFFLE CROSS SECTION
- PERMANENT POOL CROSS SECTION
- VEGETATION MONITORING QUAD
- MONITORING GAGE
- STORM WATER OUTFALL
- 20 PHOTOGRAPH LOCATIONS

GRAPHIC SCALE

200 0 100 200 400 800

( IN FEET )
1 inch = 200 ft.

| REV. No.: | REVISION: | DATE: | DRAWN BY: | CHECKED BY: |
|---|---|---|---|---|



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P.O. BOX 33068 – RALEIGH, NORTH CAROLINA 27636-3068
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CLIENT: MID-ATLANTIC MITIGATION

TITLE: MONITORING PLAN MAP

SEAL:

DATE: 02/02/07
HORIZONTAL SCALE: 1": 200'
VERTICAL SCALE: 1": 200'
DRAWN BY: JCD
DESIGNED BY: JCD
CHECKED BY: WRW

PROJECT: TARLTON STREAM AND WETLAND RESTORATION
CUMBERLAND COUNTY

ATTACHED REFERENCE FILES:
S.C.O. NUMBER: D05013-1
FIGURE NUMBER: 2

# APPENDIX A. Vegetation Raw Data

| Exhibit Table VI: Stem Counts for Each Species Arranged by Plot | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | Plots 1 | 2 | 3 | Initial Totals | Year 1 Totals | Year 2 Totals | 2008 Initial | Year 3 Totals | Survival % |
| *Betula nigra* | 4 | 12 | | 18 | 18 | 15 | 18 | 16 | 89% |
| *Chamaecyparis thyoides* | | | | 8 | 2 | | 8 | | 0% |
| *Cornus ammomum* | | 2 | 1 | 10 | 9 | 2 | 10 | 3 | 30% |
| *Fraxinus pennsylvanica* | 20 | | 14 | 35 | 35 | 43 | 35 | 34 | 97% |
| *Liriodendron tulipifera* | | | | 1 | | | 1 | | 0% |
| *Magnolia virginiana* | | 3 | | | | | 3 | 3 | 100% |
| *Nyssa aquatica* | 5 | 1 | | 6 | 6 | 8 | 6 | 6 | 100% |
| *Nyssa biflora* | 5 | | | 8 | 8 | 6 | 8 | 5 | 63% |
| *Nyssa slyvantica* | 5 | 4 | 1 | 10 | 10 | 10 | 10 | 10 | 100% |
| *Quercus bicolor* | | 3 | | | | | 3 | 3 | 100% |
| *Quercus nigra* | | | | 2 | | | 2 | | 0% |
| *Quercus phellos* | | | 1 | 1 | 1 | 1 | 1 | 1 | 100% |
| *Quercus shumardii* | | | | 1 | 1 | | 1 | | |
| *Taxodium distichium* | 7 | 10 | 8 | 25 | 21 | 24 | 25 | 25 | 100% |
| **Totals** | **46** | **35** | **25** | **125** | **111** | **109** | **131** | **106** | 85% |

**Stems per Acre**

106 / 16875 = 274 / 43560

| | | | |
|---|---|---|---|
| Plot 1 | 46 | 356 | spa |
| Plot 2 | 35 | 271 | spa |
| Plot 3 | 25 | 194 | spa |
| | 106 | 821 | |
| | | 3 | = 274 |

**Stems per Acre w/ Voluteers**

| | | | |
|---|---|---|---|
| Plot 1 | 57 | 441 | spa |
| Plot 2 | 43 | 332 | spa |
| Plot 3 | 40 | 309 | spa |
| | 140 | 1082 | |
| | | 3 | = 361 |

| Table VII. Stems Per Acre | SPA | SPA w/ volunteers |
|---|---|---|
| Plot 1 | 356 | 441 |
| Plot 2 | 271 | 332 |
| Plot 3 | 194 | 309 |
| **Total** | 274 | 361 |

| Tarlton- Vegetation plot #1 | | | | | |
|---|---|---|---|---|---|
| | Number of Planted Species/Number of Volunteers | | | | |
| **Trees/ Shrubs** | **2006** | **2007** | **2008** | **2009** | **2010** |
| ***Alnus serrulata*** | /3 | /1 | /2 | | |
| ***Betula nigra*** | 5 | 3 | 4 | | |
| ***Cephalanthus occidentalis*** | /1 | | | | |
| ***Chamaecyparis thyoides*** | 1 | | | | |
| ***Cornus amomum*** | 4 | | | | |
| ***Fraxinus pennsylvanica*** | 20 | 27 | 20/9 | | |
| ***Liriodendron tulipifera*** | | | | | |
| ***Nyssa aquatica*** | 5 | 5 | 5 | | |
| ***Nyssa biflora*** | 6 | 6 | 5 | | |
| ***Nyssa slyvantica*** | 5 | 5 | 5 | | |
| ***Quercus falcata var. pagodafolia*** | | | | | |
| ***Quercus michauxii*** | | | | | |
| ***Quercus nigra*** | | | | | |
| ***Quercus phellos*** | | | | | |
| ***Quercus shumardii*** | | | | | |
| ***Taxodium distichium*** | 7 | 8 | 7 | | |
| **Total Planted** | **53** | **54** | **46** | | |
| **Voluteers** | **4** | **1** | **11** | | |

100 % Volunteers

Plot Size: 5625 ft²

| Herbacous Vegetation | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| **Juncus spp.** | Dominant | Dominant | Dominant | | |
| ***Polygonum* spp. *(tearthumb)*** | Sub dominant | | | | |
| ***Eupatorium capillifolium*** | Common | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| Stems/plot | = | Stems/ac |
|---|---|---|
| Sq ft/plot | | Sq ft/acre |
| 46 | | 356 |
| 5625 | | 43560 |
| 57 | | 441.408 |
| 5625 | | 43560 |

| Tarlton- Vegetation plot # 2 | | | | | |
|---|---|---|---|---|---|
| **Trees/ Shrubs** | **Number of Species planted/Number of Volunteers** | | | | |
| | **2006** | **2007** | **2008** | **2009** | **2010** |
| ***Alnus serrulata*** | | | | | |
| ***Betula nigra*** | 12 | 12/4 | 12/6 | | |
| ***Cephalanthus occidentalis*** | /2 | | | | |
| ***Chamaecyparis thyoides*** | 1 | | | | |
| ***Cornus amomum*** | 1 | 1/2 | 2 | | |
| ***Fraxinus pennsylvanica*** | 1 | | | | |
| ***Liriodendron tulipifera*** | | | | | |
| ***Magnolia virginiana*** | | | 3 | | |
| ***Nyssa aquatica*** | 1 | 1/2 | 1/1 | | |
| ***Nyssa biflora*** | | | | | |
| ***Nyssa slyvantica*** | 4 | 4 | 4/1 | | |
| ***Platanus occidentalis*** | | | | | |
| ***Quercus bicolor*** | | | 3 | | |
| ***Quercus falcata var. pagodafolia*** | | | | | |
| ***Quercus michauxii*** | | | | | |
| ***Quercus nigra*** | | | | | |
| ***Quercus phellos*** | | | | | |
| ***Quercus shumardii*** | | | | | |
| ***Salix nigra*** | | | | | |
| ***Taxodium distichium*** | 8 | 10 | 10 | | |
| **Total Planted** | **28** | **29** | **35** | | |
| **Volunteers** | **2** | **7** | **8** | | |

100 % Volunteers

Plot Size: 5625 ft²

| **Herbacous Vegetation** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|
| ***Eupatorium capillifolium*** | Sparse | | | | |
| ***Juncus* spp.** | Dominant | | Dominant | | |
| ***panicum clandestinum*** | Common | | | | |
| ***polygonum pensylvanicum*** | Dominant | | | | |
| ***polygonum spp. (smartweed)*** | Common | Common | Common | | |
| ***Polygonum* spp. *(tearthumb)*** | Common | Common | Common | | |
| **sedge sp.** | Sparse | | | | |

| Stems/plot | = | Stems/ac |
|---|---|---|
| Sq ft/plot | | Sq ft/acre |
| 35 | | 271 |
| 5625 | | 43560 |
| 43 | | 332.992 |
| 5625 | | 43560 |

| Tarlton- Vegetation plot # 3 | | | | | | |
|---|---|---|---|---|---|---|
| **Trees/ Shrubs** | **Number of Species planted/Number of Volunteers** | | | | | |
| | **2006** | **2007** | **2008** | **2009** | **2010** | |
| ***Alnus serrulata*** | /5 | /5 | /10 | | | 100 % Volunteers |
| ***Betula nigra*** | 1 | | | | | |
| ***Cephalanthus occidentalis*** | | /1 | /1 | | | 100 % Volunteers |
| ***Chamaecyparis thyoides*** | | | | | | |
| ***Cornus amomum*** | 4 | 1 | 1 | | | |
| ***Fraxinus pennsylvanica*** | 14- (2 Stressed) | 16 | 14 | | | |
| ***Liriodendron tulipifera*** | | | | | | |
| ***Nyssa aquatica*** | | | | | | |
| ***Nyssa biflora*** | 2 | | | | | |
| ***Nyssa slyvantica*** | 1 | 1 | 1 | | | |
| ***Platanus occidentalis*** | | /1 | /1 | | | 100 % Volunteers |
| ***Quercus falcata var. pagodafolia*** | | | | | | |
| ***Quercus michauxii*** | | | | | | |
| ***Quercus nigra*** | | | | | | |
| ***Quercus phellos*** | 1 | 1 | 1 | | | |
| ***Quercus shumardii*** | 1 | | | | | |
| ***Salix nigra*** | /1 | /1 | /3 | | | 100 % Volunteers |
| ***Taxodium distichium*** | 6 | 6 | 8 | | | |
| **Total Planted** | **30** | **25** | **25** | | | |
| **Volunteers** | **6** | **8** | **15** | | | |

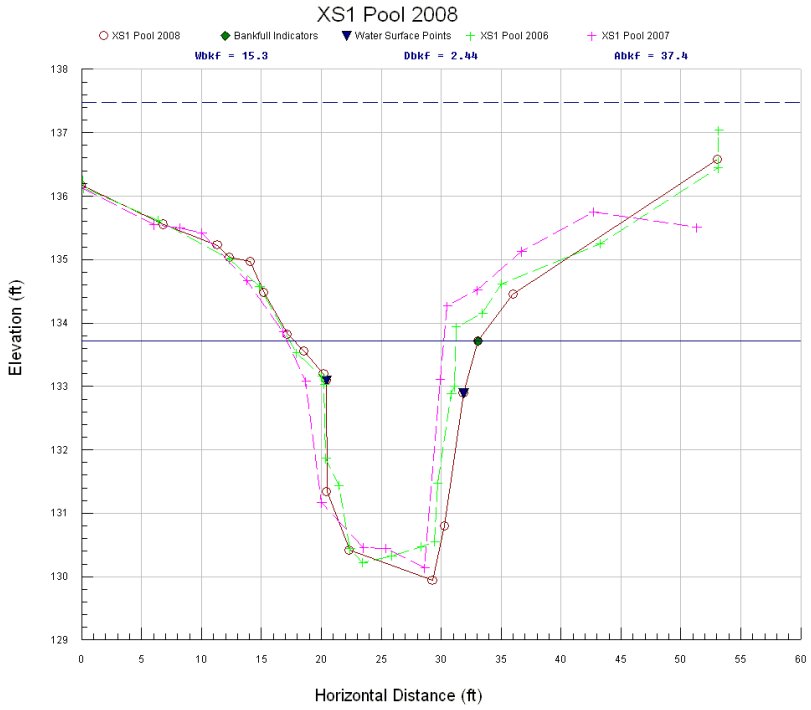
Plot Size: 5625 ft²

| **Herbacous Vegetation** | **2006** | **2007** | **2008** | **2009** | **2010** |
|---|---|---|---|---|---|
| ***Eupatorium capillifolium*** | Dominant | | | | |
| ***Juncus spp.*** | Dominant | Dominant | Dominant | | |
| ***Lycopus virginicus*** | Sparse | | | | |
| ***Mikania scandens*** | Sparse | | | | |
| ***Polygonum spp. (tearthumb)*** | Dominant | Dominant | Dominant | | |
| **unidentified** | Sparse | | | | |
| | | | | | |

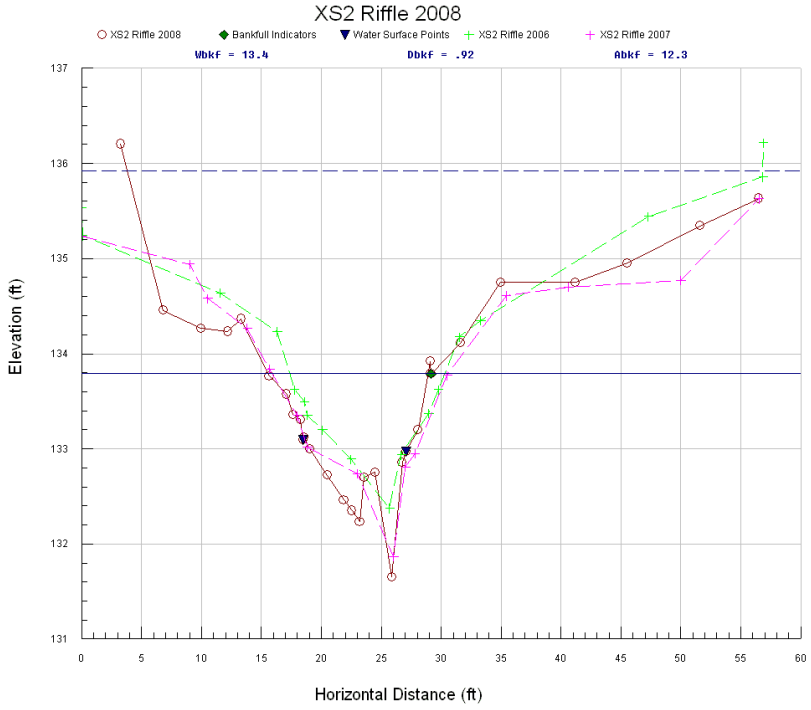
| Stems/plot | = | Stems/ac |
|---|---|---|
| Sq ft/plot | | Sq ft/acre |
| 25 | | 194 |
| 5625 | | 43560 |
| 40 | | 309.76 |
| 5625 | | 43560 |

REPLANT - 30 stems River Birch?

# APPENDIX B. Cross Sections

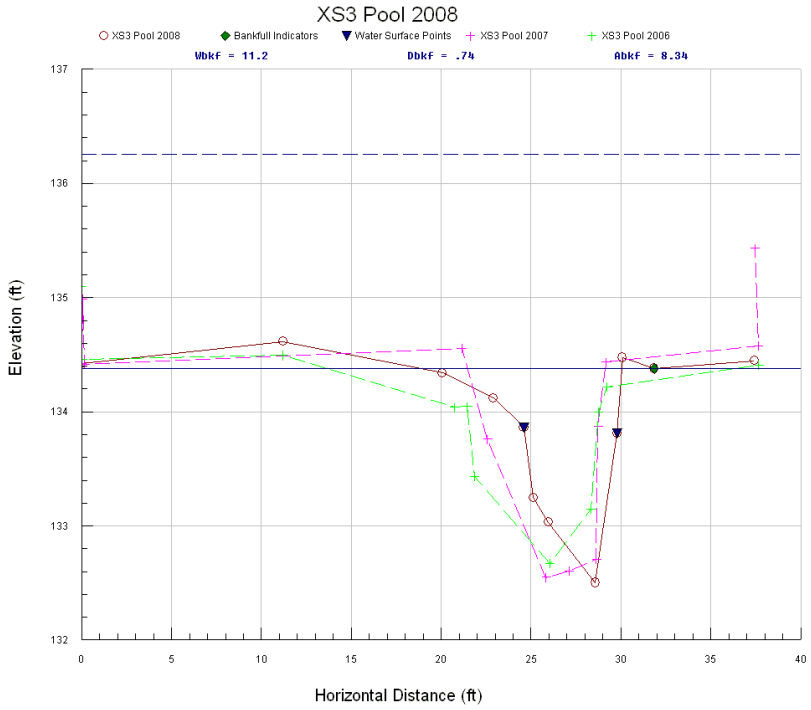



Graph 1: Cross Section 1 Pool

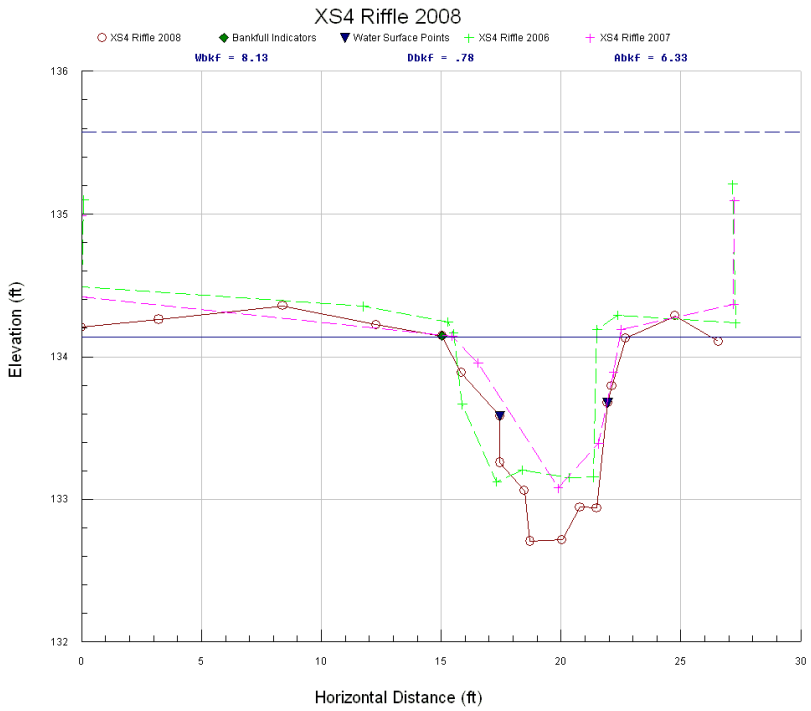



Graph 2: Cross Section 2 Riffle

| | | | |
|---|---|---|---|
| **Title** | Cross Section Survey Graphs | | |
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration Project<br>Cumberland County, North Carolina | |
| | **Date**<br>12/9/08 | **Project Number**<br>018285006 | **Figure**<br>4 |

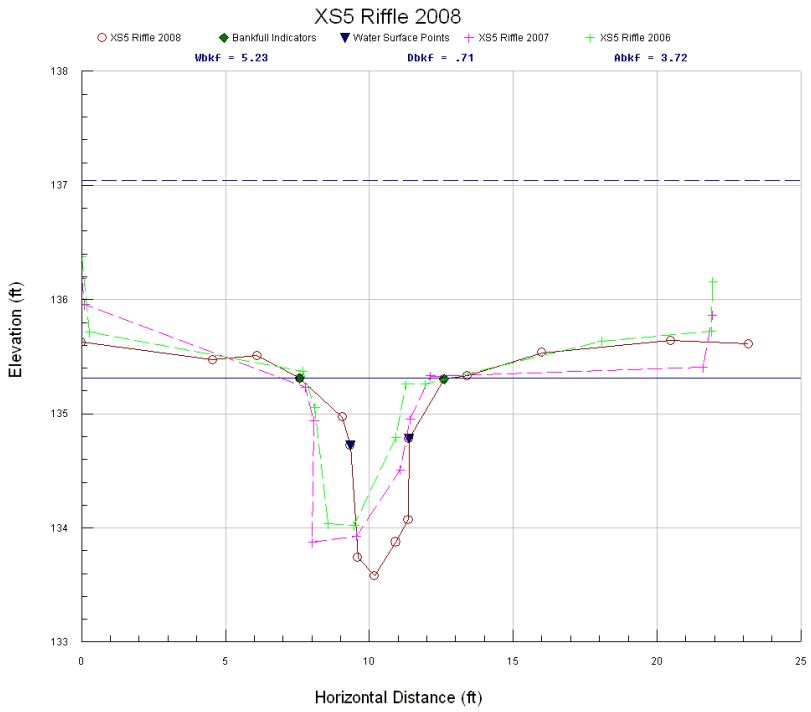



Graph 3: Cross Section 3 Pool

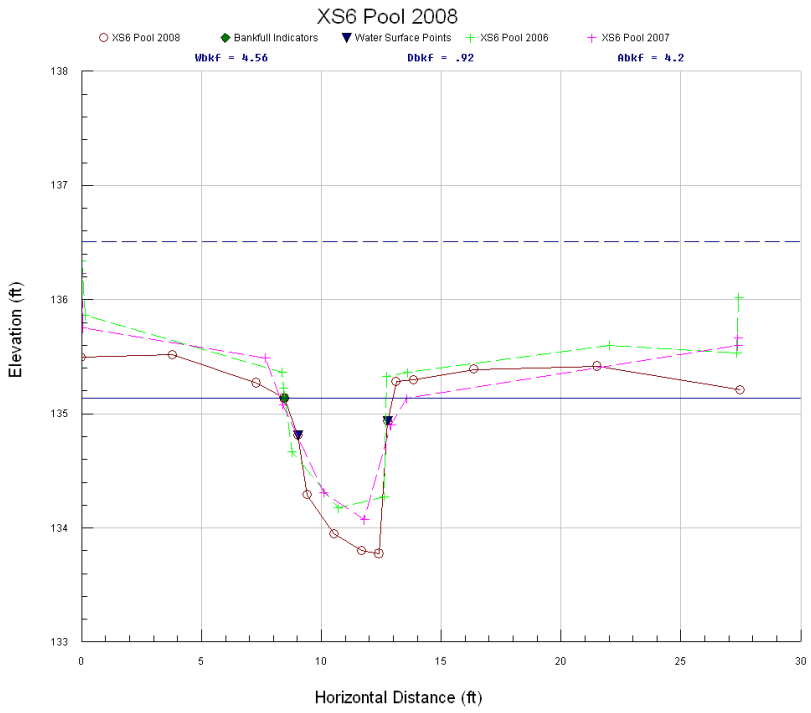



Graph 4: Cross Section 4 Riffle

| | | | |
|---|---|---|---|
| **Title** | Cross Section Survey Graphs | | |
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration Project<br>Cumberland County, North Carolina | |
| | **Date**<br>12/9/08 | **Project Number**<br>018285006 | **Figure**<br>4a |



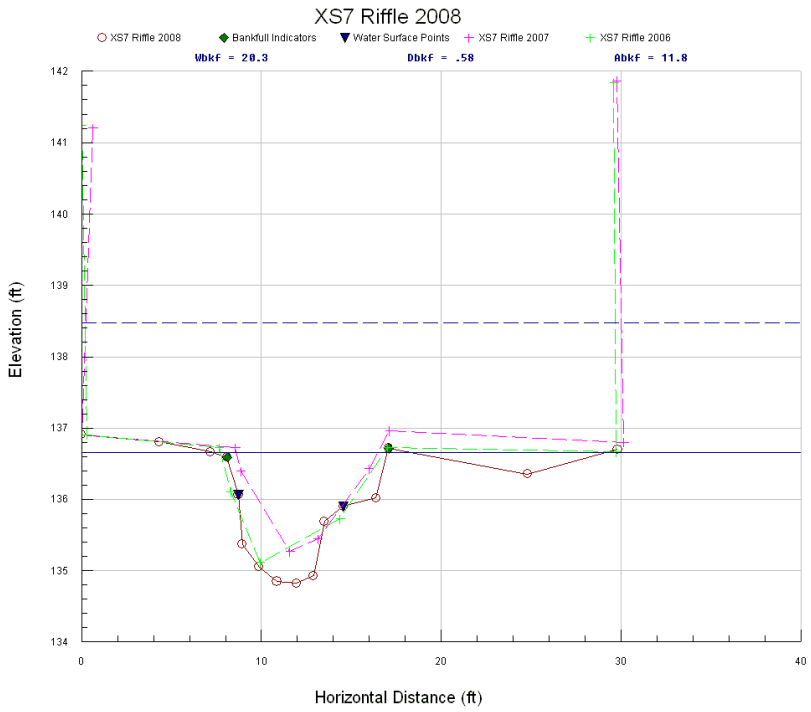

Graph 5: Cross Section 5 Riffle



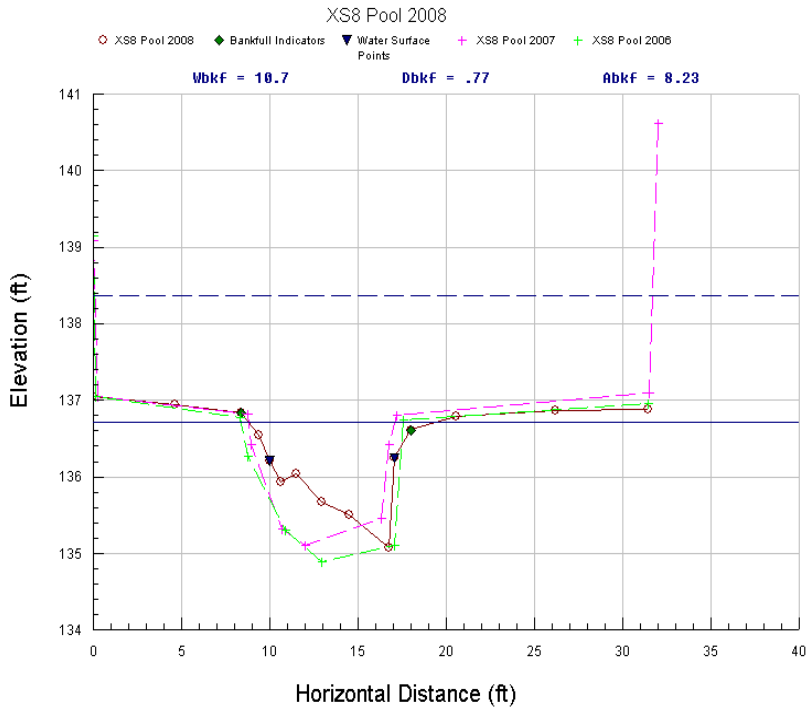

Graph 6: Cross Section 6 Pool

| | |
|---|---|
| **Title** | Cross Section Survey Graphs |

| | | | |
|---|---|---|---|
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration Project<br>Cumberland County, North Carolina | |
| | **Date**<br>12/9/08 | **Project Number**<br>018285006 | **Figure**<br>4b |

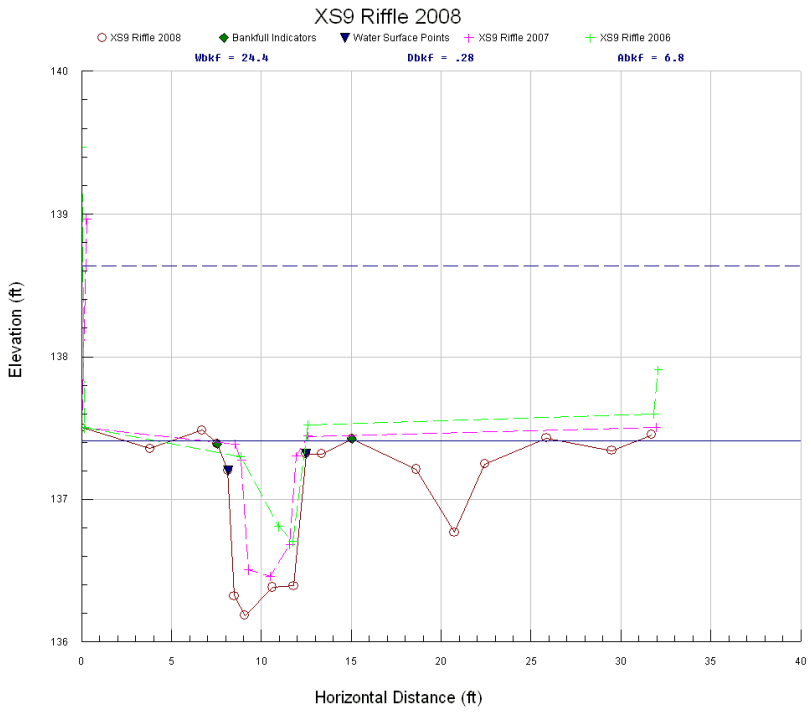



Graph 7: Cross Section 7 Riffle

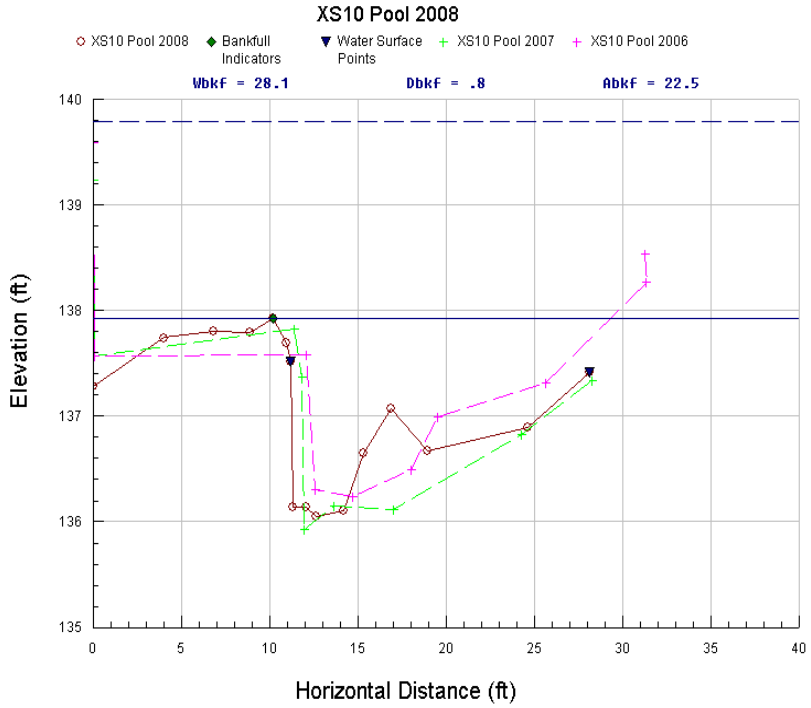



Graph 8: Cross Section 8 Pool

| | | | |
|---|---|---|---|
| **Title** | Cross Section Survey Graphs | | |
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration Project<br>Cumberland County, North Carolina | |
| | **Date**<br>12/9/08 | **Project Number**<br>018285006 | **Figure**<br>4c |




Graph 9: Cross Section 9 Riffle

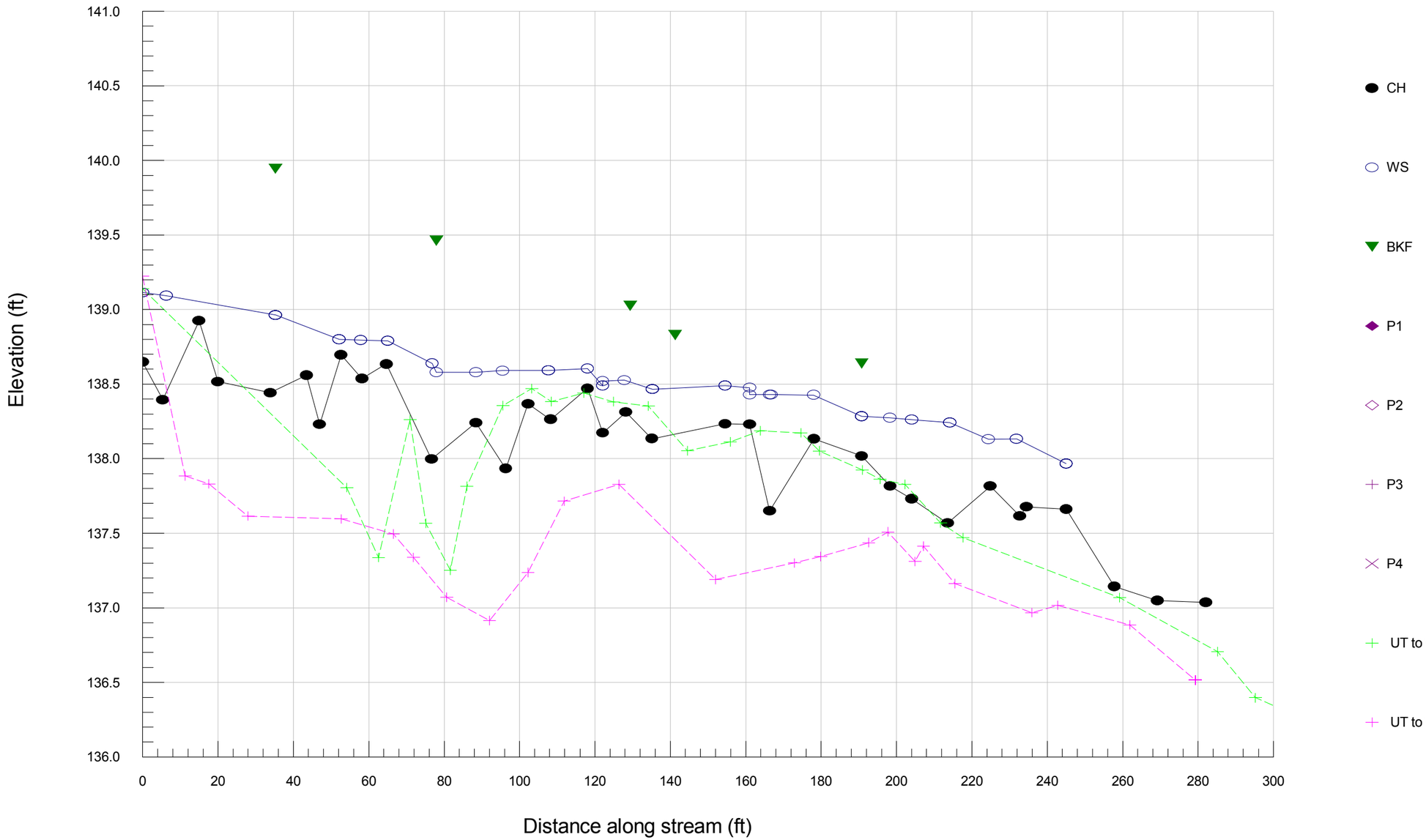



Graph 10: Cross Section 10 Pool

| | | | |
|---|---|---|---|
| **Title** | Cross Section Survey Graphs | | |
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration Project<br>Cumberland County, North Carolina | |
| | **Date**<br>12/9/08 | **Project Number**<br>018285006 | **Figure**<br>4d |

# APPENDIX C. Profile Survey

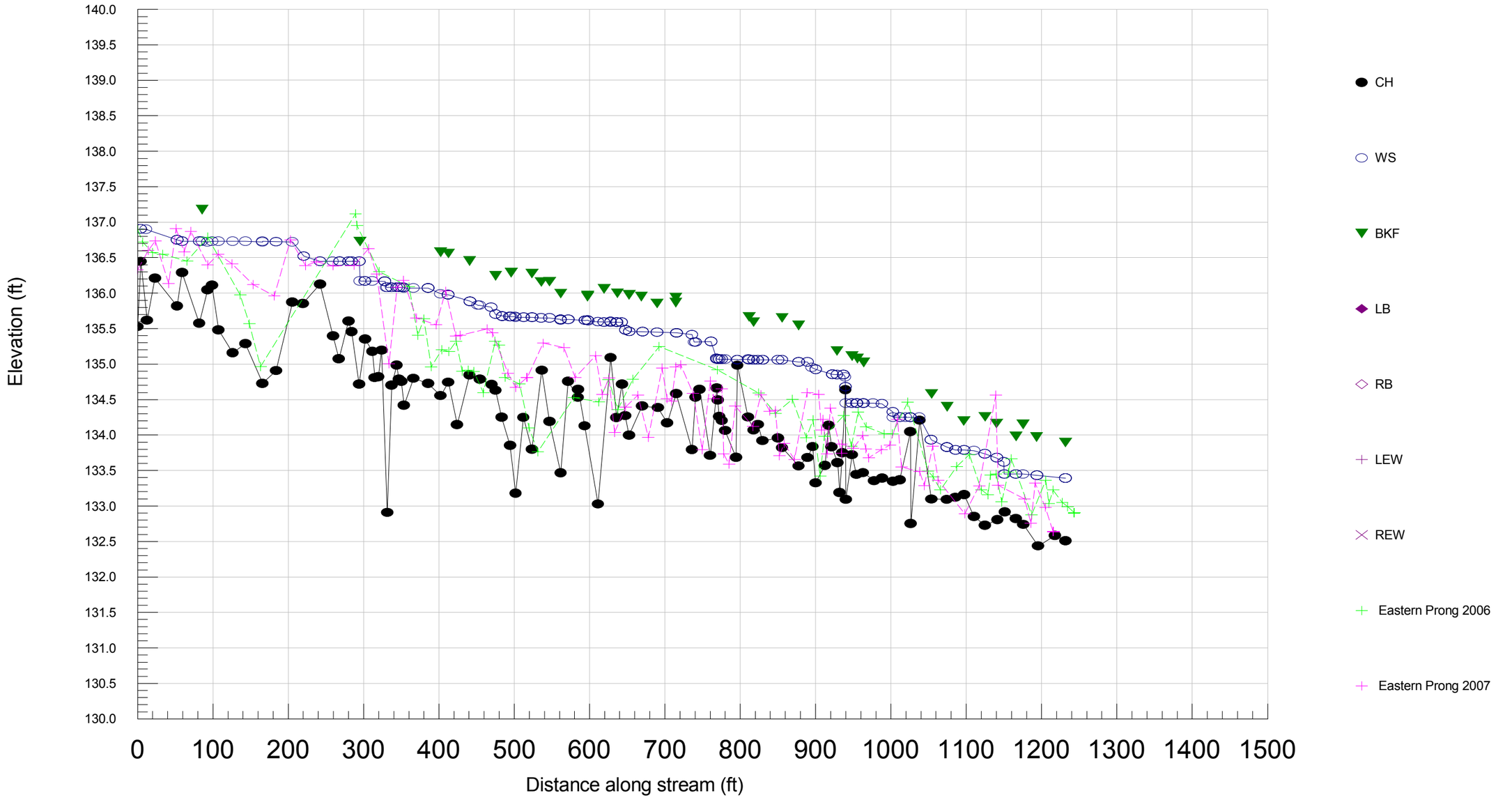
# UT to Western Prong 2008




| | |
|---|---|
| **Title** | Survey Profile Graphs |
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project**: Tarlton Stream and Wetland Restoration Project, Cumberland County, North Carolina |

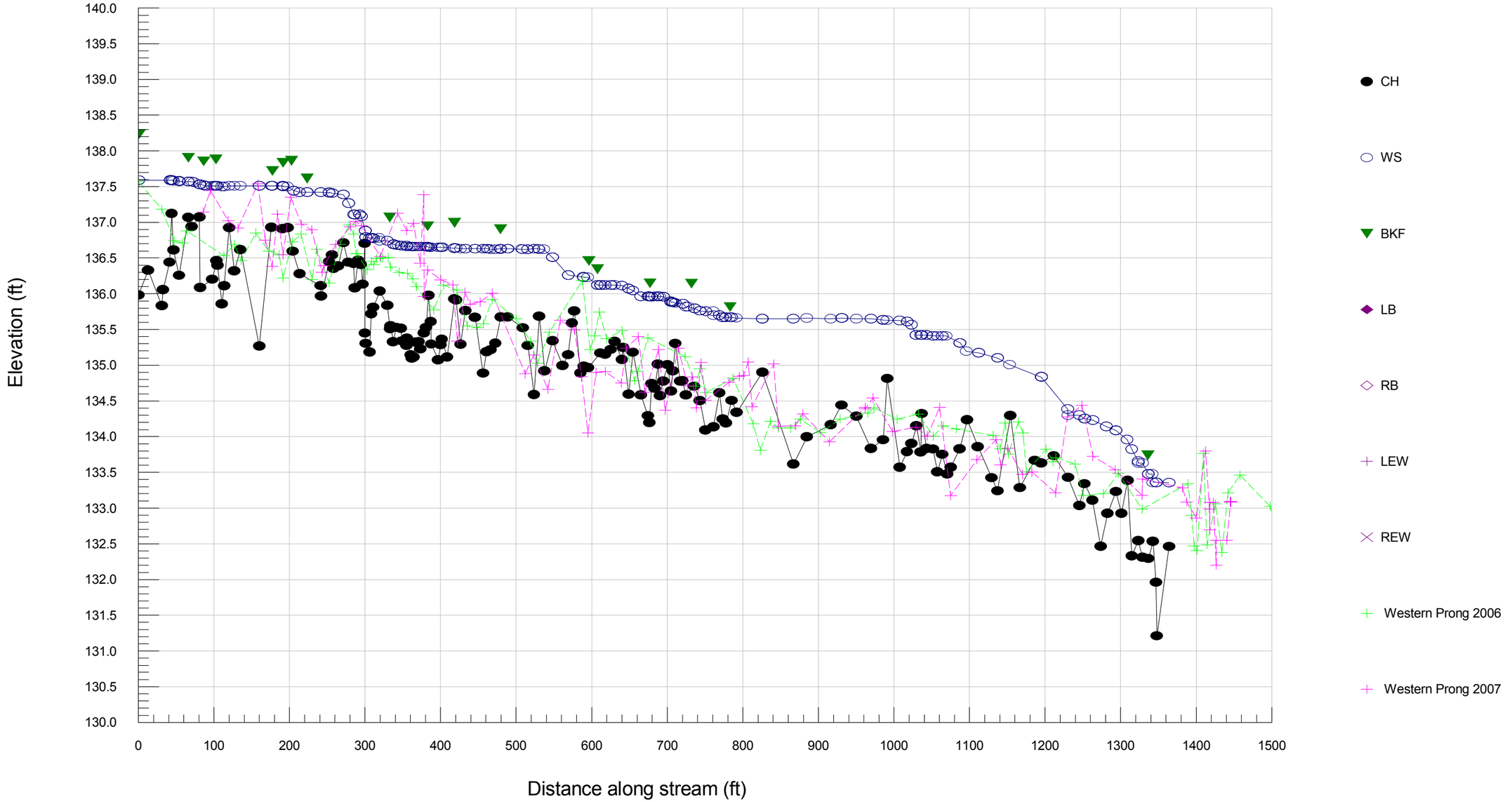
| **Date** | **Project Number** | **Figure** |
|---|---|---|
| 12/3/08 | 018257006 | 5b |

# Eastern Prong 2008




| | | | |
|---|---|---|---|
| **Title** | Survey Profile Graphs | | |
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration Project<br>Cumberland County, North Carolina | |
| | **Date**<br>12/3/08 | **Project Number**<br>018257006 | **Figure**<br>5 |

# Western Prong 2008




| | |
|---|---|
| **Title** | Survey Profile Graphs |

| | | | |
|---|---|---|---|
| Prepared For: Mid-Atlantic Mitigation, LLC | **Project** | Tarlton Stream and Wetland Restoration Project<br>Cumberland County, North Carolina | |
| | **Date**<br>12/3/08 | **Project Number**<br>018257006 | **Figure**<br>5a |

# APPENDIX D. Photo Log

# Photo Point Log


Photo Point 1


Photo Point 2


Photo Point 3


Photo Point 4


Photo Point 5


Photo Point 6


Photo Point 7


Photo Point 8


Photo Point 9


Photo Point 10


Photo Point 11


Photo Point 12 – Veg Plot 2


Photo Point 13


Photo Point 14 – Veg Plot 1


Photo Point 15


Photo Point 16


Photo Point 17


Photo Point 18


Photo Point 19


Photo Point 20 – Veg Plot 3


Photo Point 21


Photo Point 22


Photo Point 23


Photo Point 24


Photo Point 25


Photo Point 26


Photo Point 27


Photo Point 28


Photo Point 29


Photo Point 30


Photo Point 31

# Stormwater Outfall Photo Log

Outfall near Photo Point 1

Outfall S of monitoring well CEC10

Outfall SE of monitoring well CEC10

Outfall N of monitoring well CEC10

Outfall W of monitoring well TARLTON4

Outfall NNE of monitoring well CC3

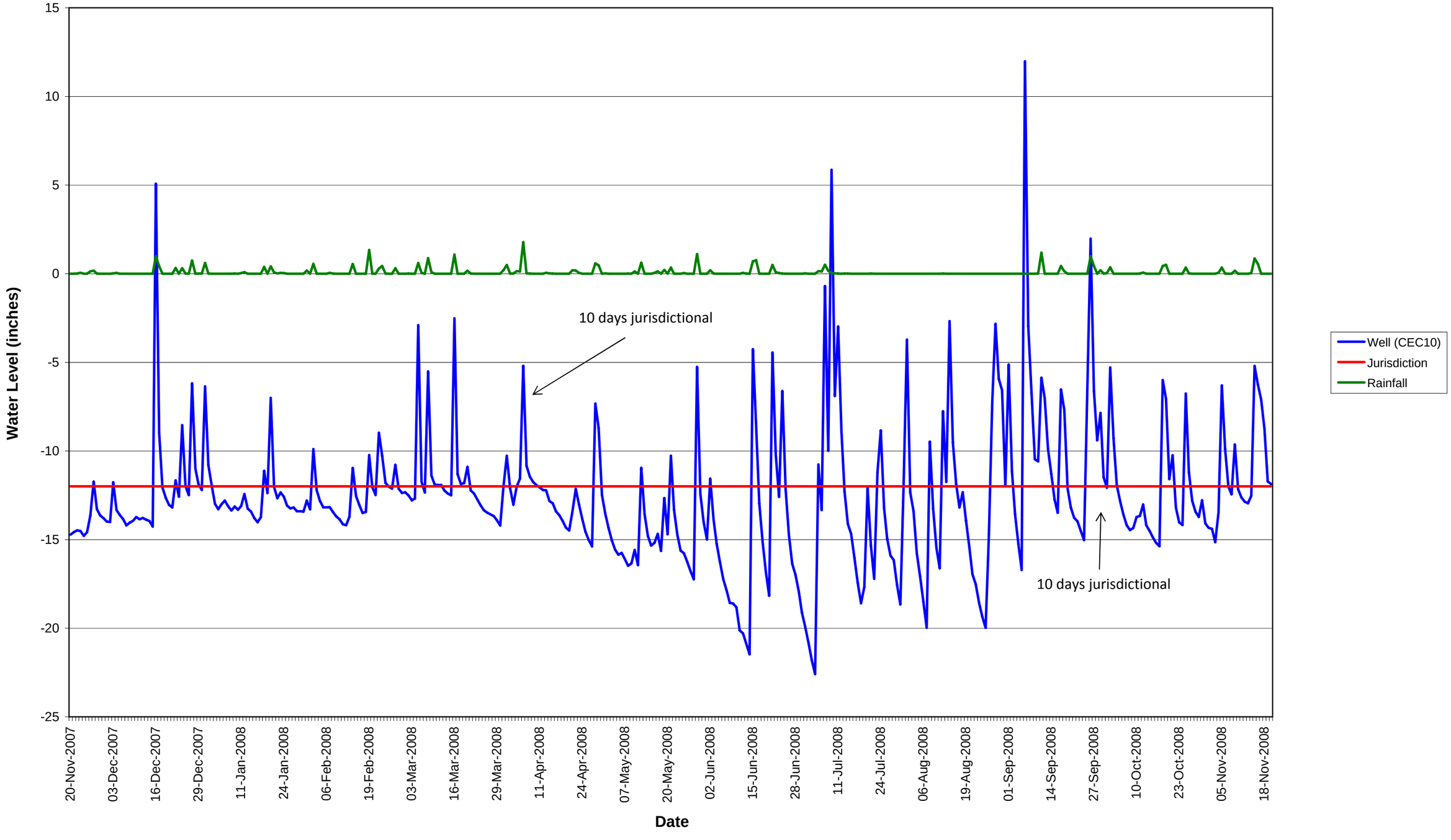
Outfall NW of monitoring well CE2

# APPENDIX E. Ground and Surface Water Data

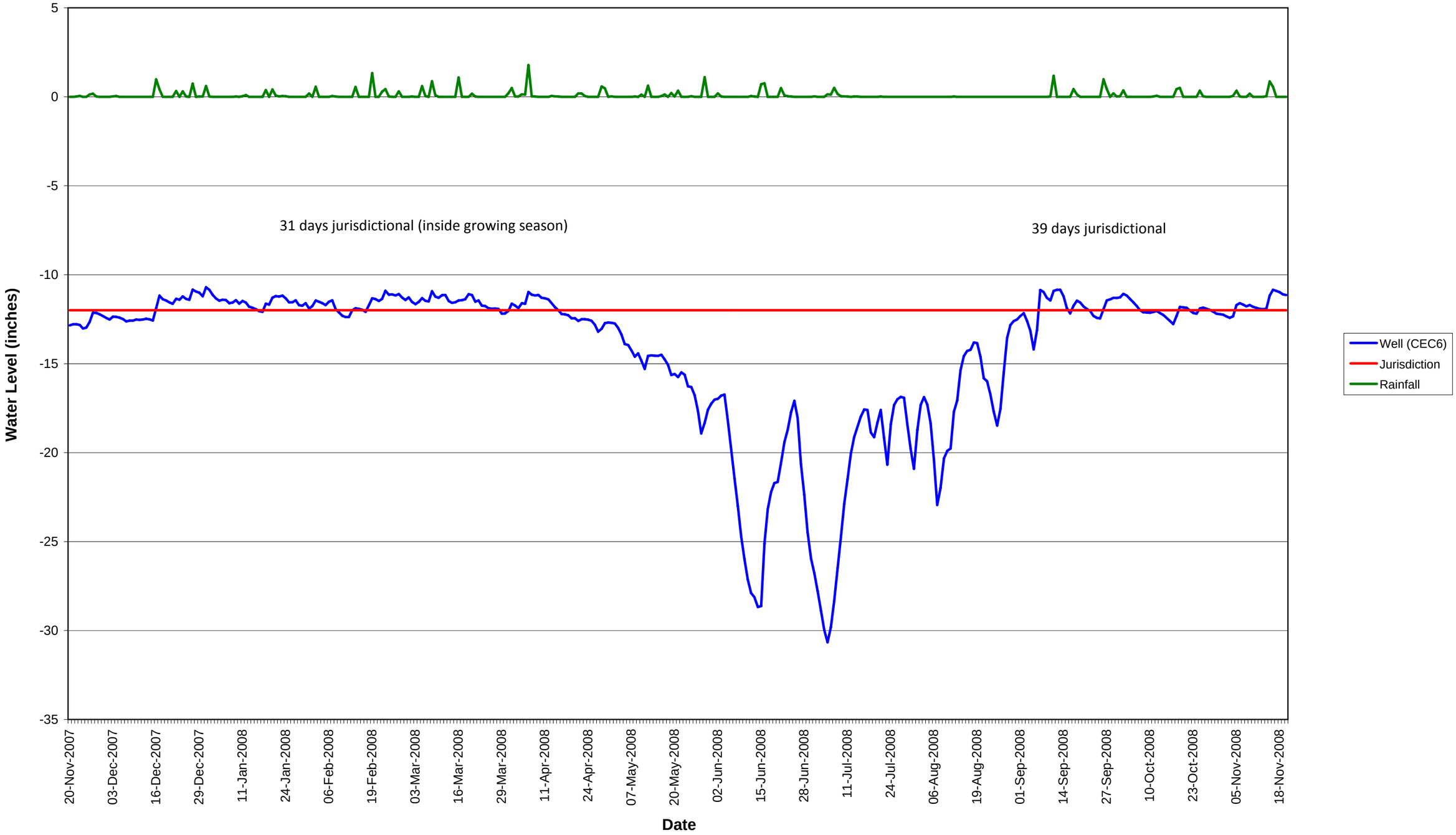
## Bank Full Event Log

## Rainfall and Stream Gage Graphs

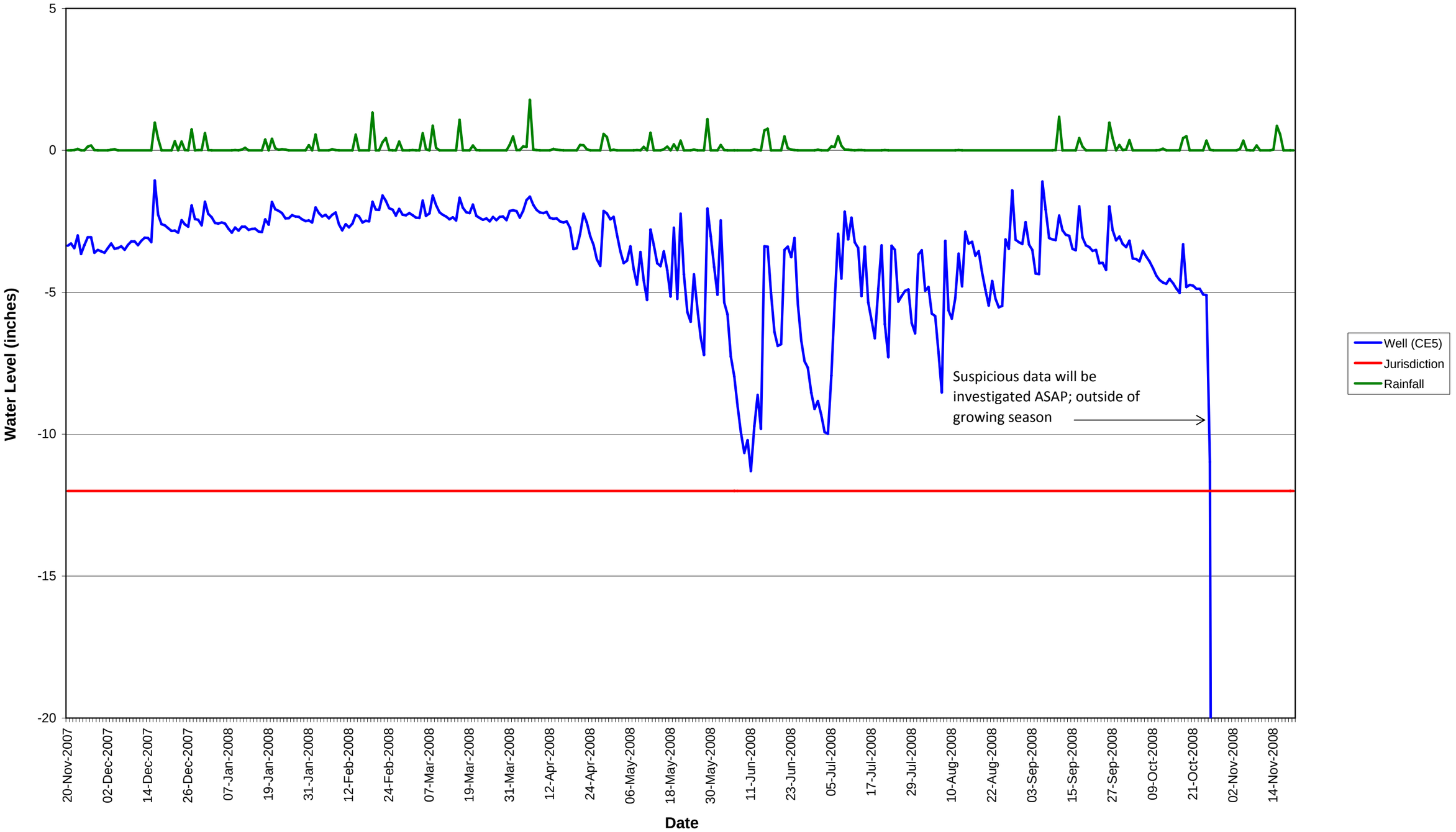
# Water Level for Tarlton Well CEC10 with Rainfall Data



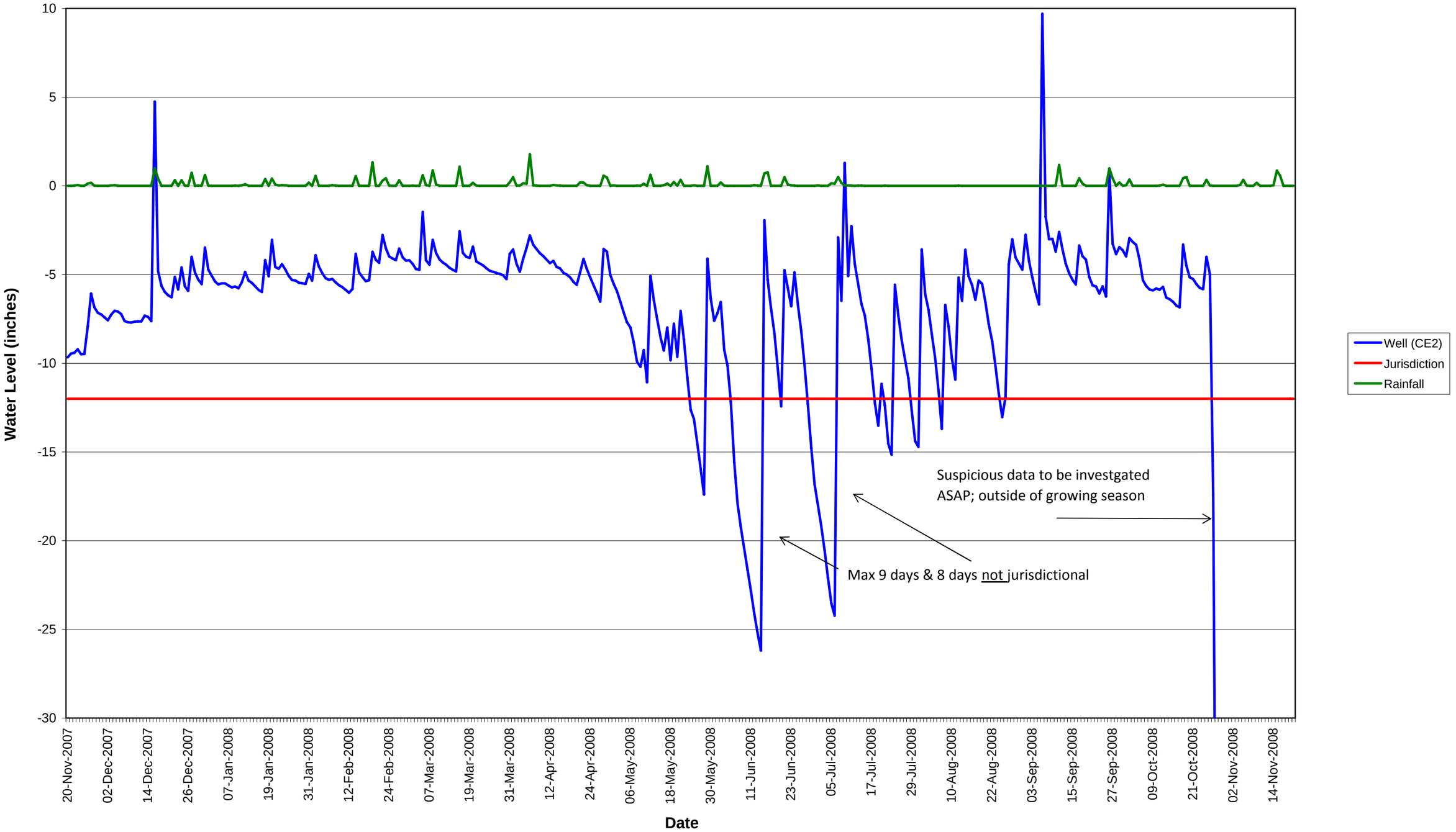
## Water Level for Tarlton Well CEC6 with Rainfall Data



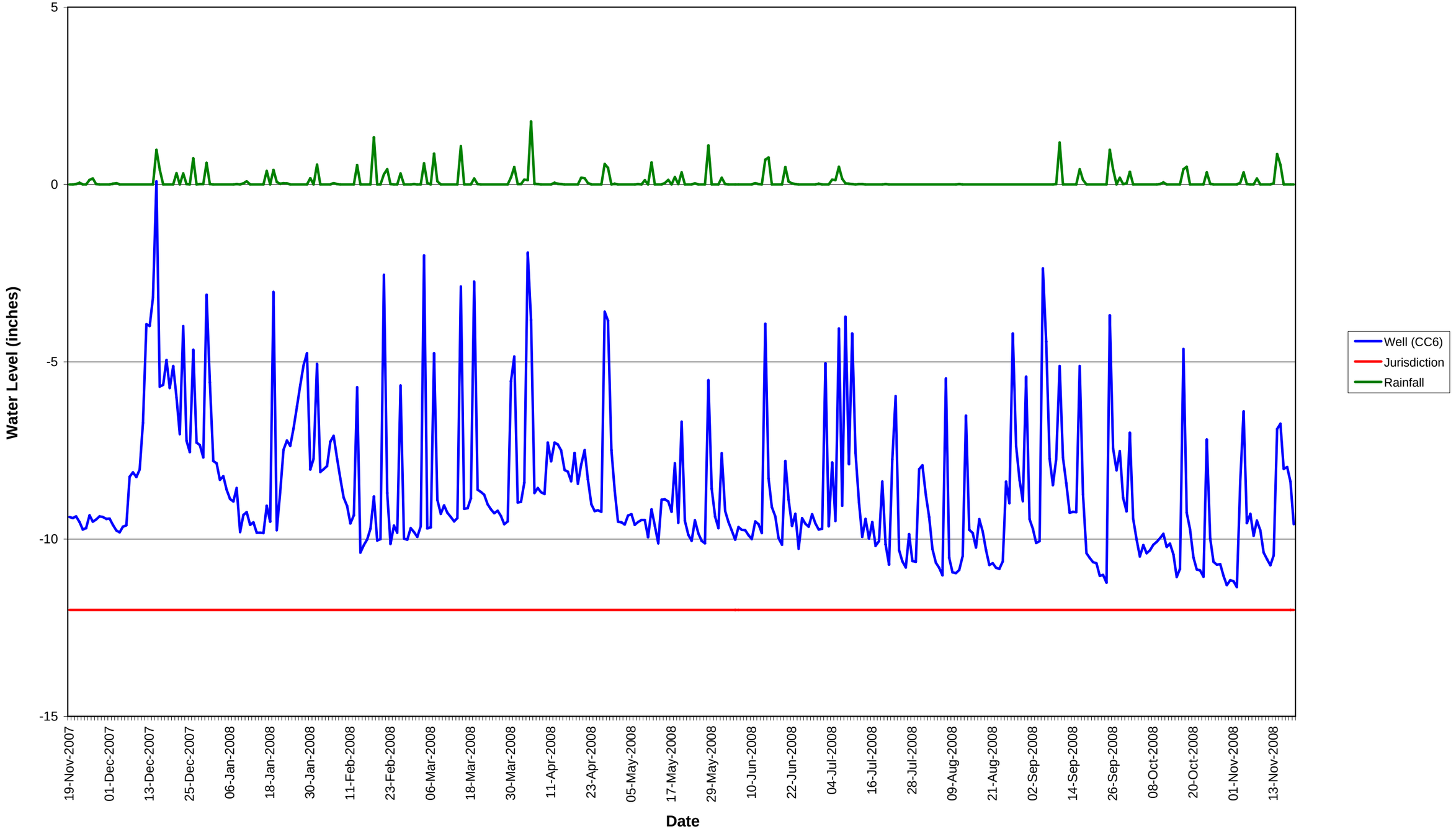
# Water Level for Tarlton Well CE5 with Rainfall Data



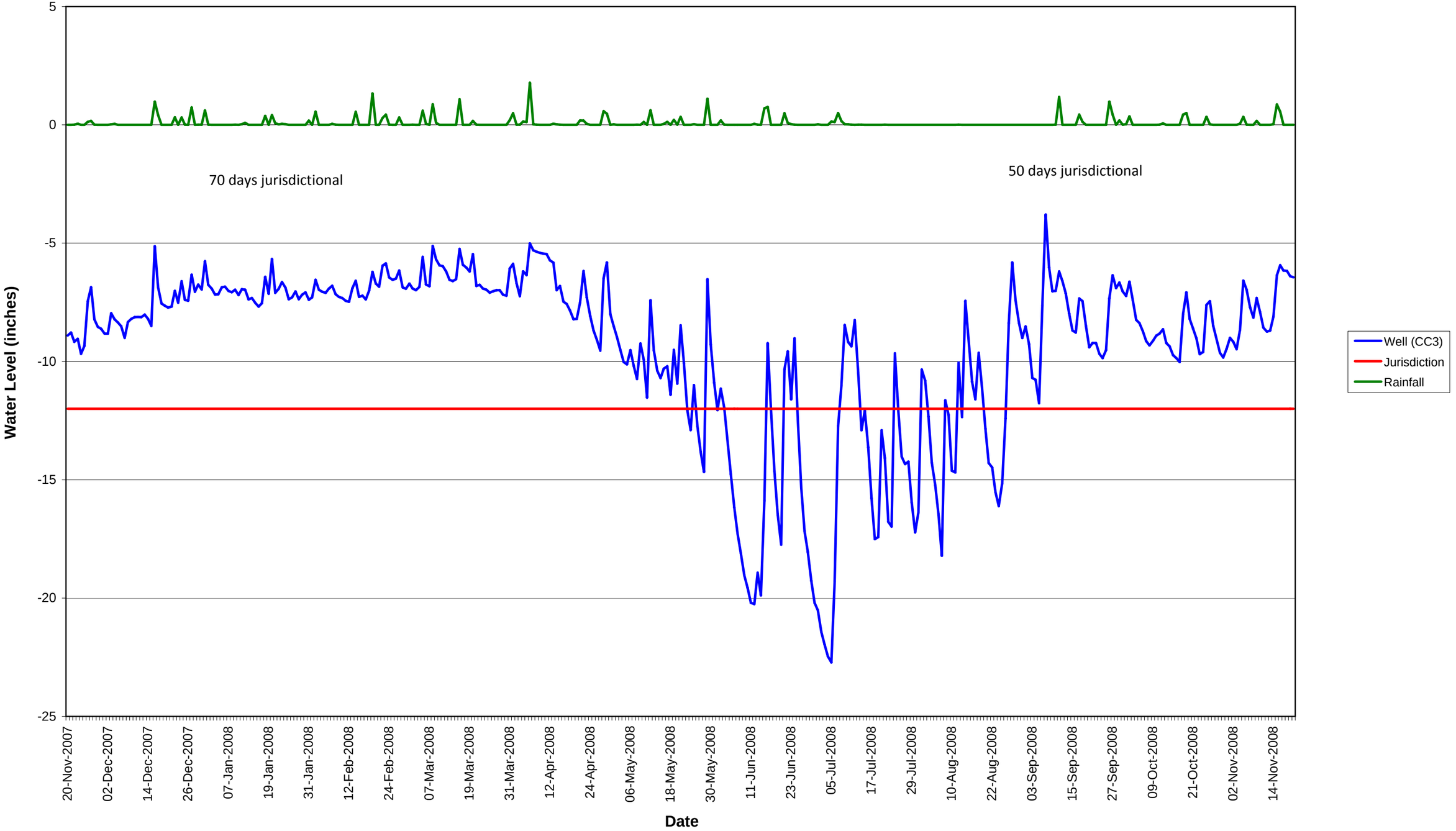
# Water Level for Tarlton Well CE2 with Rainfall Data



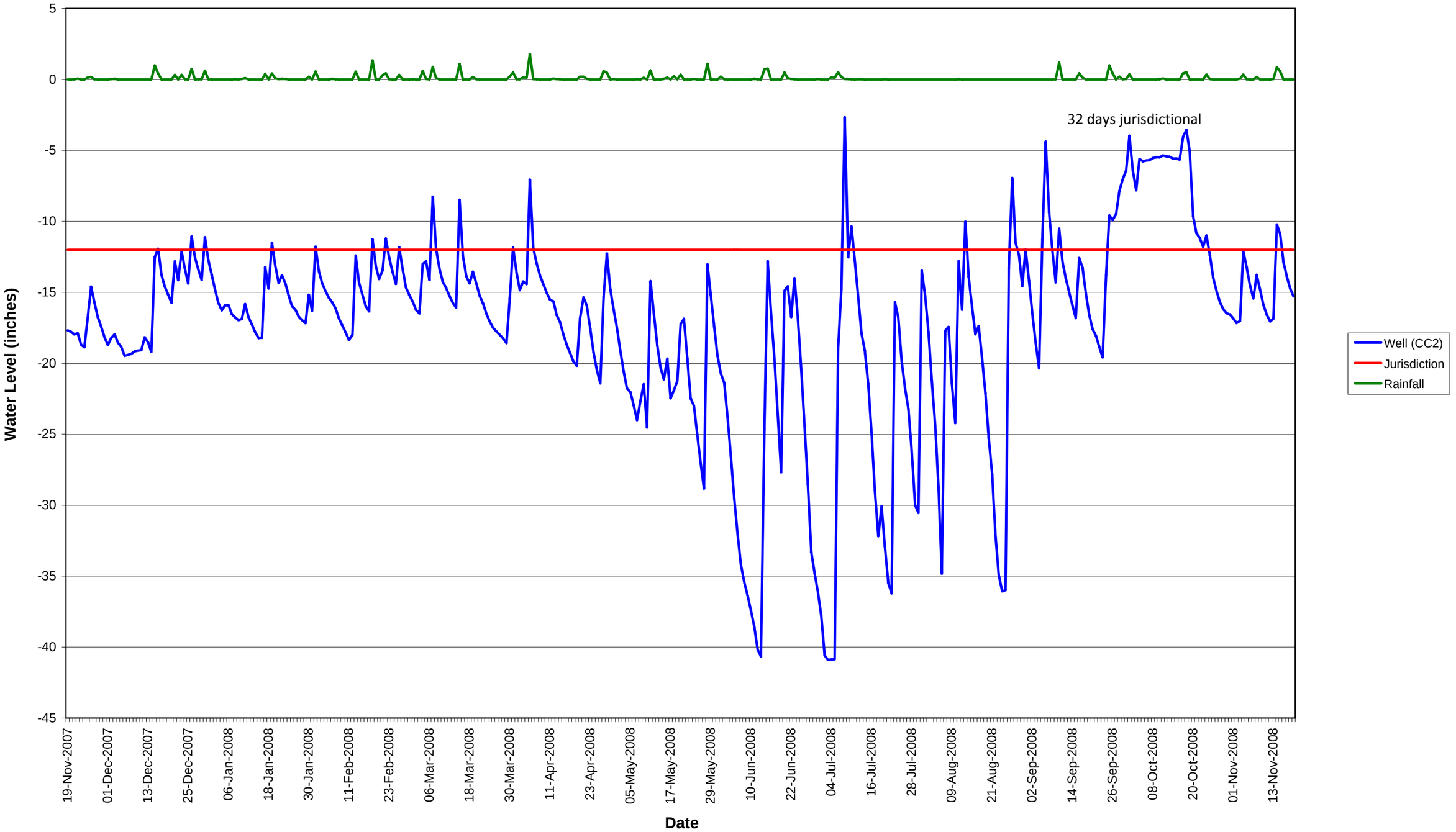
## Water Level for Tarlton Well CC6 with Rainfall Data



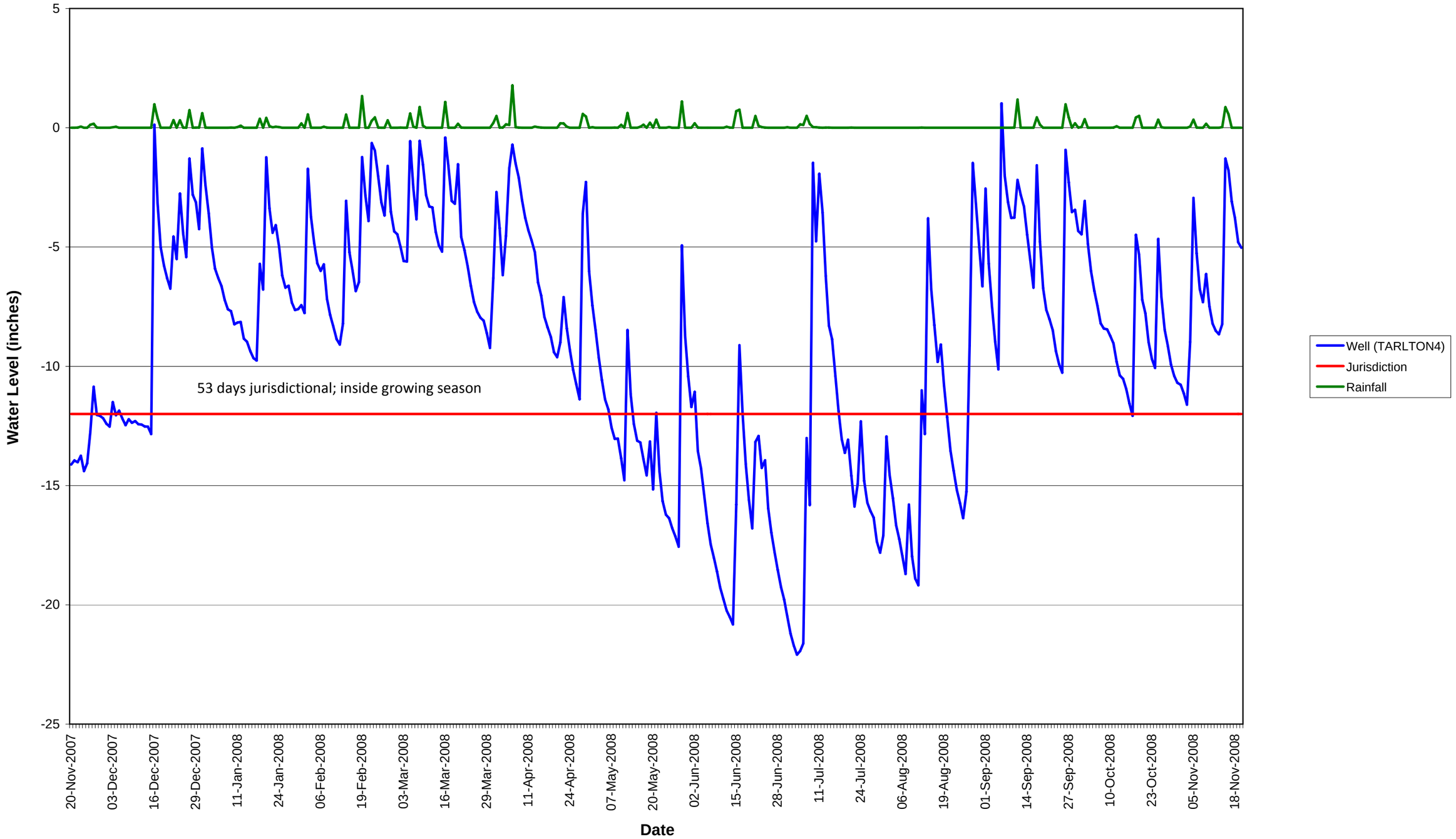
## Water Level for Tarlton Well CC3 with Rainfall Data



# Water Level for Tarlton Well CC2 with Rainfall Data



## Water Level for Tarlton Well TARLTON4 with Rainfall Data



# Bankfull Events Log


Crest Stage Gage was reset on 1/24/2008 and indicated a bankfull event
Crest Stage Gage was reset on 7/29/2008 and indicated a bankfull event

Stream gage peaks of aprox. 24 inches may result in the CSG triggering if rainfall (onsite) is significant

| Date | Stream Gage | Onsite Rainfall | Comments |
|---|---|---|---|
| 12/15/2007 | 16.21 | 0.98 | |
| 12/16/2007 | 23.92 | 0.42 | Most likely bank full event CSG |
| 2/18/2008 | 22.46 | 1.33 | |
| 3/7/2008 | 24.62 | 0.87 | |
| 3/15/2008 | 31.45 | 1.08 | |
| 4/5/2008 | 23.29 | 1.78 | |
| 6/14/2008 | 18.95 | 0.7 | |
| 6/15/2008 | 24.08 | 0.76 | Most likely bank full event CSG |
| 7/8/2008 | 29.24 | 0.03 | |
| 7/9/2008 | 21.23 | 0.02 | |
| 7/10/2008 | 24.86 | 0.01 | Rainfall offsite, upstream |
| 8/27/2008 | 35.23 | 0 | Rainfall offsite, upstream |
| 9/6/2008 | 36.83 | 0 | Rainfall offsite, upstream |
| 11/14/2008 | 20.93 | 0.86 | |
| 11/15/2008 | 27.73 | 0.56 | Most likely bank full event CSG |

## Stream Water Level vs. Rainfall