Simmons Street / Jack Smith Creek

Stormwater BMP Project

Year 3 Monitoring Report

DMS Project Number 92646

USACE Action ID

Craven County, North Carolina

March 2016

Prepared by:
NC Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699

Mitigation Services
ENVIRONMENTAL QUALITY

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1.0 PROJECT SUMMARY

The Simmons Street / Jack Smith Creek Stormwater Project is a nutrient offset project that involved the creation of 25 acres of planted stormwater wetland areas. As part of the construction, 14 acres of wetlands were impacted and converted into stormwater wetland areas. Approval of this conversion was obtained by providing on-site mitigation for the impacts. A total of 1.0 acres of wetland creation, 2.3 acres of wetland enhancement, and 10 acres of wetland preservation were proposed and approved to serve as the on-site mitigation. The construction of the stormwater wetland and wetland preservation, creation and enhancement efforts totaled to 38.3 acres. The total urban watershed area treated by the site was approximately 1,534 acres. The purpose of this report is to provide onsite mitigation information, and BMP- related monitoring associated with the project. The goals and objectives of the mitigation areas of the project are provided below.

Goals	Objectives
1. Improve the quality of stormwater runoff that flows to Jack Smith Creek by reducing nutrient and sediment loadings.	Create 25 acres of stormwater wetlands that will receive and treat stormwater runoff.
2. Reduce the impact of flooding in an urban watershed in New Bern	Utilize created stormwater wetlands for flood control through the use of pumps.
3. Protect and preserve existing bottomland hardwood/headwater forest wetlands along Jack Smith Creek.	Protect existing wetlands in a conservation easement and restore native vegetation where needed.

This project is a unique water quality partnership between the City of New Bern, the Division of Mitigation Services (DMS, formerly the Ecosystem Enhancement Program), and the NC Clean Water Management Trust Fund. The project is primarily a stormwater wetland designed to capture and treat runoff from a large watershed in New Bern. The wetland is an environmental initiative by the City and is a part of the DMS Nutrient Offset Program. The project is unique in both its size and scope, and, at the time of construction, was the largest stormwater retrofit built to date in NC. The site location and contributing watershed represents a rare chance to intercept stormwater before it gets to the Neuse River, less than one mile away. In addition, the site has been used by NC State University as a wetland research park to evaluate the ability of large scale wetlands to improve water quality.

2.0 PERFORMANCE STANDARDS

2.1 Vegetation

An average density of 260 stems/acre must be surviving after five years of monitoring to meet success. Two permanent vegetation plots were established at the project inception.

2.2 Hydrology

The wetland enhancement and creation areas will present continuous saturated or inundated hydrologic conditions for at least 12% of the growing season during normal weather conditions. A “normal” year is based on NRCS climatological data for Craven County, using the 30th to 70th percentile thresholds as the range of normal. The growing season for the site occurs from March 18 to November 14 (240 days). Hydrologic performance will be determined through evaluation of automatic recording gauge data supplemented by documentation of wetland hydrology indicators as defined in the 1987 USACE Delineation Manual, daily data will be collected from automatic wells over the 5-year monitoring period. Eight (8) continuous monitoring groundwater gauges were installed to following construction of the project.

3.0 MONITORING PLAN

Annual monitoring data will be reported using the DMS monitoring template, with the parameters below.

Parameter	Quantity	Frequency
Groundwater Hydrology	8 (2 reference, 5 creation, 1 enhancement)	annual
Vegetation	2 (1 enhancement, 1 creation)	annual
Boundary & Visual assessment	N/A	Semi-annual
BMP	The Town of New Bern will inspect and maintain stormwater cells and make repairs if necessary as described on the O&M agreement	As Needed

4.0 MONITORING

Year 3 annual monitoring (MY4) was conducted in October 2015. Monitoring activities included visual monitoring and stem counts of the project vegetation; checking the integrity of the easement; and taking photographs. Both vegetation plots are meeting vegetative success criteria in MY3. It was discovered that some of the trees previously identified in MY2 as *Liriodendron tulipifera* may be *Nyssa* species, and vegetation monitoring was updated to reflect correct species. The created wetland was replanted in the winter of 2014 due to low stem counts in 2013. Low stem counts were likely due to deer browsing (based on visual evidence). A total of 600 stems were supplemented in that area. Additionally, both areas have an established stand of obligate wetland grasses and rushes and several desirable species of volunteer trees were documented.

The project's monitoring contract expired in MY3, and when DMS conducted in-house monitoring at the end of the growing season, it was discovered that installed gauges were malfunctional and not compatible with DMS software. Gauges will be replaced in MY4 with hardware that is compatible with DMS monitoring equipment. Visual evidence including moist soils, organic surface accumulation, and water lines above monitoring PVC poles indicated that the creation and enhancement areas were inundated with standing water during periods of the growing season.

Stormwater wetland BMP areas do not have vegetative success criteria. However, both planted vegetation and volunteers have shown growth over the past few years. Each wetland cell has been substantially established in desirable stormwater wetland species. The wetland is particularly exposed to invasive species because of the surrounding natural wetland areas. Cattail removal was completed in a few areas of the constructed wetland on May 7, 2014 to provide supplemental planting areas for more desirable wetland species. This supplemental planting of 5,000 plugs was completed on May 15, 2014. The supplemental planting showed excellent growth and establishment through the growing season. In a large wetland like this one, it is difficult to completely prevent undesirable species, especially with surrounding populations. While there are areas of dense cattail growth on the site, these areas contain desirable species as well.

Initial estimates of BMP performance indicated that these stormwater wetlands could treat up to 1,000 acres of runoff and that the cells would have a treatment effectiveness of 40% total nitrogen (TN), 35% total phosphorus (TP), and 85% total suspended solids (TSS). Water quality monitoring in MY1 and MY2 conducted by NC State showed that the actual effectiveness resulted in reductions of 76% N, 91% TP, and 90% TSS. The City of New Bern has conducted regular monitoring at the site, and the project is considered to have a significant benefit to water quality and stormwater storage.

APPENDIX A

BACKGROUND TABLES

Table 1: Project Mitigation Components

Mitigation Credit Summations		
Nitrogen Nutrient Offset		
198,243 lbs*		
Project Components		
Project Component	Area (Ac)	Notes
Stormwater Wetlands	25	BMP
Created Wetland	1.0	On-Site Mitigation
Enhanced Wetland	2.3	On-Site Mitigation
Preserved Wetlands	10.0	On-Site Mitigation

*Calculations and justification included in Appendix for 40% nitrogen reduction.

Based on treatment of stormwater runoff from an urban watershed of approximately 1530 acres.

Table 2. Project Activity and Reporting History

Activity or Deliverable	**Data Collection Complete**	**Completion or Delivery**
Restoration Plan		N/A
Final Design – Construction Plans	Nov-08	Nov-10
Construction		Dec-12
Bare root plantings for mitigation areas		Jan-13
Stormwater wetland planting		Jun-13
Mitigation Plan / As-built (Year 0 Monitoring – baseline)		Dec-13
Year 1 Monitoring	Nov-13	Dec-13
Supplemental Planting		Mar-14
Cattail removal and supplemental plugs in BMP area		May-14
Year 2 Monitoring	Feb-15	May-15
Year 3 Monitoring	Oct-15	Mar-16
Year 4 Monitoring		
Year 5 Monitoring		

Table 3. Project Contacts Table

Simmon Street / New Bern Stormwater BMP Project / DMS # 92646	
Designer Primary project design POC	NCSU Biological and Agricultural Engineering Kris Bass 919.515.8245
Construction Contractor Construction contractor POC	Carolina Environmental Contracting Joanne Cheatham 336.320.3849
Survey Contractor Survey contractor POC	Turner Land Surveying Lissa Turner 919.875.1378
Planting Contractor Planting contractor POC	Carolina Wetland Services Gregg Antemann 866.527.1177
Nursery Stock Suppliers Planting POC	Wetland Plants, Inc. Ellen Colodney 252.482.5707
Monitoring Performers Wetland and Veg Monitoring POC	NC Division of Mitigation Services Lindsay Crocker 919-707-8944

Table 4. Project Attributes Table

Project Information				
Project Name	Simmons Street / New Bern Stormwater BMP			
County	Craven			
Project Area (acres)	40 acres			
Project Coordinates (latitude and longitude)	35.1243, -77.0616			
Project Watershed Summary Information				
Physiographic Province	Coastal Plain			
River Basin	Neuse			
USGS HUC for Project (14 Digit)	3020204020010			
DWQ Sub-basin	03-04-10			
Project Drainage Area (acres)	1500			
Project Drainage Area, % Impervious	55%			
Wetland Summary Information				
Parameter	Stormwater Wetland	Created Wetland	Enhanced Wetland	Preserved Wetland
Size of Wetland (acres)	25	1	2.3	10
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	Stormwater	Non-Riparian	Riparian	Riparian
Mapped Soil Series	Arapahoe FSL	Arapahoe FSL	Arapahoe FSL	Arapahoe FSL
Drainage Class	Very Poorly Drained	Very Poorly Drained	Very Poorly Drained	Very Poorly Drained
Soil Hydric Status	Yes	Yes	Yes	Yes
Source of Hydrology	Stormwater	Groundwater	Surface Water	Surface Water
Hydrologic Impairment	None	Drained and Graded	Drained	None

Regulatory Considerations			
Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the U.S. – Section 404	Yes	Yes	NCDENR CAMA Major Permit #61-10
Waters of the U.S, – Section 401	Yes	Yes	DWQ Permit #09-1010
Endangers Species Act	Yes	Yes	NCDENR CAMA Major Permit #61-10
Historic Preservation Act	Yes	Yes	NCDENR CAMA Major Permit #61-11
Coastal Area Management Act	Yes	Yes	NCDENR CAMA Major Permit #61-12
Essential Fisheries Habitat	Yes	Yes	NCDENR CAMA Major Permit #61-12

APPENDIX B

VISUAL ASSESSMENT DATA

Site Photos

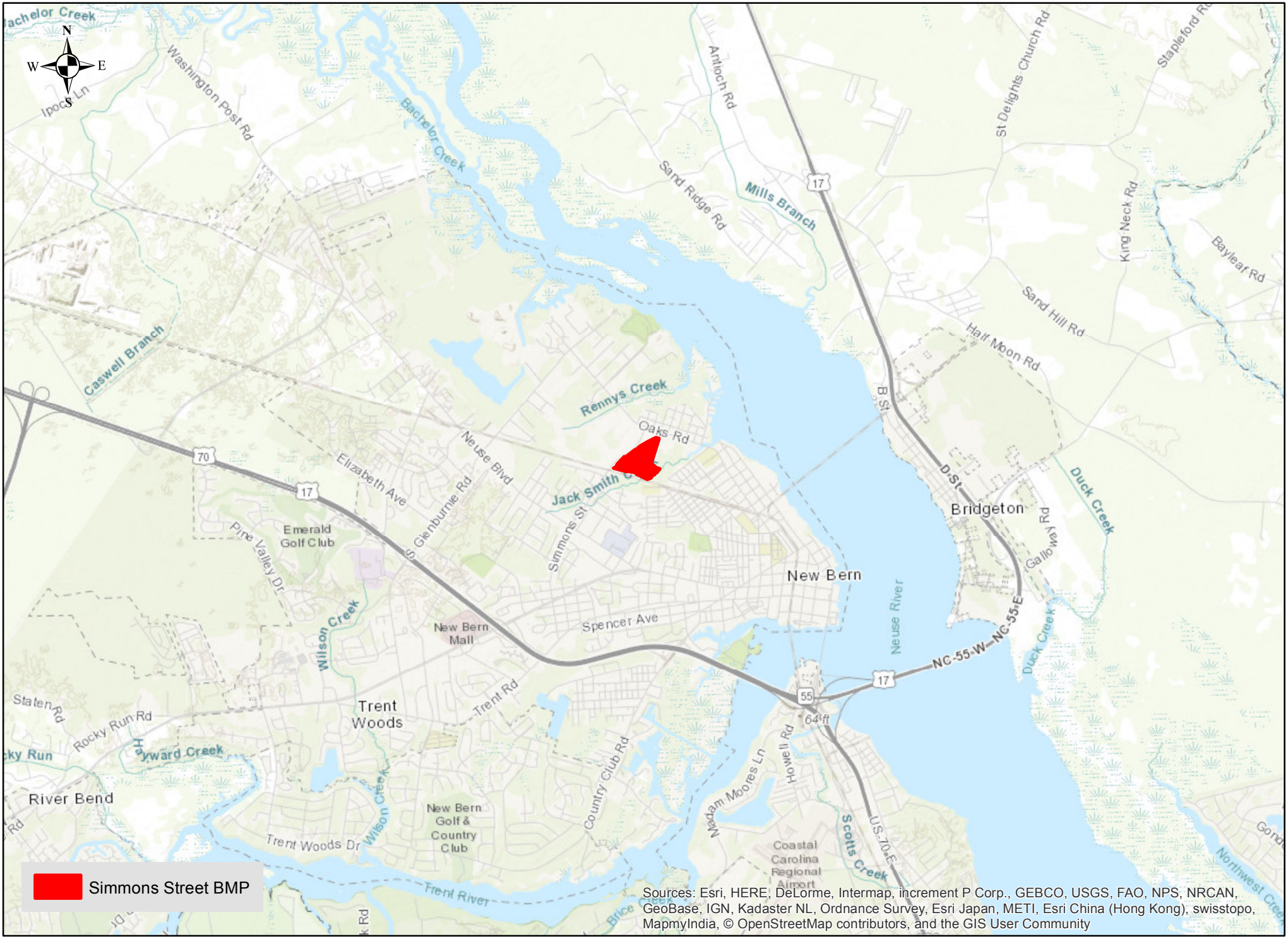
Preservation wetlands near Gauge 2

Outlet weir looking towards Cell D

Enhancement Area

Wetland Creation Area

Tidal gates looking towards outlet



Vicininty Map: Simmons Street BMP

1' = 1 Mile

0 0.5 1 2 Miles

GRADING NOTES

1. The locations and extent of improvements shown are approximate. Exact locations and limits of disturbance will be identified and marked by the Project Engineer prior to construction.

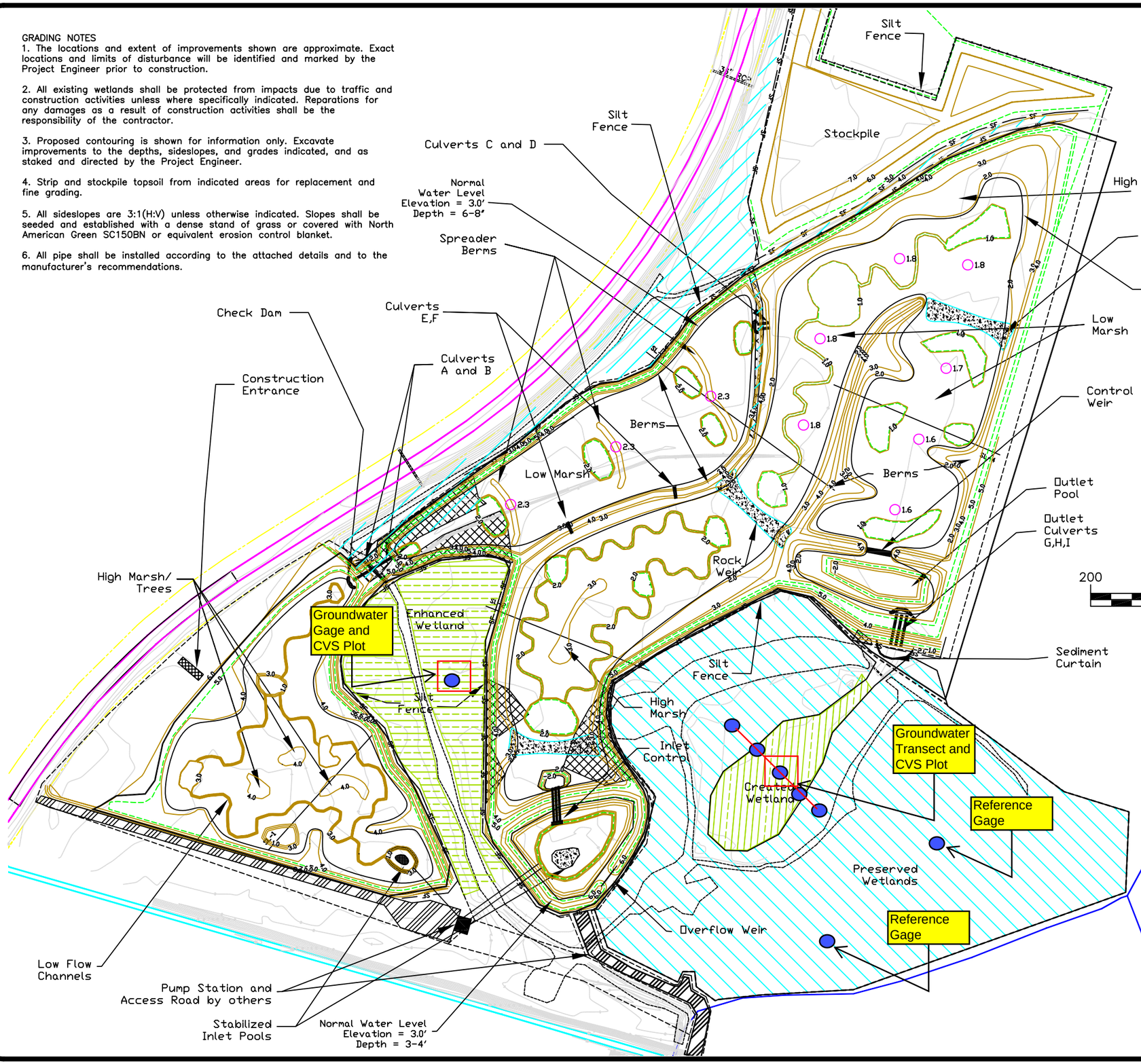
2. All existing wetlands shall be protected from impacts due to traffic and construction activities unless where specifically indicated. Reparations for any damages as a result of construction activities shall be the responsibility of the contractor.

3. Proposed contouring is shown for information only. Excavate improvements to the depths, sideslopes, and grades indicated, and as staked and directed by the Project Engineer.

4. Strip and stockpile topsoil from indicated areas for replacement and fine grading.

5. All sideslopes are 3:1(H:V) unless otherwise indicated. Slopes shall be seeded and established with a dense stand of grass or covered with North American Green SC150BN or equivalent erosion control blanket.

6. All pipe shall be installed according to the attached details and to the manufacturer's recommendations.



MAP LEGEND

- ROAD
- CULVERT
- CONTROL POINT
- BENCH MARK
- HYDRO
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- SPOT ELEVATION
- FRESHWATER WETLANDS
- SILT FENCE
- ROCK CHECKDAMS/DISSIPATORS
- CREATED WETLANDS
- ENHANCED WETLANDS

NOTES:
Total Project Area: 37 acres
Total Disturbed Area: 33 acres

Stormwater Wetland Area: 20 acres
Riparian Wetland Creation Area: 1.0 acres
Riparian Wetland Enhancement Area: 2.3 acres
Preservation Area: 10 acres

Total Riparian Wetland Impact Area: 4.1 acres
Conversion to Stormwater Wetland: 1.1 acres
Temporary Surface Water Isolation: 2.3 acres
Impacts for Pump Station: 0.7 acres.

200 0 100 200 400

(IN FEET)
1 inch = 200 ft.

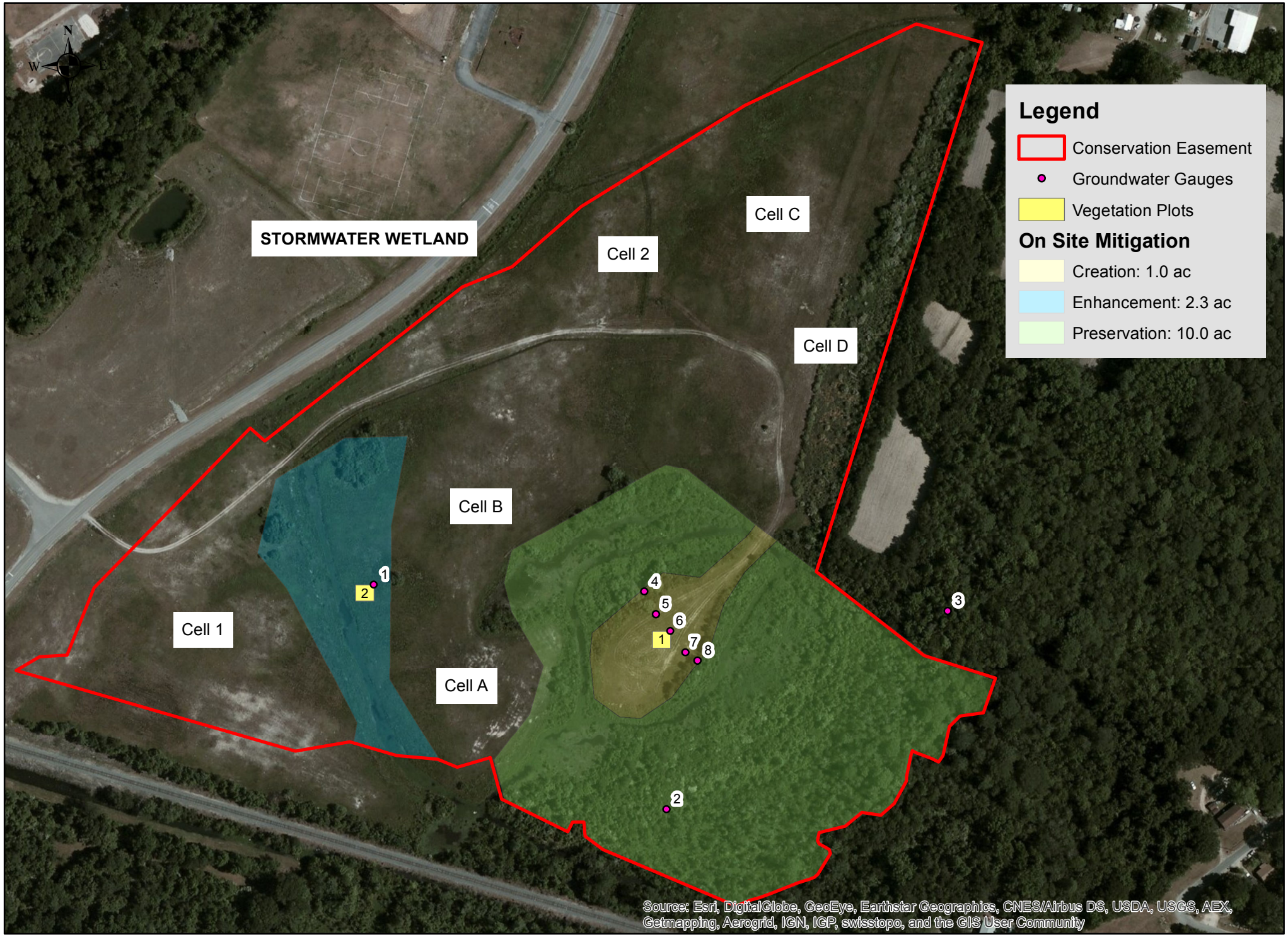
EXISTING TOPOGRAPHIC MAP COMPILED BY:
ROBERT M. CHILES, P.E.
ENGINEERS AND CONSULTANTS
NEW BERN, NORTH CAROLINA

NCSU
Biological and
Agricultural Engineering
NCSU BOX 7637 • RALEIGH, NORTH CAROLINA 27695-7637

DESIGNED: KB, BH, KD, TC
CHECKED: KLB
DATE: March 20, 2009
SCALE: 1" = 200'
PROJECT: Simmons
FILE: Simmons05

PROPOSED GRADING

Jack Smith Creek Stormwater Project
Craven County, NC



Current Condition Plan View: Simmons Street BMP

1' = 250'

0 250 500 Feet

APPENDIX C

VEGETATION PLOT DATA

Table 6. Vegetation Plot Summary

Plot #	Planted Stems	Avg. Stems per Acre	Success Criteria Met
1	7	283	Yes
2	9	364	Yes

Table 7. Vegetation Density

DMS Project Code 92646. Project Name: BMP (Simmons Street Wetland New Bern)

			Current Plot Data (MY4 2015)						Annual Means		
			92646-01-0001			92646-01-0002			MY3 (2015)		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Acer rubrum	red maple	Tree			8						8
Fraxinus pennsylvanica	green ash	Tree				1	1	1	1	1	1
Myrica cerifera	wax myrtle	shrub			13			5			18
Nyssa aquatica	water tupelo	Tree	2	2	2				3	3	3
Nyssa sylvatica	black gum	Tree	2	2	2	4	4	4	5	5	5
Pyrus calleryana	Callery pear	Exotic						1			1
Taxodium distichum	bald cypress	Tree	3	3	3	3	3	3	6	6	6
Unknown		Shrub or Tree				1	1	1	1	1	1
		Stem count	7	7	28	9	9	15	16	16	43
		size (ares)	1			1			2		
		size (ACRES)	0.02			0.02			0.05		
		Species count	3	3	5	4	4	6	5	5	8
		Stems per ACRE	283	283	1133	364	364	607	324	324	870

APPENDIX E

HYDROLOGIC DATA

	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)[1]				
Gauge	Year 1 (2013)	Year 2 (2014)	Year 3 (2015)[2]	Year 4 (2016)	Year 5 (2017)
1 (enhancement)	Yes / 115 (48%)	Yes / 58 (24%)	--		
2 (reference 1 near outlet)	N/A / 24 (10%)	N/A / 18 (8%)	--		
3 (reference 2 near creation)	N/A / 10 (4.1%)	--	--		
4 (far right creation)	Yes / 240 (100%)	Yes / 43 (18%)	--		
5 (mid right creation)	Yes/30 (12.5%)	Yes / 46 (19%)	--		
6 (center creation)	No / 19 (8%)	Yes / 70 (29%)	--		
7 (mid left creation)	Yes / 31 (13%)	Yes / 49 (20%)	--		
8 (far left creation)	Yes / 180 (75%)	--	--		

1. Growing Season is 241 days. Twelve (12) percent of the growing season is equal to 29 days or more of consecutive readings above 12 inches.
2. None of the gauges provided reliable data during the 2015 monitoring season. All gauges were pulled and replaced March 2016 to capture the 2016 growing season.

APPENDIX E

BMP SUPPORTING DATA

Jack Smith Creek Stormwater Project
Nutrient Loading/Removal Worksheet
Aug-13

Sub-watershed	Residential						Commercial	Forest	Industrial	Open space	Road	Total
	1 acre	1/2 acre	1/3 acre	1/4 acre	1/8 acre	2 acre						
0	12.49	31.01	95.08	199.85	14.28	0	88.18	81.98	82.17	43.56	148.89	797.51
1	0.84	9.55	10.71	29.16	0.44	0	54.25	3.22	13.01	9.44	18.01	148.62
2	6.86	67.95	45.98	18.03	1.22	1.35	35.25	61.09	28.24	13.65	45.78	325.41
3	0.56	14.55	46.09	12.95	8.96	0.32	63.93	48.15	8.85	27.74	30.61	262.72
Total	20.75	123.07	197.86	259.99	24.89	1.68	241.62	194.45	132.26	94.39	243.3	1534.25

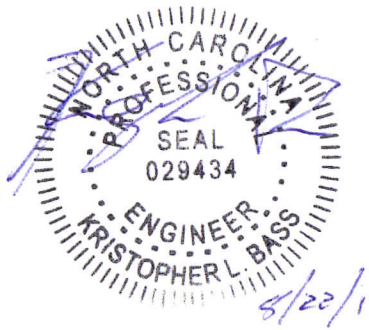
Main Watershed	8.26	92.05	102.78	60.14	10.62	1.67	153.43	112.46	50.1	50.83	94.4
Percent Impervious	0.2	0.25	0.3	0.38	0.65	0.12	0.85	0	0.72	0	0.95
Rv	0.23	0.275	0.32	0.392	0.635	0.158	0.815	0.05	0.698	0.05	0.905
R	11.3	13.5135	15.7248	19.26288	31.2039	7.76412	40.0491	2.457	34.29972	2.457	44.4717
Load (TP)	6.33	84.3376	109.57802	78.544239	22.467931	0.8791003	416.6129254	18.73410412	116.5086	8.46749522	284.6331
Load (TN)	42.2	562.251	730.52011	523.62826	149.78621	5.8606683	2777.419503	124.8940274	776.724	56.4499681	1897.554
Load (TSS)	1150	15321.3	19906.673	14268.87	4081.6742	159.70321	75684.68145	3403.362248	21165.73	1538.26163	51708.35

Extra Watershed	12.49	31.01	95.08	199.85	14.28	0	88.18	81.98	82.17	43.56	148.89
Percent Impervious	0.2	0.25	0.3	0.38	0.65	0.12	0.85	0	0.72	0	0.95
Rv	0.23	0.275	0.32	0.392	0.635	0.158	0.815	0.05	0.698	0.05	0.905
R	11.3	13.5135	15.7248	19.26288	31.2039	7.76412	40.0491	2.457	34.29972	2.457	44.4717
Load (TP)	9.571	28.4118	101.36873	261.00875	30.211117	0	239.4377095	13.65660551	191.0881	7.25642518	448.9303
Load (TN)	63.81	189.412	675.79152	1740.0583	201.40744	0	1596.251396	91.04403672	1273.92	48.3761678	2992.869
Load (TSS)	1739	5161.48	18415.319	47416.589	5488.3529	0	43497.85055	2480.950001	34714.33	1318.25057	81555.68

	Pre-BMP Loading (lbs/year)			
	Main WS	Extra WS	Total	lbs/ac/yr
TP	1,147	1,331	2,478	1.62
TN	7,647	8,873	16,520	10.77
TSS	208,389	241,788	450,176	293.42

Removal %	Removal (lbs/yr)			
	Main WS	Extra WS	Total	lbs/ac/yr
35%	401	466	***867***	0.57
40%	3,059	3,549	***6,608***	4.31
85%	177,130	205,519	***382,650***	249.41

Post-BMP Loads (lbs/yr)			
Main WS	Extra WS	Total	lbs/ac/yr
746	865	1,611	1.05
4,588	5,324	9,912	6.46
31,258	36,268	67,526	44.01



5/22/13

Since the project activation in early June of 2013, 30 base flow events and 25 storm flow events have been sampled for water quality at six locations in the wetland system. Base flow events are classified as the events that are pumped from Jack Smith Creek to the wetland by the smaller, electric pump. This is typically the actual base flow from the creek and events less than 1.50 inches. The storm events are classified as events where the larger, diesel pumps must turn on to handle the flow of the creek, typically events greater than 1.50 inches (Figure 1).

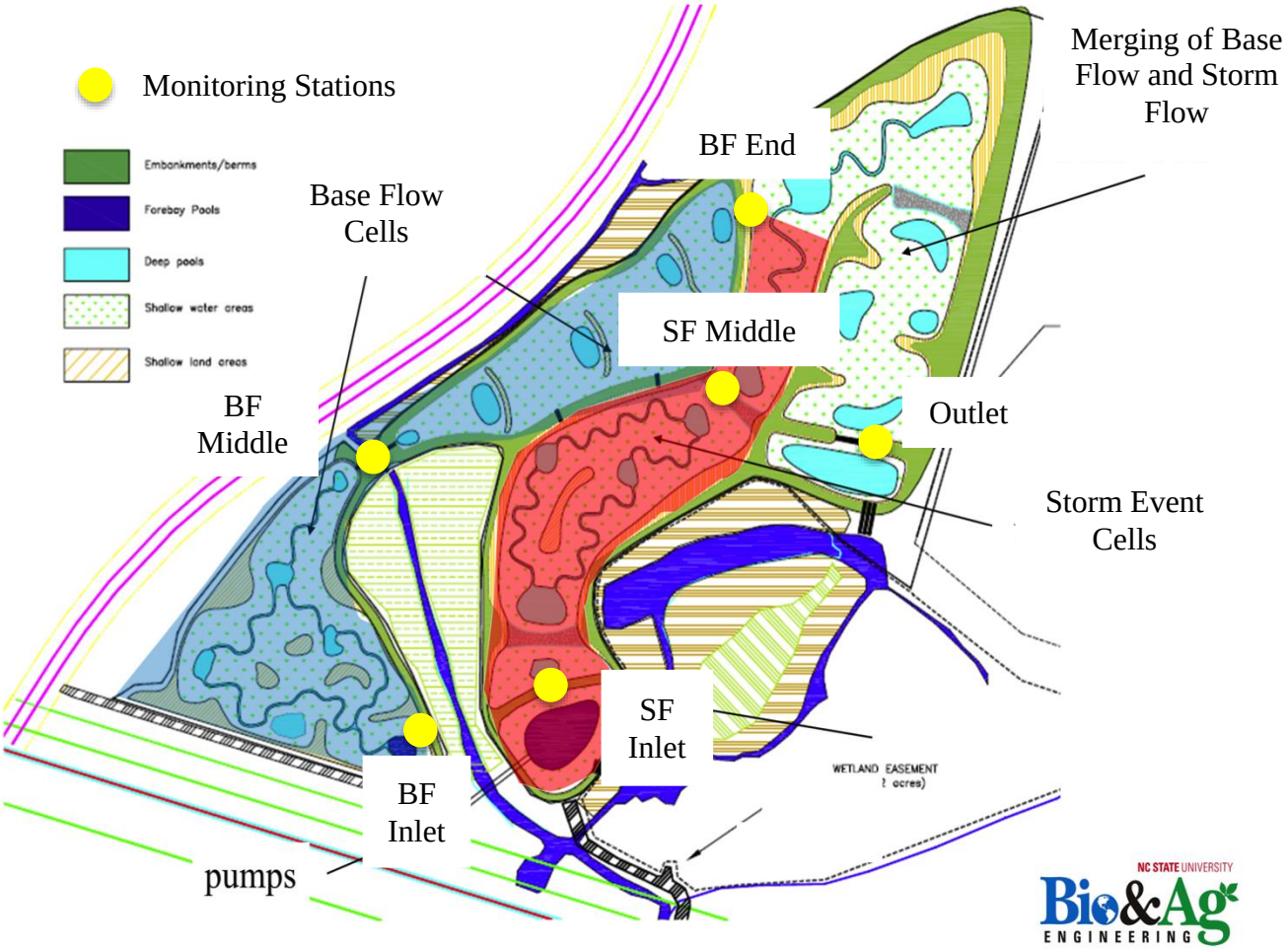


Figure 1: Schematic of the monitoring set-up and characterization of base flow and storm event cells.

The six monitoring stations consist of ISCO 6712 automated samplers to collect flow-weighted water quality samples. Hydrology is also measured via bubbler and areal velocity meter modules.

Of the events mentioned above, results from 30 base flow and 25 storm event samples have been analyzed (Table 1). The parameters of interest were Total Kjeldahl Nitrogen (TKN), Total Ammonical Nitrogen, NH_{3-4} (TAN), Nitrite-Nitrate Nitrogen (NO2-3), Total Phosphorus (TP), and Total Suspended Solids (TSS). Total Nitrogen (TN) was calculated by the addition of TKN and NO2-3.

Percent reductions are calculated inflow of the wetland vs. outflow of the cell (e.g. **SF Inlet** vs. SF Middle and **SF Inlet** vs. Outlet). The first cells tend to have the highest treatment rates for TN, especially for the storm events, and then concentrations increase slightly. This is attributed to the release and irreducible nature of certain organic nitrogen (ON) species in wetland systems; irreducible effluent concentrations typically range from 0.7-0.8 mg/L (Moore et al. 2011).

Table 8: Mean EMC Concentrations and Percent Reductions for June 2013 – October 2014

	TKN (mg/L)	% Red	TAN (mg/L)	% Red	NO2-3 (mg/L)	% Red	TN (mg/L)	% Red	TP (mg/L)	% Red	TSS (mg/L)	% Red
Storm Events												
SF Inlet	1.41		0.10		0.14		1.55		0.34		71.21	
SF Middle	0.55	61	0.03	66	0.04	69	0.59	62	0.06	82	4.20	94
Outlet	0.60	58	0.03	66	0.04	72	0.64	59	0.04	87	6.49	91
Base Flow Events												
BF Inlet	1.27		0.12		0.20		1.46		0.23		38.17	
BF Middle	0.67	47	0.09	31	0.06	69	0.73	50	0.05	77	4.35	89
BF End	0.94	26	0.08	36	0.06	69	0.97	34	0.14	40	77.48	-103
Outlet	0.62	51	0.04	67	0.04	77	0.67	54	0.05	80	7.11	81

The concentration results indicate the wetland is performing exceedingly well with all nutrient and sediment reductions (from inlets to outlet: green values) exceeding 50%. There is a large increase of TSS at the BF End station due to scouring, but treatment occurs prior to reaching the outlet, yielding an average TSS concentration of 7.11 mg/L. The City of New Bern was alerted of the scoured area will maintain the site in the near future.

The inlet (SF Inlet and BF Inlet) and outlet (Outlet) nutrient and sediment loadings will be statistically analyzed when the hydrological analysis and quality check is complete for those stations. This analysis is currently underway.

As mentioned previously, most of the treatment for all nutrients and sediment occurs in the first cells of the system, whether it's a storm event or base flow. This is illustrated in Figures 2 and 3.

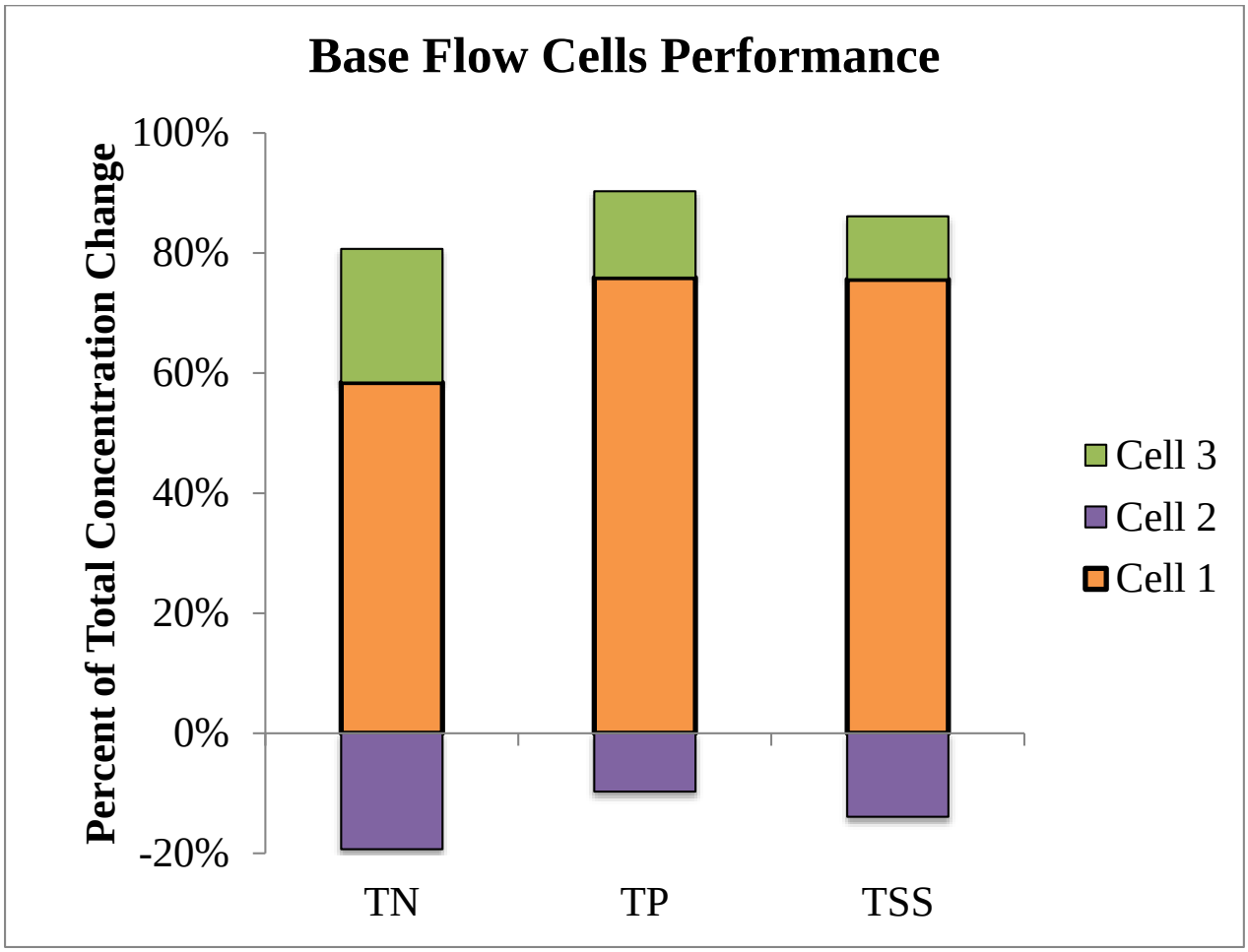


Figure 2: Illustrates where the treatment occurs in the base flow cells of the constructed wetland for each pollutant.

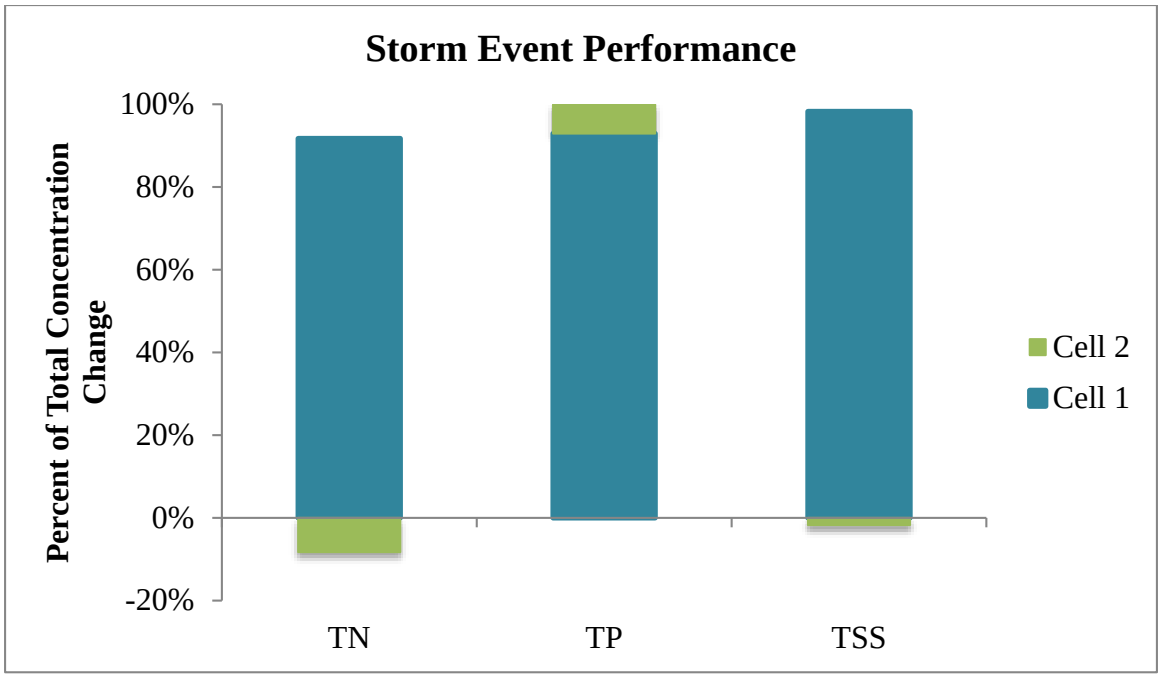


Figure 3: Illustrates where the treatment occurs in the storm event cells of the constructed wetland for each pollutant.

Nutrient (TN and TP) and sediment (TSS) loadings were also calculated for the two inlets and the outlet of the wetland system (Table 2). Observations from Table 2 indicate the wetland system has performed very well with all percent loading reductions exceeding state guidelines and relatively small loads exported from the site.

The major differences between the field monitored loading reductions and the predicted loading reductions can be attributed to the prediction of the *inlet* loadings to the site. The predicted inlet loads were much larger than the field observed loadings to the site. This affects the predicted loading reductions and exported loads from the site that were calculated using state removal guidelines.

Table 9: Predicted and Monitored Nutrient Loadings and Reductions for the Jack Smith Creek Stormwater Wetland

FIELD MONITORED RESULTS

	Storm Event Inlet			Base Flow Inlet			Outlet of System		
Loading Units	TN	TP	TSS	TN	TP	TSS	TN	TP	TSS
lb/year	1,144	249	47,385	3,943	607	103,517	1,202	80	14,526
lb/ac/year	0.75	0.16	30.88	2.57	0.40	67.47	0.78	0.05	9.47

FIELD MONITORED LOADINGS

	Loading Reductions			Percent Reductions			Exported Loads from Site		
Loading Units	TN	TP	TSS	TN	TP	TSS	TN	TP	TSS
lb/year	3,885	776	136,375	76%	91%	90%	1,202	80	14,526
lb/acre/year	2.53	0.51	88.88				0.78	0.05	9.47

PREDICTED LOADINGS

	Loading Reductions			State Removal Guidelines			Exported Loads from Site		
Loading Units	TN	TP	TSS	TN	TP	TSS	TN	TP	TSS
lb/year	6,608	867	382,650	40%	35%	85%	9,912	1,611	67,526
lb/acre/year	4.31	0.57	249.41				6.46	1.05	44.01