Mitigation Project Name	Cedar Creek	County	Sampson	USACE Action ID	2013-00389
DMS ID	95718	Date Project Instituted	12/14/2012	NCDWR Permit No	2013-0186
River Basin	Cape Fear	Date Prepared	5/22/2018		
Cataloging Unit	03030006				

Credit Release Milestone	Stream Credits						Wetland Credits							
	Scheduled Releases (Stream)	Warm	Cool	Cold	Anticipated Release Year (Stream)	Actual Release Date (Stream)	Scheduled Releases (Forested)	Riparian Riverine	Riparian Non-riverine	Non-riparian	Scheduled Releases (Coastal)	Coastal	Anticipated Release Year (Wetland)	Actual Release Date (Wetland)
Potential Credits (Mitigation Plan)		5,229.930						13.100						
Potential Credits (As-Built Survey)		5,275.930						13.720						
Potential Credits (IRT Approved)		5,229.933						13.100						
1 (Site Establishment)	N/A				N/A	N/A	N/A				N/A		N/A	N/A
2 (Year 0 / As-Built)	30%	1,582.779			2016	2/19/2016	30%	4.116			30%		2016	2/19/2016
3 (Year 1 Monitoring)	10%	527.593			2016	4/25/2016	10%	1.372			10%		2016	4/25/2016
4 (Year 2 Monitoring)	10%	522.993			2017	8/8/2017	10%	1.310			15%		2017	8/8/2017
IRT Adjustment*		-18.400				8/8/2017		-0.248						8/8/2017
5 (Year 3 Monitoring)** - NOT RELEASED	10%	522.993			2018	Not released	10%	1.310			20%		2018	Not released
6 (Year 4 Monitoring)	5%				2019		10%				10%		2019	
7 (Year 5 Monitoring)	10%				2020		10%				15%		2020	
8 (Year 6 Monitoring)	5%				2021		10%				N/A		2021	
9 (Year 7 Monitoring)	10%				2022		10%				N/A		2022	
Stream Bankfull Standard	10%						N/A				N/A			
Total Credits Released to Date		2,614.965						6.550						

*NOTE: Adjustment required due to IRT concerns on how the as-built credits were calculated

**NOTE: Due to concerns expressed by the IRT, no stream or wetland credits were released from this site for the 2017 monitoring cycle.

DEBITS (released credits only)

			Ratios	1	1.5	2.5	5	1	3	2	5	1	3	2	5	1	3	2	5
				Stream Restoration	Stream Enhancement I	Stream Enhancement II	Stream Preservation	Riparian Restoration	Riparian Creation	Riparian Enhancement	Riparian Preservation	Nonriparian Restoration	Nonriparian Creation	Nonriparian Enhancement	Nonriparian Preservation	Coastal Marsh Restoration	Coastal Marsh Creation	Coastal Marsh Enhancement	Coastal Marsh Preservation
IRT Adjusted As-Built Amounts (feet and acres)				2,943.000	680.000	4,584.000		13.100											
IRT Adjusted As-Built Amounts (mitigation credits)				2,943.000	453.333	1,833.600		13.100											
Percentage Released				50%	50%	50%		50%											
Released Amounts (feet / acres)				1,471.500	340.000	2,292.000		6.550											
Released Amounts (credits)				1,471.500	226.667	916.800		6.550											
NCDWR Permit	USACE Action ID	Project Name																	
2012-0240	1992-03237	NCDOT TIP R-2303C - NC 24, Sampson County		896.700	204.000	1,039.000		4.120											
2012-0240	1992-03237	NCDOT TIP R-2303D - NC 24, Sampson County				336.200													
2012-0240	1992-03237	NCDOT TIP R-2303D - NC 24, Sampson County		298.900	68.000	458.400		1.370											
2012-0240	1992-03237	NCDOT TIP R-2303D - NC 24, Sampson County		275.900	68.000	458.400													
Remaining Amounts (feet / acres)				0.000	0.000	0.000		1.060											
Remaining Amounts (credits)				0.000	0.000	0.000		1.060											

Contingencies (if any): None

Signature of Wilmington District Official Approving Credit Release

9/6/18

Date

1 - For NCDMS, no credits are released during the first milestone

2 - For NCDMS projects, the second credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the NCIRT by posting it to the NCDMS Portal, provided the following criteria have been met:

1) Approval of the final Mitigation Plan
2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan
4) Reciept of necessary DA permit authorization or written DA approval for porjects where DA permit issuance is not required

3 - A 10% reserve of credits is to be held back until the bankfull event performance standard has been met

CEDAR CREEK STREAM AND WETLAND RESTORATION PROJECT
MONITORING REPORT
MONITORING YEAR 4
FINAL

SAMPSON COUNTY, NORTH CAROLINA
CONTRACT NO. 005011 - PROJECT NO. 95718
USACE ACTION ID NO. 2012-00389 – NCDWR PROJECT NO. 2013-0186

Prepared for:

Division of Mitigation Services

North Carolina Department of Environment and Natural Resources
1652 Mail Service Center
Raleigh, NC 27699-1652

January 2019

302 Jefferson Street, Suite 110
Raleigh, NC 27605

Corporate Headquarters
5020 Montrose Blvd. Suite 650
Houston, TX 77006
Main: 713.520.5400

January 22, 2019

Jeff Schaffer
NC DEQ Division of Mitigation Services
217 West Jones Street
Raleigh, NC 27604

RE: Cedar Creek Stream and Wetland Restoration Site: MY4 Monitoring Report (NCDMS ID 95718)

Listed below are comments provided by DMS on December 14, 2018 regarding the Cedar Creek Stream and Wetland Restoration Site: Year 4 Monitoring Report and RES' responses.

1. **Digital drawings**: Show the 7% and 8% hydroperiods in the attribute table for the Wetland Success shapefile instead of the ranges currently shown.
   Done.

2. **Section 1.3**:
a. Revise the first paragraph of this section to reflect that project assets/credits have now been reverted to approved mitigation plan assets/credits. What is in the report now is a regurgitation of what was written last year.
   Done.
b. Table 1a:
(1) Change "Proposed SMUs/WMUs" to "Approved Mitigation Plan SMUs/WMU"
(2) Change "Baseline SMUs/WMUs" to "As-Built Baseline SMUs/WMU"
(3) Add footnote for Proposed (stream) Length and the two columns commented on above that measurements are based on centerline.
   Done.

3. **Section 5.1.4**: Please state whether this site has met the bankfull standard. If it has, please show the cumulative years of bankfull events in Table 13 in Appendix E.
   The site has met the bankfull standard with bankfull events happening in two separate years (MY2 and MY4). This has been added to Section 5.1.4.

4. **Section 5.1.5**:
a. Note that AW 7 has never met hydrologic success of 9% in years 1 through 4. If hydrology doesn't at least show improvement in MY5, this area may need to be removed from credit.
   The ditch that RES inferred was draining this wetland area was plugged in October 2018. RS expects this gauge to trend towards and meet success criteria over the remaining three years of monitoring.
b. Note that AW 11 has missed hydrologic success of 9% in 3 of 4 years. RES may need to begin looking at refining assets in this area as well.
   AW 11 is located on the outer edge of the Johns fine sandy loam area. According to Wetland Saturation Threshold Table in the 2016 Mitigation Update, Thermic Aquic Hapludults wetland

saturation range is 6-8%. This means AW 11 would have met two of the four years with the two successful years being the most recent showing an upward trend.

5. **Appendix A, Table 1**: Update footnote to read something like "Credit calculations were originally calculated along the as-built thalweg. For Monitoring Year 3 forward, credits were updated to be calculated along stream centerlines for after discussions with NC IRT stemming from the April 3, 2017 Credit Release Meeting."
   Done.

6. **Appendix B**:

a. CCPV: The locations of bank pins are not shown. Please show on appropriate figure(s).
   Done.

b. Table 5 (all): Provide description of red asterisk as footnote or remove if not necessary in both hardcopy and digital files.
   The asterisks have been removed.

c. Table 6: Explain why there is nothing discussed on the Invasive Area of Concern row when you discuss invasive vegetation in the report narrative, show it on the CCPV and list it in Table 7.
   The invasive species area has been quantified on Table 6, displayed on the CCPV, and listed in Table 7.

7. **Appendix D**: Make notation on appendix cover sheet and in Table of Contents that Stream Geomorphology Data/monitoring was not required for MY4.
   Done.

8. **Appendix E**:

a. 2018 Groundwater Monitoring Gauge Hydrographs: In reviewing these hydrographs, it appears that the entire growing season was not observed for the wetland assessment/gauge data collection. Please explain why not.
   RES collected additional groundwater monitoring on January 10, 2019. The report now includes data from the entire growing season.

b. Verify rainfall data for September. Looks low based on area impacted by Hurricane Florence.
   The rainfall data recorded 25 inches for September. The average September rainfall near Clinton, NC is 5 inches.

9. Please print this report double-sided.

Cedar Creek
Sampson County, North Carolina
DMS Project ID 95718

Cape Fear River Basin
HUC 3030006090060

Prepared by:

Resource Environmental Solutions, LLC
302 Jefferson Street, Suite 110
Raleigh, NC 27605
919-209-1061

TABLE OF CONTENTS

Appendices

1 PROJECT GOALS, BACKGROUND AND ATTRIBUTES

1.1 Location and Setting

The Cedar Creek Stream and Wetland Site is located in Sampson County approximately 3.1 miles southwest of Clinton, NC (**Figure 1**). To access the Site from the town of Clinton, travel west on Highway 24 (Sunset Avenue), take a left onto Airport Road and go 1.3 miles. Turn right onto West Main Street Extension, go approximately 350 feet, and turn left onto a dirt farm path. Follow the farm path along the cultivated field edge to the southwest corner and enter the forest. Follow the dirt path to cultivated fields adjacent to the project below UT2. Turning to the left will take you to UT2. Going to the right will take you to UT3.

1.2 Project Goals and Objectives

The Cedar Creek Stream and Wetland Restoration Project has provided numerous ecological and water quality benefits within the Cape Fear River Basin. While many of these benefits are limited to the project area, others, such as pollutant removal and improved aquatic and terrestrial habitat, have more far-reaching effects. Expected improvements to water quality, hydrology, and habitat are outlined below.

Design Goals and Objectives

Benefits Related to Water Quality	
Nutrient removal	Benefit will be achieved through filtering of runoff from adjacent agricultural fields through buffer areas, the conversion of active farm fields to forested buffers, improved denitrification and nutrient uptake through buffer zones, and installation of BMPs at the headwaters of selected reaches.
Sediment removal	Benefit will be achieved through the stabilization of eroding stream banks and reduction of sediment loss from field areas due to lack of vegetative cover. Channel velocities will also be decreased through a reduction in slope, therefore decreasing erosive forces.
Increase dissolved oxygen concentration	Benefit will be achieved through the construction of instream structures to increase turbulence and dissolved oxygen concentrations and riparian canopy restoration to lower water temperature to increase dissolved oxygen capacity.
Runoff filtration	Benefit will be achieved through the restoration of buffer areas that will receive and filter runoff, thereby reducing nutrients and sediment concentrations reaching water bodies downstream.
Benefits to Flood Attenuation	
Water storage	Benefit will be achieved through the restoration of buffer areas which will infiltrate more water during precipitation events than under current site conditions. Wetland areas will provide additional storage of runoff and flood waters.
Improved groundwater recharge	Benefit will be achieved through the increased storage of precipitation in buffer areas, ephemeral depressions, and reconnection of existing floodplain. Greater storage of water will lead to improved infiltration and groundwater recharge.
Improved/restored hydrologic connections	Benefit will be achieved by restoring the stream to a natural meandering pattern with an appropriately sized channel, such that the channel's floodplain will be flooded more frequently at flows greater than the bankfull stage.
Benefits Related to Ecological Processes	
Restoration of habitats	Benefit will be achieved by restoring riparian buffer habitat to appropriate bottomland hardwood ecosystem. Protected riparian corridors will create contiguous natural areas with uninterrupted migration corridors.
Improved substrate and instream cover	Benefit will be achieved through the construction of instream structures designed to improve bedform diversity and to trap detritus. Stream will be designed with the appropriate channel dimension and will prevent aggradation and sedimentation within the channel. Substrate will become coarser as a result of the stabilization of stream banks and an overall decrease in the amount fine materials deposited in the stream.

Addition of large woody debris	Benefit will be achieved through the addition of wood structures as part of the restoration design. Such structures may include log vanes, root wads, and log weirs.
Reduced temperature of water due to shading	Benefit will be achieved through the restoration of canopy tree species to the stream buffer areas.
Restoration of terrestrial habitat	Benefit will be achieved through the restoration of riparian buffer bottomland hardwood habitats.

The Cedar Creek Stream and Wetland Restoration Project is located in the Great Coharie Creek Watershed (http://portal.ncdenr.org/web/DMS/priorities-map). This 14-digit Hydrologic Unit Code (HUC 03003006090060) is identified as a Targeted Local Watershed (TLW) in the Cape Fear River Basin Restoration Priority (RBRP).

The North Carolina Division of Mitigation Services (NCDMS) develops River Basin Restoration Priorities (RBRP) to guide its restoration activities within each of the state's 54 cataloging units. RBRPs delineate specific watersheds that exhibit both the need and opportunity for wetland, stream and riparian buffer restoration. These TLWs receive priority for DMS planning and restoration project funds. Currently, no Local Watershed Plan (LWP) is available for the project area.

The 2009 Cape Fear RBRP identified water quality and agricultural impacts as major stressors within this TLW. The Cedar Creek Stream and Wetland Restoration Project was identified as a Stream and Wetland opportunity to improve water quality, habitat, and hydrology within the TLW.

The project goals addressed stressors identified in the TLW, and include the following:

- Water quality improvements,
- Natural resource protection, and
- Manage agricultural impacts.

The project goals were addressed through the following project objectives:

- Converting active farm fields to forested buffers,
- Stabilization of eroding stream banks,
- Reduction in stream bank slope,
- Restoration of riparian buffer bottomland hardwood habitats, and
- Construction of in-stream structures designed to improve bedform diversity.

1.3 Project Structure

Table 1a. Cedar Creek Site Project Components – Stream Mitigation

Following 2016 monitoring the NCIRT requested a review of the differential between the Approved Mitigation Plan and Baseline Monitoring Report. The table below details the discrepancies by reach. RES did not submit an asset revision and reverted to the Approved Mitigation Plan assets.

Reach	Mitigation Type*	Proposed Length (LF)***	Mitigation Ratio	Approved Mitigation Plan SMUs***	As-Built Baseline SMUs
UT1	Enhancement II	3,064	2.5:1	1,226	1,226
UT1	Enhancement I	415	1.5:1	277	277
UT1	Enhancement II	615	2.5:1	246	246
UT1	Enhancement I	265	1.5:1	177	177
UT1	Enhancement II	827	2.5:1	331	331
UT2	Headwater Valley	337	1:1	337	337
UT2	P1 Restoration	504	1:1	504	518
UT2C	Headwater Valley	190	1:1	190	193
UT3	P1 Restoration	1,912	1:1	1,912	1,941
UT4	Enhancement II	78	2.5:1	31	31
	Total	**8,207**		**5,230**	**5,276**

*P1=Priority 1
**The contracted amount of credits for this Site is 5,000 SMUs
***Stream lengths are based on the designed stream centerline

Wetland	Mitigation Type	Mitigation Area (ac)	Mitigation Ratio	Approved Mitigation Plan WMUs	As-Built Baseline WMUs
W1	Restoration	13.10	1:1	13.10	13.72
	Total	**13.10**		**13.10**	**13.72**

*The contracted amount of credits for this Site is 9.00 WMUs

1.3.1 Restoration Type and Approach

Stream restoration efforts along the unnamed tributaries to Great Coharie Creek were accomplished through analyses of geomorphic conditions and watershed characteristics. The design approach applied a combination of analytical and reference and/or analog reach based design methods that meet objectives commensurate with both ecological and geomorphic improvements. Proposed treatment activities ranged from minor bank grading and planting to re-establishing stable planform and hydraulic geometry. Reaches that required full restoration, natural design concepts have been applied and verified through rigorous engineering analyses and modeling. The objective of this approach was to design a geomorphically stable channel that provides habitat improvements and ties into the existing landscape.

Priority Level I stream restoration, headwater valley restoration, stream Enhancement Levels I and II, and stream buffers throughout the project site have been restored and protected in perpetuity. Priority

Level I stream restoration was incorporated into the design of a single-thread meandering channel, with parameters based on data taken from the reference site. Priority 1 stream restoration was proposed on 2,416 linear feet of stream channel. Headwater valley restoration was applied to 527 linear feet of channel. Enhancement Level I was applied to 680 linear feet of channel that required buffer enhancement, bank stabilization and habitat improvements. Enhancement Level II was applied to an additional 4,584 linear feet of channel that required buffer enhancement and/or minimal bank and habitat improvements.

UT1
UT1 flows from southeast to northwest across the project, totaling 5,186 linear feet of Enhancement Level I and II. The upper-most portion of UT1 (reaches UT1A and UT1B) is stable and has a forested buffer along both banks; however, privet was dominant within the right buffer. The downstream portion of UT1 (reaches UT1C, UTD and UT1E) was moderately stable and exhibited some areas of localized erosion prior to mitigation activities. The buffer along this section consisted of a five year old clear-cut along the left bank and cultivated fields along the right bank. A 60-foot easement break is present within the downstream section (UT1E) to account for an existing farm crossing which has been upgraded. 680 linear feet of Enhancement Level I was performed along reach UT1. Selective locations were identified to include streambed structures, minor bank grading, planting a native stream buffer and invasive species control. Primarily, Stabilization/Enhancement II activities included performing minor bank grading, planting the buffer with native vegetation, and invasive species control.

UT2
UT2 is the middle tributary of the project, totaling 337 linear feet of headwater valley restoration along the upstream section and 518 linear feet of Priority 1 restoration through the downstream section. The upper section of the channel was channelized and bordered by cultivated fields to the northwest and a pine stand to the southeast, while the lower portion was a small ditch surrounded by cultivated fields. The headwater valley portion relocated the flow path to the natural valley (to the left of the existing ditch), and the abandoned ditch has been back filled. The performed P1 restoration included relocating the channel to follow the natural valley and emptying into Cedar Creek near STA 25+50. A 60-foot easement break crossing is present at STA 4+66 along UT2. Twin 24" HDPE culverts were installed within the easement break crossing. Restoration activities included constructing a meandering channel, installing habitat and drop structures, filling and plugging the abandoned channel, planting the buffer with native vegetation, and invasive species control.

UT2C
UT2C is also located in the middle of the project (adjacent to UT2), totaling 193 linear feet of headwater valley restoration. The upstream end of the reach begins at an existing wetland that borders a farm path to the north. Flow from the wetland originally had been diverted to a ditch that ran east-west along the farm path before it was conveyed across the path and into UT2 near the upstream end. Restoration activities involved redirecting channel flow to the natural valley and grading out the existing ditch and path such that the area matches existing grade on either side of the path. Additional activities included planting the buffer with native vegetation and invasive species control.

UT3
UT3 is the western most tributary of the project, totaling 1,941 linear feet of Priority 1 restoration. The upper section of the channel was incised/oversized and began at a pond outlet east of the airport and flowed through a wooded area consisting of saplings and some mature hardwoods, while the lower section flowed through a cultivated field. The restored channel has been relocated to the west to follow the natural valley, and now flows through the middle of the wetland restoration area (W1). UT3 now outlets into Cedar Creek near STA 43+10. Restoration activities included constructing a meandering channel, installing habitat and grade control structures, filling and plugging the abandoned channel,

planting the buffer with native vegetation, and invasive species control. Small ditches located adjacent to UT3 and within the conservation easement have also been plugged and filled to redirect and diffuse flow through the wetland restoration area and/or into UT3.

UT4
UT4 is the eastern most tributary of the project, totaling 78 linear feet of Enhancement Level II. The reach was relatively stable, but had been historically channelized. The buffer along this section consisted of an agricultural field along the right bank, and a forested buffer along the left bank; however, privet was common within the left buffer. Stabilization/Enhancement II activities included performing minor bank grading, cutting a floodplain bench, and planting the buffer with native vegetation, and invasive species control.

Wetland W1
This 13.72-acre wetland is located along UT3 and where it reaches the confluence of with UT1 Reach E. The pre-restoration land use was sparsely wooded and active cropland. Wetland restoration activities consisted of removing valley fill, filling drainage ditches, removing subsurface drainage tiles, and raising adjacent stream channels to reconnect the floodplain with seasonal and out of bank flows. Raising the stream bed will also reduce the "dry shoulder" effect near the stream channel. Specific wetland restoration activities included: reconnecting low lying areas of hydric soil with the floodplain, plugging agricultural drainage ditches, planting native tree and shrub species commonly found in small stream swamp ecosystems, and surface roughening to increase infiltration and storage. Wetland restoration activities also included the breaching, backfilling, and planting of an old pond (0.22 acres) that was identified after Mitigation Plan approval. The IRT has not approved these additional 0.22 acres therefore RES will revert back to the 13.10 WMUs from the Approved Mitigation Plan. Wetland restoration limits and hydroperiods will be determined by on-site soil investigations and hydrologic modeling in conjunction with pre-construction water table monitoring at the restoration sites and reference wetlands. Combined with the stream restoration, these actions will result in a sufficiently high water table and flood frequency to support hydrophytic vegetation and wetland hydrology, resulting in restored riparian wetlands.

1.4 Project History, Contacts and Attribute Data

1.4.1 Project History

The Cedar Creek Stream and Wetland Restoration Site was restored by Resource Environmental Solutions, LLC (RES) through a full-delivery contract awarded by NCDMS in 2012. Tables 2, 3, and 4 in **Appendix A** provide a time sequence and information pertaining to the project activities, history, contacts, and baseline information.

1.4.2 Project Watersheds

The easement totals 42.0 acres and is broken into four tributaries, UT1, UT2, UT3, and UT4. The land use in the 2,778-acre (4.34 mi^2) project watershed that drains to UT1 consisted of row crop production, livestock production, silviculture, and sand mining areas. Past land use practices caused increased erosion and sedimentation along drainage-ways and stream banks in the watershed.

UT2 has a drainage area of 32 acres (0.05 mi^2) and flows southwest into UT1. Land use in this small drainage area consisted entirely of row crop production and disturbed hardwood forest. UT2 originated in a disturbed hardwood forest and flows through a cultivated field to its confluence with UT1.

UT3 has a drainage area of 147 acres (0.23 mi^2) and flows south into UT1. Land use in this drainage area consisted of row crop production, historical and future livestock production, disturbed hardwood

forest, maintained open space, and impervious surfaces associated with residential commercial development. Portions of the Sampson County Airport, including parts of the runway, terminal, and apron areas, lie within the UT3 drainage area. UT3 originates at a pond that is adjacent to the airport property. This reach flowed through a disturbed hardwood forest, and then through a cultivated field to its confluence with UT1.

UT4 has a drainage area of 77 acres (0.12 mi^2), originates within a disturbed hardwood forest, and flows southwest into UT1. Land use in this small drainage area consisted of a mix of row crop production and disturbed hardwood forest located primarily along the drainage way.

UT2, UT3 and UT4 were straightened, dredged, or re-aligned in the past to promote drainage. Soil investigations showed that much of the low-lying landscape adjacent to UT1 and its confluences with UT2 and UT3 exhibited hydric characteristics and a shallow seasonal high water table. The low lying fields in this area were considered prior converted wetlands (PC) that were drained and are currently utilized for row crop and livestock production.

The land use in the watershed is characterized by evergreen forest (47 percent), cultivation (31 percent), woody wetlands (9 percent), open space (8 percent) and shrub/scrub (5 percent).

2 Success Criteria

The success criteria for the Cedar Creek Site stream restoration will follow accepted and approved success criteria presented in the USACE Stream Mitigation Guidelines and subsequent NCDMS and agency guidance. Specific success criteria components are presented below.

2.1 Stream Restoration

2.1.1 Bankfull Events

Two bankfull flow events must be documented within the seven-year monitoring period. The two bankfull events must occur in separate years. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years. Bankfull events will be documented using crest gauges, auto-logging crest gauges, photographs, and visual assessments for evidence of debris rack lines.

2.1.2 Cross Sections

There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio). Cross-sections are classified using the Rosgen stream classification method, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

2.1.3 Bank Pin Arrays

Bank pin arrays will be used as a supplemental method to monitor erosion on selected meander bends where there is not a cross section. Bank pin arrays will be installed along the outer bend of the meander. Bank pins will be installed just above the water surface and every two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank. There should be little change in as-built cross-sections. If changes do take place, they should be evaluated to determine if they represent a movement toward a less stable condition (for example

down-cutting or erosion), or are minor changes that represent an increase in stability (for example settling, vegetative changes, deposition along the banks, or decrease in width/depth ratio).

2.1.4 Digital Image Stations

Digital images are used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal images should not indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral images should not indicate excessive erosion or continuing degradation of the banks over time. A series of images over time should indicate successional maturation of riparian vegetation.

2.2 Wetland Restoration

Success criteria and monitoring for wetland hydrology within the wetland restoration areas on the site follows NCDMS Guidance dated 7 November 2011. The target minimum wetland hydroperiod is 9 percent of the growing season. Stream hydrology and water balance calculations indicate the wetland area will meet jurisdictional criteria (5 percent hydroperiod). However, due to immature vegetation and reduced PET, a longer success criterion is appropriate. Auto recording gauges are used to measure daily groundwater elevations throughout the Sampson County growing season in all seven years of monitoring.

If a hydrology gauge location fails to meet these success criteria in the seven-year monitoring period then monitoring may be extended, remedial actions may be undertaken, or groundwater modeling may be used to demonstrate the limits of wetland restoration.

2.3 Vegetation Success Criteria

Specific and measurable success criteria for plant density within the wetland restoration and riparian buffers on the site will follow NCDMS Guidance dated 7 November 2011. Vegetation monitoring plots are a minimum of 0.02 acres in size, and cover a minimum of two percent of the planted area. The following data is recorded for all trees in the plots: species, height, planting date (or volunteer), and grid location. Monitoring occurs in the fall of Years 1, 2, 3, 5, and 7. The interim measures of vegetative success for the site is the survival of at least 320 three-year old planted trees per acre at the end of Year 3, and 260 planted trees per acre at the end of Year 5. The final vegetative success criteria is the survival of 210 planted trees per acre at the end of Year 7 of the monitoring period.

Invasive and noxious species will be monitored and controlled so that none become dominant or alter the desired community structure of the site. If necessary, RES will develop a species-specific control plan.

2.4 Scheduling/Reporting

The monitoring program will be implemented to document system development and progress toward achieving the success criteria. The restored stream morphology is assessed to determine the success of the mitigation. The monitoring program will be undertaken for seven years or until the final success criteria are achieved, whichever is longer.

Monitoring reports will be prepared in the fall of each year of monitoring and submitted to NCDMS. The monitoring reports will include all information, and be in the format required by NCDMS in Version 2.0 of the NCDMS Monitoring Report Template (Oct. 2010).

3 MONITORING PLAN

Annual monitoring data will be reported using the DMS monitoring template. Annual monitoring shall be conducted for stream, wetland, and vegetation monitoring parameters as noted below.

3.1 Stream Restoration

3.1.1 As-Built Survey

An as-built survey was conducted following construction to document channel size, condition, and location. The survey will include a complete profile of thalweg, water surface, bankfull, and top of bank to compare with future geomorphic data. Longitudinal profiles will not be required in annual monitoring reports unless requested by NCDMS or USACE.

3.1.2 Bankfull Events

Three sets of manual and auto-logging crest gauges were installed on the site, one along UT2, one along UT2C, and one along UT3. The auto logging crest gauges were installed within the channel and will continuously record flow conditions at an hourly interval. Manual crest gauges were installed on the bank at bankfull elevation. Crest gauges will be checked during each site visit to determine if a bankfull event has occurred since the last site visit. Crest gauge readings and debris rack lines will be photographed to document evidence of bankfull events.

3.1.3 Cross Sections

A total of 27 permanent cross sections were installed to monitor channel dimensions and stability. Cross sections were typically located at representative riffle/shallows and pool sections along each stream reach. Four cross sections were installed along UT1 where enhancement activities were performed. Eight cross sections (three pools, two runs, and three shallows) were installed along UT2. UT2C has one cross section installed throughout its length. Stream reach UT3 has 14 cross sections installed along its length where stream restoration was performed. Each cross section was permanently marked with 3/8 rebar pin to establish a monument location at each end. A marker pole was also installed at both ends of each cross section to allow ease locating during monitoring activities. Cross section surveys will be performed once a year during annual monitoring years 1, 2, 3, 5, and 7 and will include all breaks in slope including top of bank, bottom of bank, streambed, edge of water, and thalweg.

3.1.4 Digital Image Stations

Digital photographs will be taken at least once a year to visually document stream and vegetation conditions. This monitoring practice will continue for seven years following construction and planting. Permanent photo point locations at cross sections and vegetation plots have been established so that the same directional view and location may be repeated each monitoring year. Monitoring photographs will also be used to document any stream and vegetation problematic areas such as erosion, stream and bank instability, easement encroachment and vegetation damage.

3.1.5 Bank Pin Arrays

Eight bank pin array sets have been installed at pool cross sections located along UT2 and UT3. These bank pin arrays were installed along the upstream and downstream third of the meander. Bank pins are a minimum of three feet long, and have been installed just above the water surface and every two feet above the lowest pin. Bank pin exposure will be recorded at each monitoring event, and the exposed pin will be driven flush with the bank.

3.1.6 Visual Assessment Monitoring

Visual monitoring of all mitigation areas is conducted a minimum of twice per monitoring year by qualified individuals. The visual assessments include vegetation density, vigor, invasive species, and easement encroachments. Visual assessments of stream stability include a complete stream walk and structure inspection. Digital images are taken at fixed representative locations to record each monitoring event as well as any noted problem areas or areas of concern. Results of visual monitoring are presented in a plan view exhibit with a brief description of problem areas and digital images. Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures. Longitudinal photos should indicate the absence of developing bars within the channel or an excessive increase in channel depth. Lateral photos should not indicate excessive erosion or continuing degradation of the banks over time. A series of photos over time should indicate successional maturation of riparian vegetation.

3.1.7 Surface Flow

The headwater valley restoration reaches on UT2 and UT2C will be monitored to document intermittent or seasonal surface flow. This will be accomplished through direct observation, photo documentation of dye tests, and continuous flow monitoring devices (pressure transducers). An auto logging crest gauges has been installed within the headwater valley channel and will continuously record flow conditions at an hourly interval. This gauge will be downloaded during each site visit to determine if intermittent or seasonal flows conditions are present.

3.2 Wetland Hydrology

Wetland hydrology will be monitored to document hydric conditions in the wetland restoration areas. This will be accomplished with automatic recording pressure transducer gauges installed in representative locations across the restoration areas and reference wetland areas. A total of fourteen automatic recording pressure transducers (Auto-Wells) have been installed on the site. Eleven auto-wells have been installed within the wetland restoration area and three within reference areas. The gauges will be downloaded quarterly and wetland hydroperiods will be calculated during the growing season. Gauge installation followed current regulatory and DMS guidance. Visual observations of primary and secondary wetland hydrology indicators will also be recorded during quarterly site visits.

3.3 Vegetation

A total of 20 vegetation plots were randomly established within the planted stream riparian buffer easement. Vegetation plots measure 10 meters by 10 meters or 5 meters by 20 meters (0.02 acres) and have all four corners marked with metal posts. Planted woody vegetation was assessed within each plot to establish a baseline dataset. Within each vegetation plot, each planted stem was identified for species, “X” and “Y” origin located, and measured for height. Reference digital photographs were also captured to document baseline conditions. Species composition, density, growth patterns, damaged stems, and survival ratios will be measured and reported on an annual basis. Vegetation plot data will be reported for each plot as well as an overall site average.

4 MAINTENANCE AND CONTINGENCY PLAN

All identified problematic areas or areas of concern such as stream bank erosion/instability, aggradation/degradation, lack of targeted vegetation, and invasive/exotic species which prevent the site from meeting performance success criteria will be evaluated on a case by case basis. These areas will be documented and remedial actions will be discussed amongst NCDMS staff to determine a plan of action. If it is determined remedial action is required, a plan will be provided.

4.1 Stream

No stream problems were identified in MY4. The three stream problem areas noted in MY3 were repaired in October 2018. The log outlet structure at the confluence of UT-1 and UT-2 was fixed as well as the double log drop before the confluence of UT-3 and UT-1. Also the localized areas of bank erosion on UT-1 were stabilized with livestakes and matting and a brush toe was added to one localized problem area.

4.2 Wetlands

No wetland problems areas were noted during the Year 4 monitoring period. The ditch between AW8 and AW7 was plugged in October 2018. Wetland hydrology and vegetation represent typical conditions of a site in Year 4 post construction monitoring. If any wetland problem areas are identified in the future, they will be documented and mapped on the CCPV as part of the annual monitoring report.

4.3 Vegetation

One vegetation problem area remained during the Year 4 monitoring period. The vegetation problem area is mapped on the Current Conditions Plan View (CCPV) as part of the annual monitoring report. The vegetation problem area (VPA1) consists of a 0.5-acre area of invasive species Chinese Privet (*Ligustrum sinense*) at the upstream portion of UT-1. Invasive treatment (cutting and spraying) was completed again in August 2018 and will continue as necessary in following years. The other vegetation problem area reported in MY3 was a small sparse herbaceous vegetation area along UT-2 above the stream crossing (Sta. 4+00). This area was reseeded, mulched, and replanted in October 2018.

5 YEAR 4 MONITORING CONDITIONS (MY4)

The Cedar Creek Year 4 Monitoring activities were completed in late August 2018. Year 4 wetland, stream hydrology, and vegetation monitoring data is present below and in the appendices. Per the Approved Mitigation Plan, cross section monitoring was not performed in Year 4. Data presented shows the site has no stream problem areas and one vegetation problem area; however, the site is on track to meeting stream, wetland and vegetation interim success criteria (**Figure 3**).

5.1 Year 4 Monitoring Data Collection

5.1.1 Morphological State of the Channel

Per the Approved Mitigation Plan, cross section monitoring was not performed in Year 4. Visual monitoring, however, was performed and no new problems were found in Year 4. Problems from previous years were repaired in October 2018 and are discussed in section 4.1.

5.1.2 Vegetation

The Year 4 monitoring vegetation survey was completed in late August 2018 and resulted in an average of 652 planted stems per acre, well above the interim survival density of 260 stems per acre at the end of Year 5 monitoring. The average stems per vegetation plot was 16 planted stems. The minimum planted stem per plot was nine stems and the maximum was 31 stems per plot. Six volunteer tree species were noted during MY4 activities. The average planted stem height was 5.6 feet. Vegetation summary data tables can be found in **Appendix C** and vegetation plot photos in **Figure 5**.

5.1.3 Photo Documentation

Permanent photo point locations have been established at cross sections, vegetation plots, stream crossings, and stream structures by RES staff. Any additional problem areas or areas of concern will

also be documented with a digital photograph during monitoring activities. Stream digital photographs can be found in **Figure 4** and **Figure 5** for vegetation photos.

5.1.4 Stream Hydrology

Three sets of manual and auto-logging crest gauges were installed on the site, one along UT2, one along UT2C, and one along UT3. The auto logging crest gauges were installed within the channel and continuously record flow conditions at hourly intervals. Crest Gauge 1 and Crest Gauge 3 documented bankfull events towards the end of Year 4 monitoring period. With the bankfull events in 2018, the site has now met the bankfull standard. Crest Gauge 2, on the headwater valley restoration reach UT-2C, documented 57 consecutive and 168 total flow days. Stream hydrology data can be found in **Appendix E**.

5.1.5 Wetland Hydrology

Eight of the eleven wetland gauges achieved the success criteria by remaining continuously within 12 inches of the soil surface for at least nine percent of the growing season. Groundwater gauge data indicate the hydroperiods being very responsive to rainfall events. Wetland hydrology gauge AW7 fell short of the nine percent success criteria. AW7 documented 7 days consecutively (3%) throughout the growing season. RES plugged the ditch adjacent to AW7 to make sure wetland hydrology is met in this area in future years. AW8 and AW11 fell short of the success as well but stayed above the five percent hydroperiod for jurisdictional wetlands with eight percent. All three reference gauges documented hydroperiods well above the nine percent success criteria ranging from 15 to 23 percent of the growing season. Wetland gauge and rainfall data is presented in **Table 15 and Figure 8**.

6 REFERENCES

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Appendix A

Project Background Data and Maps

Table 1. Project Components and Mitigation Credits

Table 1. Project Components and Mitigation Credits

Cedar Creek Stream and Wetland Restoration Project/DMS Project # 95718

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	5,230	0	13.10	N/A	N/A	N/A	N/A	N/A	N/A

Project Components

Project Component -or- Reach ID	Mitigation Plan Stationing/Location (LF)	Existing Footage/Acreage	Approach (PI, PII etc.)	Restoration or-Restoration Equivalent	Mitigation Plan Restoration Footage or Acreage	Mitigation Ratio	SMUs/ WMUs
UT1	1+01 to 31+65	3,064	Enhancement II	R	3,064	1 : 2.5	1,226
UT1	31+65 to 35+80	415	Enhancement I	R	415	1 : 1.5	277
UT1	35+80 to 41+95	615	Enhancement II	R	615	1 : 2.5	246
UT1	41+95 to 44+60	265	Enhancement I	R	265	1 : 1.5	177
UT1	44+60 to 53+51	891	Enhancement II	R	827	1 : 2.5	331
UT2	0+11 to 3+48	364	Headwater Valley	R	337	1 : 1.0	337
UT2	3+48 to 9+12	587	P1 Restoration	R	504	1 : 1.0	504
UT2C	0+02 to 1+92	NA	Headwater Valley	R	190	1 : 1.0	190
UT3	0+60 to 19+72	1,428	P1 Restoration	R	1,912	1 : 1.0	1,912
UT4	0+36 to 1+14	78	Enhancement II	R	78	1 : 2.5	31
Wetland 1	Adjacent to UT1 & UT3	17.3	Restoration	R	13.10	1 : 1.0	13.1

Component Summation

Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	2,416	13.10				
Headwater Valley	527					
Enhancement I	680					
Enhancement II	4,584					
Creation						
Preservation						
High Quality Preservation						

BMP Elements

Element	Location	Purpose/Function	Notes
---	---	---	---
---	---	---	---
---	---	---	---

BMP Elements

BR = Bioretention Cell; SF = Sand Filter; SW = Stormwater Wetland; WDP = Wet Detention Pond; DDP = Dry Detention Pond; FS = Filter Strip; S = Grassed Swale; LS = Level Spreader; NI = Natural Infiltration Area; FB = Forested Buffer

Credit calculations were originally calculated along the as-built thalweg. For Monitoring Year 3 forward, credits were updated to be calculated along stream centerlines following discussions stemming from the April 3, 2017 Credit Release Meeting.

Table 2. Project Activity and Reporting History

Project Activity and Reporting History Cedar Creek Stream and Wetland Restoration Project / DMS Project #95718		
Activity or Report	**Data Collection Complete**	**Completion or Delivery**
Mitigation Plan	NA	Aug-14
Final Design – Construction Plans	NA	Dec-14
Construction Completed	Mar-15	May-15
Site Planting Completed	May-15	May-15
Baseline Monitoring Document (Year 0 Monitoring – baseline)	Jul-15	Nov-15
Year 1 Monitoring	Dec-15	Feb-16
Year 2 Monitoring	Oct-16	Dec-16
Year 3 Monitoring	Stream: July-17 Vegetation: Aug-17	Feb-18
Beaver Management	NA	Sep-17
Year 4 Monitoring	Vegetation: Aug-18	Jan-19
Stream and Wetland Repair	NA	Oct-18
Year 5 Monitoring		
Year 6 Monitoring		
Year 7 Monitoring		

Table 3. Project Contacts

Project Contacts Table Cedar Creek Stream and Wetland Restoration Project /DMS Project #95718	
Designer	WK Dickson and Co., Inc. 720 Corporate Center Drive Raleigh, NC 27607 (919) 782-0495 Frasier Mullen, PE
Construction Contractor	Wright Contracting PO Box 545 Siler City, NC 27344 (919) 663-0810 Joseph Wright
Planting Contractor	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 (919) 209-1061 David Godley
Seeding Contractor	Wright Contracting PO Box 545 Siler City, NC 27344 (919) 663-0810 Joseph Wright
Seed Mix Sources	Green Resource
Nursery Stock Suppliers	Arbogen, NC Forestry Services Nursery
Full Delivery Provider Project Manager:	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 Brad Breslow
Monitoring Performers Project Manager:	Resource Environmental Solutions, LLC 302 Jefferson Street, Suite 110 Raleigh, NC 27605 (919) 741-6268 Ryan Medric

Table 4. Project Information

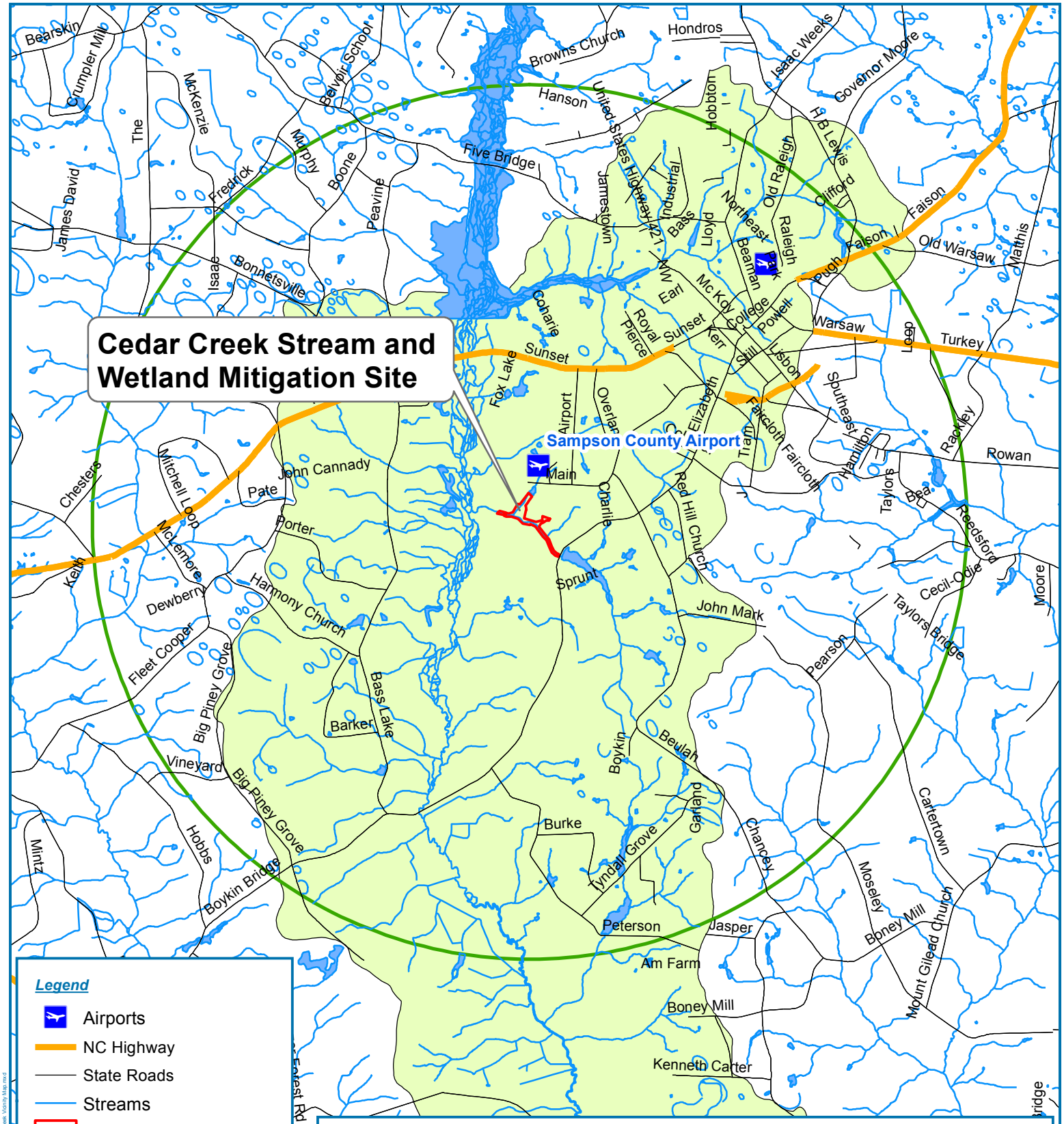
Project Information	
Project Name	Cedar Creek Site
County	Sampson
Project Area (acres)	42
Project Coordinates (latitude and longitude)	34° 57' 59.663" N 78° 22' 0.778" W
Project Watershed Summary Information	
Physiographic Province	Outer Coastal Plain
River Basin	Cape Fear
USGS Hydrologic Unit 8-digit	3030006
USGS Hydrologic Unit 14-digit	3003006090060
DWQ Sub-basin	3/6/2019
Project Drainage Area (acres)	2,890 acres
Project Drainage Area Percentage of Impervious Area	4.50%
CGIA Land Use Classification	Woody wetlands, Shrub/scrub, cultivated crops, evergreen forest

Reach Summary Information (As-Built Conditions)				
Parameters	**UT1**	**UT2**	**UT3**	**UT4**
Length of reach (linear feet)	5,186	1,048	1,941	78
Valley Classification	X	X	X	X
Drainage area (acres)	2780	35	151	77
NCDWQ stream identification score	50	34.5	40	42.5
NCDWQ Water Quality Classification	N/A	N/A	N/A	N/A
Morphological Description (stream type)	E5	E5	E5	E5
Evolutionary trend	Stage II	Stage II/III	Stage II/III	Stage II/III
Underlying mapped soils	BH	Jo	BH	BH
Drainage class	frequently flooded	undrained	frequently flooded	frequently flooded
Soil Hydric status	Hydric	Hydric	Hydric	Hydric
Slope	0.20%	1.40%	1.10%	1.00%
FEMA classification	N/A	N/A	AE	N/A
Native vegetation community	cultivated , mixed hardwood forest	cultivated, mixed hardwood forest	mixed hardwood	mixed hardwood
Percent composition of exotic invasive vegetation	<5	0	0	<5

Table 4 con't. Project Information

Wetland Summary Information	
Parameters	**Wetland 1 UT1/3**
Size of Wetland (acres)	13.72
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	Riparian Riverine
Mapped Soil Series	Bibb/Johnson
Drainage class	Frequently Flooded
Soil Hydric Status	Hydric
Source of Hydrology	Runoff/Groundwater Discharge
Hydrologic Impairment	Incised Channel, Dredging
Native vegetation community	Forested
Percent composition of exotic invasive vegetation	1 – 2%

Regulatory Considerations			
Regulation	**Applicable**	**Resolved**	**Supporting Documentation**
Waters of the United States - Section 404	Yes	Yes	SAW-2013-00389
Waters of the United States - Section 401	Yes	Yes	DWR # 13-0186
Endangered Species Act	Yes	Yes	USFWS (Corr. Letter)
Historic Preservation Act	Yes	Yes	SHPO (Corr. Letter)
Coastal Zone Management Act (CZMA)/Coastal Area Management Act (CAMA)	No	NA	N/A
FEMA Floodplain Compliance	Yes	Yes	EEP Floodplain Requirements Checklist
Essential Fisheries Habitat	No	NA	N/A



The Cedar Creek Stream and Wetland Site is located in Sampson County approximately 3.1 miles southwest of Clinton, NC. To access the Site from the town of Clinton, travel west on Highway 24 (Sunset Avenue), take a left onto Airport Road and go 1.3 miles. Turn right onto West Main Street Extension, go approximately 350 feet, and turn left onto a dirt farm path. Follow the farm path along the cultivated field edge to the southwest corner and enter the forest. Follow the dirt path to cultivated fields adjacent to the project below UT2. Turning to the left will take you to UT2. Going to the right will take you to UT3.

Figure1
Project Vicinity Map
Cedar Creek Stream and Wetland Restoration Site
Sampson County, North Carolina

Date: 11/6/2015
Drawn by: BSH

res

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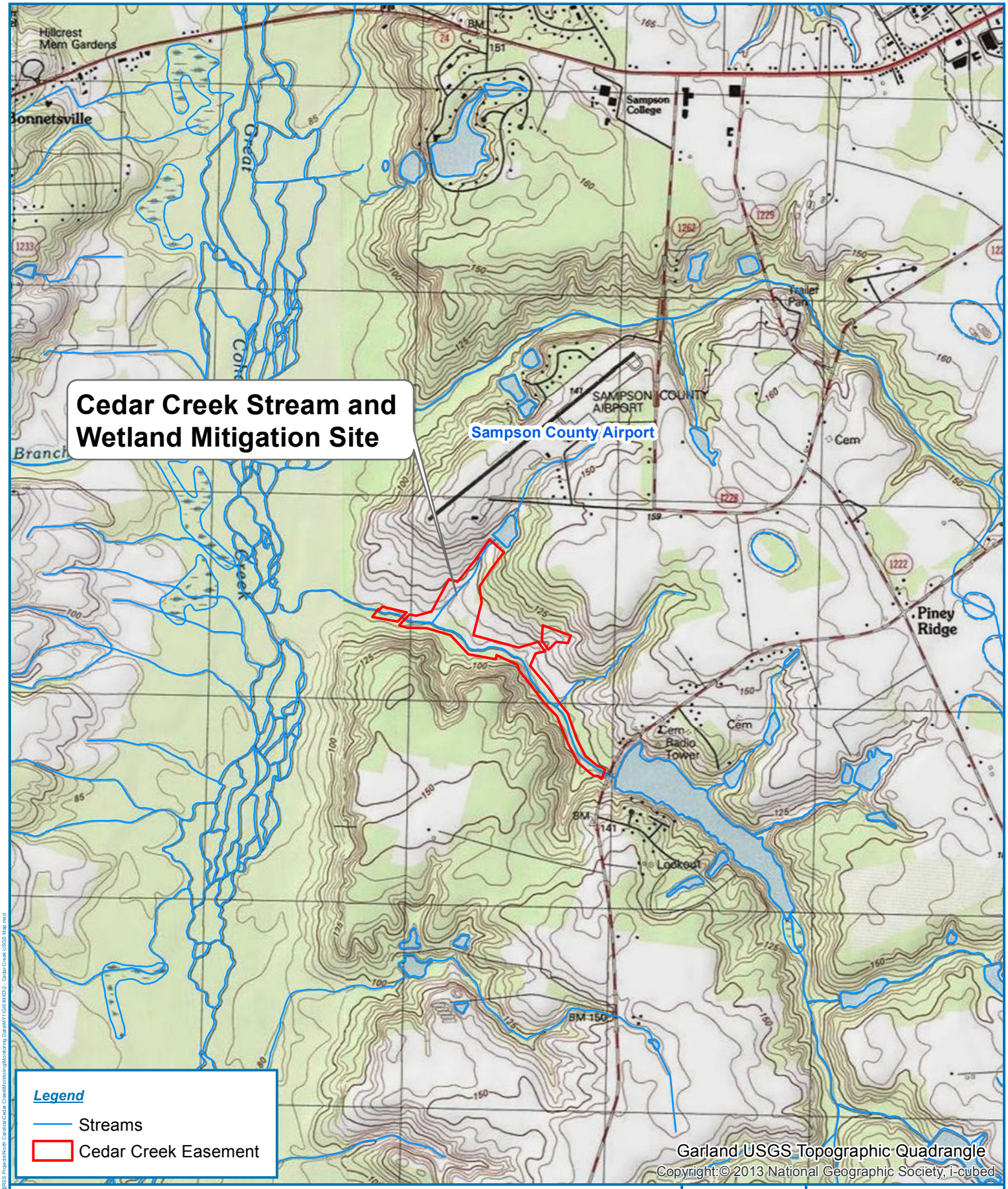


0 1,000 2,000
Feet

Figure2
Project USGS Map
Cedar Creek Stream and Wetland Restoration Site
Sampson County, North Carolina

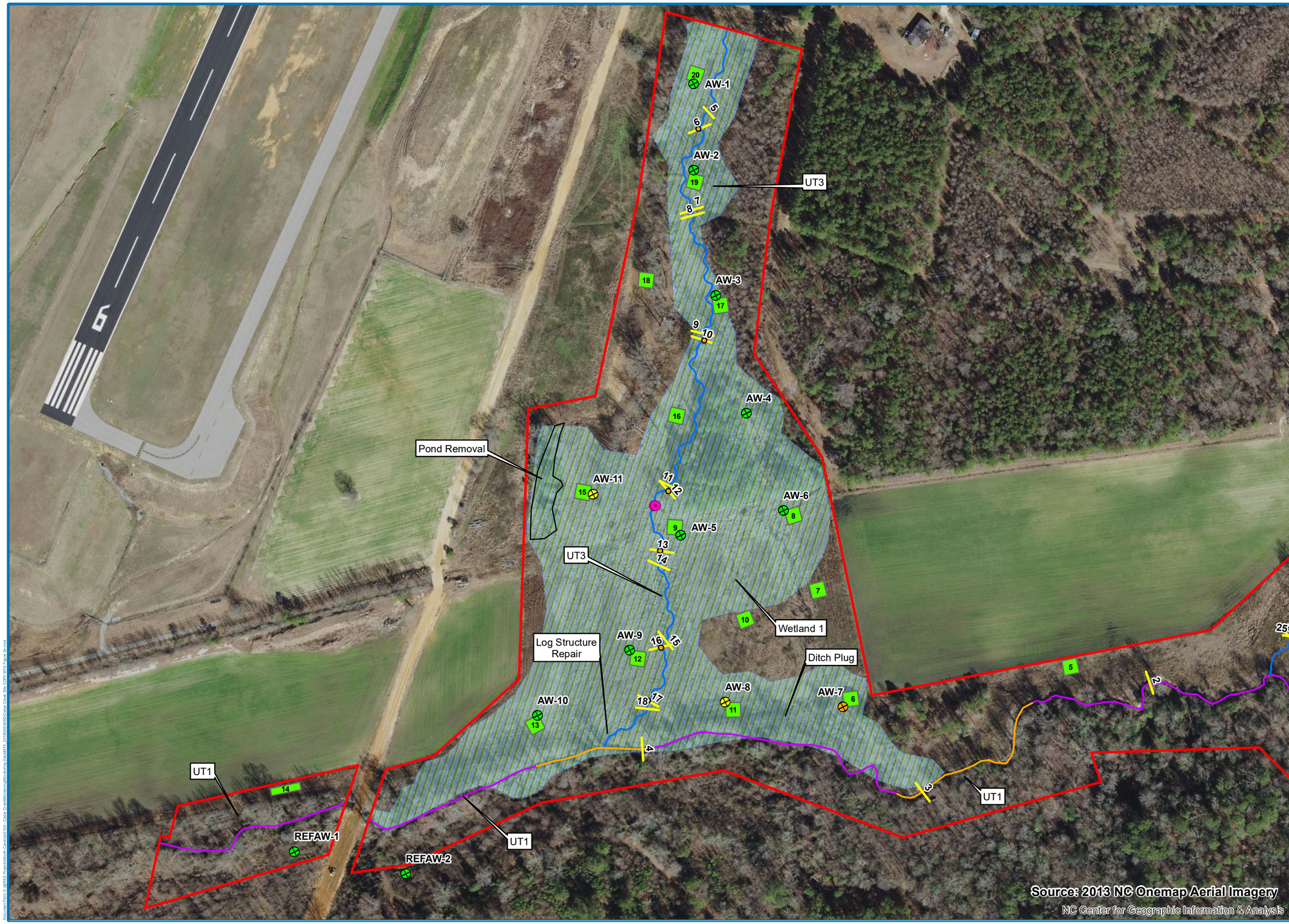
Date: 2/16/2016
Drawn by: BSH

res

Document Path: C:\Users\bhocker\Dropbox (RES)\@RES Projects\North Carolina\Cedar Creek\Monitoring\Monitoring Data\MYI\GIS\MXD\2 - Cedar Creek USGS Map.mxd

Appendix B

Visual Assessment Data



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Feet

1 inch = 200 feet

Figure 3a.

Cedar Creek Restoration Project MY4 2018

Current Conditions Plan View

Date: 1/22/2019	Drawn by: BPB

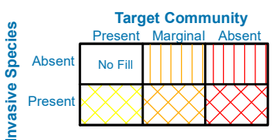
LEGEND

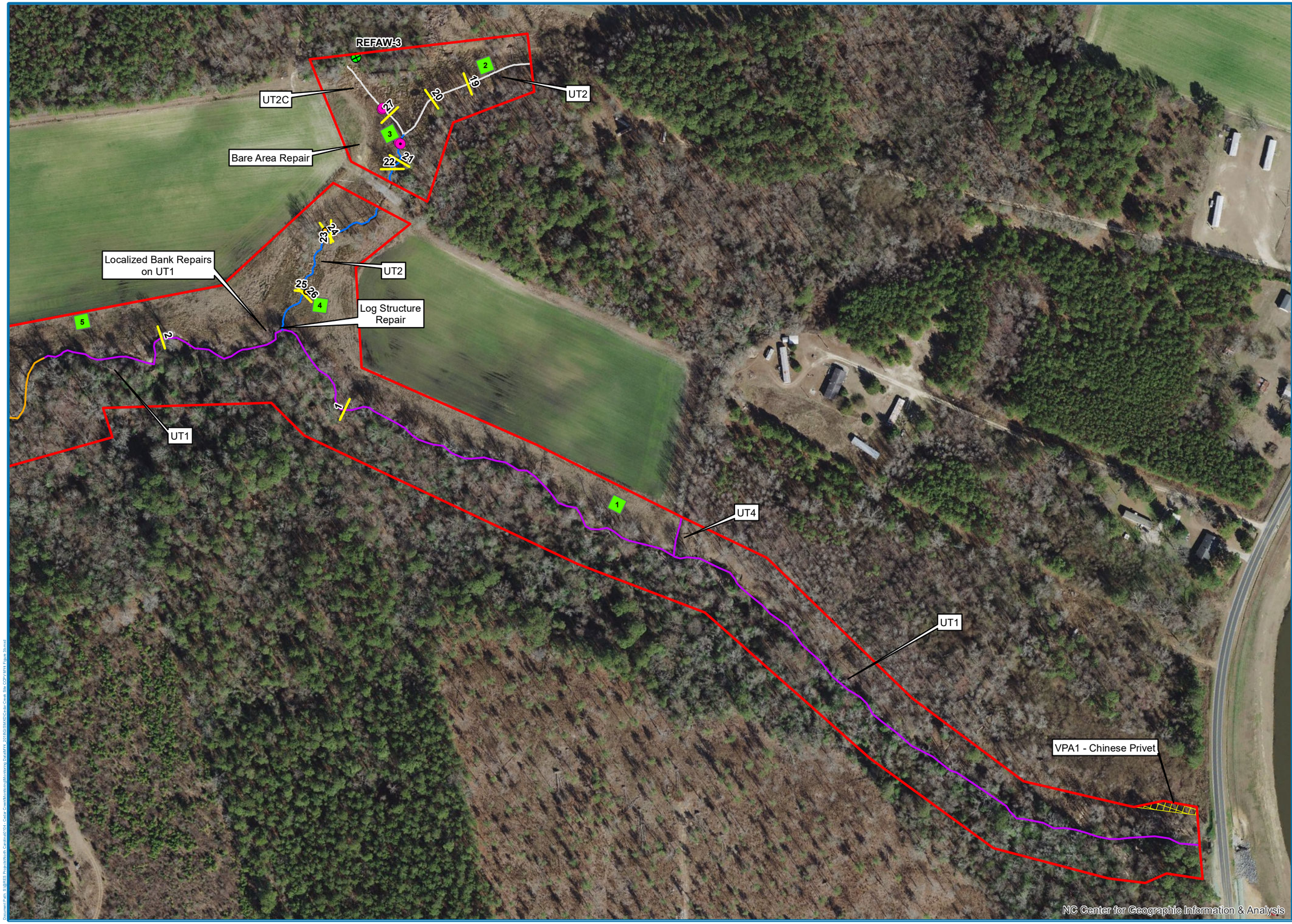
- Conservation Easement
- Wetland Restoration Area
- VP >260 stems/acre
- Cross Sections
- P1 Restoration
- Headwater Valley Restoration
- Enhancement I
- Enhancement II
- Bankpin
- Crest Gauge

Wetland Hydroperiod

- >9%
- 5-8%
- <4%

Vegetation Condition Assessment





res

0 100 200
Feet

1 inch = 200 feet

Figure 3b.

Cedar Creek Restoration Project MY4 2018

Current Conditions Plan View

Date: 1/22/2019	Drawn by: RTM

LEGEND

- Conservation Easement
- Wetland Restoration Area
- VP >260 stems/acre
- Cross Sections
- P1 Restoration
- Headwater Valley Restoration
- Enhancement I
- Enhancement II
- Bankpins
- Crest Gauge

Wetland Hydroperiod

- >9%
- 5-8%
- <4%

Vegetation Condition Assessment

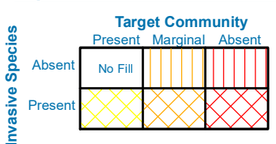


Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT1**
Assessed Length **5186**

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	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	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%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	5	5			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	5	5			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	5	5			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT2**
Assessed Length **855**

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	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	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%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	21	21			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	21	21			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	21	21			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	21	21			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	21	21			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT2C**
Assessed Length **193**

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	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	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%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	3	3			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	3	3			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	3	3			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	3	3			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	3	3			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT3**
Assessed Length **1941**

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	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	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%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	19	19			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	19	19			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	19	19			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	19	19			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	19	19			100%			

Table 5 **Visual Stream Morphology Stability Assessment**
Reach ID **UT4**
Assessed Length **78**

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	Adjusted % for Stabilizing Woody Vegetation
1. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			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%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%			100%
2. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	0	0			N/A			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	0			N/A			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	0	0			N/A			
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	0	0			N/A			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio > 1.6 Rootwads/logs providing some cover at base-flow.	0	0			N/A			

Table 6 Vegetation Condition Assessment

Planted Acreage[1] **20**

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

Easement Acreage[2] **37.6**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	Areas or points (if too small to render as polygons at map scale).	1000 SF	Yellow Crosshatch	1	0.05	0.1%
5. Easement Encroachment Areas[3]	Areas or points (if too small to render as polygons at map scale).	none	Red Simple Hatch	0	0.00	0.0%

1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

2 = The acreage within the easement boundaries.

3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likley trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly ealry in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolzing invasives polygons, particulalry for situations where the conditon for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

Table 7. Stream Problem Areas Cedar Creek Stream and Wetland Restoration Project - Project # 95718			
Feature Issue	**Station # / Range**	**Suspected Cause; Repair**	**Photo Number**

Table 8. Vegetation Problem Areas Cedar Creek Stream and Wetland Restoration Project - Project # 95718			
Feature Category	**Station Numbers**	**Suspected Cause; Repair**	**Photo Number**
VPA1	UT1 @ 1+00 to 2+25	One patch of Chinese Privet present along the right bank on the most upstream easement corner of UT1. Treatments will continue as needed.	N/A

Figure 5. MY4 Vegetation Plot Photos

Vegetation Plot 1

Vegetation Plot 2

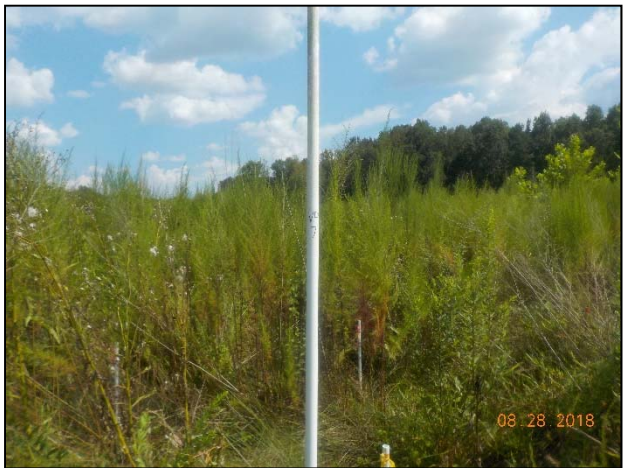

Vegetation Plot 3


Vegetation Plot 4

Vegetation Plot 5

Vegetation Plot 6

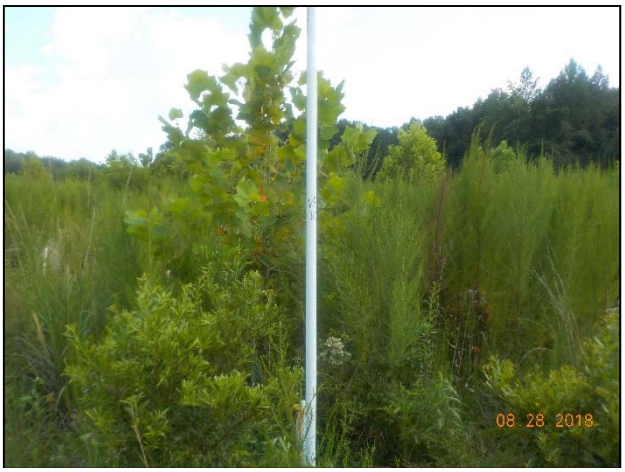
Cedar Creek MY4 Vegetation Plot Photos



Vegetation Plot 7

Vegetation Plot 8

Vegetation Plot 9



Vegetation Plot 10

Vegetation Plot 11

Vegetation Plot 12

Cedar Creek MY4 Vegetation Plot Photos

Vegetation Plot 13

Vegetation Plot 14

Vegetation Plot 15

Vegetation Plot 16

Vegetation Plot 17

Vegetation Plot 18

Cedar Creek MY4 Vegetation Plot Photos

Vegetation Plot 19

Vegetation Plot 20

Appendix C

Vegetation Plot Data

Table 9a. Vegetation Plot Criteria Attainment Summary
Table 9b. CVS Vegetation Plot Metadata
Table 9c. Planted and Total Stem Counts (Species by Plot)

Table 9a. Vegetation Plot Criteria Attainment Summary

Plot #	Planted Stems/Acre	Volunteer Stems/Acre	Total Stems/Acre	Success Criteria Met?	Average Stem Height (ft)
1	890	25,293	26,183	Yes	5.8
2	1,255	0	1,255	Yes	5.3
3	971	4,087	5,059	Yes	4.5
4	728	32,375	33,103	Yes	8.0
5	486	0	486	Yes	7.3
6	728	2,954	3,683	Yes	4.7
7	445	1,052	1,497	Yes	2.8
8	607	0	607	Yes	8.8
9	364	2,671	3,035	Yes	6.9
10	526	4,290	4,816	Yes	2.3
11	567	0	567	Yes	5.5
12	688	0	688	Yes	8.0
13	526	0	526	Yes	8.9
14	647	0	647	Yes	3.5
15	809	0	809	Yes	8.4
16	486	6,637	7,122	Yes	4.8
17	486	4,856	5,342	Yes	5.0
18	971	4,937	5,908	Yes	1.8
19	405	0	405	Yes	6.8
20	445	121	567	Yes	4.8
Project Avg	**652**	**4,464**	**5,115**	**Yes**	**5.6**

Table 9b. CVS Vegetation Plot Metadata Cedar Creek Stream and Wetland Restoration Site	
Report Prepared By	Ryan Medric
Date Prepared	11/6/2018 11:53
database name	Cedar_Creek_MY4_2018.mdb
database location	S:\@RES Projects\North Carolina\0104 - Cedar Creek\Monitoring\Monitoring Data\MY4_2018\Vegetation Data
computer name	DESKTOP-SN39OLO
file size	76546048
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY	
Project Code	95718
project Name	Cedar Creek Restoration Site
Description	
River Basin	Cape Fear
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	20

Table 9c. Planted and Total Stem Counts (Species by Plot)

Cedar Creek			Current Plot Data (MY4 2018)																																		
			95718-01-0001			95718-01-0002			95718-01-0003			95718-01-0004			95718-01-0005			95718-01-0006			95718-01-0007			95718-01-0008			95718-01-0009			95718-01-0010			95718-01-0011			95718-01-0012			95718-01-0013		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree			621						100			500						60			24						54			100								
Asimina triloba	pawpaw	Tree																												7	7	7	1	1	1				1	1	1
Betula nigra	river birch	Tree	12	12	12							1	1	1	1	1	1							2	2	2							1	1	1						
Carya ovata	shagbark hickory	Tree																																						
Chamaecyparis thyoides	Atlantic white cedar	Tree							5	5	5																6	6	6							11	11	11			
Crataegus aestivalis	may hawthorn	Shrub Tree																																						
Diospyros virginiana	common persimmon	Tree																2	2	2	3	3	3																	
Liquidambar styraciflua	sweetgum	Tree			4															9									12			4								
Liriodendron tulipifera	tuliptree	Tree												300						4			2									2								
Malus	apple	Tree																																						
Nyssa sylvatica	blackgum	Tree																									1	1	1												
Pinus	pine	Tree																																						
Pinus taeda	loblolly pine	Tree																																						
Platanus occidentalis	American sycamore	Tree	1	1	1							6	6	6	1	1	1							8	8	8				1	1	1	1	1	1				4	4	4
Quercus	oak	Tree	2	2	2																2	2	2																	
Quercus lyrata	overcup oak	Tree	4	4	4				1	1	1	2	2	2	6	6	6	7	7	7										2	2	2	1	1	1				3	3	3
Quercus michauxii	swamp chestnut oak	Tree							1	1	1	3	3	3	1	1	1	5	5	5	4	4	4	1	1	1				2	2	2	3	3	3						
Quercus nigra	water oak	Tree																															1	1	1				1	1	1
Quercus phellos	willow oak	Tree	3	3	3				3	3	3	6	6	6										1	1	1				1	1	1	2	2	2						
Salix nigra	black willow	Tree									1																														
Sambucus	elderberry	Shrub																																						
Taxodium distichum	bald cypress	Tree				31	31	31	14	14	14				3	3	3	4	4	4	2	2	2	3	3	3	2	2	2				4	4	4	6	6	6	4	4	4
Unknown		Shrub or Tree																																						
		Stem count	22	22	647	31	31	31	24	24	125	18	18	818	12	12	12	18	18	91	11	11	37	15	15	15	9	9	75	13	13	119	14	14	14	17	17	17	13	13	13
		size (ares)	1			1			1			1			1			1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	5	5	7	1	1	1	5	5	7	5	5	7	5	5	5	4	4	7	4	4	6	5	5	5	3	3	5	5	5	8	8	8	8	2	2	2	5	5	5
		Stems per ACRE	890	890	26183	1255	1255	1255	971	971	5059	728	728	33103	486	486	486	728	728	3683	445	445	1497	607	607	607	364	364	3035	526	526	4816	567	567	567	688	688	688	526	526	526

			Current Plot Data (MY4 2018)																					Annual Means																	
			95718-01-0014			95718-01-0015			95718-01-0016			95718-01-0017			95718-01-0018			95718-01-0019			95718-01-0020			MY4 (2018)			MY3 (2017)			MY2 (2016)			MY1 (2015)			MY0 (2015)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree									150			120			100									1829			1042						15					
Asimina triloba	pawpaw	Tree	2	2	2																2	2	2	13	13	13	13	13	13	16	16	16	22	22	22	30	30	30			
Betula nigra	river birch	Tree				4	4	4																21	21	21	21	21	21	22	22	22	22	22	22	28	28	28			
Carya ovata	shagbark hickory	Tree																											2											
Chamaecyparis thyoides	Atlantic white cedar	Tree										2	2	2										24	24	24	25	25	25	28	28	28	32	32	32	34	34	34			
Crataegus aestivalis	may hawthorn	Shrub Tree	2	2	2																			2	2	2	2	2	2											
Diospyros virginiana	common persimmon	Tree																						5	5	5	5	5	5	4	4	4								
Liquidambar styraciflua	sweetgum	Tree									2															31			170						16					
Liriodendron tulipifera	tuliptree	Tree				1	1	1									1							1	1	310	1	1	47	3	3	3	9	9	9	19	19	19			
Malus	apple	Tree																												3	3	3	4	4	4	10	10	10			
Nyssa sylvatica	blackgum	Tree	1	1	1							1	1	1										3	3	3	4	4	4	1	1	1								
Pinus	pine	Tree									10						13									23														
Pinus taeda	loblolly pine	Tree																											3											
Platanus occidentalis	American sycamore	Tree				7	7	7							2	2	2				1	1	1	32	32	32	32	32	32	33	33	33	35	35	35	40	40	40			
Quercus	oak	Tree																						4	4	4	5	5	5	10	10	10	20	20	20	181	181	181			
Quercus lyrata	overcup oak	Tree	2	2	2	4	4	4	1	1	1	1	1	1	13	13	13				2	2	2	49	49	49	48	48	48	55	55	55	54	54	54						
Quercus michauxii	swamp chestnut oak	Tree	3	3	3				4	4	4	2	2	2	4	4	4							33	33	33	35	35	35	51	51	51	61	61	61	35	35	35			
Quercus nigra	water oak	Tree	3	3	3												8	1	1	1	1	1	1	7	7	15	6	6	27	7	7	7	9	9	9	2	2	2			
Quercus phellos	willow oak	Tree	3	3	3	1	1	1	3	3	3				5	5	5	1	1	1	1	1	1	30	30	30	34	34	37	35	35	35	44	44	44	21	21	21			
Salix nigra	black willow	Tree									2												3			6			7											
Sambucus	elderberry	Shrub																																		1	1	1			
Taxodium distichum	bald cypress	Tree				3	3	3	4	4	4	6	6	6				8	8	8	4	4	4	98	98	98	98	98	98	102	102	102	107	107	107	142	142	142			
Unknown		Shrub or Tree																																		3	3	3			
		Stem count	16	16	16	20	20	20	12	12	176	12	12	132	24	24	146	10	10	10	11	11	14	322	322	2528	329	329	1623	370	370	370	419	419	450	546	546	546			
		size (ares)	1			1			1			1			1			1			1			20			20			20			20			20					
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.49			0.49			0.49			0.49			0.49					
		Species count	7	7	7	6	6	6	4	4	8	5	5	6	4	4	8	3	3	3	6	6	7	14	14	18	14	14	19	14	14	14	12	12	14	13	13	13			
		Stems per ACRE	647	647	647	809	809	809	486	486	7122	486	486	5342	971	971	5908	405	405	405	445	445	567	652	652	5115	666	666	3284	749	749	749	848	848	911	1105	1105	1105			

Appendix D

Stream Geomorphology Data

(Not required for MY4)

Appendix E

Hydrology Data

Table 13. Documentation of Geomorphologically Significant Flow Events

Crest Gauge	Stream Reach	Flow Events	Maximum Consecutive Flow Days	Cumulative Flow Days
Crest Gauge 2 (HWV)	UT-2C	32	57	168

Crest Gauge	Number of Bankfull Events	Maximum Bankfull Height (ft.)
Crest Gauge 1 (UT3)		
MY1	0	NA
MY2	4	1.15
MY3	0	NA
MY4	4	1.05
Crest Gauge 3 (UT2)		
MY1	0	NA
MY2	1	0.4
MY3	0	NA
MY4	2	0.25

Table 14. 2018 Rainfall Summary

Month	Average	Normal Limits		Clinton Precipitation
		30 Percent	70 Percent	
January	4.33	3.32	5.03	3.81
February	3.23	2.14	3.87	1.82
March	4.50	3.23	5.32	3.23
April	3.16	1.70	3.85	4.39
May	3.68	2.69	4.34	4.34
June	4.49	3.11	5.34	2.6
July	6.06	4.16	7.22	7.18
August	5.40	3.12	6.56	4.85
September	5.00	2.04	6.07	25.68
October	3.21	1.62	3.92	1.64
November	2.89	1.83	3.49	3.98
December	3.24	2.14	3.88	6.79
Total	49.19	31.10	58.89	70.31

Table 15a. 2018 Wetland Hydrology Criteria Attainment

2018 Max Hydroperiod (Growing Season 17-Mar through 14-Nov, 242 days) Success Criterion 9%					
Gauge	Consecutive		Cumulative		Occurrences
	Days	Percent of growing Season	Days	Percent of growing Season	
AW1	242	100	242	100	1
AW2	242	100	242	100	1
AW3	242	100	242	100	1
AW4	242	100	242	100	1
AW5	49	20	160	66	12
AW6	98	40	149	62	3
AW7	7	3	34	14	21
AW8	19	8	128	53	16
AW9	49	20	162	67	12
AW10	36	15	157	65	11
AW11	19	8	108	44	19
RAW1*	36	15	86	35	10
RAW2	62	25	185	76	8
RAW3	62	25	176	73	9

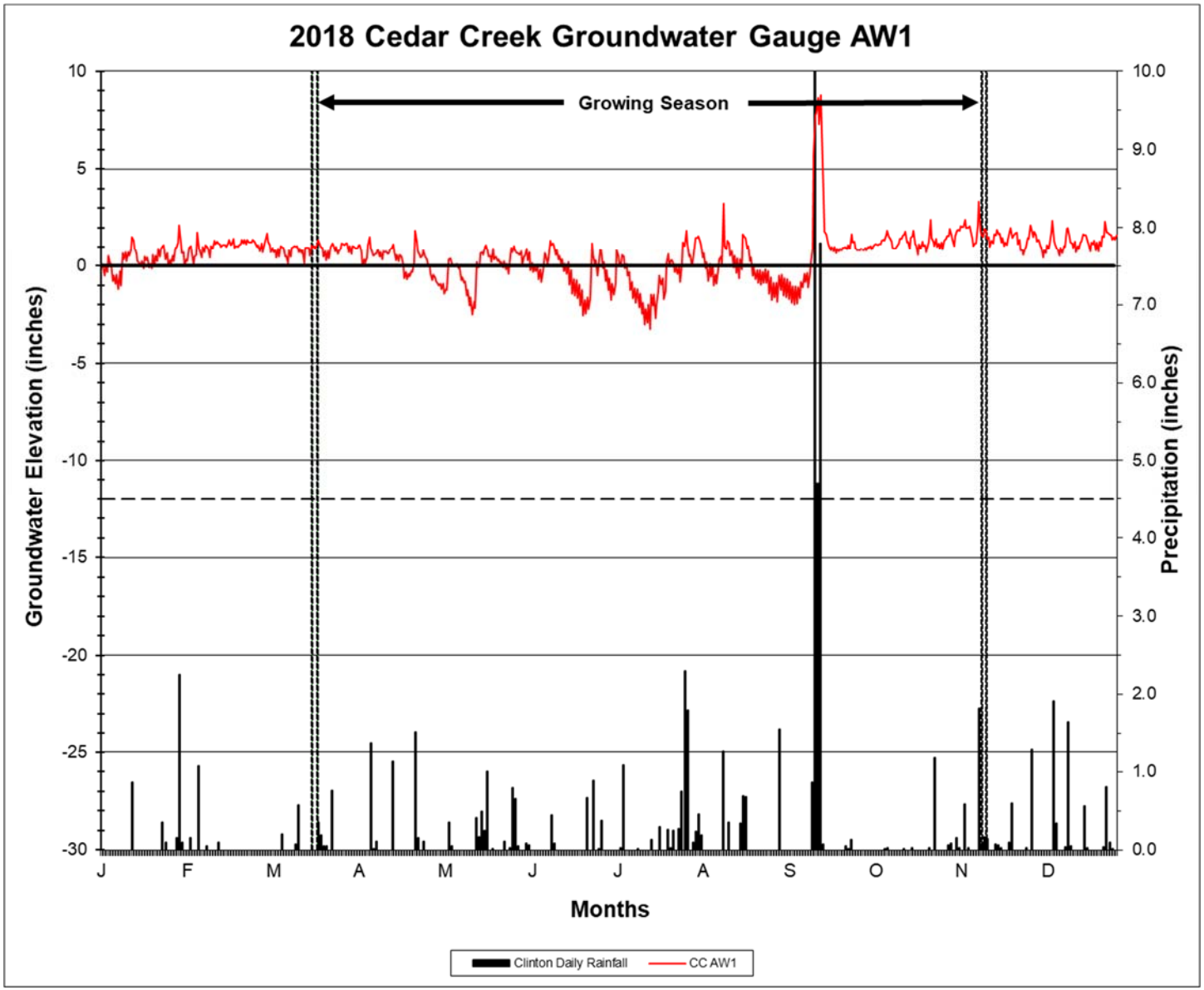
*Reference Well 1 was damaged during Hurricane Florence

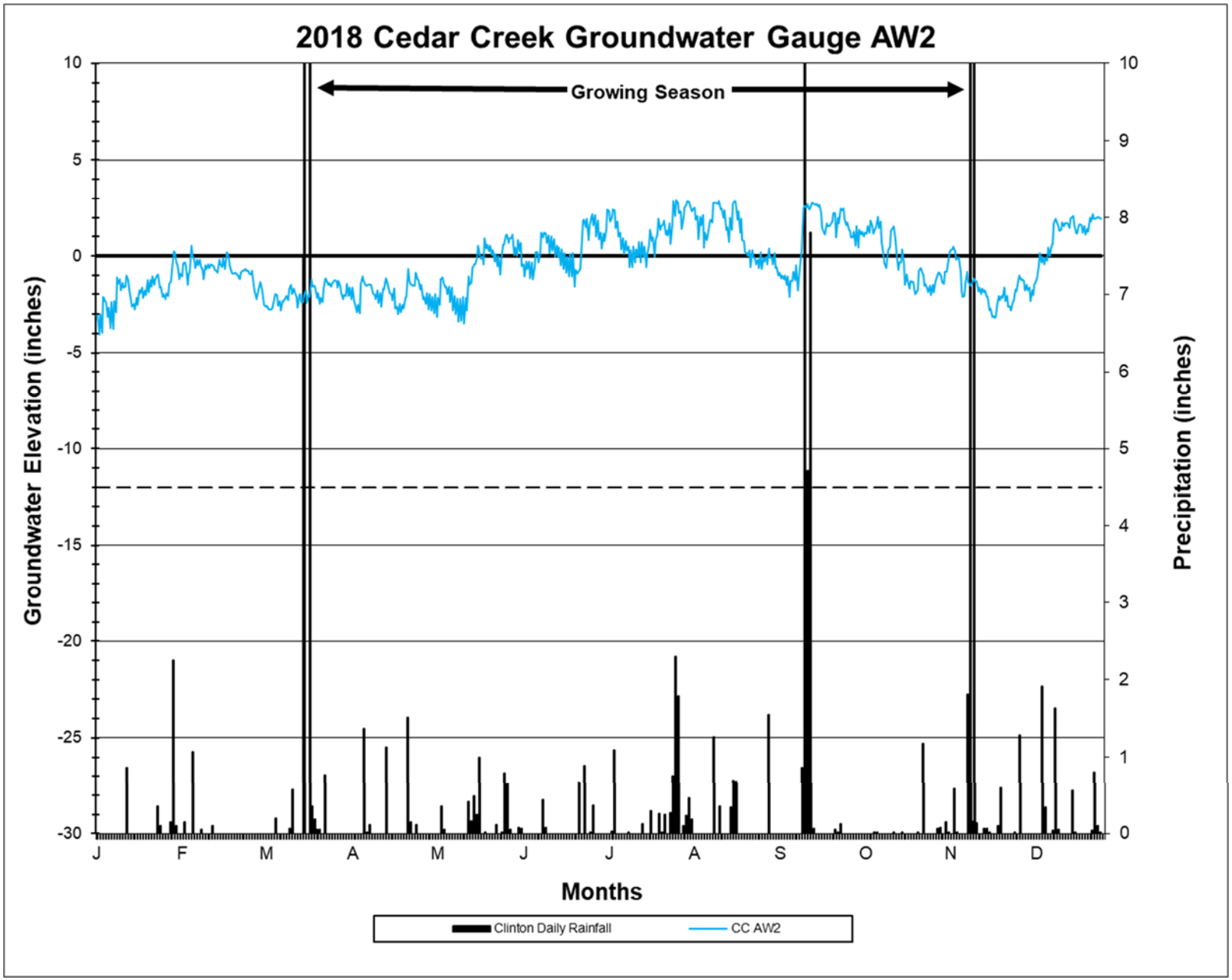
Table 15b. Wetland Hydrology Gauge Summary

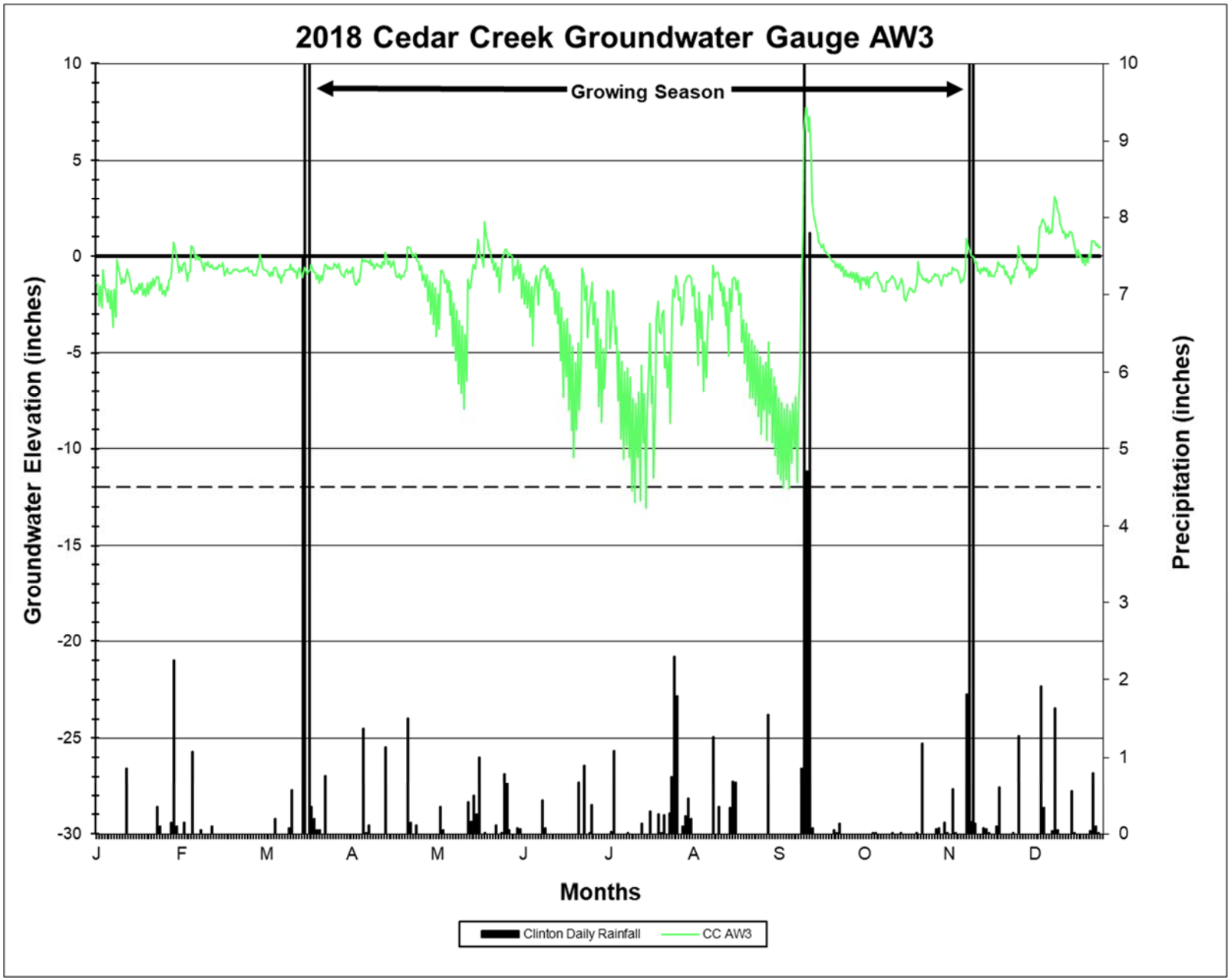
Gauge	MY1 - 2015 Consecutive		MY2 - 2016 Consecutive		MY3 - 2017 Consecutive		MY4 - 2018 Consecutive	
	Days	Percent of growing Season	Days	Percent of growing Season	Days	Percent of growing season	Days	Percent of growing season
AW1	162	67	229	94	240	99	242	100
AW2	162	67	229	94	240	99	242	100
AW3	71	29	134	55	242	100	242	100
AW4	100	41	229	94	131	54	242	100
AW5	51	21	60	25	53	22	49	20
AW6	51	21	96	39	79	32	98	40
AW7	5	2	4	2	2	1	7	3
AW8	21	9	34	14	28	12	19	8
AW9	51	21	33	13	61	25	49	20
AW10	50	21	35	14	31	13	36	15
AW11	13	5	6	2	24	10	19	8
RAW1	23	10	56	23	177	73	36	15
RAW2	52	21	99	41	191	79	62	25
RAW3	51	21	88	36	63	26	62	25

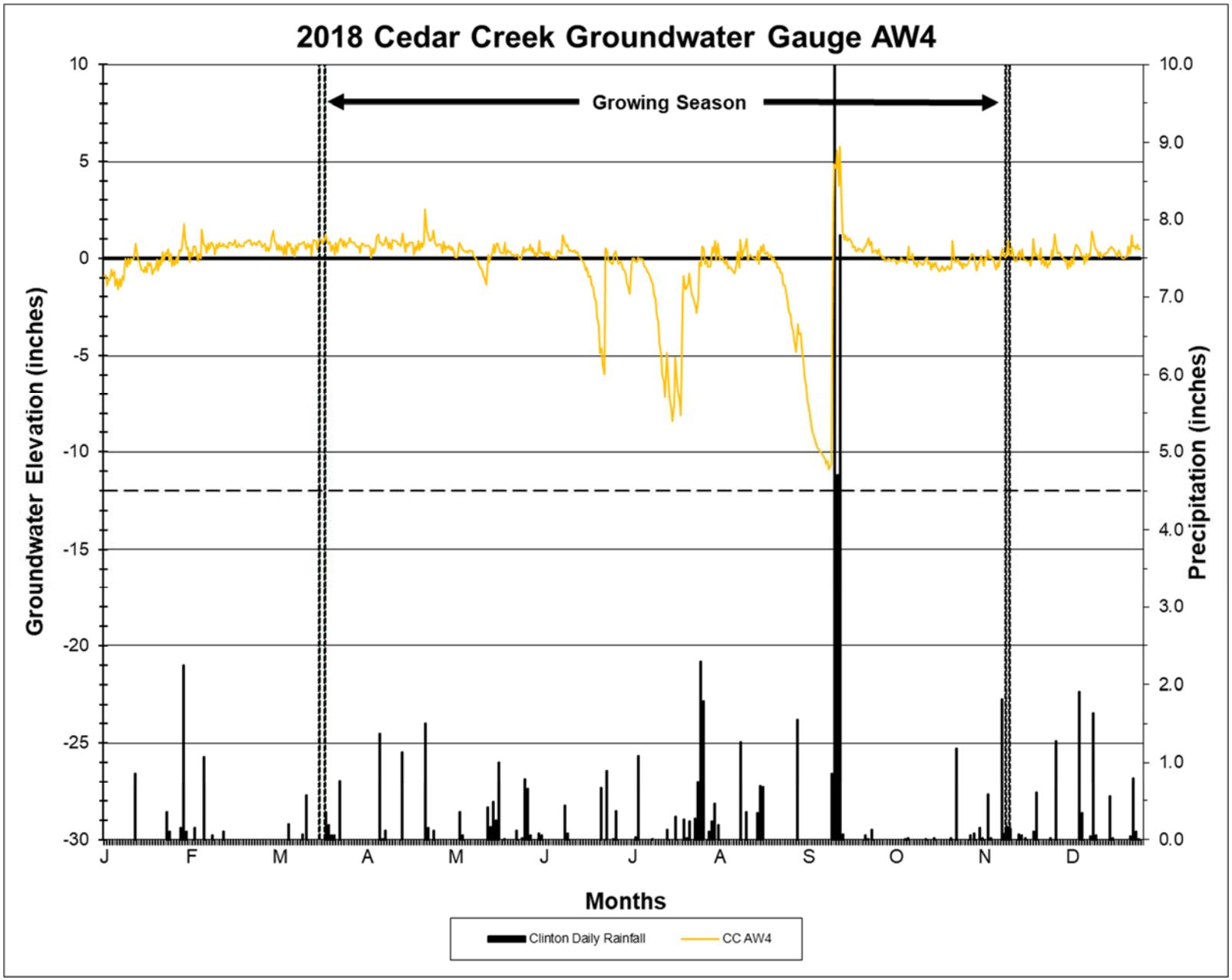
<5%	5-8%	≥9%

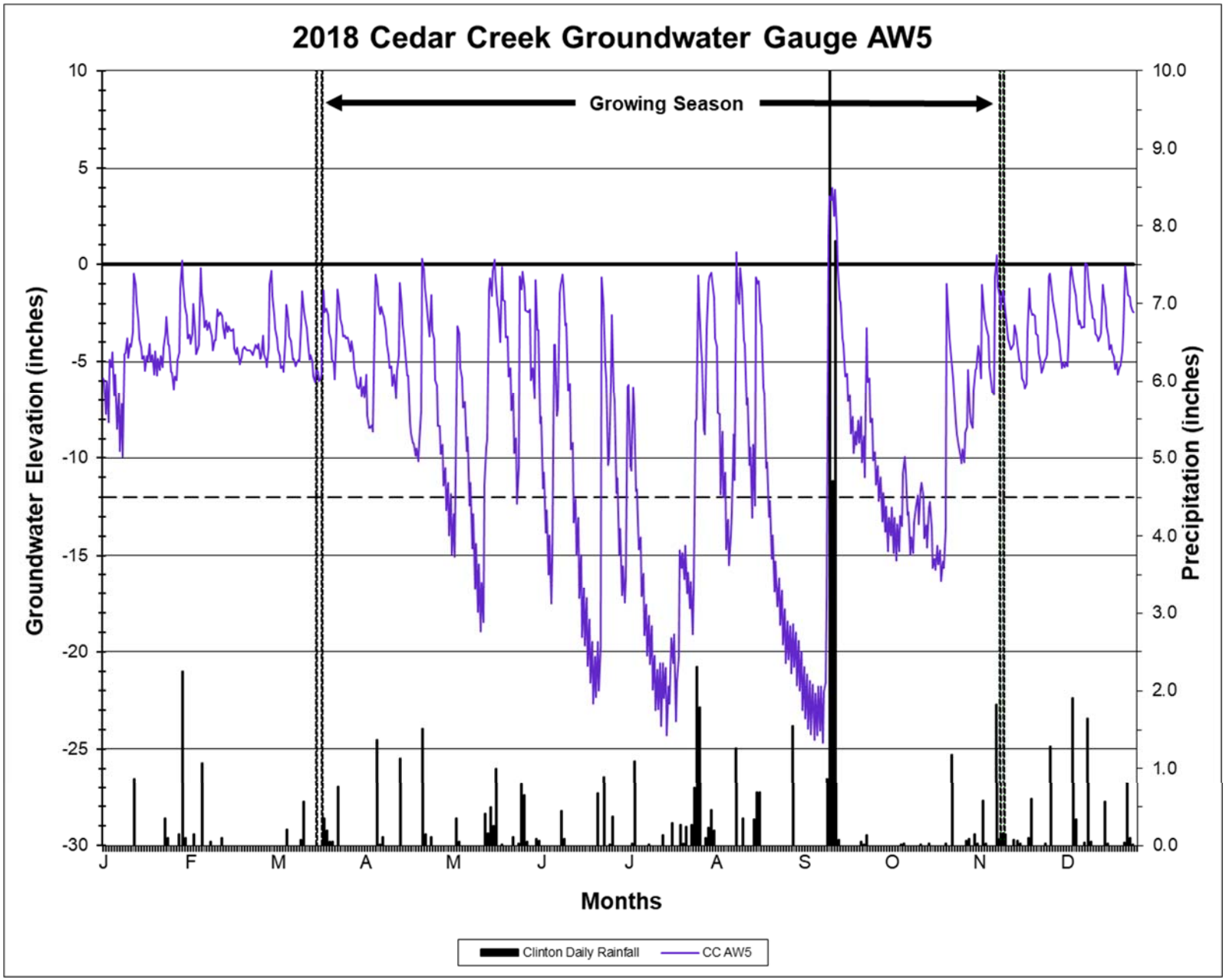
Figure 8. 2018 Cedar Creek Groundwater Monitoring Gauge Hydrographs

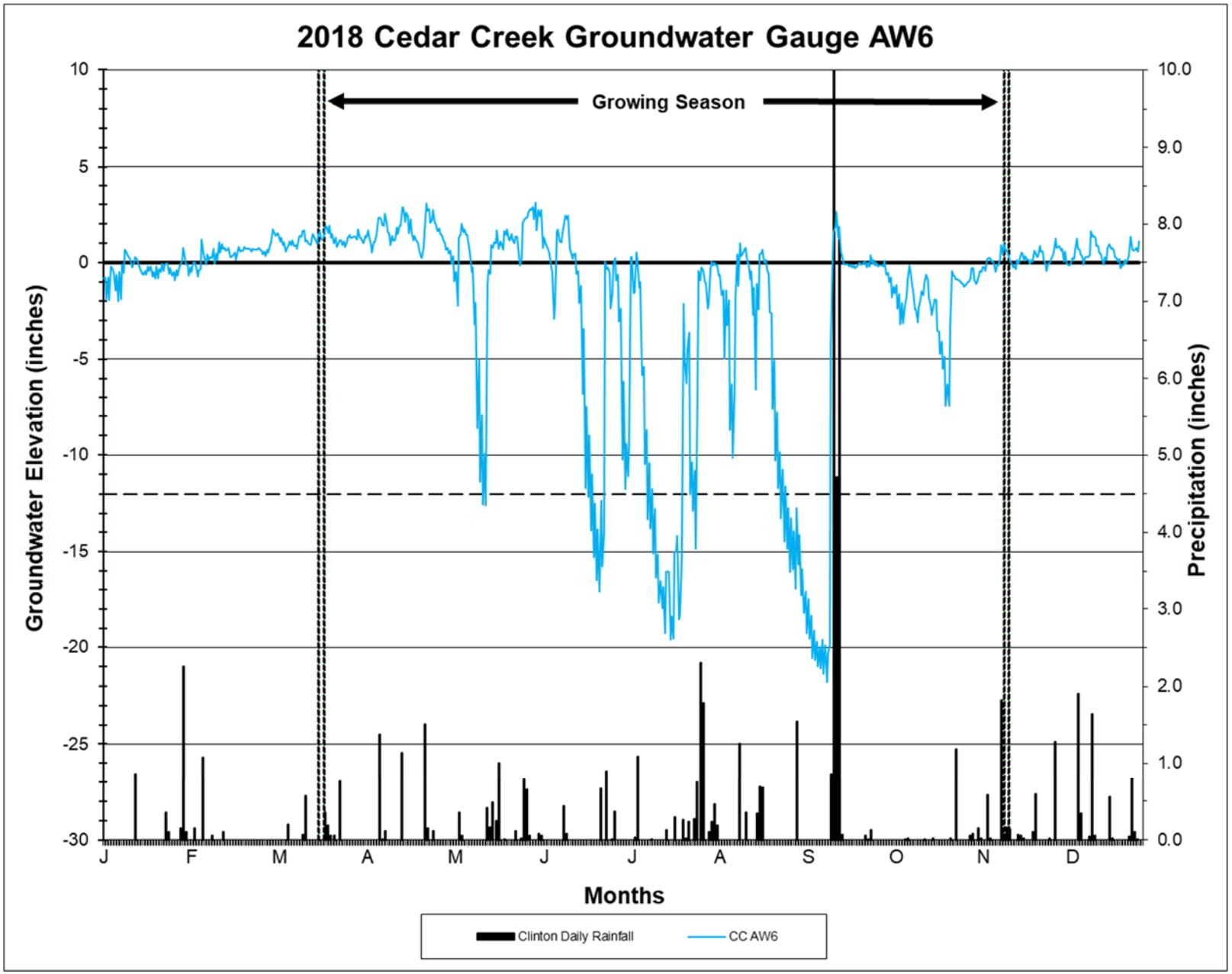


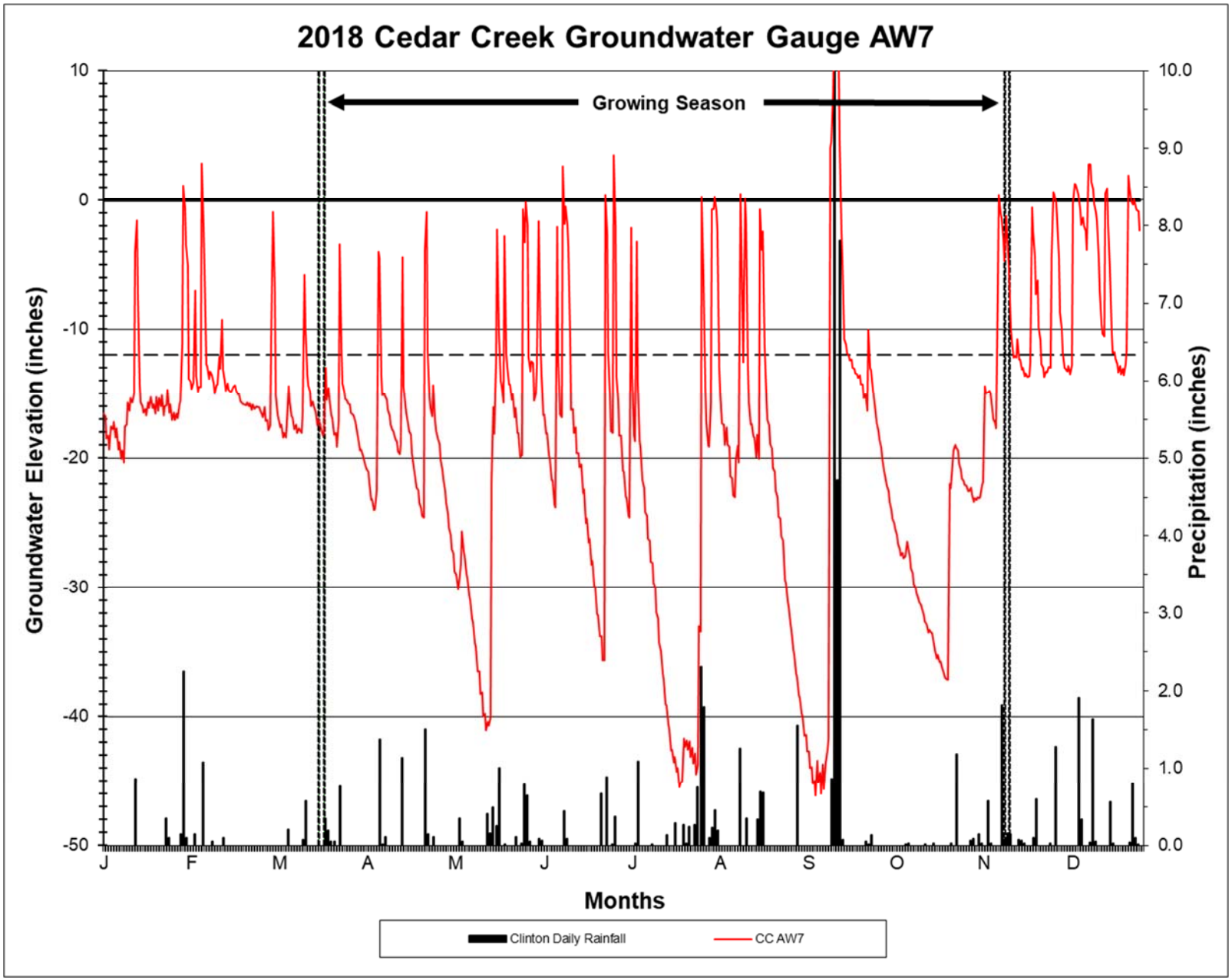

2018 Cedar Creek Groundwater Gauge AW2
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
9
8
7
6
5
4
3
2
1
0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW2

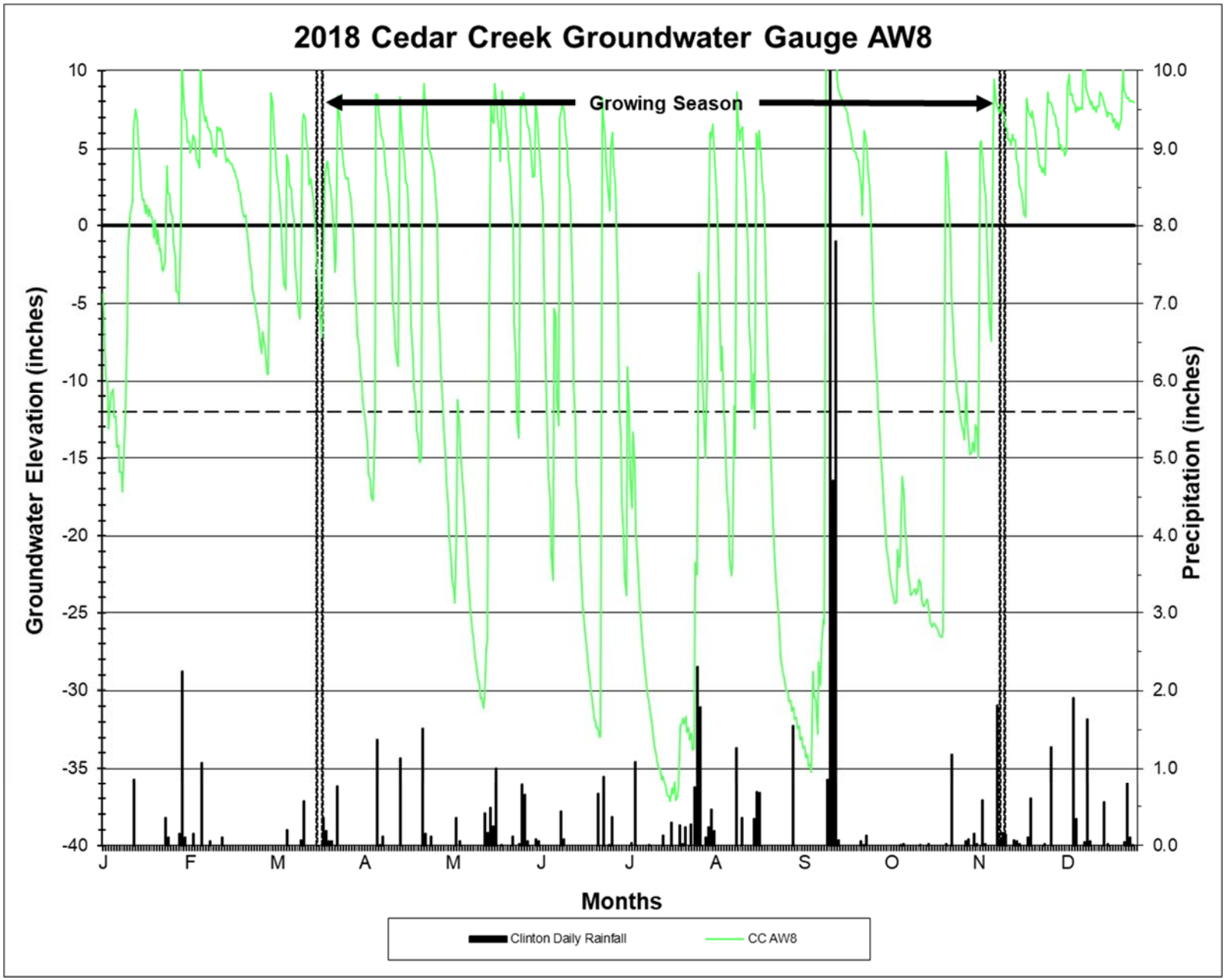

2018 Cedar Creek Groundwater Gauge AW3
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
9
8
7
6
5
4
3
2
1
0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW3

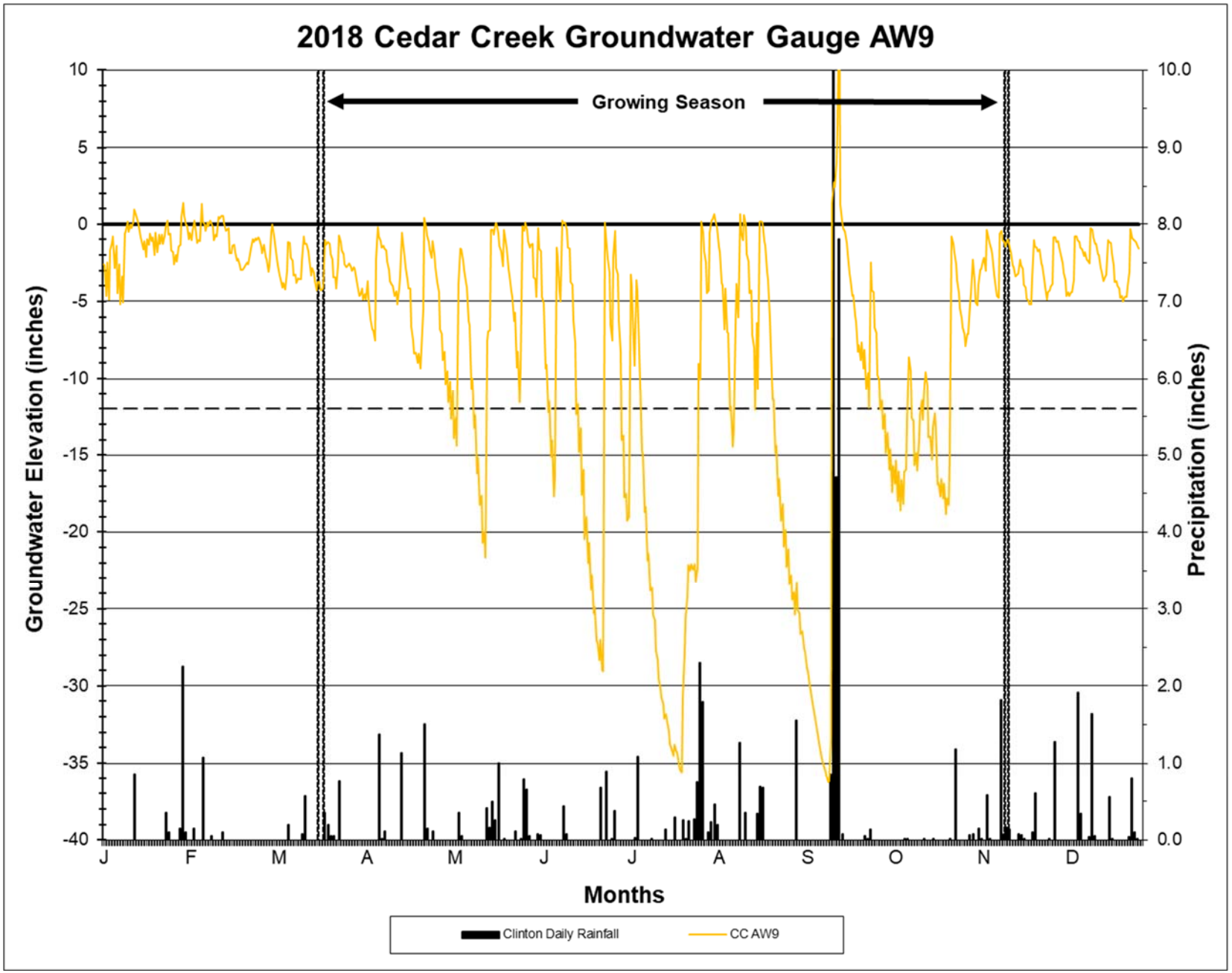

2018 Cedar Creek Groundwater Gauge AW4
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW4

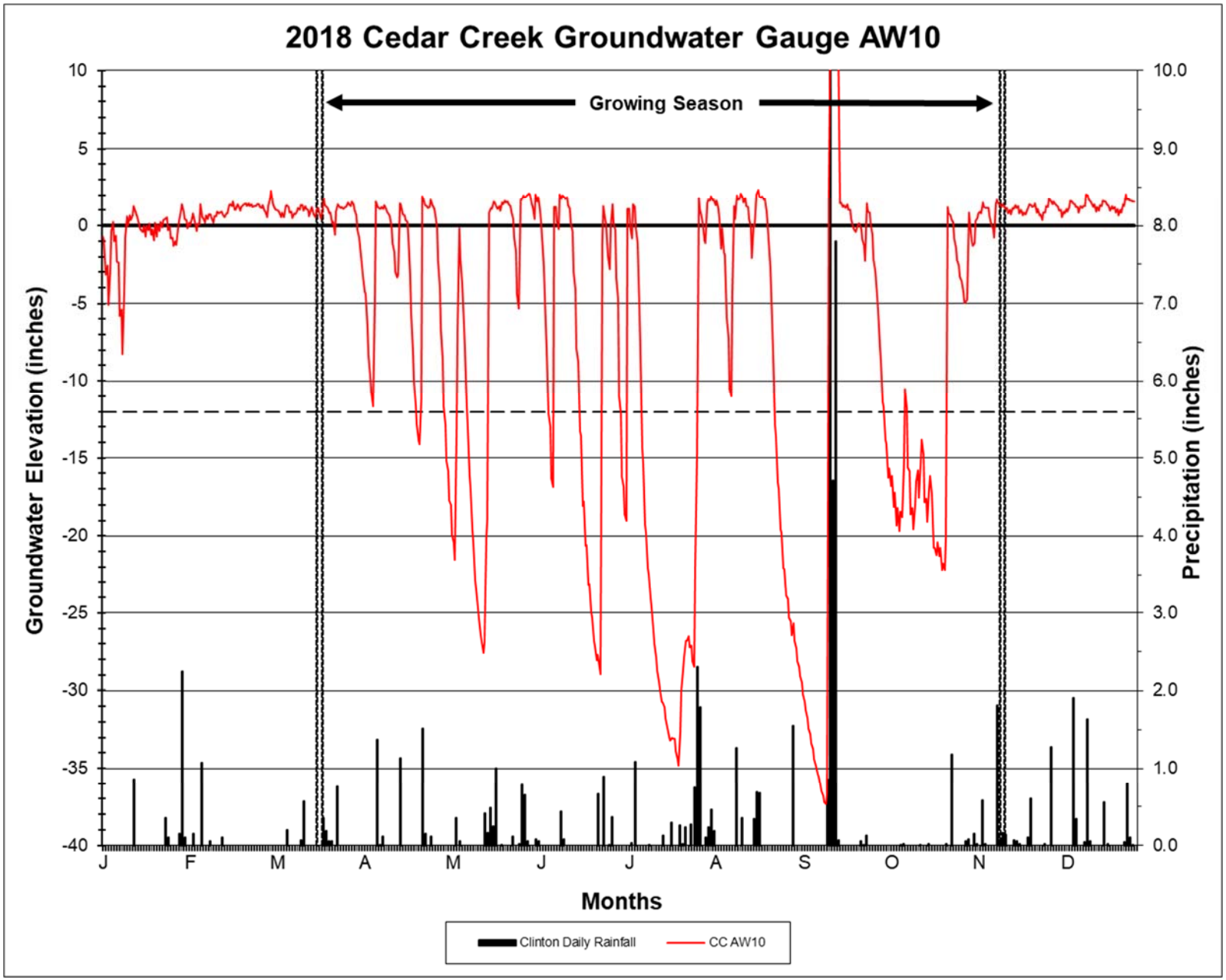

2018 Cedar Creek Groundwater Gauge AW5
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
Months
J
F
M
A
M
J
J
A
S
O
N
D
10
5
0
-5
-10
-15
-20
-25
-30
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Clinton Daily Rainfall
CC AW5

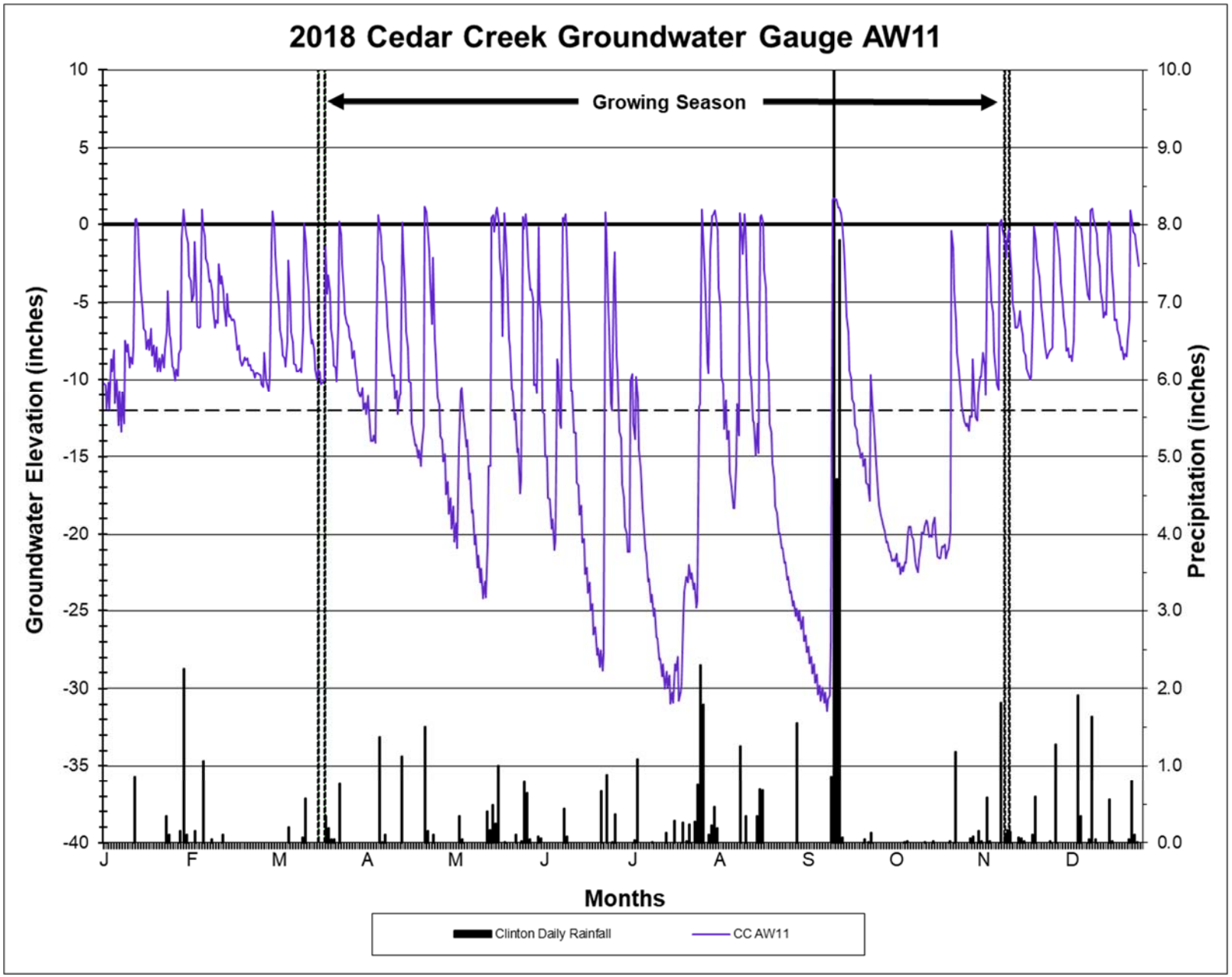

2018 Cedar Creek Groundwater Gauge AW6
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW6

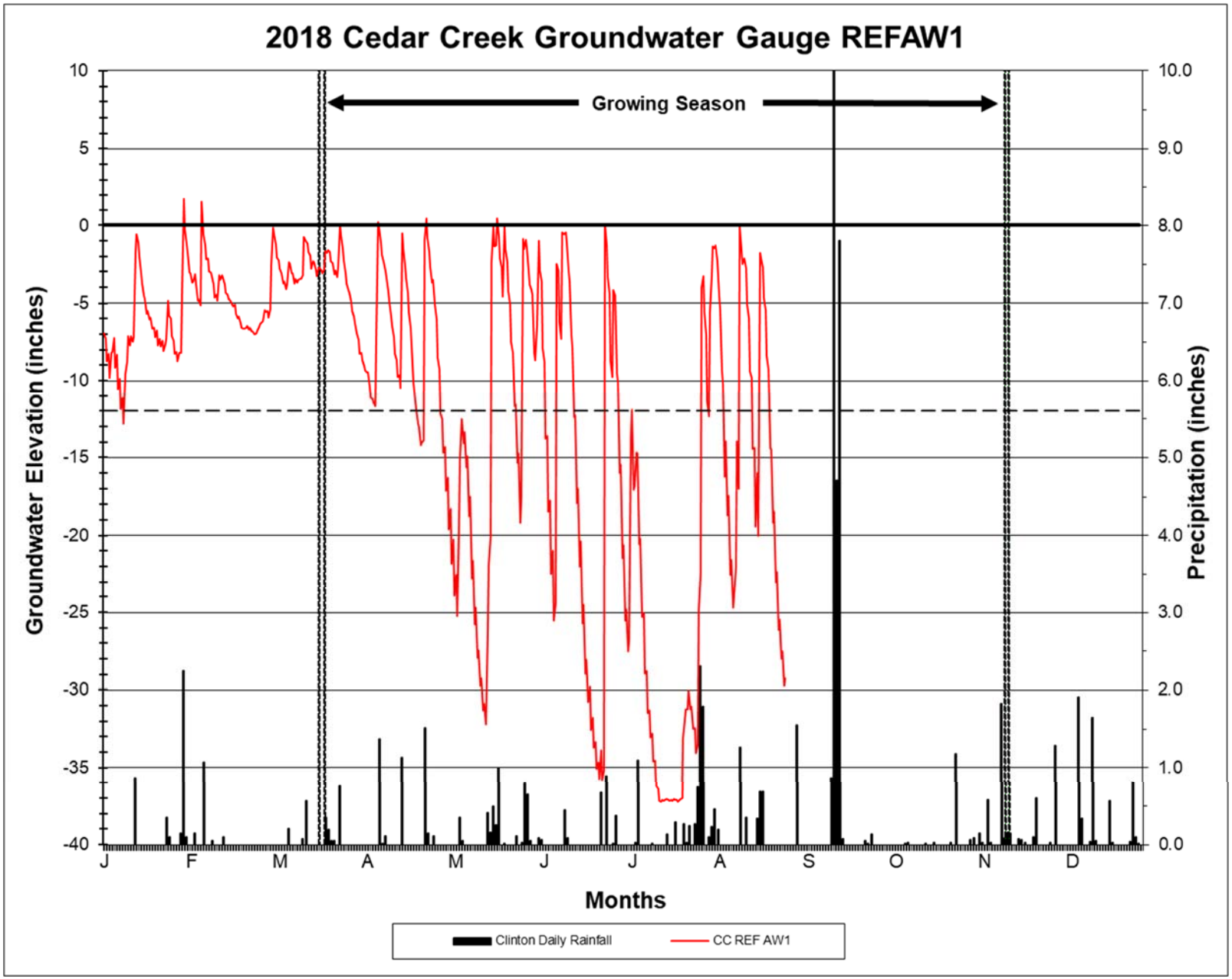

2018 Cedar Creek Groundwater Gauge AW7
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
0
-10
-20
-30
-40
-50
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW7

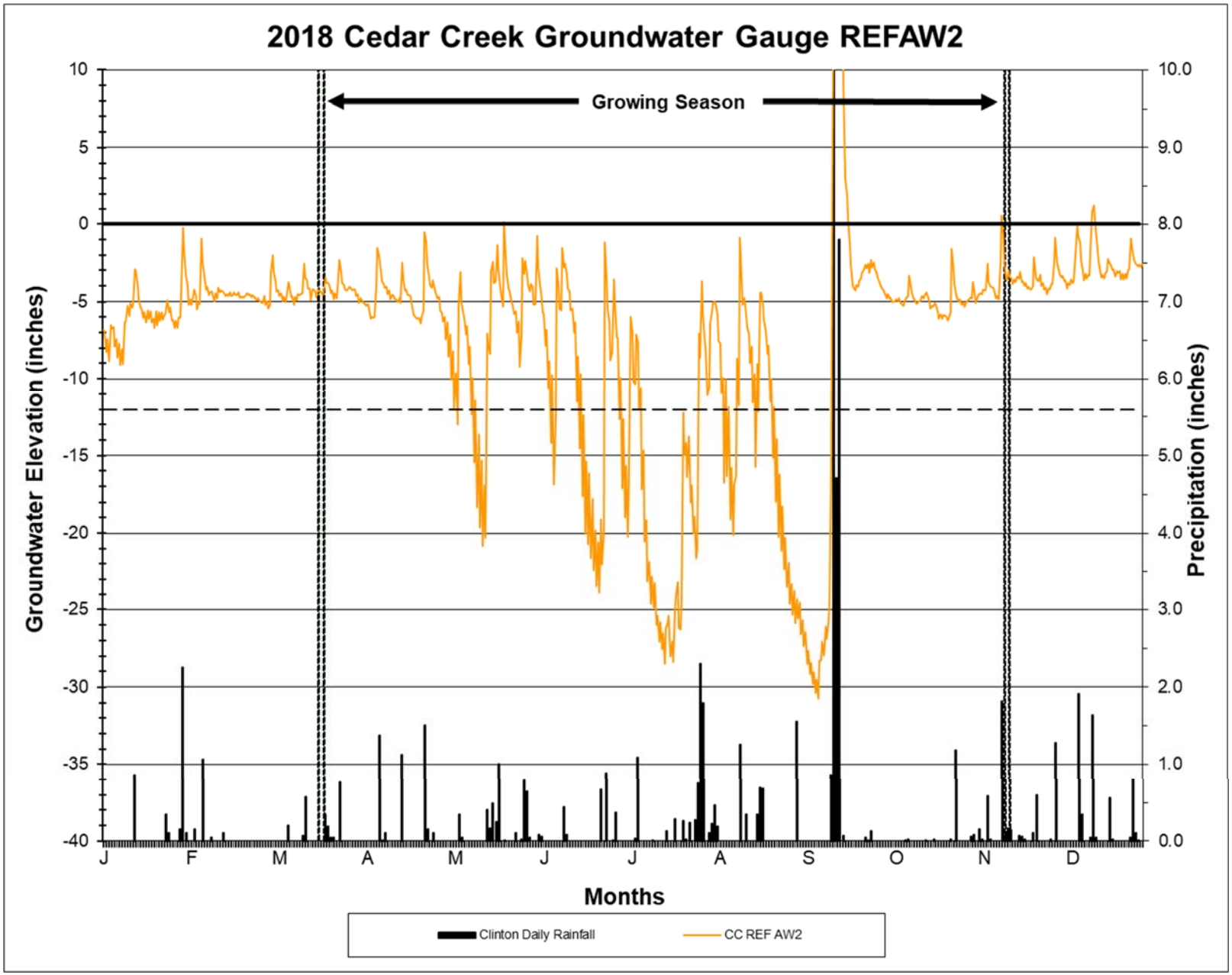

2018 Cedar Creek Groundwater Gauge AW8
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW8

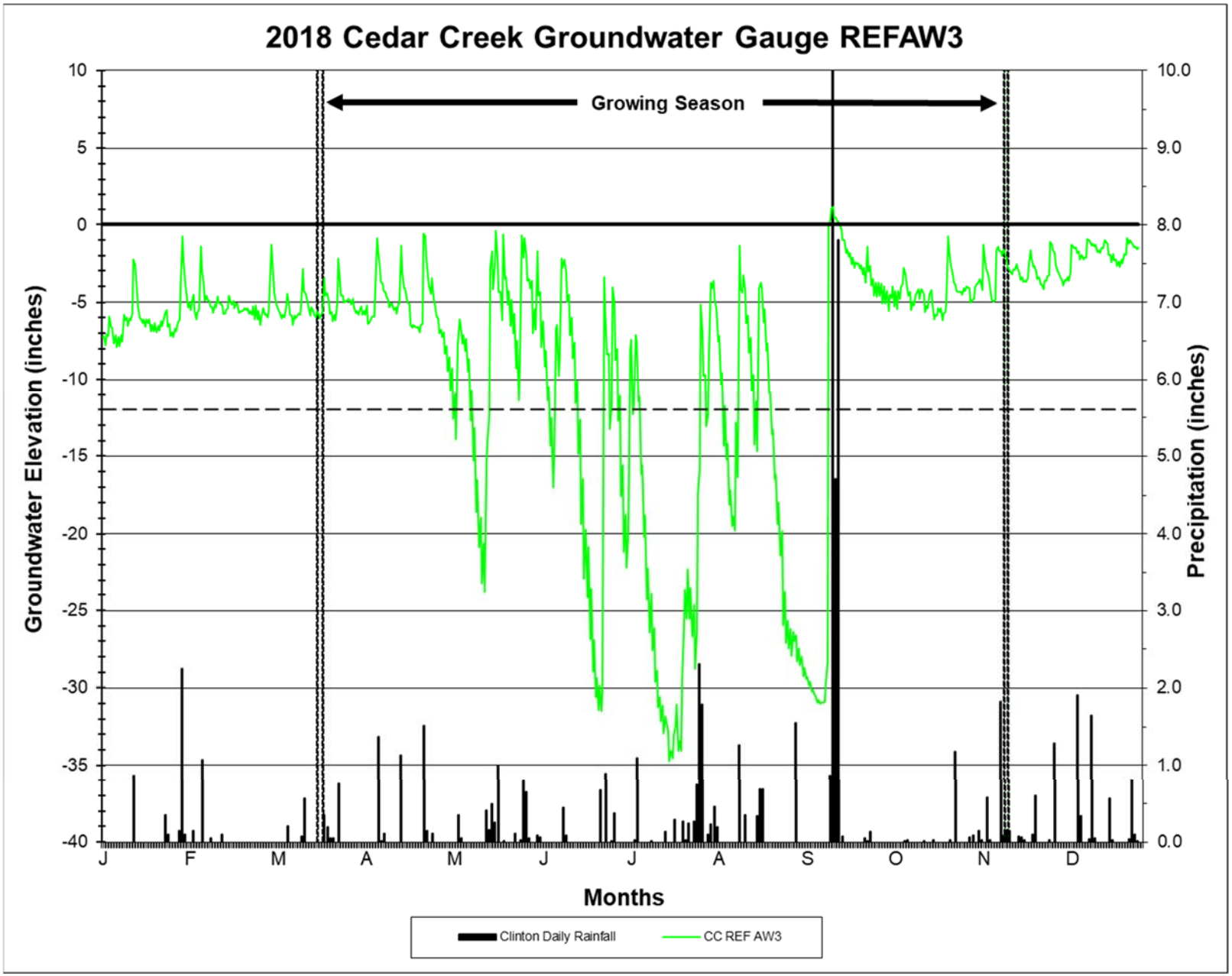

2018 Cedar Creek Groundwater Gauge AW9
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW9

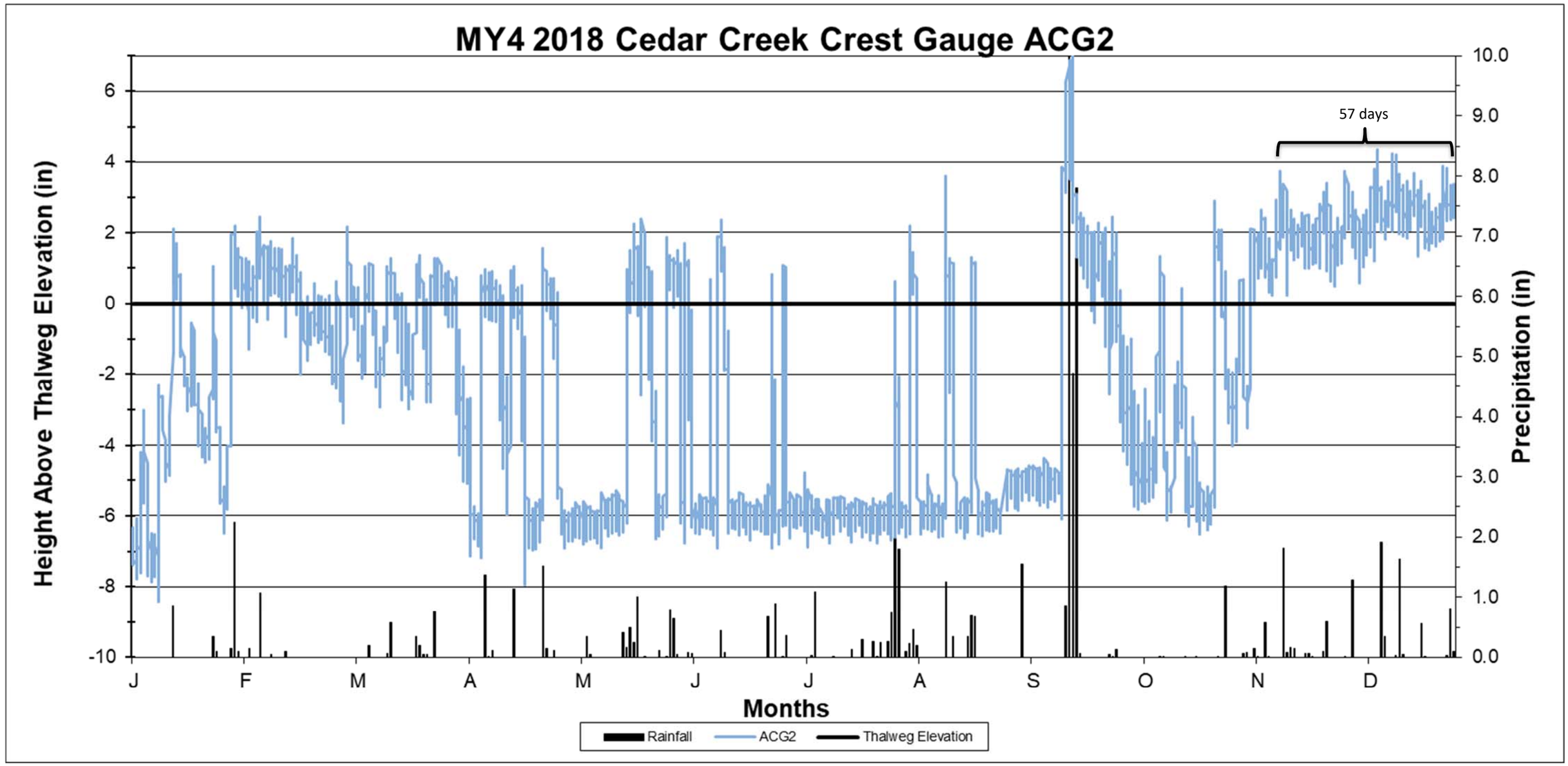

2018 Cedar Creek Groundwater Gauge AW10
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW10


2018 Cedar Creek Groundwater Gauge AW11
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC AW11


2018 Cedar Creek Groundwater Gauge REFAW1
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC REF AW1


2018 Cedar Creek Groundwater Gauge REFAW2
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC REF AW2


2018 Cedar Creek Groundwater Gauge REFAW3
Growing Season
Groundwater Elevation (inches)
Precipitation (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Clinton Daily Rainfall
CC REF AW3


MY4 2018 Cedar Creek Crest Gauge ACG2
Height Above Thalweg Elevation (in)
Precipitation (in)
57 days
6
4
2
0
-2
-4
-6
-8
-10
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
J
F
M
A
M
J
J
A
S
O
N
D
Months
Rainfall
ACG2
Thalweg Elevation

Appendix E – Crest Gauge Verification Photos

Crest Gauge 1 Reading 1.05 ft (9/15/2018)

Crest Gauge 3 Reading 0.25 ft (9/15/2018)