A. PROJECT INFORMATION

1. Project Title: Assessment of Change in North Carolina Coastal Plain Wetlands

2. Track: One 3. Actions related to NC WPP: NC WPP: Monitoring and Assessment [Objective.Action] 1.2, 2.1, 2.3, 3.1, 3.2; NC DWR WPP Addendum Action 3: Address Important and/or Urgent Issues, Action 5: Public Outreach and Education (see also Table 1)

4. Name of Applicant: NC Division of Water Resources (NC DWR): DUNS number: 809785280

5. Key Personnel and Contact Information: Kristie Gianopulos, Environmental Senior Specialist, NC DWR, kristie.gianopulos@ncdenr.gov, 919-743-8479; Greg Rubino, Environmental Senior Specialist, NC DWR, gregory.rubino@ncdenr.gov, 919-743-8450; Brian Wrenn, Ecosystems Branch Chief, Water Sciences Section, NC DWR, brian.wrenn@ncdenr.gov, 919-743-8409

Partnership Information: University of North Carolina Wilmington; Duke University; NC State University; The Nature Conservancy; Albemarle-Pamlico National Estuary Partnership; Nutrien/PCS Phosphate

6. Geographic Location: Outer Coastal Plain of North Carolina (Attachment A)

7. Federal Dollars Requested: $233,260 : Cost Share: $77,753 : Total Project Cost: $311,013

8. Abstract: Coastal Plain wetlands make up the majority of wetland acreage in North Carolina (NC)(Street et al. 2005). These wetlands, as “natural infrastructure”, provide a myriad of important functions to the environment and people of NC. These vital functions have caused Coastal Plain wetlands to be singled out as priority ecosystems by state agencies. However, the outer Coastal Plain is experiencing changes from increased climate variability, sea level rise, and flooding events. Most organizations modeling these changes rely primarily on remote sensing and national spatial data. These datasets generally allow detection of dramatic plant community shifts and coastline movement, but earlier, more subtle, indicators of change require on-the-ground data collection, which is lacking. This project entails collecting

current detailed data from 30 Outer Coastal Plain freshwater and brackish wetland sites that we have historical data from for comparison. We will supplement this dataset with resample data collected in smaller studies done by our project partners. Results will be used to calibrate models being developed by our partners and will also help us understand if and how ecosystem functions of our coastal wetland resources are changing. Results will be shared proactively via an online story map and presentations to the Governor's Working and Natural Lands Stakeholder Group, as well as with regulatory staff, our academic partners, the NC Cooperative Extension, and the public through our outreach website.

B. PROJECT DESCRIPTION:

1. Project Description: The goal of this project is to compare current wetland condition and function to historical data obtained 5, 10, and in some cases, 30 years ago, to understand how our Coastal Plain wetlands are being changed by sea level rise and increased inundation, as well as how far inland these changes are taking place. We will collect detailed resample data (vegetation, soil, water, buffer, and general habitat) from 30 wetland sites scattered across the outer Coastal Plain. Information gained from the detailed data as well as rapid assessments on function and habitat quality will allow us to make some statements about ecosystem functions being provided by these wetlands, and if any changes have occurred since the last data collection. We will also partner with several universities and organizations to augment our dataset using their resample data collected for other localized projects.

2. Description of Need: NC Governor Cooper's Executive Order No. 80, "North Carolina's Commitment to Address Climate Change and Transition to a Clean Energy Economy" (October 2018), states that the order was issued because the NC Constitution "requires the conservation, protection, and preservation of state lands and waters in public trust" and the state needs "to provide responsible environmental stewardship" and "build resilient communities and develop strategies to mitigate and prepare for climate-related impacts in North Carolina" (Art. XIV; Sec. 5). The order states that "the effects of more frequent and

intense hurricanes, flooding, extreme temperatures, droughts, saltwater intrusion, and beach erosion have already impacted and will continue to impact North Carolina's economy". The order requires that cabinet agencies, including the NC Department of Environmental Quality, "shall evaluate the impacts of climate change on their programs and operations." It also calls the North Carolina Climate Change Interagency Council to "support communities interested in assessing risks and vulnerabilities to natural and built infrastructure", which includes our wetlands.

Importance of North Carolina's coastal wetlands

The Coastal Plain of NC contains between 3.1 and 3.9 million acres (60-75 percent) of the state's wetlands, including marshes, swamps, forested riverine wetlands, pocosins, and other wetland habitats (Street et al. 2005). These coastal wetlands provide the state with an array of essential services. Coastal wetlands, especially forested wetlands, stabilize shorelines and serve as buffers against storms and erosion, a service valued at $25.6 billion per year (NCDEQ 2016). They can store water and lessen flooding, which creates value in protection from extreme rain or storm events. Wetlands are needed as natural filters for water supplies, a service vitally important to the Coastal Plain aquifers which supply more than half of NC's population (EPA 2010). They also are important for sequestering carbon. "Peatlands and vegetated coastal wetlands are among the most carbon rich sinks on the planet, sequestering approximately as much carbon as do global forest ecosystems" (Moomaw et al. 2018). Our wetlands serve as refuges for beneficial pollinators and other insects and provide critical habitat for wildlife and plants. Over two-thirds of NC's rare, threatened and endangered species of plants and animals live in wetlands (USGS 1996). Coastal wetlands serve as vital breeding and migration stopover points for many migratory birds, as well as key breeding areas for some bird species in decline (Defenders of Wildlife 2010). In particular, Coastal Plain freshwater wetlands are very important habitat for bitterns, rails, and a variety of other wading and shorebirds.

NC has a billion-dollar commercial and recreational fishing industry, ranking it among the nation's highest seafood producing states (NC DEQ 2016). The state's estuaries and associated wetlands are an essential economic resource, serving as nursery grounds for many commercially important fish and shellfish, such as crabs, shrimp, and flounder species (DeWan et al. 2010). Tidal freshwater wetlands provide nursery habitat for aquatic species that live in salt waters but rely on fresh and brackish waters for larval recruitment and development. These freshwater swamps and marshes occur along rivers or sounds in areas where flooding is influenced by wind or lunar tides.

Additionally, NC's wetlands provide value in aesthetics, tourism, and recreation, especially in the Coastal Plain where large national wildlife refuges, game lands, and preserves exist. Lake Mattamuskeet National Wildlife Refuge is a major stopover for huge flocks of migratory and overwintering waterfowl, where more than 130,000 visitors come every year for wildlife observation and other recreation (USFWS 2008).

For all these reasons, wetlands are singled out as priority ecosystems by state agencies. The NC Wildlife Resource Commission 2015 Wildlife Action Plan describes all wetlands statewide as priority habitat for conservation, including coastal wetland habitats such as tidal freshwater wetlands, bottomland and floodplain wetlands, pocosins, bays, isolated depressional wetlands, wet pine savannahs, and brackish marshes (NCWRC 2015). The NC Division of Coastal Management's Coastal and Estuarine Land Conservation Program lists all coastal wetland habitats as priority for restoration and conservation (NCDCM 2007, 2011).

Our wetlands are vulnerable to climate variability and sea level rise

Eastern NC has 1,729 square miles of land equal to or less than one meter of elevation above current sea level (Attachment A1). This land area is particularly vulnerable to sea level rise, temporary and permanent flooding, and coastal erosion. In NC, tide gauge measurements reveal that relative sea level has risen 10 to 23.3cm in 50 years (1970s to 2010)(NCDCM 2015). Local, county, and state officials, along with local

residents and researchers have noticed changes in hydrologic patterns in the Coastal Plain. The Coastal Plain communities are being affected by an increase in the amount of water, as well as salinity changes. Effects of higher water levels on forested wetlands and uplands are becoming obvious throughout the Coastal Plain (Table 1; Attachment A1, A2). Changes in salinity can kill trees and make plant communities vulnerable to invasion by non-native species such as *Phragmites*, which is happening along the Albemarle Sound, 40 miles from the ocean. Thousands of trees have died at the northern tip of Alligator River National Wildlife Refuge, 21.5 miles from the nearest ocean inlet. Wetland plant community shifts from forested cypress wetlands to marshes are evident along the Northeast Cape Fear River, north of Wilmington, 30 miles from the ocean. In some places in NC, *upland* pine forests are converting to brackish marshes because of increased inundation and salinity changes. In Hyde County, agricultural lands have changed into freshwater and brackish wetlands, timber tracts have changed from pine stands to brackish marshes, and in some places residential land is transitioning to coastal marsh (pers. comm. Scarbraugh 2019). Some farmers in the Lake Mattamuskeet area have noticed water flowing into their ditches instead of draining out, as well as loss of available acreage to farm due to increased wetness (pers. comm. Nora Deamer 2019). Point Peter Road on the Pamlico Sound offers a dramatic example of forested freshwater wetland transitioning to brackish marsh (Attachment A2).

Rising sea levels threaten NC's outer Coastal Plain wetlands, but increased intensity of storms, both in rainfall and wind, are also causing increased freshwater inundation. Drainage ditches can facilitate increased flooding as well as saltwater intrusion into more inland areas (McPherson 2009). The presence of salt promotes rapid decomposition of peat soils by sulfate-reducing bacteria (Hackney and Yelverton 1990). Loss of peat causes soil subsidence and increased inundation. Within wetlands, these changes are expected to result in plant composition shifts and more open water habitat. Invasion by non-native species is also a concern, for loss of diversity and habitat provision. Even if climate change causes an

Table 1. What people are saying.

"There is a lot of area over there that if it were not for pumps, they would not be able to farm. Some of that land on the south side of 264 … used to be farmland and now it is in marsh," Frank Winslow, County Extension Director for Tyrrell and Washington Counties. (Boerema 2013)
"More and more communities are having problems with drainage and flooding, not just as a result of hurricanes, but often simply from storms bringing heavy rains and strong winds." (Scarbraugh 2018)
"As waters rise, fingers of saltwater are pushing their way into eastern NC through a network of ditches that crisscrosses the land… to drain the land for timbering, farming, and road-building. Two hundred and eighty miles of ditches lie within the Alligator River National Wildlife Refuge alone." (Peach 2014)
Belhaven Town Manager, Woody Jarvis, "hopes to work toward raising the primary roads and sidewalks, as well as the floors of the businesses that are repeatedly flooded with excess water." (Oliver and Roberts 2016)
"Dare County residents are less willing to talk about sea level rise but do refer to erosion as the key source of changes on the coast, while Inner Banks residents are more willing to discuss sea level rise because of the increase in salt-water intrusion and its effect on Inner Banks crops." (Cortright 2015)
"Farms have noticed changes with the way water moves in some areas of the coast (flowing in, instead of draining out of canals/ditches/streams) and farmers have also reported a loss of available acreage to farm due to increased wetness." (Deamer, 2019 pers. comm.)
"Northeastern NC, which is very close to sea level, is extremely vulnerable to climate change, causing impacts to major economic contributors like agriculture, fishing, tourism and even military installations…. [the] state [needs] to improve or restore natural systems to mitigate flooding and other impacts of climate change. Those natural systems include wetlands, floodplains, oyster beds, and pocosins." (Hawley 2019, quoting Brian Boutin, The Nature Conservancy)
"In the coastal region in NC, we have a lot of places where the soils are largely organic, … as seawater water intrudes into those soils, the salinity itself can foster the growth of bacteria that decompose that organic matter. … And so in some of the inland areas where you've got saltwater now getting into places that used to be freshwater marshes, you're seeing a very high rate of land subsidence….So there are places in coastal North Carolina that are in very big trouble." Dr. Lawrence Cahoon, University of NC - Wilmington (Hilburn 2016)
"Many bird species associated with [estuarine wetland communities] have experienced significant declines ….Two of the greatest threats posed by sea level rise to fish and wildlife in North Carolina are loss of marsh and wetland habitats because of erosion and flooding, and the expected increase in salinity of coastal aquifers, freshwater drainage basins, and estuarine systems because of saltwater intrusion (Neumann and Hearty 1996)." (NC Wildlife Resources Commission 2015)
"From New Jersey all the way down to South Carolina — simultaneously — we're losing wetlands. It isn't just one place. It's everywhere." Skip Stiles, Executive Director of Wetlands Watch (Peach 2014)

increase in estuarine wetlands, this may come at the expense of the often more diverse freshwater wetlands. Lost biodiversity comes with a loss in the variety of ecosystem services freshwater wetlands provide (Isbell et al. 2011).

Given the importance of these wetland systems to the environment and economy of NC, their priority for wildlife and coastal management agencies, and their vulnerability to water related changes brought about by climate change, it is imperative that we assess their current condition relative to historical condition. Most academics and state and federal agency staff rely on remote sensing or nationally available spatial datasets for change detection, but these only allow detection of substantial plant community shifts and erosion. Earlier, more subtle, indicators of change require on-the-ground data collection, which is lacking, particularly in freshwater wetlands vulnerable to impacts from salt. We will collect current wetland condition information from Outer Coastal Plain freshwater and brackish wetland sites with historical data available for comparison. Information gathered from this project will be useful for land use planning, conservation, restoration, and regional regulatory staff. Data collected will be used by partners to calibrate their prediction models. Results can also be used to prioritize conservation areas to maintain these wetland types and the ecosystem services they provide. This project addresses several components of NC's Approved Wetland Program Plan and "Activities proposed in support of the NC Wetland Program Plan 2015-2019" (referred to as the "WPP NC DWR Addendum") (Table 2).

3. Project tasks: This proposal lays out a three-year timeline for completion, beginning in October 2020. Semi-annual progress reports will be submitted to the EPA grant supervisor on May 31st and November 30th each year. The primary tasks are as follows:

Table 2. NC WPP Objectives and Actions Addressed.

WPP NC DWR Addendum: Action 3: Address Important and/or Urgent Issues	
Sea level rise is beginning to be acknowledged as a critical problem facing large areas of NC. This work will enable us to understand how our coastal wetlands are being impacted by sea level rise, saltwater intrusion, and inundation. Our results will be communicated directly to the governor's NC Natural and Working Lands Stakeholder Group, which is focused on a range of actions that conserve, manage, and restore coastal areas, including wetlands.	
WPP NC DWR Addendum: Action 5: Public Outreach and Education	
The results of this project will be shared with the public through a story map on NC DEQ's new website, ncwetlands.org. It will be provided to NC Cooperative Extension staff, NC Coastal Federation, Division of Coastal Management, and our academic partners to inform their decisions and distribute to their communities. We will also host webinars connecting states, tribes, and our partners pre-project and post-project to share plans, experiences, results, and challenges.	
WPP Objective/Action	**Proposed Project Action**
NC WPP Monitoring and Assessment	
Objective 1: Refine and publish the North Carolina wetland monitoring and assessment strategy	
Action 1.2 Utilize NC's Monitoring and Assessment Strategy to monitor NC's wetland resources	**1.2.a Conduct various types of wetland monitoring efforts** This project will compile data gathered from EPA's 2021 NWCA effort, as well as from a further number of sites for assessing changes in condition, focused on outer Coastal Plain wetlands.
Objective 2: Develop and refine recommended standardized wetland monitoring protocols and utilize them to assess wetland condition.	
Action 2.1 Develop and refine the wetland monitoring design	**2.1.b Utilize current wetland monitoring protocols on wetland monitoring projects** This project will utilize the NWCA protocol and CVS protocol for project data collection, which are established monitoring protocols.
Action 2.3 Utilize wetland monitoring data to assess baseline wetland extent, density, and condition/ function/services & trends	**2.3.d Use available wetland monitoring data to assess trends in the ambient conditions of wetlands.** The purpose of this project is to gather data from wetlands in outer Coastal Plain areas where they are vulnerable to direct effects of climate change. We will collect data from sites with historical data available, some decades old, to enable comparisons and assess changes in wetland condition.
Objective 3: Make wetlands data available to inform wetland decisions	
Action 3.1 Provide public access to wetland monitoring data in an electronic system	**3.1.a.i.** The data and results of this project will be shared with the public through NC DEQ's new website on NC wetlands. It will be shared with partners and NC Cooperative Extension to share with their communities.
Action 3.2: Incorporate monitoring and assessment data into other programs and planning units	The data collected in this project will provide a variety of groups with insight into changes in our coastal wetlands. We will communicate our results to our division watershed planning group, our ambient monitoring groups, DEQ's NC Natural and Working Lands Stakeholder Group, our academic partners, and environmental nonprofits.

Task 1: Develop Quality Assurance Project Plan (QAPP) - The first three months of the project will be devoted to developing a Quality Assurance Project Plan (QAPP), which will outline QA/QC practices to be followed for this project. This project will be generating new data from vegetative sampling, soils, and rapid assessments.

Task 2: Connect via webinars with Region IV states and our project partners pre and post project - For this task, we will host a pre-project webinar to connect with EPA Region IV states and tribes and our partners to present how we plan to accomplish the project, and solicit feedback and advice that will help guide and inform our efforts. After project completion, we will again connect with other EPA region IV states and tribes to present our findings and share lessons learned and challenges encountered. This task is expected to take one month, divided between two webinars.

Task 3: Background research, site selection, and reconnaissance –

Background research: Background research will involve literature searches for indicators of change in freshwater/brackish systems, but also communication with scientists working in the Coastal Plain (NC and other states) to discover any new indices or threshold analyses being done. Initial literature searches did not uncover much in the way of plant community shift indicators other than those using remote sensing on large areas. We have made initial contact with staff at UNC Wilmington, NC State University, Duke University, East Carolina University, National Oceanic and Atmospheric Agency, Albemarle-Pamlico National Estuary Partnership (APNEP), NC DEQ's Division of Coastal Management, and The Nature Conservancy. This task will give us the big picture of work being done and gaps that need filling.

Site selection and reconnaissance: This subtask will be done at the beginnings of each sampling season. Approximately 12 National Wetland Condition Assessment (NWCA) resample sites will be selected by the EPA as part of the NWCA 2021 effort (Serenbetz 2019 pers. comm). During summer 2022, approximately 15 additional historical (data collected 2006-2011) NWCA and NC DWR sites will be selected to cover the

Coastal Plain while representing a variety of wetland types and salinity regimes (map of potential sites in Attachment A3). We will supplement NWCA and NC DWR sites with approximately 5 CVS sites which had vegetation data collected in the 1980s and 1990s. These CVS sites will be chosen geographically to augment areas not covered by NWCA or NC DWR sites, such as the northeastern and southeastern corners of the state. Once potential sites are selected, we will work to obtain access permission from landowners and reconnoiter sites to ensure they can be used. Purchasing of supplies will occur during this task, which will take approximately 6 months.

Task 4: Data collection, obtaining external data, and data compilation

Subtask 4.1 Field data collection by NC DWR – We propose to gather data for two growing seasons; the first will coincide with 2021 NWCA data collection. During summer 2021, we will collect data from the assigned NWCA sites (funded by NWCA; approximately 12 will be resample sites) and from two or three additional coastal NWCA sites (first sampled in 2011 or 2016) that are not being resampled for the NWCA effort (this resampling will be funded by this project). During summer 2022, we will resample 15 additional NWCA sites we did not revisit in 2021, as well as 5 strategically selected CVS plots that were sampled decades earlier (between 1985 and 2006)(Attachment A3). We will collect detailed resample data from a minimum of 30 sites scattered across the outer coastal plain of NC.

For resampled NWCA sites, data collected will follow the NWCA protocol, which includes soil profile information and chemistry, detailed vegetation plot data, as well as disturbance and buffer information. Rapid assessments (ORAM and NCWAM) will be completed all at sites. Vegetation resampling of the historical DWR sites or CVS sites will use the same protocol that was used for historical data collection to facilitate comparisons.

Subtask 4.2 Obtaining external resample data from partners – Our partners at Duke University, NC State University (NCSU), UNC Wilmington, PCS Phosphate, and The Nature Conservancy have agreed to share

resample data of their own or help collect data (see Section 9). Whenever possible, we will incorporate data from our partners into our overall analysis. When sampling protocols used for the external (historical and recent) data collections produce comparable datasets, we will use the external data to assess inundation, salinization, and vegetation community shifts. These three additional localized data sources will bolster our final dataset and enable us to make more robust statements about how our wetlands have changed across the Coastal Plain.

Subtask 4.3 Data compilation - We will begin compiling data as soon as we receive it from partners and will continue with this task through December following the second sampling season.

Task 5: Data analysis and report on findings - We will be looking for soil changes such as peat changing to muck, organic matter changes, higher water table, soil salinity changes, and changes in soil sodium, magnesium, calcium, and sulfates. With the vegetation analysis, we will be looking for tree mortality, changes in tree and shrub species composition, invasion by non-native species, presence of salt tolerant herbaceous vegetation, and general herbaceous plant community shifts. As part of the effort to find methods for early detection of plant community shifts with salinity increases, we hope to utilize work of a graduate student at NCSU. He is conducting a salinity threshold analysis for herbaceous coastal wetland species by compiling vegetation data along a salinity gradient and developing tolerance thresholds for each species using the Threshold Indicator Taxa Analysis (TITAN)(Baker and King 2010; Andersen et al. 2019 pers. comm.). We hope to use this index along with the newly collected data to detect shifts in vegetative communities over time. Information gained from the detailed data as well as rapid assessments on function and habitat quality will also allow us to make some conclusions about ecosystem functions being provided by these wetlands, and if changes have occurred since the last data collection. Products of this task will be a final report and journal manuscript summarizing study results. The final

report will include project description, data collection methods, maps of study locations, analysis of results, conclusions and recommendations. This task is expected to take one year.

Task 6: Story map and dissemination of results – An online story map will be built to communicate project findings to the widest audience possible and facilitate sharing among users. This story map will be similar to one produced by Saint Mary's University (Geospatial Services 2019). It will be posted on our website, ncwetlands.org, along with a project summary page and final report. We will also share results via webinar and conference presentation. (See Section 6 for plan for transfer of results.)

4. Milestone Schedule:

This project has a 36-month timeline.

Table 2. Milestone Schedule - tasks, associated products.

Task	Product
Task 1: Develop QAPP	QAPP submitted for approval
Task 2: Connect with Region IV states and tribes, partners	Webinars pre and post project
Task 3: Background research, site selection, and reconnaissance	Final selection of sites
Task 4: Data collection, obtaining external data, and database compilation	Compiled database of NC DWR past data and newly collected data, along with data from partners
Task 5: Data analysis and report on findings	Final report on findings, journal manuscript
Task 6: Story map and dissemination of results	Published story map, project summary and downloadable final report posted to website

Table 3. Expected task timeline during project period.

Timeline	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Oct-Dec 2020	X					
Jan - Mar 2021		X	X	X		
Apr-Jun 2021			X	X		
Jul-Sep 2021				X		
Oct-Dec 2021				X		
Jan - Mar 2022			X	X		
Apr-Jun 2022				X		
Jul-Sep 2022				X	X	
Oct-Dec 2022				X	X	
Jan - Mar 2023					X	X
Apr-Jun 2023					X	X
Jul-Sep 2023					X	X
Oct-Dec 2023		X			X	X

5. Detailed Budget:

Detailed Budget					
Form 424a Items	**Year 1**	**Year 2**	**Year 3**	**Total**	**Notes:**
a. Personnel	$ -	$ -	$ -	$ -	
b. Fringe	$ -	$ -	$ -	$ -	
c. Travel	$1,800	$12,000		$13,800	project travel for field team
d. Equipment	$ -	$ -		$ -	n/a
e. Supplies	$2,000	$1,000		$3,000	sampling supplies
f. Contractual	$32,780	$103,340	$70,340	$206,460	soil samples ($3,500), water samples ($10,500), $15,000 for 3 summers of graduate student assistance, $25,000 for 2 temporary botanists (year 2), $152,460 for 2 temporary staff scientists 3 years
g. Construction	$ -	$ -		$ -	n/a
h. Other:	$ 2,000	$ 4,000	$ 4,000	$ 10,000	staff travel to annual Region IV wetland meetings
i. Total Direct Charges (sum of a-h)	$38,580	$120,340	$74,340	$233,260	
j. Indirect Charges	$ -	$ -	$ -	$ -	
Total Requested/ Year	$38,580	$120,340	$74,340	**$233,260**	**Federal Requested Total**
				$77,753	**State Cost Share (25%)**
				$311,013	**Total Project Cost**

Total by Task	**Federal Share**	**State Match**	
Task 1	$19,438	$6,479	QAPP development
Task 2	$6,479	$2,160	Connecting with Region IV states, tribes, partners
Task 3	$38,877	$12,959	Background research, site selection, reconnaissance
Task 4	$97,192	$32,397	Data collection, obtaining external data, database compilation
Task 5	$42,116	$14,039	Analysis and report on findings
Task 6	$29,158	$9,719	Story map and dissemination of results

The requested federal budget for this project is $233,260 with a state match of $77,753 (project total $311,013). This project capitalizes on efficiencies created by overlap with NWCA 2021. Staff will be mostly supported by NWCA for the first year of data collection, and we will be able to make use of the data collected. We will hire two botanists for NWCA using NWCA funds and then rehire them for the second summer of data collection using funding from this project ($25,000). This three-year project will be

carried out by a core project staff of two temporary environmental senior specialists (Greg Rubino and Kristie Gianopulos). We also have budgeted $5,000 contractual funds each year for graduate student assistance with data collection, compilation, and analysis. Funds are also included for field sampling and safety supplies, soil samples, water samples, and staff travel to attend annual EPA Region IV wetland coordination meetings each year. NC state government will also provide a minimum of $77,753 in-kind match over three years through supporting state personnel, vehicle and equipment use, software licensing fees, facilities, and some sampling equipment. State government personnel include those from the wetland permitting branch, water chemistry lab, supervisory staff, administrative personnel, public information officers, and IT staff.

6. Transfer of Results: Dissemination to a wider audience will be accomplished through a new online story map, partners, webinars, meeting presentations, and our wetland resource website (ncwetlands.org). The project story map will be shared on our website along with a project summary page and final report. Results will be communicated directly to the Governor's Natural and Working Lands Stakeholder Group, which is focused on a range of actions that conserve, manage, and restore coastal areas, including wetlands. Results will also be provided to NC Cooperative Extension staff, NC Coastal Federation, Division of Coastal Management, The Nature Conservancy, APNEP, and our academic partners to inform their decisions and distribute to their communities. We will communicate our results to our division wetland regulatory staff, watershed planning group, our ambient monitoring groups, our academic partners, and environmental nonprofits. We will also connect via webinar with other EPA region IV states and tribes to present our findings and share lessons learned and challenges encountered.

Travel funds are included in the budget for findings to be presented at appropriate conferences. We will also submit a manuscript to an appropriate journal for publication to the scientific community.

7. Outputs, Outcomes, and Tracking:

7i. Link to EPA Strategic Plan – This project will collect data within outer Coastal Plain wetlands for comparison to historical vegetative communities and other parameters. The results will indicate the extent and type of change, if any, with sea level rise, saltwater intrusion, and inundation. Knowing how and where these wetlands are being impacted will help direct investment into protection and restoration. Restoration efforts can be more effectively targeted using knowledge of what wetland types and ecosystem functions are being lost or changed.

7ii. Outputs:

Compiled database of NC DWR historical data and newly collected data, along with data from partners
Report on applicability of new salinity tolerance index with plant community data
Webinars (pre and post project) with EPA region 4 states and partners to share results and lessons learned
Report on ambient condition of Coastal Plain wetlands, which are at-risk from climate change impacts
Summary of results webpage and final report posted on ncwetlands.org
Story map describing project results posted on the NC wetlands website (ncwetlands.org)
Participation and sharing of ideas at annual wetland meetings
New partnerships with universities and other organizations

7iii. Outcomes:

Increased quality and/or accuracy of models of coastal marsh migration and other models being developed by our partners to predict impacts of climate change on NC's Coastal Plain wetlands.
Increased awareness in groups negatively affected by climate related changes to wetlands, such as forestry industry, farmers, homebuilders, realtors.
Increased information for coastal communities for decisions about resiliency, adaptation, and migration
Improved information for planting lists for living shorelines for longer term sustainability
Improved information for state and local water resource staff, conservation groups, national refuge system staff, and wetland focused nonprofits to use in planning and decision making
Increased availability of and access to field verified data to calibrate remote sensing projects and tools.
Increased understanding of impacts of salinity changes on NC Coastal Plain wetland
Increased understanding of current ecological condition of NC Coastal Plain wetlands
Better prioritization of conservation areas to maintain current wetland types and their ecosystem services.

7iv. Tracking Outputs and Outcomes - A detailed workplan will be created and followed, based on the milestone schedule, with deadlines for each task. NC DWR wetland staff hold monthly internal staff meetings to assess progress based on milestone schedules and to plan future work toward project goals. We will hold regular meetings with project partners to assist with our work toward project goals and maximize efficiency. We maintain regular communication with NC DWR budget staff to track budget status. Additionally, our progress will be documented in semi-annual progress reports to the EPA.

Analytics built into our new website and into ArcGIS Online will allow us to track the number and geographical location of views of the story map and our website pages, as well as downloads of our report.

8. Program Capability/Technical Experience/Qualifications:

8i. Organizational Experience – The NC DWR wetland science staff is part of the Water Sciences Section's Ecosystems Branch and currently consists of three half to three-quarter time senior environmental specialists (one permanent and two temporary). The above-mentioned staff have been involved in data collection for NWCA 2011 and 2016 and various wetland field studies over the last 8+ years. These staff have master's degrees in their area of work and have participated in continued training in areas such as the NWCA protocol, stream identification, and water resource challenges. One staff member will be available to begin work on the project in fall of 2020; the two remaining staff members will be available for years two and three of this project to assist with site sampling and data analysis. Office space, computers, employee resources, and state support staff are all in place and available for continued work.

8ii. Staff Experience/Qualifications: Kristie Gianopulos (temporary environmental senior specialist) will be project lead and will also assist in data collection, analysis, and report writing. Gianopulos was staff scientist, data analyst and author of the final report for a project focused on aquatic biota in restored wetlands (CD-00D01512), and data analyst and co-author of the final report for the Southeast Wetlands Monitoring Intensification Grant (CD-95449910). She has been project co-lead on a project developing a

new website ncwetlands.org (CD- CD00D51216) and staff project lead for a project testing a rapid floristic quality index (CD-00D51316). She has worked for NC DWR for 7 years and has extensive experience with managing large databases, mapping, statistical analysis, technical writing, and presentations. Gregory Rubino (temporary environmental senior specialist) will be field team lead on this project. Rubino is a trained geologist who has worked for NC DWR for 8 years and most recently led the field team for the 2016 NC NWCA effort, as well as soil/buffer team lead for the 2011 NC NWCA effort. He has led and assisted with field data collection, data compilation, and research for a grant project focused on aquatic biota (CD-00D01512) and the Environmental Law Institute's study of mitigation success (WD-83504301). Additional staff will be hired (two botanists and three graduate students) through NCDEQ's temporary staffing agency, Temporary Solutions. Project lead is experienced in the processes for selecting and hiring temporary project staff.

9. Partnerships: Multiple new partnerships are being established for data sharing purposes. NC State University (Dr. Marcelo Ardón Sayao) and Duke University (Dr. Justin Wright) have agreed to share data from recently resampled several CVS wetland plots on the Albemarle-Pamlico Peninsula. Our collaboration with them will also allow for utilization and validation of the TITAN model to develop salinity threshold levels for various wetland plant species. UNC Wilmington (Dr. Devon Eulie, Dr. Sheri Shiflett, Dr. Larry Cahoon) have plans to resample vegetation plots from a 2000 study along the Cape Fear River, and have offered graduate student assistance and data to incorporate into our analysis. They will use our newly collected data to calibrate their salt marsh migration models. PCS Phosphate (Jeff Furness, Sr. Scientist) has agreed to share long term wetland monitoring data they have. The Nature Conservancy (Aaron McCall) has offered access to boats and sites. APNEP (Stacey Feken) has agreed to assist with dissemination of results. These partnerships will enhance our wetland program by encouraging

information sharing and continued collaboration on future wetland projects. There will be no subgrantees.

10. Past Performance: For all following EPA agreements, the proposed projects were successfully completed with acceptable final technical reports. NC DWR has consistently submitted timely semiannual reports to the EPA providing progress toward outputs and outcomes for all active WPDGs. In cases where work has been delayed, complete explanation has been reported to the EPA and no-cost extensions have been awarded when necessary.

Development of Engaging Wetland Education Materials for NC (CD00D51216): NC DWR developed a new website (ncwetlands.org) to present educational material specific to North Carolina wetlands. The website includes general wetland information, how to help wetlands, a laws summary, summaries and final reports of past DWR wetland projects, downloadable materials for students and teachers, photo galleries and videos, and an interactive map of publicly accessible wetlands across the state. Presentations on the website were made at the EPA Region 4 annual meeting (November 2018), to environmental educators (September 2018 – February 2019), and exhibited at several conferences. All project outputs, presentations, and reports were produced on time. The remaining time on this grant timeline is being used to add additional material to the website and to present the website at appropriate conferences, meetings, and exhibits.

National Wetland Condition Assessment 2016 (I00D30215): NC DWR participated in the 2016 NWCA survey of wetland sites. All project lead personnel attended national training and successfully sampled the assigned 23 wetland sites in NC. All water, soil, and plant samples were collected, preserved, and shipped per project protocols. Staff coordinated with the EPA and maintained project supplies so sampling could proceed as scheduled. Weekly paperwork was submitted and document reviews were returned in a timely manner. The project remained within budget, which was managed efficiently.

Evaluation of amphibian and macroinvertebrate communities of NC wetlands with regards to restoration techniques (CD00D01512): NC DWR sampled 16 wetland sites in the Coastal Plain and Sandhills ecoregions to provide insight on mitigation design and restoration practices aimed at improving amphibian and macroinvertebrate habitat. Staff collected thorough data on landscape settings, rapid functional assessment, hydrology, precipitation, vegetation, macroinvertebrates, and amphibians in a timely manner. A no-cost extension was granted to accommodate the loss of staff and reassignment of completion of the project. The final report was submitted December 2016 and results were presented at the NC Water Resources Research Institute annual conference in 2018.

Reassessing Criteria for Impaired Urban Waters and Stream Restorations (CD00D51116): NC DWR conducted a study to determine if it is possible to refine the current impairment scale used to assess stream water quality using macroinvertebrates - the goal being to refine the scale to document biological uplift when it occurs on stream restoration projects. Possible metrics were examined to determine if the scale could be refined on a specific parameter. The study proposed utilizing % Intolerant Taxa, EPT abundance, EPT Taxa Richness or TV<4, but noted that stream size impacted metric effectiveness. No-cost extensions were granted to account for hiring delays at the state level, but the research was completed within the approved extension time. A presentation was given at the EPA Region 4 annual meeting in November 2018, and the final report was submitted in December 2018. The remaining time on this grant is being utilized to submit appropriate past reports to peer-reviewed journals.

Assessing Biological Impacts of Small Impoundments on Streams (CD00D01312): NC DWR successfully sampled and characterized effects of small impoundments on macroinvertebrate communities downstream. A no-cost extension was granted to accommodate staff loss and delay in hiring/reassigning personnel. A presentation of results was made in November 2016 at the EPA Region IV 2016 Regional 401 annual meeting and a final report was submitted in February 2017.

C. Restoration Demonstration Project Information – N/A

D. QA/QC: Upon the start of the project in October 2020, we will write a Quality Assurance Project Plan (QAPP) for this project and submit it to EPA for approval.

E. Invasive Species Control – The NC DWR is very aware of the problem of invasive species, especially in Coastal Plain wetlands, and we will use appropriate controls to minimize the chance of spreading invasive species when collecting data for this project. We will also train any assisting temporary project staff on controlling the spread of invasive species.

F. Attachments:

A Maps and pictures

B Letters of commitment

- University of North Carolina - Wilmington
- Duke University
- North Carolina State University
- Albemarle-Pamlico National Estuary Program
- The Nature Conservancy
- Nutrien/PCS Phosphate

C Resumes of key project personnel

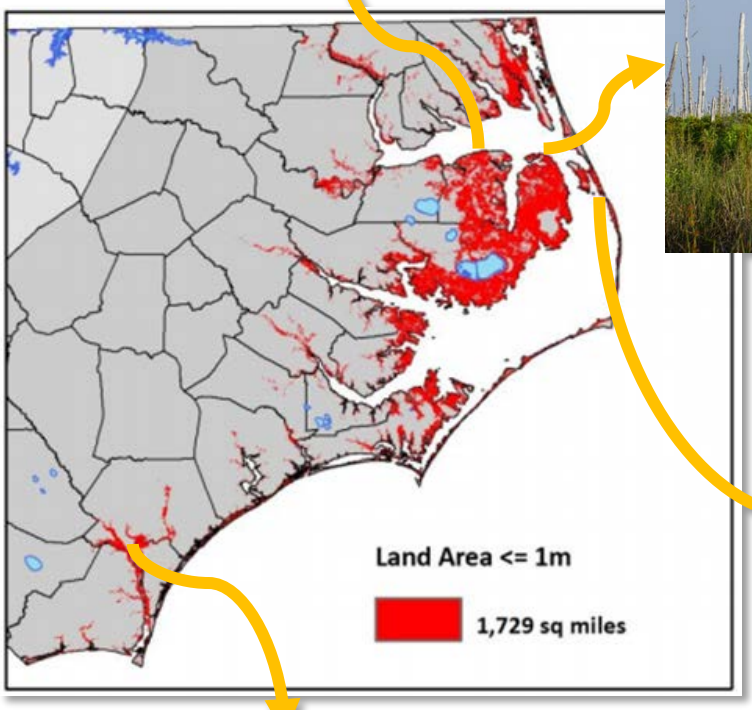
D NC Governor's Executive Order 80

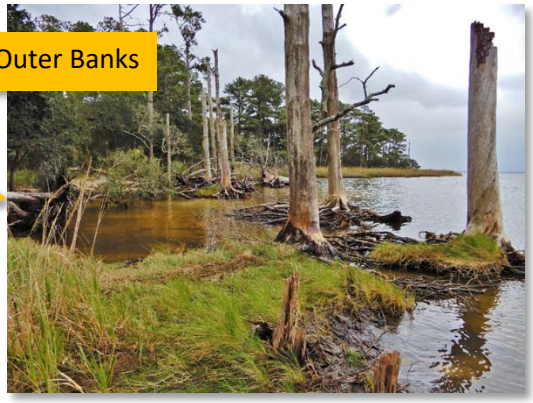
E Literature Cited

Attachment A1. Wetland plant community shifts from forested wetlands or uplands to marsh are evident in many parts of the outer Coastal Plain (photo dates 2018). Map showing land area equal to or less than one meter of elevation above sea level. (source: N.C. Interagency Leadership Team. 2010. Climate maps)

Albemarle Sound

Albemarle-Pamlico Peninsula

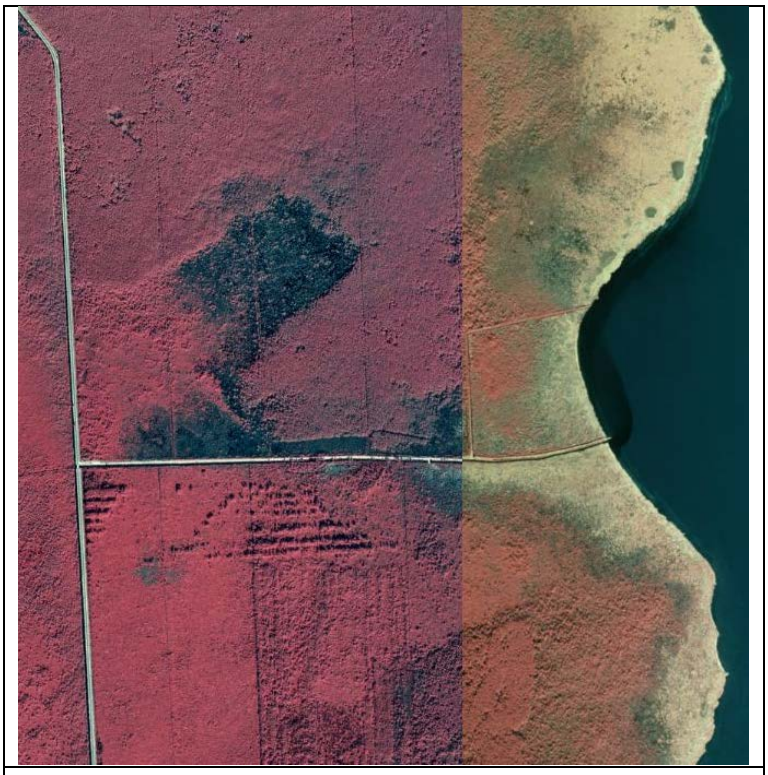




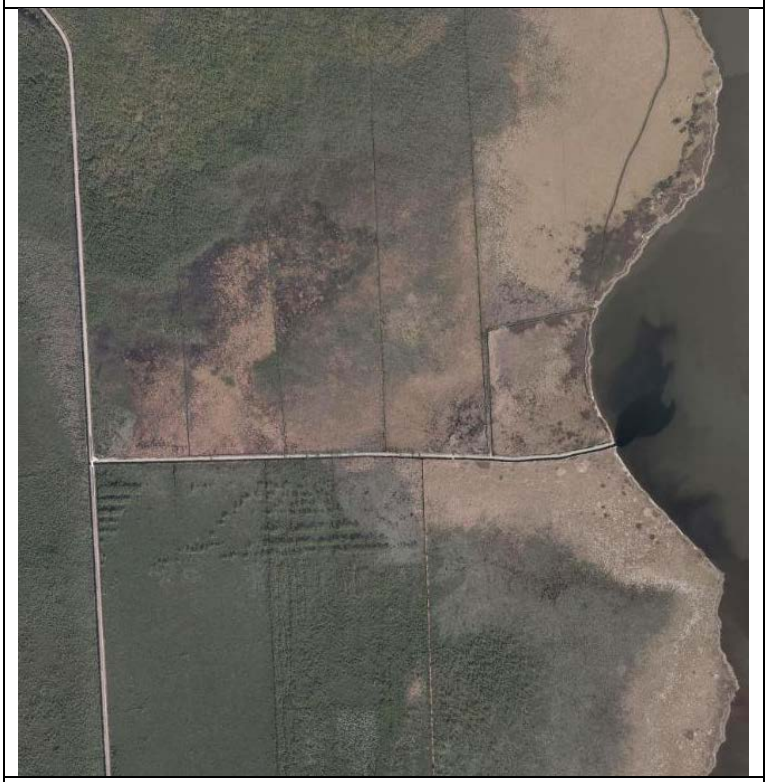
Outer Banks

Cape Fear River

Attachment A2. Point Peter Road on the Pamlico Sound, a location with a more pronounced shift in vegetation community from forested wetland to marsh. The darker areas are forested wetland; lighter regions are brackish marsh.

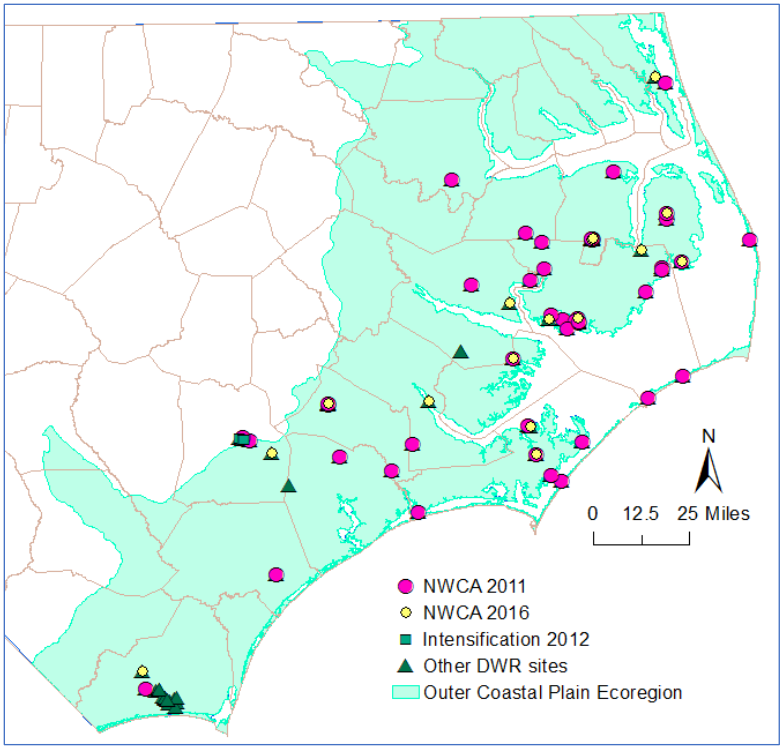


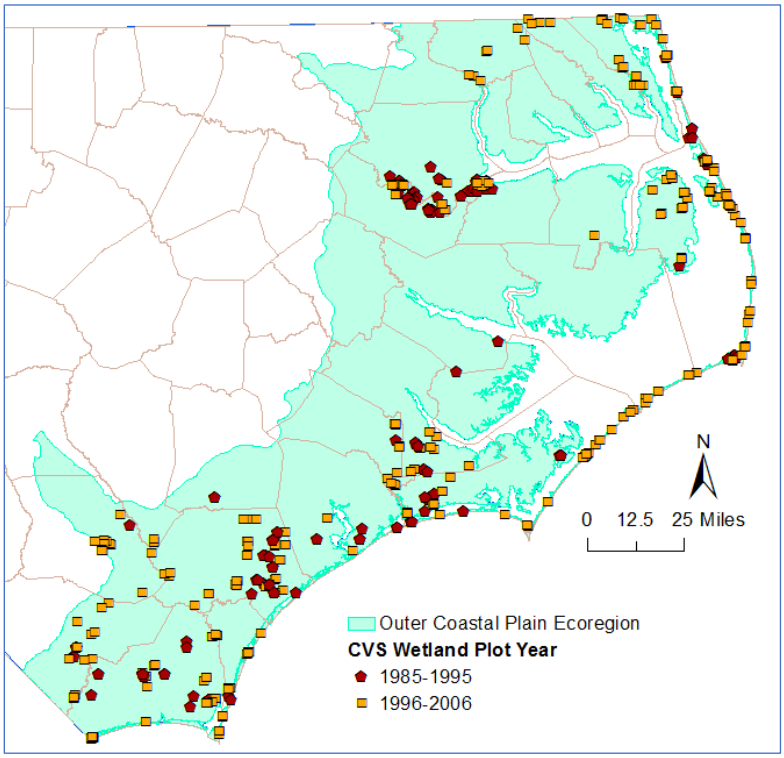
1998



2018

Attachment A3. Maps of Outer Coastal Plain project area with plots available for revisiting – NC DWR and NWCA sites with historical data available for comparison from 2006 to 2016 and Carolina Vegetation Survey (CVS) plots from 1985 to 2006.





UNIVERSITY OF NORTH CAROLINA WILMINGTON

April 30, 2019
Kristie Gianopulos
NC Division of Water Resources
NC Department of Environmental Quality
Office GI55
4401 Reed Creek Road
Raleigh, NC 27607

Dear Ms. Gianopulos,

As faculty members of the UNCW Environmental Science Department who conduct environmental research in coastal and wetland settings, Dr. Devon Eulie and myself are happy to provide this letter of partnership for your proposed research project, "Assessment of Change in North Carolina Coastal Plain Wetlands." We believe this project has substantial value for not only UNCW faculty and students, but the state of North Carolina. There is clear synergy with not only major environmental foci in North Carolina, but also on-going research projects at UNCW and other academic institutions.

I joined UNCW as new faculty in August 2018 where I currently teach Wetlands Ecology and Management and have a research and applied background in coastal plant ecophysiology, wetlands ecology, and remote sensing. Before joining UNCW, I worked for 2.5 years at the US Army Corps of Engineers promulgating regulations under Section 404 of the Clean Water Act, including conducting wetland habitat assessments and monitoring wetland mitigation success. Furthermore, I am excited to begin developing wetland functional assessment related research projects in the Coastal Plain Region. My colleague Dr. Eulie has been a faculty member at UNCW since 2012 and has conducted a variety of research projects related to living shorelines, assessment of shoreline change, coastal vulnerability, and water quality assessments. Moreover, she has expertise in GIS and shoreline modelling.

We are interested in serving as partners or end-users of your proposed project, which is intended to document how Coastal Plain wetland sites have changed in terms of vegetation communities, soil characteristics, and ecosystem functions. We are also willing to share data with you as specified per UNCW-NCDEQ data use agreement dated 4-29-19. While we are not directly contributing any funds to the project, we can provide our expertise to assist with data collection and analysis and would also like to involve students in assisting with future project-related data collection efforts.

DEPARTMENT OF ENVIRONMENTAL SCIENCES
601 SOUTH COLLEGE ROAD ● WILMINGTON, NORTH CAROLINA 28403-5949 ● 910-962-7675 ● FAX 910-962-7634

I will look forward to working with you on this project. If there is anything I can do to advance your project or assist you in implementing this research, please let me know.

Sincerely,

Sheri Shiflett, PhD
Assistant Professor
Dept. of Environmental Sciences
University of North Carolina Wilmington
shiflettsa@uncw.edu

Devon Eulie, PhD
Assistant Professor
Graduate Program Coordinator
Dept. of Environmental Sciences
University of North Carolina Wilmington

UNIVERSITY OF NORTH CAROLINA WILMINGTON

April 18, 2019

Kristie Gianopulos
Sr. Environmental Specialist
Division of Water Resources: Water Sciences Section
NC Dept. of Environment Quality

Dear Ms. Gianopulos:

I am pleased to offer this letter of commitment for the 2019 Coastal Plain wetland change proposal now being developed by the North Carolina Division of Water Resources. This proposal is timely, the work proposed is urgently needed, and the research interests of my doctoral student, Mr. LeRoy Humphries, coincide almost perfectly with what you propose.

The Cape Fear River Estuary has experienced significant loss of freshwater coastal wetlands over the last several decades, perhaps more so than any other portion of North Carolina's extensive coastal region. Sea level rise and coastal development have been important factors in driving this change, but the major factor here has been repeated deepening of the navigation channel for the Port of Wilmington, some 24 miles up-river from the ocean. Current project depth as of the last deepening project (@ about 2000) is 42 feet. Plans are now being developed to deepen and widen the channel to accommodate larger cargo vessels, with figures of 5-6 feet deeper being discussed. Two consequences arise from a deeper, wider channel: 1) the larger volume of the estuary allows more seawater to flow farther upstream with tidal action, raising salinities and pushing saltier water farther into what were freshwater coastal wetlands; 2) tidal amplitude at Wilmington and the head of the estuary is greater, forcing additional salt water intrusion farther upstream and increased frequency of flooding events in the downtown Wilmington area. There is already significant evidence of the impacts of increasing salt water intrusion, dramatically illustrated by the proliferation of 'ghost forests' in the tidal creeks adjacent to the estuary. These 'ghost forests' are typified by standing dead or dormant cypress trees. Cypress are intolerant of salt, so their presence as 'ghost trees' is stark evidence of conversion of freshwater wetlands to salt-water marshes.

The loss of freshwater wetlands so dramatically illustrated by the extensive ghost forests in our coastal region raises substantial concerns within the community and among coastal management agencies and environmental NGOs about the likely environmental impacts of new port deepening projects. It is clear that these impacts must be considered with a full scientific understanding of cause-effect relationships and in light of the need to mitigate these impacts if they cannot be avoided. The port channel deepening project is bringing these concerns into sharper focus.

The study you propose will, therefore, be urgently needed and timely.

DEPARTMENT OF BIOLOGY AND MARINE BIOLOGY
601 SOUTH COLLEGE ROAD · WILMINGTON, NORTH CAROLINA 28403-5915 · TEL 910-962-3487 · FAX 910-962-4066

One of my doctoral students, Mr. Humphries, is studying the issue of salt water intrusion effects on cypress trees in this region. The study you propose will be an excellent vehicle for some of the work he is planning to do. I understand that he is also writing a letter of commitment for this project. I understand that other UNCW faculty have similarly expressed support and a willingness to participate in this project. We can offer various kinds of support, including the University's clear interest in supporting environmental research in our region, participation by students with appropriate scientific backgrounds and training, and access to equipment as needed and available.

I look forward to seeing this project move forward.

Sincerely,

Lawrence B. Cahoon
Professor of Biology & Marine Biology

LeRoy Humphries
Graduate Student
Marine Biology Dept.
UNC Wilmington
601 South College Road
Wilmington, NC 28403

UNIVERSITY OF NORTH CAROLINA WILMINGTON

April 23, 2019

Kristie Gianopulos
Sr. Environmental Specialist
Division of Water Resources, Water Sciences Section
NC Division of Environmental Quality
4401 Reedy Creek Road
Raleigh, NC 27607

Dear Ms. Gianopulos:

The purpose of this letter is to express my commitment to your research project examining changes in coastal wetland system dynamics in eastern North Carolina. I will contribute field assistance during the summer months and data analysis to the project. I will also assist in conducting background research and working with historical data to help meet project goals.

Additionally, the data obtained from this project will aid me in my dissertation work at UNCW. Data collected from this research will assist me in ground-truthing remote sensing data that will be utilized to delineate plant community structure in wetland systems. My intention is to utilize historic wetland plant community structure compared to current community structure to determine change over time and whether any observed effects are due to sea level rise resulting from climate change or human activities such as filling, dredging, or other land alterations.

Please let me know if you require any additional information. I can be reached at 919-906-4693 or via email at leroy319411@sccnc.edu.

Sincerely,

LeRoy F. Humphries III

LeRoy Humphries
Graduate Student
Marine Biology Dept.

The Department of Biology
Duke University

April 26, 2019

Kristie Gianopulos
Senior Environmental Specialist
Division of Water Resources
NC Department of Environmental Quality

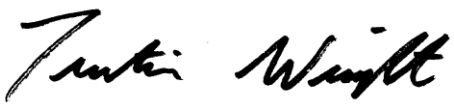
Dear Ms. Gianopulos,

I am pleased to provide my support for your proposal to the EPA WPDG program. I have been involved in an interdisciplinary collaborative project with Ryan Emanuel (NCSU), Marcelo Ardon (NCSU) Emily Bernhardt (Duke), and Todd BenDor (UNC Chapel Hill). We are examining the human and ecological consequences of saltwater intrusion in the Albemarle-Pamlico Peninsula of North Carolina. This project focuses specifically on saltwater intrusion across the Albemarle-Pamlico peninsula. My work on this project has the primary goal of understanding and predicting how coastal freshwater wetland plant communities will respond to the complex dynamics of drought, salt water intrusion and altered land-use management, so your project goals align extremely well with the work we are currently doing.

I can see how the work being proposed by the NC Division of Water Resources is directly relevant to our work, and will augment our understanding of changing conditions in eastern North Carolina. *I am writing to express my intent to partner with the NC Division of Water Resources* on the proposed project by sharing data from our resampling efforts in the Albemarle-Pamlico Peninsula. I also look forward to using data collected by NC DWR from the proposed project to inform our work, allowing us to put it into a larger context. We have been developing statistical tools to assess environmental drivers of vegetation change (TiTAN), and anticipate a productive partnership with your work to help analyze data at the broader landscape scale.

In conclusion, I strongly support the work proposed here. It will provide important new data to address a critical question and will allow data we have already collected to serve a broader function. I commit to assisting with this project in any way that I can.

Sincerely,



Justin Wright
Associate Professor of Biology
Duke University
jw67@duke.edu

NC STATE UNIVERSITY

College of Natural Resources
Department of Forestry and Environmental Resources
cnr.ncsu.edu/fer

Campus Box 8008
2800 Faucette Drive
Raleigh, NC 27695-8008
P: 919.515.2891

28 April 2019

Kristie Gianopulos
Senior Environmental Specialist
Division of Water Resources
NC Department of Environmental Quality

Dear Ms. Gianopulos,

I am writing this letter in support of your proposal to the EPA WPDG program. I currently have two ongoing projects examining forested wetlands in the Albemarle-Pamlico Peninsula of North Carolina. I am part of an interdisciplinary collaborative project with Ryan Emanuel (NCSU), Justin Wright (Duke) Emily Bernhardt (Duke), and Todd BenDor (UNC Chapel Hill). We are examining the human and ecological consequences of saltwater intrusion in the Albemarle-Pamlico Peninsula. I have another project that is focused on understanding the drivers and consequences of forested wetland change in this area. For both projects we are interested in understanding the complex drivers of change to coastal wetlands, and what consequences these changes have for the provision of ecosystem services. Your project goals align very well with the work in my lab.

The project being proposed by the NC Division of Water Resources (DWR) is relevant to our work, and will improve our understanding of how wetlands are changing along the North Carolina coast. *I intend to partner with the NC Division of Water Resources on the proposed project by sharing data we have collected on carbon and nitrogen sequestration rates in different wetland types.* We are also looking forward to using the data collected by DWR to help inform our ongoing work. We have been developing statistical tools to assess environmental drivers of vegetation change, as well as methods to detect early warning signals of forested wetland change. The broader dataset provided by DWR will allow us to test some of the tools we have been developing. We anticipate a productive partnership helping to analyze data and provide a better understanding of the drivers of change, and the consequences of coastal wetland change.

In summary, I strongly support the proposed work by DWR. It will provide new data to help understand how coastal plain wetlands are changing, and what that might mean for the provision of ecosystem services. I commit to assisting the project in any way that I can.

Sincerely,

Dr. Marcelo Ardón
Department of Forestry and Environmental Resources
North Carolina State University
Raleigh, NC 27695
Phone: 919-515-5574
mlardons@ncsu.edu

Albemarle-Pamlico National Estuary Partnership

Our mission is to identify, protect, and restore
the significant resources of the Albemarle-Pamlico estuarine system.

May 1, 2019

Kristie Gianopulos
Division of Water Resources Water Sciences Section
Mail Service Center 1623
Raleigh, NC 27699

Dear Ms. Gianopulos,

The Albemarle-Pamlico National Estuary Partnership (APNEP) strongly endorses your proposal, **Coastal Plain Wetland Change**, for a US Environmental Protection Agency's Wetland Program Development Grant. We commit to continue to partner with the North Carolina Department of Environmental Quality Division of Water Resources where feasible to integrate your results to achieve shared goals and objectives. The goal of comparing current wetland condition and function to historical data will substantially further the objectives of APNEP's 2012-2022 Comprehensive Conservation and Management Plan (CCMP) for the Albemarle-Pamlico estuarine system, specifically supporting the following implementation actions:

- A1.2: Facilitate the refinement and use of online conservation planning tools.
- A2.2: Create and improve projections of land use and climate change related impacts on the regional ecosystem.
- A3.1: Assess the effectiveness of policies and regulations to minimize wetland loss.
- C3.2: Develop and implement a coordinated wetland restoration strategy.

The outcomes of your proposed research will provide valuable information for updating and expanding our 2012 Albemarle-Pamlico Ecosystem Assessment. Our staff will work through the APNEP Wetlands Monitoring and Assessment Team and the Science and Technical Advisory Committee to identify opportunities to integrate the results of your research into future assessments. These teams are charged with developing ecosystem indicators and metrics that will allow the Partnership to monitor the overall health of the Albemarle-Pamlico region.

APNEP regularly engages and educates citizens, stakeholders, managers, and researchers on issues involving the Albemarle-Pamlico estuarine system. To this end, APNEP hosts science and policy meetings and collaborates with local environmental groups within the watershed. We would be pleased to invite the research team to present their findings at a technical workshop or symposium, and assist in disseminating the results of your research by helping coordinate other outreach opportunities through our network.

We rely on regional partnerships and collaboration to implement our CCMP within the watersheds of our congressionally designated "estuary of national significance." The proposed partnerships under this proposal will enhance regional coordination and collaboration among a variety of wetland resource practitioners including state and federal resource managers, academic institutions, and non-governmental partners.

In closing, we strongly endorse the full funding of the North Carolina Department of Environmental Quality's submittal to the Wetland Program Development Grants Program. Please contact me at 919-707-8633 if you have any questions.

Sincerely,

W. Crowell

William L. Crowell, Jr., Ph.D., AICP
Director

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone/Fax: 919-707-8633 | www. apnep.org

The Nature Conservancy
Protecting nature. Preserving life.

The Nature Conservancy
North Carolina Chapter
Nags Head Woods Preserve
701 West Ocean Acres Drive
Kill Devil Hills, NC 27948

tel (252) 441-2525

nature.org/nhw

April 29, 2019

Kristie Gianopulos
Sr. Environmental Specialist
Division of Water Resources: Water Sciences Section
NC Dept. of Environment Quality

Dear Kristie Gianopulos,

As a representative for The Nature Conservancy, I am pleased to write this letter in support of Coastal Plain wetland change proposal by NC Dept. of Environmental Quality. This project bodes well for the health of our estuary systems, our coastal communities and creating the understanding for stewardship necessary to ensure their continued productivity. If funded, we will also be a supporting partner in this project by providing resources for example boats and access to our conservation preserve in the North - east region.

The Nature Conservancy has been doing conservation work in North-eastern North Carolina for over 35 years and has conserved around 362,000 acres in the area. Our work includes such places as Nags Head Woods Preserve located on Bodie Island in Dare County. Here, we own and manage a 1,400 acre maritime forest with the in conjunction with the Towns of Kill Devil Hills and Nags Head. We also own and manage the Currituck Banks Game Land located in Currituck County on the Outer Banks, where we work with our partners USFWS and the State Coastal Reserve program to oversee all properties in a whole system approach.

The Nature Conservancy's mission is to preserve the lands and waters on which all life depends. The loss of Coastal Plain wetlands increases the threats to the community as it faces sea level rise. Due to the low-lying topography of the landscape around the North-east region it is highly vulnerable to sea level rise and storm surge. This project sets in motion measures to improve the understand to the health and resilience of these wetland communities that will not only offer a physical buffer to protect our communities, but will also extend the life of natural resources upon which the local economy, including fisheries, hunting, farming, and tourism depends.

The Nature Conservancy finds this to be a beneficial research project for the local ecosystem and hope it is chosen for funding.

Sincerely,

Aaron McCall
Northeast Regional Steward

Nutrien
Feeding the Future

May 1, 2019

Ms. Kristie Gianopulos
Sr. Environmental Specialist
Division of Water Resources
NC Dept. of Environmental Quality
Mail Service Center 1623
Raleigh, NC 27699-1623

Dear Ms. Gianopulos:

This letter serves as PCS Phosphate Company, Inc.'s agreement to partner with the NC Division of Water Resources in your proposal to compare current wetland condition and function to historical data obtained in past years. Our partnership will consist of providing wetland vegetation plot data that we have been collecting on estuarine tributary creek marshes and forested bottomlands in the coastal plain of North Carolina for at least the last 10 years.

We look forward to working with NCDWR on this project.

Sincerely,

Jeffrey C. Furness
Senior Scientist

[1] Effective January 1, 2018, PCS Phosphate Company, Inc. is an indirect subsidiary of Nutrien Ltd. PCS Phosphate Company, Inc. remains the legal operating entity and permittee.

Kristie Gianopulos, M.S.
(919) 743-8479
Kristie.Gianopulos@ncdenr.gov

Education

-- B.S. Biology, Summa Cum Laude, 1997 Daemen College, Amherst, NY
-- M.S. Zoology, 2001 University of South Florida, Tampa, FL

Professional Experience

2014 – present– Environmental Senior Specialist (NC DEQ, Div. of Water Resources): Responsible for database compilation, data analysis, GIS mapping, report writing, and presentation of results for several major EPA Wetland Program Development grants.

2012 – 2014 – Environmental Specialist (NC DEQ, Division of Water Resources): Project lead for Coefficient of Conservatism database development for Southeast wetland plants; Assistant Botanist for Southeast Wetlands Monitoring EPA Intensification Grant

2004 – 2013 – Wildlife Biologist (Progress Ecology Inc.- Feb. 2006 to 2010): Owner and Project Manager for projects including protected species and general wildlife surveys, permitting, statistical data analysis, GIS mapping and analysis, and wildlife identification training

2001 – 2004 – Environmental Scientist, Transportation Group, Scheda Ecological Associates, Inc., Tampa, FL: Project Manager or Deputy Project Manager for numerous projects including protected species and general wildlife surveys, habitat mapping, upland and wetland ecology, wetland jurisdictional determination, environmental impact studies, floral and faunal field survey, inventory and monitoring, statistical data analysis, GIS mapping and analysis, agency coordination

1997 – 2001 – Teaching Assistant, University of South Florida: Independently instructed and supervised biology and ecology students in classroom, supervised other teaching assistants in lab preparation, coordinated lab schedules, prepared and presented general biology and ecology lectures

Biological Research Experience

2016-2018 – Study of amphibian and macroinvertebrate communities of NC wetlands with regards to restoration techniques: assistance with data collection on macroinvertebrates, water quality, vegetative communities, and hydrology; data analysis, mapping, report writing, and presentations

2013-2015 –Southeast Wetlands Monitoring EPA Intensification Grant: data collection in NC as Assistant Botanist; compilation of data for wetlands across 4 Southeastern states on plants, soils, water quality, land use, amphibians, and macroinvertebrates; data analysis, mapping, report writing, and presentation

2008-2009 – Independently organized and implemented data collection, and performed statistical analysis for breeding bird survey on Tampa Executive Airport

2002-2007 - Independently organized and supervised data collection and performed statistical analysis for research on success of transplants versus nursery stock for hardwood swamp mitigation in West Central Florida.

1998-2001 - Independently gathered, analyzed field data for graduate thesis research in central Florida

1996-1997 - Designed and independently performed lab experiment, analyzed data, and published manuscript for undergraduate research project on painted turtles

Presentations

Gianopulos, K. 2019. NCwetlands.org: A new wetlands education and outreach resource to increase awareness about North Carolina's wetlands. Water Resources Research Institute annual conference. Raleigh, NC.

Gianopulos, K. 2018. You Don’t Need to Know It All - Performance of Rapid Floristic Quality Assessment Indices for Evaluating Wetland Condition. EPA Region IV 401 Coordination Meeting. Jekyll Island, GA.

Gianopulos, K. and A. Mueller. 2018. NCwetlands.org: a new wetland education resource. Environmental Educators of North Carolina annual meeting. Durham, NC.

Gianopulos, K. 2018. Evaluation of macroinvertebrate communities in restored (enhanced), re-established, and reference wetlands in North Carolina. Water Resources Research Institute annual conference. Raleigh, NC.
Gianopulos, K. 2018. Letting the SUN in: open canopy wetlands are critical to our amphibians. Water Resources Research Institute annual conference. Raleigh, NC.
Gianopulos, K. 2017. An evaluation of macroinvertebrate communities with regards to restoration techniques. (invited) Albemarle-Pamlico National Estuary Program Science & Technical Advisory Committee. Greenville, NC.
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Gianopulos, K. 2016. Factors influencing macroinvertebrate communities in restoration, mitigation, and reference wetlands in North Carolina. Carolina Area Benthological Society. Hot Springs, NC.
Gianopulos, K. 2015. Southeast Forested Wetlands Monitoring Intensification Grant Report. EPA Region IV 401 Coordination Meeting. Hot Springs, NC.
Gianopulos, K. 2015. A Preliminary Scoring System for USA-RAM. Southeast Wetland Workgroup meeting. Jekyll Island, GA.
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Professional Memberships Past and Present

Carolina Wetlands Association (current Secretary and founding member)
North Carolina Audubon Society
North Carolina Herpetological Society
Association of State Wetlands Managers
Society of Wetland Scientists
Florida Native Plant Society
Florida Association of Environmental Professionals
Society for the Study of Amphibians and Reptiles
American Society of Ichthyologists and Herpetologists

GREGORY D. RUBINO

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EDUCATION

University of Delaware
M.S. Geology; Thesis title "Chronicling Geomorphologic Change on a Salt Marsh"

University of Rhode Island
B.S. Geology

Alternate Route to Certification Program, CT Department of Education;
Certification in 7 – 12 Earth Science and General Science

U.S. Peace Corps
Language, Culture and program development training in soil conservation techniques for local Bolivian farmers

PROFESSIONAL EMPLOYMENT HISTORY

Environmental Senior Specialist, 2011-present: NCDEQ/DWR; member of the NWCA, ELI, WRC wetland, and Small Impoundments II surveys for North Carolina as soil investigator, assistant vegetation surveyor, macroinvertebrate stream sampler and post sampling data manager. Lead investigator Raleigh Urban Wetlands Water Quality WPGD grant 2017. Crew Field Leader NWCA 2016. Member of 2012 mitigation site survey state-wide as soil investigator, land access coordinator, soil protocol trainer and developer, assistant vegetation and macrobenthic surveyor. Assisted in field studies for NCWetlands.org grant 2016. Stream identification training (SWITC) coordinator and instructor for entire state, 2013. Cyndi Karoly/Branch Chief

7th Grade Science Teacher, 2008-2009: Butner-Stem Public Middle School, Butner, NC. Taught the entire seventh grade weather, biology and physics under NC license #302. Calvin Timberlake / Principal

Middle School Physical Science and Biology Teacher, 2000-2008: Ruxton Country School, Owings Mills, MD. Department chairman 2003-2008. Built professional-quality science program teaching sixth and eighth grade biology, physics, chemistry and natural environments. Steve Barker / School Head

Earth Science, Ecology and Astronomy Teacher, 1998-1999: Windsor Public High School, Windsor, CT. Taught ninth to twelfth graders self-generated earth science program and administered year-end state test. (CT license #033)

Environmental Geologist, 1995: Geo-Technical Services, Inc., Harrisburg, PA; conducted/supervised rock and soil sampling for road/bridge construction.

Staff Geologist, 1992-1995: R.E. Wright Associates, Middletown, PA; wetlands investigator, hydrogeologist; conducted field soils investigations, field map construction, private water budget feasibilities, supervised well drilling for clean water prospecting, contaminated site remediation. Delineated wetlands and assisted in soil surveys for sewage feasibility. Prepared proposals, supervised subcontractors, programmed well log templates using GINT computer software.

Asbestos Air Monitor, 1991: Certified Engineering and Testing, Inc., Memphis Tennessee; conducted air and solid-structure sampling during asbestos abatement projects. Provided project oversight for abatement contractors.

USGS geophysics survey fieldworker, 1990, southeast Missouri and Arkansas: assisted in gathering shallow seismic data in conjunction with Memphis State University's New Madrid Earthquake research project.

University of Delaware and Geological Survey student assistant, 1989-1990: assisted in surface and underground hydrogeologic investigations involving state water supply.

Teaching Assistant, spring 1989: taught undergraduate non-major introductory geology laboratory sections.

VOLUNTEER EXPERIENCE

NCDENR/DWQ, 2011: 401 Development Unit volunteer. Assisted wetland mitigation program staff in QA/QC of GIS database of registered mitigation sites state-wide. Assisted WAT team in stream sampling, stream restoration preconstruction survey mapping, identified wetland boundaries for isolated wetland program in conjunction with University of South Carolina. Entered storm water data for stormwater branch. Assisted in amphibian and macroinvertebrate stream sampling.

NC State Museum of Natural Sciences, 2010 to 2011: invertebrate laboratory and Curiosity Class volunteer. Duties include maintaining scientific organism collection and presenting natural history classes to K-12 museum field trip groups. Jamie Smith/Kathleen Freeman supervisors: 919-733-7450

U.S. Peace Corps Volunteer, 1996: Bolivia #13, South America. Enrolled in soil conservation program, including intensive Spanish language, cultural and development classes with goal of promoting soil conservation techniques in Bolivian rural areas. Medical separation in May 1996 after site assignment.

Diocese of Norwich Mission House, 1996: **Port-au-Price, Haiti.** Assisted in refurbishing Catholic mission house serving local and country-wide service programs.

El Centro de la Comunidad, New London, CT, 1996-1999: Assisted ESL classes for local Latino immigrants including administering listening and reading comprehension tests and home tutoring. Created K-1st grade after-school program for non-English speaking (Latino) children.

CERTIFICATIONS AND MEMBERSHIPS

Carolina Wetlands Association, NC Earth Science (#302), NC Surface Water Identification Training Certification, NC Wetland Assessment Method Certification, CT Earth Science 7-12 (#33), NSTA, American Red Cross Lifeguard, Lifeguard Instructor, Water Safety Instructor, Society of Wetland Scientists, NAUI Scuba I, Hazwoper 40-Hour, Sigma Chi Fraternity/University of Rhode Island

State of North Carolina

ROY COOPER

GOVERNOR

October 29, 2018

EXECUTIVE ORDER NO. 80

NORTH CAROLINA'S COMMITMENT TO ADDRESS CLIMATE CHANGE AND TRANSITION TO A CLEAN ENERGY ECONOMY

WHEREAS, North Carolina residents deserve to be better educated, healthier, and more financially secure so that they may live purposeful and abundant lives; and

WHEREAS, N.C. Const. art. XIV, § 5 requires the conservation, protection, and preservation of state lands and waters in public trust; and

WHEREAS, North Carolina is well positioned to take advantage of its technology and research and development sectors, along with its skilled workforce, to promote clean energy technology solutions and a modernized electric grid; and

WHEREAS, public-private partnerships in North Carolina foster market innovations and develop clean energy technology solutions that grow the state's economy; and

WHEREAS, the effects of more frequent and intense hurricanes, flooding, extreme temperatures, droughts, saltwater intrusion, and beach erosion have already impacted and will continue to impact North Carolina's economy; and

WHEREAS, climate-related environmental disruptions pose significant health risks to North Carolinians, including waterborne disease outbreaks, compromised drinking water, increases in disease-spreading organisms, and exposure to air pollution, among other issues; and

WHEREAS, to maintain economic growth and development and to provide responsible environmental stewardship, we must build resilient communities and develop strategies to mitigate and prepare for climate-related impacts in North Carolina.

NOW, THEREFORE, by the authority vested in me as Governor by the Constitution and the laws of the State of North Carolina, **IT IS ORDERED**:

1. The State of North Carolina will support the 2015 Paris Agreement goals and honor the state's commitments to the United States Climate Alliance.

   The State of North Carolina will strive to accomplish the following by 2025:

   a. Reduce statewide greenhouse gas emissions to 40% below 2005 levels;
   b. Increase the number of registered, zero-emission vehicles ("ZEVs"; individually, "ZEV") to at least 80,000;
   c. Reduce energy consumption per square foot in state-owned buildings by at least 40% from fiscal year 2002-2003 levels.

2. Cabinet agencies shall evaluate the impacts of climate change on their programs and operations and integrate climate change mitigation and adaptation practices into their programs and operations. Council of State members, higher education institutions, local governments, private businesses, and other North Carolina entities are encouraged to address climate change and provide input on climate change mitigation and adaptation measures developed through the implementation of this Executive Order. Consistent with applicable law, cabinet agencies shall actively support such actions.

3. The Secretary or designee of each cabinet agency and a representative from the Governor's Office shall serve on the North Carolina Climate Change Interagency Council ("Council"), which is hereby established. The Secretary of the North Carolina Department of Environmental Quality, or the Secretary's designee, shall serve as the Council Chair. The North Carolina Department of Environmental Quality shall lead the Council by providing strategic direction, scheduling and planning Council meetings, determining the prioritization of activities, facilitating stakeholder engagement, and assisting in the implementation of pathways to achieve the goals provided in Section 1 of this Executive Order.

   The duties of the Council shall include the following:

   a. Recommend new and updated goals and actions to meaningfully address climate change;
   b. Develop, implement, and evaluate programs and activities that support statewide climate mitigation and adaptation practices;
   c. Establish workgroups, as appropriate, to assist the Council in its duties;
   d. Consider stakeholder input when developing recommendations, programs, and other actions and activities;
   e. Schedule, monitor, and provide input on the preparation and development of the plans and assessments required by this Executive Order;
   f. Review and submit to the Governor the plans and assessments required by this Executive Order.

4. The North Carolina Department of Environmental Quality ("DEQ") shall develop a North Carolina Clean Energy Plan ("Clean Energy Plan") that fosters and encourages the utilization of clean energy resources, including energy efficiency, solar, wind, energy storage, and other innovative technologies in the public and private sectors, and the integration of those resources to facilitate the development of a modern and resilient electric grid. DEQ shall collaborate with businesses, industries, power providers, technology developers, North Carolina residents, local governments, and other interested stakeholders to increase the utilization of clean energy technologies, energy efficiency measures, and clean transportation solutions. DEQ shall complete the Clean Energy Plan for the Council to submit to the Governor by October 1, 2019.

5. The North Carolina Department of Transportation ("DOT"), in coordination with DEQ, shall develop a North Carolina ZEV Plan ("ZEV Plan") designed to increase the number of registered ZEVs in the state to at least 80,000 by 2025. The ZEV Plan shall help establish interstate and intrastate ZEV corridors, coordinate and increase the installation of ZEV infrastructure, and incorporate, where appropriate, additional best practices for increasing ZEV adoption. DOT shall complete the ZEV Plan for the Council to submit to the Governor by October 1, 2019.

6. The North Carolina Department of Commerce ("DOC") and other cabinet agencies shall take actions supporting the expansion of clean energy businesses and service providers, clean technology investment, and companies with a commitment to procuring renewable energy. In addition, DOC shall develop clean energy and clean transportation workforce assessments for the Council to submit to the Governor by October 1, 2019. These assessments shall evaluate the current and projected workforce demands in North Carolina's clean energy and clean transportation sectors, assess the skills and education required for employment in those sectors, and recommend actions to help North Carolinians develop such skills and education.

7. Cabinet agencies shall prioritize ZEVs in the purchase or lease of new vehicles and shall use ZEVs for agency business travel when feasible. When ZEV use is not feasible, cabinet agencies shall prioritize cost-effective, low-emission alternatives. To support implementation of this directive, the North Carolina Department of Administration ("DOA") shall develop a North

Carolina Motor Fleet ZEV Plan ("Motor Fleet ZEV Plan") that identifies the types of trips for which a ZEV is feasible, recommends infrastructure necessary to support ZEV use, develops procurement options and strategies to increase the purchase and utilization of ZEVs, and addresses other key topics. DOA shall complete the Motor Fleet ZEV Plan and provide an accounting of each agency's ZEVs and miles driven by vehicle type for the Council to submit to the Governor by October 1, 2019, and annually thereafter.

8. Building on the energy, water, and utility use conservation measures taken pursuant to N.C. Gen. Stat. § 143-64.12(a), DEQ shall update and amend, where applicable, a Comprehensive Energy, Water, and Utility Use Conservation Program ("Comprehensive Program") by February 1, 2019, and biennially beginning December 1, 2019, to further reduce energy consumption per gross square foot in state buildings consistent with Section 1 of this Executive Order. The Comprehensive Program shall include best practices for state government building energy efficiency, training for agency staff, cost estimation methodologies, financing options, and reporting requirements for cabinet agencies. DEQ and cabinet agencies shall encourage and assist, as requested, higher education institutions, K-12 schools, and local governments in reducing energy consumption. To achieve the required energy consumption reductions:

    a. By January 15, 2019, each cabinet agency shall designate an Agency Energy Manager, who shall serve as the agency point of contact.
    b. Each cabinet agency shall develop and submit an Agency Utility Management Plan to DEQ by March 1, 2019, and biennially thereafter, and implement strategies to support the energy consumption reduction goal set forth in Section 1 of this Executive Order. DEQ shall assess the adequacy of these plans and their compliance with this Executive Order.
    c. By September 1, 2019, and annually thereafter, each cabinet agency shall submit to DEQ an Agency Utility Report detailing its utility consumption, utility costs, and progress in reducing energy consumption.
    d. DEQ shall develop an annual report that describes the Comprehensive Program and summarizes each cabinet agency's utility consumption, utility costs, and achieved reductions in energy consumption. DEQ shall complete this report for publication on its website and for the Council to submit to the Governor by February 1, 2019, and annually thereafter beginning December 1, 2019.

9. Cabinet agencies shall integrate climate adaptation and resiliency planning into their policies, programs, and operations (i) to support communities and sectors of the economy that are vulnerable to the effects of climate change and (ii) to enhance the agencies' ability to protect human life and health, property, natural and built infrastructure, cultural resources, and other public and private assets of value to North Carolinians.

    a. DEQ, with the support of cabinet agencies and informed by stakeholder engagement, shall prepare a North Carolina Climate Risk Assessment and Resiliency Plan for the Council to submit to the Governor by March 1, 2020.
    b. The Council shall support communities that are interested in assessing risks and vulnerabilities to natural and built infrastructure and in developing community-level adaptation and resiliency plans.

10. DEQ shall prepare and manage a publicly accessible Web-based portal detailing the Council's actions and the steps taken to address climate-related impacts in North Carolina. Cabinet agencies shall submit data, information, and status reports as specified by the Council to be published on the portal. In addition, DEQ shall develop, publish on the portal, and periodically update an inventory of the state's greenhouse gas emissions that, among other things, tracks emissions trends statewide by sector and identifies opportunities for additional emissions reductions.

11. By October 15, 2019, and annually thereafter, the Council shall provide to the Governor a status report on the implementation of this Executive Order.

12. This Executive Order is consistent with and does not otherwise abrogate existing state law.

13. This Order is effective October 29, 2018 and shall remain in effect until rescinded or superseded by another applicable Executive Order.

IN WITNESS WHEREOF, I have hereunto signed my name and affixed the Great Seal of the State of North Carolina at the Capitol in the City of Raleigh, this the 29th day of October, in the year of our Lord two thousand eighteen.

Roy Cooper
Governor

ATTEST:

Rodney S. Maddox
Chief Deputy Secretary of State

Attachment E. Literature Cited

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