Improving North Carolina's Resilience to Coastal Riverine Flooding

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Please note: this is only the section that the NC Foundation for Soil and Water Conservation contributed. For the full report, please contact the Foundation directly.

1 Executive Summary

Three major storms during the past twenty years, Hurricanes Floyd (1999), Matthew (2016) and Florence (2018), have resulted in loss of life and billions of dollars in impacts to homes, businesses, transportation infrastructure, agriculture, and commerce and hundreds of millions of dollars in emergency response and recovery costs. The frequency and intensity of severe storms and associated flooding are expected to increase due to climate change. Major engineered water control structures such as dams and levees are not practical or affordable in the North Carolina Coastal Plain, because they cannot store much water on relatively flat land, and would need massive berms and construction, and require inundating vast areas. In response, an innovative network of dispersed natural flood mitigation systems has been proposed. The large-scale implementation of strategically located natural infrastructure (NI) measures (e.g. wetlands, forests, water control systems) to increase water storage capacity and reduce flooding was evaluated in the middle Neuse River Basin.

Eighteen NI measures initially considered were reduced to three measures - reforestation, water farming and flood storage wetlands - based on a literature review, expert opinion, geospatial mapping of opportunity, and ground truthing of three study subwatersheds. NI implementation was modeled in three subwatersheds– Little River, Bear Creek and Nahunta Swamp – and the results were extrapolated to the other sub-watersheds of the middle Neuse Basin. Costs and secondary economic benefits of investing in these NI measures were also evaluated.

Approximately 112,737 acres constituting 10.5% of the middle Neuse Basin that drains to Kinston were identified as suitable for the NI measures. The greatest opportunity was in the lower portion of the basin where the land is flatter and less developed. In areas of high-density NI adaption, localized flooding could be substantially reduced (up to 45% peak flow reduction and up to 1.5 ft. water level reduction). The degree of flood reduction was a function of the density and location of NI implementation in a watershed, with greater reductions occurring along smaller tributaries than on the mainstem of the rivers. Lower water levels (0.3 to 0.5 ft.) resulting from the full implementation of NI resulted in estimated reductions in damages to structures ranging from 7% to 21% for Goldsboro and Kinston, depending on the scale of the storm. The largest damage reduction percentages were estimated for the 50-year storm. In addition, water quality modeling indicated that widespread NI measures could reduce nutrients (6 to 18%) and sediment (16 to 30%) export.

The costs of establishing all of the identified NI measures in the middle Neuse River Basin was estimated at $726 million. Full wetland restoration with earthen berms and water outlet control structures would hold the most water (3 acre feet of water per acre of land), but was the most expensive practice, at $131,208 per acre, or $43,736 per acre foot of water stored. Water farming with smaller berms and less capacity (1 acre foot per acre) was cheaper, at $3,242 per acre. Reforestation was cheapest, at $68 for pine and $396 for hardwoods per acre, but would only store 0.1 to 0.33 acre feet of water, respectively, or $206 to $3,960 per acre foot. These net costs for the three best opportunities in the middle Neuse River Basin, which we identified with complete mapping and ground truthing, were then $677 million for wetland restoration; $34.1 million for water farming; and $15.5 million for reforestation, totaling the $726 million.

Flood damage reductions to structures in the floodplain were estimated at 13% to 14% ($23 to $35 million) when NI practices were adopted compared to scenarios without NI adoption for two theoretical 30-year future scenarios. Water quality benefits and avoiding frequent damages to crops and to ecosystem services would increase the merits of NI approaches, and these would be more significant for even periodic large storms and runoff, not just major floods. Direct employment and the economic response that would result from fully implementing the measures were estimated at 1665 jobs and $791 million. Economic multipliers for indirect employment were estimated at approximately 5.2 to 5.4 for all three measures and secondary economic impact multipliers were above 2.16. Selling nitrogen credits at the value set by the NC Division of Mitigation Services could potentially offset about 20% of the construction costs for flood storage wetlands.

Because of the low cost of reforestation, combined with substantial water quality and modest flow reduction benefits, increased investments in forest conservation programs should be a high priority. Moderate flood reduction, especially at the local scale, combined with substantial water quality benefits and large economic multipliers associated with NI investment indicate that further investigation of the other identified NI measures is warranted. Further study of the optimization of NI placement and density and a deeper examination of the ancillary and indirect benefits of NI adoption, through additional modeling studies and on the ground pilot projects is recommended.

NI implementation will require installation and management on private working lands, so landowners should be involved in the process early. Other state's conservation-based flood mitigation programs, such as Iowa and Minnesota, could serve as possible program models. Finally, because reductions in existing flooding impacts through NI are limited and future storms are projected to increase flooding, it is recommended that North Carolina restrict future development or redevelopment in floodplains to reduce future losses.

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2 Project Summary

2.1 Introduction

Flooding, especially resulting from hurricanes, is the most frequent natural disaster globally and one of the most devastating in terms of both lives lost and economic damage (Collentine & Futter 2018, Dadson et al., 2017; Jha et al. 2012). Riverine flooding is believed to affect more people than any other natural disaster by deteriorating infrastructure, damaging crops, displacing residents, contaminating local water supplies, and disrupting natural ecosystems (Jonkman, 2005). It is expected that the frequency and duration of riverine flooding events will increase in the coming years due to changing patterns in precipitation, continued urbanization, and other changes in land use that affect natural landscapes (Jha et al., 2012; Kim et al., 2014; Wobus et al., 2019, Kunkel et al., 2020).

Nature-based solutions, also known as natural infrastructure, present advantages for water quantity and quality and is a more sustainable approach to flood management (Metcalfe et al., 2016). When implemented as a series of distributed practices across a watershed, natural infrastructure can be designed, approved and built more rapidly than large reservoirs, levees or other flood mitigation projects. Natural infrastructure uses natural land features such as wetlands and forests to slow down runoff from storms and store water for an extended period. The purpose of natural infrastructure practices is to increase infiltration and incorporate water storage through constructed natural land features (Metcalfe et al., 2017; Quinn et al., 2013; SEPA, 2013). The goals of this study were to determine the extent to which natural infrastructure can mitigate the impacts of flooding and improve water quality in the Neuse River Basin. A successful natural infrastructure based flood mitigation program in eastern North Carolina should ensure that environmental, social and economic benefits are realized, and ensure that financial resources are spent wisely.

2.2 Study Approach

A multidisciplinary team of university faculty, staff and student researchers (NCSU, UNC-CH) and non-government organization representatives spent 16 months evaluating the potential for natural infrastructure (NI) to mitigate riverine flooding in eastern N.C. NI refers to a strategically planned and/or managed network of natural lands (i.e. forests and wetlands), working landscapes and other open spaces that conserves or enhances ecosystem functions and provides associated benefits (e.g. flood control) to people (Benedict and McMahon 2006). The study team conducted geospatial mapping analyses; hydrologic, hydraulic and water quality modeling; economic analyses; landowner and community outreach and a preliminary review of potential programs and measures for implementing a conservation-based NI program. The Middle Neuse River Basin from Johnston to Lenoir County, which has been heavily impacted by recent riverine flooding events, was the focus area of the study.

Through a literature review and exploration of 18 conservation, restoration and land management measures, eight key natural infrastructure measures were identified with the greatest potential to help improve flood resilience in Eastern North Carolina. Three subwatersheds (50 – 80 square miles; 32,000 to 51,000 acres) of the Basin – Little River, Bear Creek and Nahunta Swamp –

were intensively modeled to estimate the peak flow reductions during large storms and water quality benefits resulting from implementing the NI measures. Geospatial mapping combined with ground truthing of the subwatersheds resulted in the selection of three NI measures with the highest potential for implementation in the study area - wetlands, water farming and reforestation.

NI potential and peak flow reductions from the three study watersheds were extrapolated to the full middle Neuse Basin using regression relationships developed from the subwatershed results. Existing NC Division of Emergency Management (EM) floodplain mapping models were used to estimate water level reductions along the Neuse River and several tributaries. The peak discharge and river water level changes were used to estimate the number of structures that would experience less flooding along the Neuse River with a focus on the communities of Kinston and Goldsboro.

The total costs of establishing the NI measures in the middle Neuse River Basin were estimated to quantify the potential direct and indirect economic benefits of investing in NI. Project elements and the resulting spending pathways (labor, materials, fuel, etc.) were based on past restoration projects and input from stream and wetland contractors and practitioners. To evaluate the feasibility and cost associated with various leasing and purchase agreements the team held workshops and conducted a detailed survey of more than 50 landowners. The web-based survey was circulated to farmers across six counties within the Basin to estimate the costs of leasing and buying land for NI practices. The estimated total costs were then input into the IMPLAN economic impact assessment software system to estimate the potential secondary economic benefits of investing in NI. In addition, detailed economic engineering and finance analyses were conducted for multiple scenarios of the seven NI measures identified to determine average costs for the selected measures and the payments that might be required for landowners to adopt them.

A committee of working lands experts was formed to explore the innovative NI measures identified and consider the process that would be necessary to implement a NI-based conservation program focused on flood mitigation. Science, economics, community collaboration, and governance structures relevant to conservation and environmental programs both within and outside of North Carolina were reviewed. Results were used to prepare program development and communications recommendations.

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7 Outreach

7.1 Demonstration Farm

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7.1.1 Introduction

In order to enroll landowners in conservation programs that would convert their land to wetlands or water farming for the purposes of flood mitigation, outreach and education regarding the purpose, function, operation and long-term implications of these systems is essential. To aid with the landowner outreach for this study, including a workshop and a survey of landowners regarding land leasing options, concept designs were prepared for both wetlands and water farming for an area of cropland located on the NC Department of Agriculture and Consumer Services' Cherry Research Farm located in Goldsboro. Renderings and text explaining the function and flooding extents for both practices were developed.

7.1.2 Methods

Topographic data for the Cherry Research farm was evaluated in order to identify crop areas with low enough slope (less than 1%) that would be suitable for water farming and wetlands. Three fields at the Cherry Research Farm were selected as case study locations (Figure 7-1). Aerial photos of the fields from a birds-eye perspective were collected using Unmanned Aerial View (UAV) technology. Using AutoCAD Civil3D®, preliminary designs for two wetland configurations (10 acres and 15 acres) were developed for the 75 acre crop field to the west. For the 50 and 75 acre fields located to the east, the location and extent of berms were identified and the number of outflow points were determined from the existing topography, including the location of existing ditches. The College of Design then created computer renderings atop the aerial photos for both the wetland and water farming designs. The renderings show the existing condition as well as the condition of the crop land and wetland when water storage is at its peak. In addition, descriptive text to explain the purpose and function of the two NI systems was also developed.

Figure 7-1. Water farming and wetland locations at Cherry Farms

7.1.3 **Results**

Water Farming

Much of the cropland in eastern North Carolina has enhanced drainage via a network of ditches. The ditches are designed to remove excess water after it rains and when the water table is high. Despite improved drainage, some crops are still damaged or completely destroyed during extreme rainfall events that frequently accompany hurricanes and tropical storms. In contrast, during hot, dry periods, the ditched drainage may produce a water deficit that puts stress on crops. Water control systems have been used in North Carolina to allow for proactive water management of croplands. These systems are proven to improve water quality and crop productivity when managed correctly. In addition, establishing an engineered system to temporarily store water during extreme flooding events, known as "water-farming", could help to alleviate downstream flooding.

To reduce downstream flooding, water-farming systems must store water during significant storms, such as the 25-year storm or greater. The 25-year storm has a 4% chance of occurring each year, but has a 33.5% chance of occurring over a 10-year period. Flooding can be triggered both by large amounts of rain and moderate rainfall that falls in a very short time period. For example, 7-8 inches of rain or more in a 24 hour period, is likely to produce significant flooding. However, 3-5 inches of rain falling during a very short time (1-2 hours), can also produce flooding, especially when the ground is already saturated. The water would need to be stored on the farm field for 3-5 days, depending on the distance from the farm to downstream areas of flooding concern. Water depths on the field would range from 0-4 feet depending on the

elevation of the field. This delay will allow time for the water to infiltrate the ground, evaporate or to not contribute to the peak flow rates that can swamp downstream communities or roadways and other infrastructure.

One or more outlet structures would be installed along the lowest points of the field perimeter. The structure can have many configurations, but all designs must allow for operational control of the water levels in the field. During normal rainfall and weather conditions, the structure would remain open. Prior to a large storm, the structure would be closed so that all water that falls on the field will be captured. After 3-5 days, the structure will be opened to allow any remaining water to drain off the field. Figure 7-2 below show the resulting renderings for water farming.

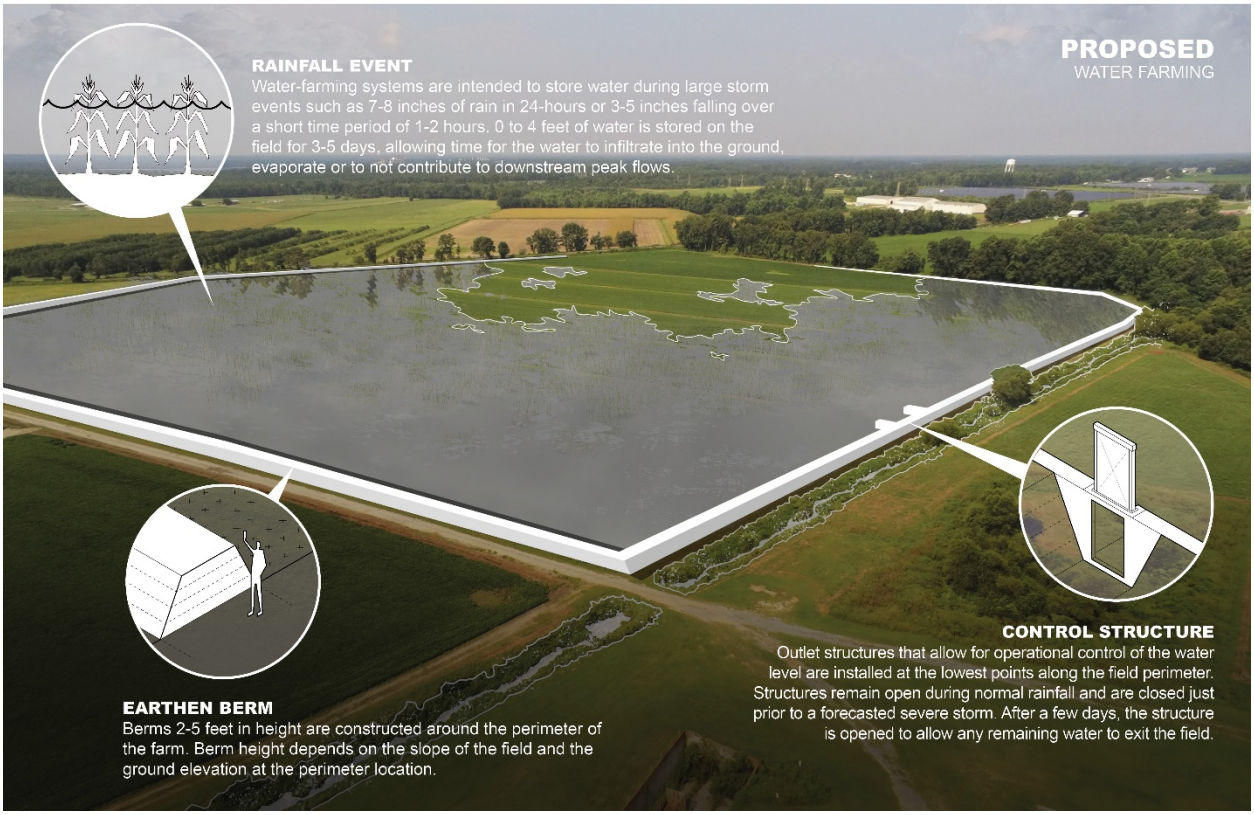

Figure 7-2. Concept Rendering of Water Farming

Flood Control Wetlands

North Carolina has lost and estimated 5.3 million acres of wetlands. Many of these valuable water storage and filtering landscapes were ditched and drained so they could be converted to managed forests and farming. Depending on size, location in the drainage network and their design, restored wetlands can provide significant flood storage and water quality benefits. Wetlands are often referred to as natural sponges that soak up water, However they actually function more like natural tubs, storing either flood waters that overflow riverbanks or surface water that collects in isolated depressions. Wetlands have the capacity to temporarily store flood waters during high runoff events. As flood waters recede, the water is released slowly from the wetland soils. By holding back some of the flood waters and slowing the rate that water re-enters

the stream channel, wetlands can reduce the severity of downstream flooding and erosion. Earthen embankments, berms and drainage control structures can be added to restored or created wetlands to maximize their flood storage benefits. In order to store water during storm events, an earthen embankment with a pipe outlet structure must be constructed at the downstream end of the wetland. When it rains, the embankment blocks the flow of water and causes water to back up into the wetland area. This temporary storage of water helps to reduce downstream peak flow rates, which can help to mitigate flooding. Depending on the slope of the existing ditch, a series of berms or embankments may be necessary to provide enough water storage to significantly reduce downstream flows. Figure 7-3 below show the resulting renderings for flood control wetlands.

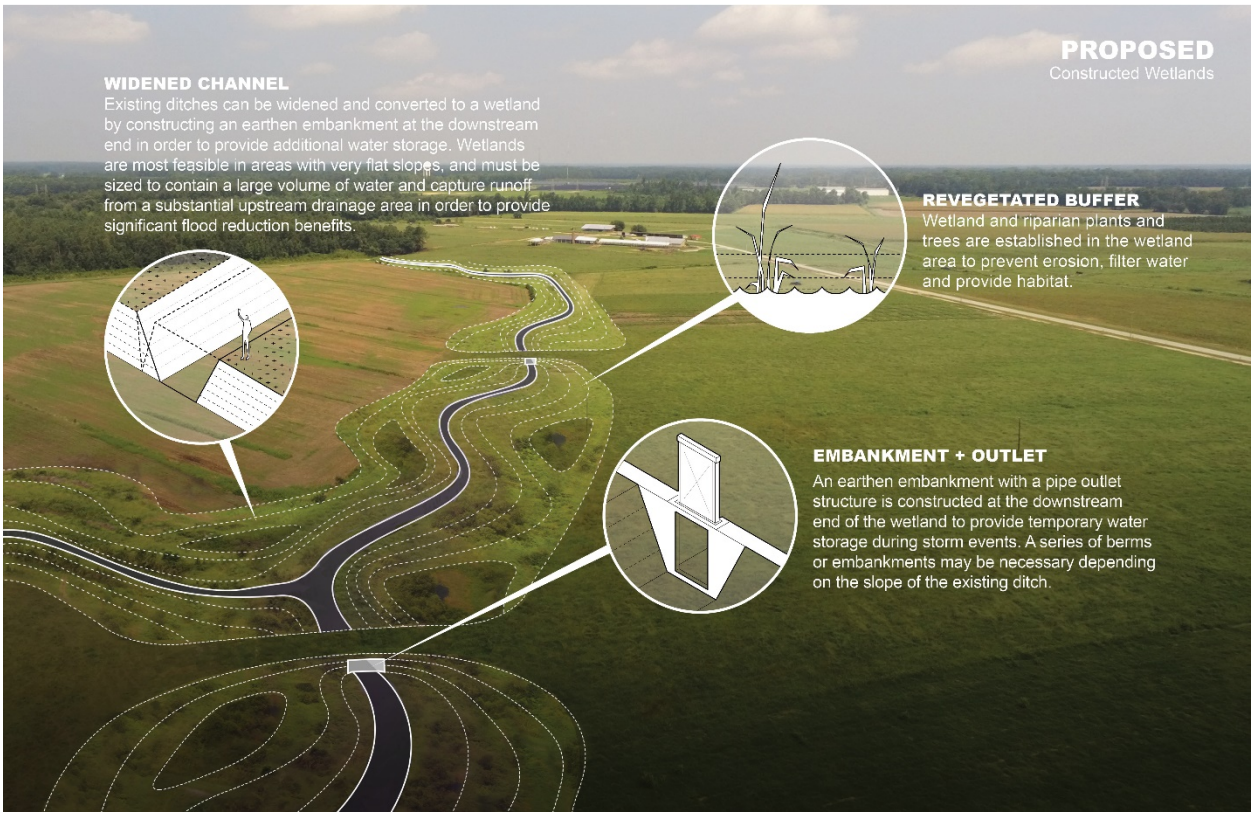

Figure 7-3. Concept Rendering of Flood Control Wetland

7.1.4 **Conclusions**

The concept design renderings for both water farming and wetlands were shared with landowners who attended a workshop in Wayne County on February 23. The text and the renderings were used to explain the practices being explored for flood mitigation. This information will also be incorporated into North Carolina Sea Grant's informational web page focused on coastal riverine flood mitigation (go.ncsu.edu/flood-mitigation) and into a fact sheet about natural infrastructure practices targeted at landowners.

7.2 Community Engagement and Program Delivery Exploration

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7.2.1 Introduction

The intent of this study is to ensure strategic implementation of natural infrastructure in eastern North Carolina such that environmental, social and economic benefits are realized, and to ensure financial resources are spent wisely. A successful program for mitigating flooding by implementing natural infrastructure at the landscape scale must intersect carefully designed practices based on geomorphological and hydrologic criteria with working lands in private ownership. For this study, working lands include properties actively managed for agriculture (food, fiber, and bioenergy) and forestry production as well as for wildlife. Private land ownership entities and management structures are diverse and may include family ownership, LLCs or lands controlled by groups such as hunting clubs, Timber Investment Management Operations (TIMOs) or Real Estate Investment Trusts (REITs). Conservation delivery is most effective when the program participants, in this case, the landowners and users (also referred to as farmers, producers or operators), are given multiple opportunities to provide meaningful input and feedback throughout the design and implementation process.

"Locally led conservation" is fundamental to the success of our state's conservation programs and the working lands community relies on partnerships with local soil and water conservation districts and county level Cooperative Extension staff to enhance their operations. A community-level work group of working lands advisors in Wayne County was assembled to explore innovative practices and delivery processes to evaluate the possibility of a natural infrastructure based flood mitigation program. The NC Foundation for Soil and Water Conservation (Foundation) formally and informally connected a cross section of stakeholders from several state level groups to identify community needs relative to flood mitigation and to develop workable strategies to improve community resilience. The stakeholders provided input and shared knowledge regarding the science, economics, community collaboration, and governance structures related to a variety of conservation and environmental programs. In addition, a suite of best practices were identified and compared to efforts underway nationally. Finally, practical recommendations that local communities can support were prepared.

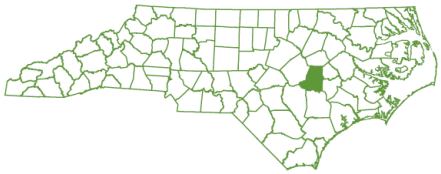
7.2.2 The Project Area: Wayne County's Agriculture and Forestry Economic Profiles

Two watersheds in Wayne County were selected for natural infrastructure evaluation, Nahunta Swamp and Bear Creek (see Section 4). The Foundation, in partnership with the Wayne County Soil and Water Conservation District and Cooperative Extension, formed a community landowner and land user group. Roughly 90% of Wayne County is in either farm or private forestry ownership. A summary of the current economic state of agriculture and forestry production in Wayne County is provided below.

Wayne County Agriculture Production: According to the *2017 USDA Census of Agriculture*, Wayne County has the 3rd highest agriculture sales out of 100 counties and is 72nd out of 3,077 counties nationally. Wayne County is ranked 6th nationally in the production of tobacco. Wayne County ranks 3rd out of 100 counties for the agricultural products market value. For livestock, poultry and products, Wayne County is listed 3rd out of 100 counties, more specifically, 4th in hogs and pigs and 6th in poultry and eggs. For Crops, Wayne County is listed 6th out of 100 counties, more specifically 6th in tobacco, 7th in grains, oilseeds, dry beans, dry pea; and 8th in vegetables, melons, potatoes, and/or sweet potations. Of the total land in farms by acres, 37% is in soybeans for beans, 15% is in corn for grain, 11% is in wheat for grain, and 5% both in tobacco and forage (hay/haylage). For conservation practices, 41% is in no-tillage or reduced tillage and 15% is in cover crop.

WAYNE COUNTY

Census of Agriculture - 2017	
Total Acres in County	353,730
Number of Farms	551
Total Land in Farms: Acres	165,345
Average Farm Size: Acres	300
Harvested Cropland: Acres	123,617
Average Age of Farmers	57.1
Average Value of Farm & Buildings	$825,006,000
Average Market Value of Machinery & Equipment	$122,433,000
Average Total Farm Production Expense	$713,388



Crops - 2019	Acres Harvested	Yield	Production	Rank
Corn for Grain: Bu.	24,100	96	2,314,000	17
Cotton: Lbs.: Production in 480 Lb. Bales	9,200	1,070	20,500	18
Peanuts: Lbs.	*	*	*	*
Soybeans: Bu.	53,400	33	1,764,000	8
Sweet Potatoes: Cwt.	*	*	*	*
Wheat: Bu.	12,300	43	530,000	3

Livestock	Number	Rank
Broilers Produced (2019)	11,000,000	23
Cattle, All (Jan. 1, 2020)	8,800	35
Beef Cows (Jan. 1, 2020)	*	*
Milk Cows (Jan. 1, 2020)	*	*
Hogs and Pigs (Dec. 1, 2019)	550,000	4
Layers (Dec. 1, 2019)	*	*
Turkeys Raised (2019)	4,950,000	2

Cash Receipts - 2019	Dollars	Rank
Livestock, Dairy, and Poultry	282,350,849	5
Crops	85,873,052	8
Government Payments	11,705,288	11
Total	379,929,189	4

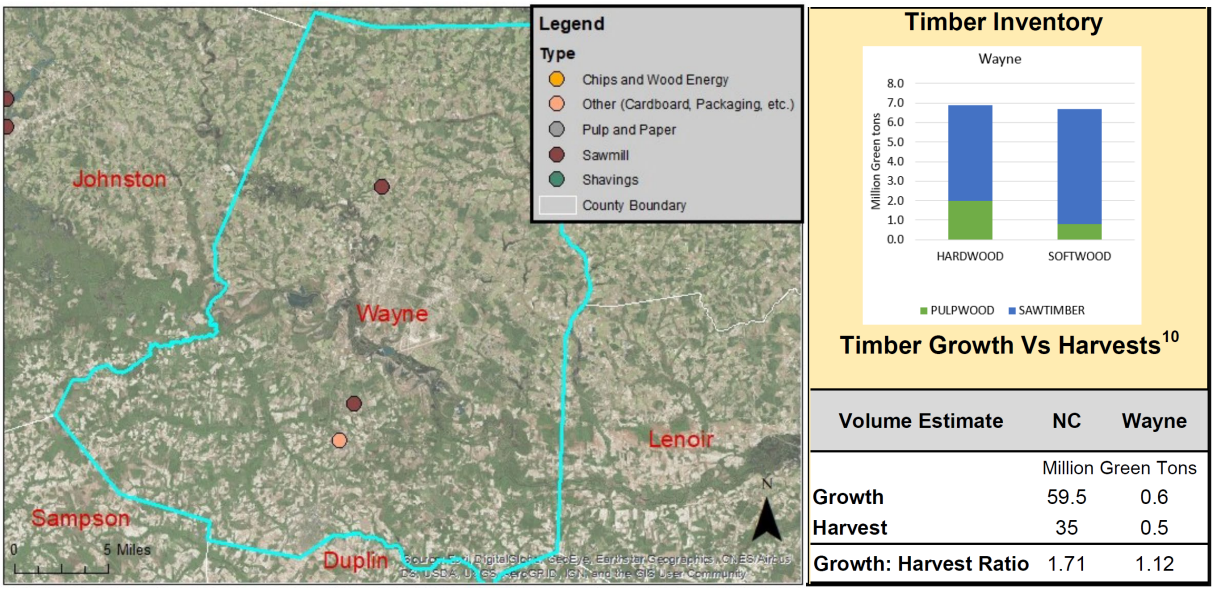
Figure 7-4. Wayne County Agricultural Production Rates (Source: USDA Census of Agriculture, 2020)

In 2019, Wayne County was ranked statewide as 2nd for turkeys, 3rd for wheat; 4th for hogs; 5th for livestock, dairy, and poultry; and 8th for soybeans (USDA, 2020) (*Figure 7-4*).

Wayne County Timber Production: 45% of the county's acreage is privately owned timberland. Landowners received an estimated stumpage value of $3.9 million, with the county's forestry sector contributing $157 million in industry outputs (Cooperative Extension, *2018)* (see Figure 7-5).

7.2.3 Community and Broader Stakeholder Discussions across Eastern North Carolina

The Foundation has led and participated in several stakeholder processes to discuss working lands, flooding and natural infrastructure. These efforts are highlighted to provide the reader a broader understanding of past and current discussions among North Carolina communities regarding the prospect of establishing natural infrastructure on working lands for the purposes of flood management.



Volume Estimate	NC	Wayne
	Million Green Tons	
Growth	59.5	0.6
Harvest	35	0.5
Growth: Harvest Ratio	1.71	1.12

Figure 7-5. Timber Inventory data and a map showing local forest product mills diagrams (Source: Wayne County Cooperative Extension, 2018)

- **Sentinel Landscapes County Roundtables** were facilitated by the Foundation in early 2020 in Craven, Hyde, Jones, Moore, and Washington Counties for the NC Sentinel Landscape Committee. The Eastern North Carolina (ENC) Sentinel Landscapes, a nationally designated area encompassing 33 eastern counties including Wayne County, is defined as an area in which natural and working lands are well suited to protect defense facilities from land use that is incompatible with the military's mission. These roundtables focused on discussions with private landowners and land users, as well as local businesses and natural resource agency representatives. These small groups evaluated agriculture and forestry economies at the county level to identify ways state partners could help strengthen local economies. Flooding and flood management were top issues identified in the roundtables. In addition, the discussions identified other common themes relative to the state of working lands, including farmland loss and land transitions; markets and the challenges of making a living from farming and forestry; and the need for increased support for conservation programs and local economic development. See *2019 – 2020 ENC Sentinel Landscapes Working Lands Community Outreach* for more details (https://ncsoilwater.org/programs/enc-sentinel-landscapes-managing-your-land-and-legacy/).

- **Regional Coastal Resilience Workshops** were facilitated by the NC Department of Environmental Qualities' Division of Coastal Management in partnership with the NC Coastal Federation including the May 14, 2019 Southeast Regional Resilience Workshop in Wilmington and the June 11-12, 2019 Coastal Resilience Summit in Havelock. These workshops brought together landowners, community leaders, state agencies and NGOs to consider barriers and strategies.

Figure 7-6. Word Cloud Response of Top Climate-Hazard Issues Facing Coastal North Carolina.

As noted in the word cloud above (Figure 7-6), generated from participants at the Havelock Meeting, flooding was the most frequently referenced key issue to be considered in the State's plan. Stakeholders identified the need to evaluate nature-based solutions for effectiveness and create streamlined permitting processes. They also recommended the need to conduct watershed management along geographic rather than political boundaries. Stakeholders expressed interest in policies that incentivize towns to test innovative resilience measures including opportunities on surrounding working lands. See *Appendix D of the North Carolina Climate Risk Assessment and Resilience Plan,* June 2020 for a full report (https://deq.nc.gov/energy-climate/climate-change/nc-climate-change-interagency-council/climate-change-clean-energy-17).

- **The North Carolina Coastal Federation,** in partnership with The Pew Charitable Trusts, convened stakeholders in four work groups: New Development; Roadways; Stormwater Retrofit of Existing Land Use; and Working Lands. The Working Lands work group discussions are reported in the *Action Plan for Nature-based Stormwater Strategies: Promoting Natural Designs that Reduce Flooding and Improve Water Quality Working Lands* (https://www.nccoast.org/project/nbss/). The work group identified cross-cutting impediments including lack of awareness; restrictive / outdated planning processes, regulations, and policies; design challenges related to timing of solution consideration and lack of technical expertise; misunderstanding of true implementation costs versus perceived costs and limited or intermittent funding; inadequate maintenance guidelines; limited monitoring leading to inadequate or more costly evaluation. The work groups recommended 1) local and state government lead by example on encouraging adoption of natural infrastructure; 2) increase education, outreach, and training across the government and private sectors; and 3) the need to create a Nature-Based Stormwater Steering Committee to provide leadership for a longer-term effort that promotes and coordinates adoption of Plan recommendations.

- **ReBuild NC's State Disaster Recovery Task Force** stakeholder process is on-going at the time of drafting this report, the Foundation is participating in the Recovery Support Function 7: Environmental Preservation work group. A March 24, 2021 memo from the

work group to Michael Sprayberry, Executive Director of NC Division of Emergency Management and NC Office of Recovery and Resiliency, recommends the creation of a Statewide Flood Resilience Framework with the primary purpose of driving efficient and effective funding decisions across federal, state, and local government to reduce flooding and improve economic, social, and environmental outcomes across the state.

7.2.4 Methods

7.2.4.1 Original Scope of Work

In an effort to identify communities' needs relative to flood mitigation and develop workable strategies for them to improve their resilience, the Foundation, along with other project partners, designed a process to engage community level working lands stakeholders through work groups and focus group discussions. Target stakeholders included landowners and land users, county level natural resource organizations and other rural leaders. Discussions would focus on determining viable, locally derived solutions that address flood mitigation based on lessons learned during recent natural disasters. The working group would evaluate local governance structures including Soil and Water Conservation Districts, Service Districts, Drainage Districts, and Watershed Districts for local program management and assess the need to modify existing processes. Specific activities included the following:

a) Establish a community group within a watershed to engage through their Soil and Water Conservation District via 3 discussion meetings to (1) identify flood-prone areas across the watershed and (2) identify and assess conservation practices that will serve as effective mitigation measures at the landscape scale.
b) Create a farm demonstration that represents a whole farm system of conservation practices that support weather resilience at the watershed level.
c) Review existing policies for implementation of conservation practices, identify policy gaps for delivering innovative practices, and develop a strategy to improve policies to expedite program scalability.
d) Review current local government's ability to manage weather resiliency efforts and make recommendations on areas of improvement.
e) Development and dissemination of fact sheets and videos that succinctly convey solutions determined by the working and community group.
f) Create a webpage that describes solutions identified and suggestions for applications.

7.2.4.2 Modified Scope: Community Engagement

The Foundation assembled a core Advisory Group to provide feedback and process guidance that included representatives from the NC Association of Soil and Water Conservation Districts, the NC Farm Bureau Federation, and the Environmental Defense Fund. The group met on an as-needed basis through online platforms and provided recommendations on specific policy and local governance topics to explore as well as identifying interview candidates.

The Foundation formed a partnership with the Wayne County Soil and Water Conservation District to assess programmatic delivery processes, policy and permitting hurdles, and to solicit landowner and land user input on the three practices of (1) wetland restoration - converting drainage ditches to water retention sites, (2) water farming - using flood prone fields to temporarily store flood water, and (3) reforestation - using existing forest tracts or converting cropland to forest tracts and manage the sites to store flood water. To gain effective input under COVID social distancing restrictions, the following methods were deployed at the county level.

a) A Wayne County technical work group was formed with representatives from the conservation district, county Cooperative Extension, US Department of Agriculture, and a local drainage district in order to provide a connection to local landowners and land users;
b) The Cherry Research Farm was utilized as a visual backdrop to digitally simulate practices during a flooding event in lieu of a farm demonstration on private lands; and
c) One focus group meeting of landowners and land users was facilitated in February.

NC Farm Bureau Federation and the NC Association of Soil and Water Conservation Districts encouraged participation in the process through their membership ranks. The Foundation worked with county level Cooperative Extension and Conservation Districts in Craven, Greene, Jones, Lenoir, Wayne, and Wilson Counties to solicit input through their network of landowners and land users to participate in the landowner finances survey, see Section 8.2 for further information on this effort. The Foundation, with a subgroup of project partners, is also beginning a similar investigation in Robeson County, with the support of a NC Department of Justice Environmental Enhancement Grant. Plans include conducting focus group meetings later in 2021 and into 2022, COVID19 social gathering restrictions dependent.

County Technical Support Team (County Team): The Wayne Conservation District approved a partnership with the Foundation in February 2020. The Conservation District was tasked with forming a County Team, with recommended member organizations including county Cooperative Extension, USDA field office partners, the NC Forest Service, county Emergency Response, local Drainage Districts, and local commodity groups. All members of the County Team are landowners or land users, however this was not a selection qualification. Throughout the investigation, the County Team provided input and feedback to the project's preliminary modeling results and the design of the landowner and land user engagement. The Conservation District formed a community group (Focus Group) of landowners and land users, specifically land owners and operators in the Nahunta Swamp watershed.

Focus Group Participant Selection: The County Team strategically invited a select group of 20 participants using guidelines established by the Advisory Group. Invited participants included known innovative farmers, early program adopters or controlled a significant amount of acreage in the county. A random selection of participants was not contacted due to COVID19 restrictions. It was essential to build off of existing well-established trusted relationships since the modified process prevented a lengthy facilitated effort necessary to establish trust with new contacts. In addition to the Advisory Group, Cultivating Resilience LLC provided feedback on

the meeting's structure and facilitation guidance. A Focus Group was hosted by the Conservation District in February 2021 with 10 participants in attendance.

Focus Group Meeting Process: The Focus Group meeting explored ways that conservation practices can be used as a flood mitigation tool and reviewed the concept of "water farming". The meeting facilitators included Foundation staff, a representative from NC Farm Bureau Federation and a graduate student from NC State University's Department of Forestry and Environmental Resources. Reforestation was discussed during the meeting, but a definition was not provided, the Advisory Group opted to focus on the novel conservation practices of water farming as defined below. Visuals provided with the meeting materials were created using drone images of the Cherry Research Station that were generated by NC State University's Department of Biology and Agriculture Engineering and the Coastal Dynamics Design Lab with assistance from NC Farm Bureau Federation. The meeting details and materials are provided in Appendix 10.4.

> **Flooding Event Definition:** Flooding events were defined as 25-year storm events, which have a 4% chance of occurring each year but a 33.5% chance of occurring over a 10-year period. Rainfall volume was described as 7 to 8 inches of rain falling in a 24-hour period or 3 to 5 inches of rain falling in 1 to 2 hours.
>
> **Wetland Restoration:** A designed wetland in the drainage ditch system created by expanding the size of the ditch to temporarily store a greater volume of water during a flooding event. These wetlands are designed to temporarily store flood water then slowly release the water after the event. Earthen embankments, berms and drainage control structures would be used to maximize the flood storage capacity.
>
> **Water Farming:** A process to store flood waters on upstream farm fields that normally flood to lessen flooding impacts downstream. Water Farming Systems would store flood waters for 3 to 5 days with a total of accumulation of up to 4 feet of water, depending on the elevation of the field.

7.2.4.3 Modified Scope: Exploring State Programs

The Foundation employed a two-pronged approach to explore and compare existing state programs to programs in other state by: (A) participating in existing formalized stakeholder processes actively discussing flood management described in Section 7.2.3 and (B) conducting online interviews with state natural resource technical specialists in North Carolina, Wisconsin, Minnesota, and Iowa.

North Carolina Natural Resource Management Technical Experts Input: The Foundation conducted online interviews with 15 natural resource technical specialists from federal and state agencies, environmental nonprofits, and farmer advocacy groups in North Carolina. Each interview was tailored to specific conversation topics and questions relevant to the interviewee's

knowledge of historic program development, field of expertise, or current programs they manage.

State Program Reviews: Both Iowa and Minnesota have developed watershed programs that are coordinated at both the state and local level to improve water quality and use natural infrastructure to address flooding. Foundation staff reviewed online materials and conducted interviews with various program managers at the state level. The Foundation also participated in an information exchange trip with the Iowa Flood Center in 2019. These two state programs were selected for evaluation because of their holistic approach to flooding at a watershed level through robust stakeholder engagement. The programs were also selected based on major funding and programmatic differences. Iowa's program was established through several large federal grants whereas Minnesota's program is supported by state seed funds in preparation to administer federal grants. In addition, a Wisconsin Conservation District is testing water farming practices, called by another name, to evaluate their effectiveness in managing flood waters at the farm level.

> **Minnesota's One Watershed One Plan** is designed to create capacity for consolidated watershed planning across 81 major watershed boundaries supported by long-term predictable implementation state funding leveraged through shared or consolidated services across local government units.
>
> **Iowa's One Watershed Approach** goal is to create a vision of the state's future, through voluntary stakeholder engagement across the watershed to achieve common goals that builds the state's resilience while demonstrating a commitment to agricultural stewardship, the environment, and the future of local communities.

7.2.5 Results

7.2.5.1 Focus Group Input Results

Below is a summary of feedback from the February 2021 Wayne County Focus Group meeting. Quotes are used for language directly stated by a participant. Overall, participants recognize the need to be more proactive to flooding events, recommend conducting water management at a regional level and acknowledge that opportunities exist for using natural infrastructure on working lands as one of several viable solutions. Valuable insight was provided as to how a program should be structured, with a preference for local decision-making and management across political boundaries within a defined watershed and consideration of dual use systems for storing water and allowing stored water to be used for irrigation.

Previous Flooding Experience:

- Participants discussed the realities of flooding, the need to find a way to "live with the water". The flooding events are more than just hurricanes and more frequent; flash flooding events now lead the water to "pile up on us" where it did not in the past. They noted that a

water management program may be able to help with smaller storm events but not the large events like hurricanes.

- They framed the cause of flooding as directly related to intense urban development further upstream, like the Raleigh metro area. “I know there is a lot we can do, but a lot of it is out of our control.” They feel that urban areas need to do their “fair share” in managing stormwater, that agricultural land management cannot be the only solution. They are apprehensive that this is another effort to “point the finger at agriculture”.
- They all noted they have taken land out of production due to flooding. They noted how flooding events lead to economic losses beyond crop loss, such as impacting agri-tourism.
- Overall, they feel that Wayne County farmers have “done a good job”. They referenced conservation efforts such as establishing riparian buffers; taking land out of production on marginal lands; and in-field practices like no-tillage. Some have already converted flood prone fields to other forms of production like pasture or orchards.
- They discussed the history of the drainage districts, how federal assistance in the 1960s and 1907s allowed for more land to come into production with watershed structures. They noted an opportunity in retrofitting existing watershed structures to re-establish capacity to hold flood waters.

Program Delivery Insights:

- They referenced the need for a dedicated revenue to design, install, and maintain practices. The current drainage district system does not work, no appropriated funds exist, taxes collected are not enough to cover the longer-term costs of regular maintenance plus repairs after storm events.
- Some felt they were best suited to manage the water releases. Others were ok with a 3rd party overseeing water management if it was a locally employed person that worked within an existing county agency. No one was willing to provide property access to someone they did not know, like a person stationed in Raleigh.
- They discussed how current natural disaster recovery programs require locals to have money up front, the landowner must fix the structure soon after the event and relief funds are not delivered in a timely manner. A reimbursement structured program will not work.
- They noted concerns around qualified contractors that can be mobilized in a timely manner. If a natural disaster happens in another state, contractors do not always finish the local job, opting to mobilize elsewhere.
- They all agreed they needed a high level of local control. “People in Raleigh have no idea how we farm in Wayne County.” They want the ability to rank / prioritize program resources at the county level but were not in support of creating a new oversight board. The recommended increasing capacity within existing programs.
- They concurred that a water management program would need to operate along watershed boundaries and not county boundaries, the counties would need to work together.

Conservation Practices Exploration:

- They recommended practices with a dual purpose of holding back flood waters and retaining water for irrigation purposes, some type of hybrid system. They noted that during June and July they can use the water, then release excess water prior to storm events similar to how they manage freeboard levels in animal waste lagoons.
- They recommended restoring water storage capacity in existing farm ponds and watershed structures. They also noted that water farming will take active management, it will not do any good if you don't systematically release the waters after the event.
- They recommended demonstrations where soils could be tested after a water impoundment event to measure additional impacts, if any, such as soil quality degradation.
- They raised concerns about creating "new" wetlands; once land convert to a wetland it can no longer be farmed.
- They recommended consideration of farm roads (private roads used exclusively by farmers); could they be raised and constructed as a "leaky dam" as opposed to using a large culvert? This would allow them to maintain access to certain parts of the farm and provide a water retention benefit during an event.

Landowner Incentives Consideration:

- A program that allows dual use, such as irrigation, would be a strong incentive beyond monetary compensation.
- They noted that financial incentives had to be more than what crop insurance programs offer. Crop insurance does not consider a financial bridge to get you to the next cropping season, it only covers a percentage of current losses. "Land doesn't come back into production overnight (after an event)".
- They had questions on the impacts of the actual flood waters and if it would cause them to lose nutrients in the soil bank or lead to a loss of a significant amount of soil overall. Would they have to increase fertilizer rates the following year because nutrients leached out at a higher rate during the water impoundment period?
- They noted that short term contracts would not be a good investment in all cases. If permanent water control structures are put in place, the landowner needs to make a long-term commitment. Some participants were interested in multi-year contracts or deed restrictions, others thought a permanent easement was best. Overall, they agreed that the incentives needed multiple tiers so that farmers can decide what works best for them.
- They all agreed that some money needed to be provided upfront and not just rely on reimbursement funds. Some were interested in a base payment with bonus payments offered annually.
- They were not comfortable with discussing transferable tax credits as a funding mechanism. They would need to understand how conservation tax credits work in other states before providing feedback.

Other Items of Note:

- Access to broadband is a major issue, a water management system that relies on automation will not work without major broadband infrastructure improvements.
- They frequently referenced continued urban growth and questioned how a water management program would deal with ever increasing water issues. They questioned if existing urban stormwater measures were adequate; they strongly noted that residences of Wayne County should not burden the cost of what is happening in the urban areas further upstream in the river basin.
- They noted the need to better coordinate efforts with NC Department of Transportation and referenced farmland that becomes flood prone after a new road is installed or existing roads are overhauled.
- They were very concerned around any additional restrictions on farming, like prohibiting specific commodity crops in water farming fields. "The more someone is told how to farm the less they want to farm."
- They questioned why partners are exploring a whole new program without first considering rehabilitating the existing watershed structures and systems maintained by the drainage districts. They recommended exploring the capacity for existing farm ponds, not part of drainage districts, to be used for water management purposes.
- They wanted to know if these efforts could overlap with regional drinking water source needs. Could captured water be pumped into the existing drinking water systems? They wanted to know why partners were not considering large reservoirs as opposed to smaller scale catchments spread across a larger geographic area.

7.2.6 State Natural Resource Management Technical Experts Input Results

Below is a summary of points raised regarding the proposed natural infrastructure and program structure at the state level that were not brought up by Focus Group participants.

Program Delivery Insights:

- Demonstrations are needed so that farmers can talk to farmers about management issues and how the issues were resolved. Farmer should be carefully selected to include ones the agricultural community already trusts.
- Take into consideration lessons learned around community engagement from water management overseen by federal and state partners on existing lake systems, the farming community has a history of being flooded out.
- The program will need regional variations and include opportunities for the "down east" farmland to participate.
- Evaluate opportunities to restructure how federal partners conduct management on controlled lands and their ability to share in expenditures beyond their land boundaries if it indirectly benefits their management.

- Keep the program voluntary housed within a government agency that does not have a regulatory requirement.
- Consider improving the taxing authority of drainage districts, lack of enforcement, and tax collection process.
- The program will not be successful if it is viewed as a land retirement program, most of that need is being met through the USDA Conservation Reserve Program.
- Explore if the program could enroll land already enrolled in the USDA Conservation Resource Program or the USDA / State Conservation Reserve Enhancement Program. Explore existing programs with lands enrolled under conservation easements to determine if there are any legal prohibitions to installing a water management system or constrains to "credit stacking".
- During program design work closely with Division of Mitigation Services to avoid duplicating efforts or creating competing programs.
- Evaluate lessons learned from the former Environmental Enhancement Program's local watersheds engagement to refine program delivery mechanisms.
- Evaluate lessons learned from the NC Agricultural Pond Exemption process to determine if a similar process can be used to develop streamlined permitting processes with federal and state agencies.
- Program delivery should be coupled with promotion of climate smart agriculture practice adoption, by increasing the rate of conservation practice adoption overall, flooding impacts lessen at the farm level.
- Consider using existing federal watershed scale planning processes to help streamline accessing Farm Bill programs to support the program; federal partners do not have the capacity to undertake the work but can accept 3rd party work if done according to standards and adopted guidelines.

Conservation Practices Exploration:

- Evaluation should be conducted on flood water contaminants, especially salt, and impacts on future crop yields.
- When siting practices, ensure adequate farm equipment maneuver space in-field and from one field to the next.
- Consider what to do with the crop residuals after a flooding event.
- Additional outreach is needed on appropriate crop rotations for fields structured to store flood waters.
- More extension studies are needed related to irrigation opportunities.
- Automated water control systems are the only option, manual management of the structures is not practical.
- State controlled land should be considered first for this program.

- Evaluate waterfowl impoundments, from impacts on soil quality to management and maintenance issues.
- Expand the suite of practices to include tide gauges and rehabilitating existing watershed dams with coring *(adding a clay inner wall to stabilize older dams).*
- Revisit the watershed and drainage district plans to identify areas of opportunity, not all plans were completed.
- After large storm events, nutrient leaching from the soil profile does occur, including nitrogen, magnesium, boron, and calcium. The impacts of this need to be assessed more to understand the additional costs to replace the lost nutrients.
- Prolonged water storage can also destabilize soil aggregation and texture, affecting soil quality after the fields are drained. Impacts would vary by soil type, specifically the soil texture and porosity prior to the flooding event.

Landowner Incentives Consideration:

- A two-tiered approach to compensation is needed, one for the landowner and one for the leasing producer. Consider the state "leasing" the land from the landowner, either through permanent or term easements or long-term contracts with financial compensation. Require that the landowner's agreement with the leasing producer includes the right to farm but a notice of periods of water impoundment during flood events. Then offer additional financial compensation to the producer after each event. The producer's compensation needs to be like crop insurance plus resources to either plant a second cash crop that season or manage the field until the next cash crop can be planted the following season.
- Carefully consider in program design how to avoid producers "competing" against the state's program for land access, if the landowner receives payments from the state, they may not consider renting it for agriculture.
- If the incentive structure includes payments to producers, it will increase the number of lands enrolled in that the producer will market it to their landlords.
- The concept of holding water on an already flood prone field may be a selling point if it lowers the amount of acreage overall being flooded at the farm level.

Other Issues Noted:

- Clearly communicate to rural stakeholders the role urban populations play in lessening stormwater impacts.
- Farmer advocacy groups will likely be willing to support a flood water management program if it does not add an additional regulatory burden on the producer and if the financial compensation is appropriate.
- Larger towns have the capacity to remove sediment directly from blocked stormwater systems, but this is cost prohibitive in rural towns; identify opportunity regions where a water

management program could alleviate sediment accumulation in rural town stormwater systems.

- Explore partnerships with the Department of Defense through the Sentinel Landscapes Program, an emerging issue is resilience and training impeded by flooding events.

7.2.7 Evaluation of State Programs

Minnesota and Iowa both have watershed focused programs that encourage natural infrastructure on working lands to help with flooding management and allow local governments to collaborate across political boundaries through a stakeholder process. A program comparison chart is included below (see Table 7-1 and Table 7-2). In addition, a Wisconsin Conservation District is implementing similar water farming practices at the farm level and early findings indicate that natural infrastructure on working lands is a viable flood management approach.

Minnesota's One Watershed One Plan Findings: Prior to 2010, Minnesota had multiple local government units involved in watershed planning with a state requirement to review all plans every 5 to 10 years, a cumbersome process that was costly and inefficient. State associations of local government units established a roundtable to provide consensus recommendations on delivering a more efficient and effective water management process. The state funded a transition period enabling local government units to develop working relationship without pressure to quickly implement projects and removed the barrier of counties competing for resources. The process was originally water quality driven but now partners are exploring how to incorporate flooding issues and resilience processes. With the built-in flexibility of state funding streams, local government units can alleviate organizational silos to fully integrate all watershed issues into an overarching decision-making process.

Iowa's One Watershed Approach Findings: The Iowa Economic Development Authority was awarded a $10.5 million US Housing and Urban Development's Community Development Block Grant (HUD CBDG) in 2010 and the Iowa General Assembly created authority for a local intergovernmental agreement with a focus on water quality and quantity issues. A second HUD grant awarded $96.9 million in 2016, including $31.5 million to nine watersheds for implementing natural infrastructure. Phase I included the Iowa Flood Center working with Watershed Management Authorities to complete hydrologic assessments; Phase II focused on implementation of the watershed plan created by the Authority with stakeholder input supported by a robust monitoring process. Early successes include communities being able to receive reduced flood insurance premium rates. A co-benefit includes a real-time information system for soil moisture data that helps inform farming practices. A major missing component is a dedicated state funding stream to continue efforts past the HUD grant and the Watershed Management Authorities are not set up with designated appropriations, taxing or other local government authorities.

Wisconsin Innovative Pilot: The Outagamie County Land Conservation Department is evaluating flood mitigation practices in the Green Bay and the Great Lakes system. The natural infrastructure practices include Agricultural Runoff Treatment Systems (ARTS), Wetland

Creation/Enhancement/Restoration, Streambank Protection/Stabilization, Two-Stage Ditches and Saturated Buffers. The ARTS practices "provide the most opportunity to store water and reduce downstream flow rates, thereby also reducing streambank erosion and the need for streambank stabilization practices". ARTS, similar in practice to storm water ponds, include wetlands cells that mimic natural functions. They are also exploring how to analytically verify which sub-watersheds have the biggest reduction in peak flow potential with the smallest number of acres used to store water.

Table 7-1. Comparison of Watershed Program Framework for Minnesota and Iowa.

	Minnesota	Iowa
Program Name	**One Watershed, One Plan**	**Iowa Watershed Approach**
Lead State Agency	Minnesota Board of Water and Soil Resources	Iowa Department of Natural Resources
Enforcement	Voluntary, required to receive state funding	Voluntary
Program Goal(s)	*"Align local water planning on major watershed boundaries with state strategies towards prioritized, targeted, and measurable implementation plans*" Consolidates number of water plans reviewed across the state from 200 to less than 100	*"Focus on water quality and quantity issues through collaboration and education"* Foster multi-jurisdictional cooperation Leverage technical assistance and funding Stakeholder involvement for watershed management
Watershed Level	**HUC 8**	**HUC 8**
Funding Sources	***Innovative State Funds*** · Natural Resources Block Grants combined from 4 existing funding sources. · Environment and Natural Resources Trust Fund (40% net proceeds state lottery sunsets 2024) · Clean Water, Land & Legacy Amendment: increased sales tax by 3/8 of 1% ***Traditional State Funds*** · Direct Appropriation: Transition Planning Grants, no match required. · Watershed-Based Implementation Funding: 90% cost share on projects. ***Local*** · Local tax levies · Locally issued bonds	***Innovative Federal Funds*** · Iowa Watershed Approach's HUD grant ***Traditional State Funds*** · Dept Natural Resources via EPA Section 319 Nonpoint Source Program · Iowa Dept Agriculture's Conservation Grants, Watershed Development and Planning Assistance Grants (available to Conservation Districts) ***Local*** · Dependent on 28E agreement membership's ability to raise funds or secure 3rd party grants.

Table 7-2. Comparisons of the Planning Process for Minnesota and Iowa's Watershed Programs

	Minnesota	Iowa
Local Leads	**Conservation Districts, Watershed Districts, Counties**	**Watershed Management Authority:** intergovernmental (cities, counties, Conservation Districts)
Geographic Scope	Suggested Boundary Map (at HUC8 level) is recommended, can deviate with approval.	HUC 8, no set recommendation or map. Can be established at HUC 12 level.
Participation Requirements	**Required: Conservation Districts, 103D Watershed Districts, Counties;** all local government invited to participate.	**Required: Two+ eligible local government units** (cities, counties, Conservation Districts). All required to be invited within 30 days.
Planning Agreement	**Memorandum of Agreement:** purpose, participants, procedures, fiscal agent; programs necessary to achieve goals; id existing (or new) organizational structures needed.	**Chapter 28E agreement** filed with the Secretary of State establishes separate legal entity or designates a fiscal agent from the partner governmental units.
Committees and Workgroups	**Steering Team recommended:** logistics decision-making during plan development. **Policy Committee required:** final decisions on plan content, expenditures oversight. Needs to have formal by-laws and agreement, may dissolve post plan adoption. **Advisory Committee required:** stakeholders recommend priorities and projects to Policy Committee.	**Board of Directors** (local gov reps) focus: · Assess and reduce flood risk · Assess and improve water quality · Monitor federal flood risk activities · Educate stakeholders on flood risks + water quality · Allocate funding for water quality and flood mitigation purposes

Table 7-2 Cont'd	Minnesota	Iowa
Plan Requirements	**Must address:** · Surface and ground water quality protection, restoration, surface water erosion prevention · Restoration, protection, preservation of surface water, ground water storage and retention systems · Promotion of groundwater recharge · Minimize public capital expenditures needed to correct flooding + water quality problems · Wetland enhancement, restoration, establishment · Identify priority areas riparian zone management · Protection and enhancement of habitat and water recreational facilities *Not required to address, but highly encouraged: extreme weather events*	**Recommended**: · Resource concerns · Partnership opportunities · Strategic direction of Authority · GIS maps: land use, conservation easements, demographics, existing structural and non-structural practices · Existing stormwater ordinances, other policies (stream buffer laws, agricultural protection, development zones) · Existing local plans: parks & rec plans or comprehensive land use plans · Physical & natural resources: hydrology, topography, soils and erodibility data · Water quality: pollutant sources, water conditions, TMDL studies
Regulatory Authority	**Watershed Districts:** regulatory, assess taxes. **Counties:** acquire property, taxing authority, assess service fees, issue capital improvement bonds	None. Can only make recommendations to member/governments but cannot acquire land through eminent domain and does not have taxing authority. [WEB25]

7.2.8 Recommendations: A Top Down and Bottom-Up Approach to Address Localized Flooding Impacts

Overarching Goal: Create an integrated *Process Action Plan* with a top-down and bottom-up approach based on a detailed evaluation of current flood water management processes, with watershed pilots focused on combating localized flooding with natural infrastructure implemented in the Cape Fear or Neuse river basins.

The overarching themes from all sources are two-fold (1) flooding is a real issue, we need new ways of thinking and working across political boundaries to deliver effective local solutions, and (2) the state's working lands owners and users are willing to be part of the solution if adequate compensation and land use protection is provided. While the state looks to natural infrastructure on working lands to offer a viable solution to flooding issues, a greater focus must be placed on resilient design in our urban landscapes. Working lands cannot provide all the solution but they can be part of a suite of solutions. The reality is that the state's flooding issues will increase with population growth if we maintain current urban design processes. Continued urban and rural silo efforts will only prolong the impacts whereas strategic efforts will serve a dual purpose of providing flooding solutions and bolstering the state's #1 economic driver of agriculture. It will take a top-down and bottom-up approach, the following recommendations define a path forward to get the State to the middle road of practical solutions in an efficient manner.

Recommendation 1: The State of North Carolina should offer a suite of state resources and technical assistance, within a broader flood resilient construct, for local units of government to work collaboratively across political boundaries at the appropriate watershed scale to identify where natural infrastructure can be installed to offset localized flooding impacts and prioritize future implementation at the local level.

1.1 Include working lands owners and land users in a meaningful way at the beginning and throughout process design of the state level flood resilient construct.

1.2 Provide local units of government with decision processes to elevate their communities' awareness of natural infrastructure on working lands capacity to minimize localized flooding impacts and the authority to effectively install resilient systems in a targeted manner.

Recommendation 2: The state and federal natural resource agencies should prioritize implementation of natural infrastructure practices implementation on working lands to minimize localized flooding impacts.

2.1 Develop a streamlined permitting process for implementing and maintaining the practices through their expected lifetime.

2.2 Provide programmatic flexibility in existing conservation programs so that working lands owners and users can dovetail multiple programs when the appropriate co-benefits are generated from natural infrastructure installation; obtain legal concurrence on when natural

infrastructure practices are allowed within a program specific deed of restrictions or conservation easement.

2.3 Assess how crop insurance coverage can be maintained on parts of the private landowner or land user's management unit that does not include natural infrastructure.

Recommendation 3: Conservation partners should establish pilots in areas under agriculture production that encompass a system of natural infrastructure practices to document management issues versus water storage benefits, with a preference for state-controlled land or collectively motivated landowners in a specific watershed.

3.1 Pilots should focus on retrofitting existing wetland restoration systems and rehabilitating watershed and drainage district structures to improve water storage capacity.

3.2 Pilots should evaluate impacts in the soil profile as well as aggregated impacts across working lands immediately upstream and downstream.

3.3 Pilots should evaluate a variety of payment structures for the landowners and the potential land users so that acreage enrolled in the program is not permanently taken out of agriculture or forestry production.

3.4 Pilots during construction and post construction results should be open to the public with the information provided through a variety of outreach events and multiple media types.

3.5 Pilots should document opportunities to improve federal practice standards to allow for more regional flexibility based on a variety of geomorphological conditions.

Recommendation 4: The State of North Carolina should reserve an appropriate amount of resources, as recommended by conservation agencies, to ensure the programmatic cost of stewardship and individual practice retirement is covered for regional natural infrastructure systems.

4.1 All pilots should include a "practice retirement program" to ensure that working lands owners and users are not left with a system of practices that cannot be adequately maintained, like many of the existing watershed and drainage districts.

4.2 Adequate resources need to be made immediately for repair work after a storm event; landowners and land users should not be expected to cover the costs upfront and wait a lengthy time to be made financially whole again.

7.2.9 References

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