FINAL MITIGATION PLAN

Pilot Projects to Address Chronic Flooding in the Stoney Creek Watershed

Wayne County, North Carolina

NC Division of Mitigation Services Project ID No. 100653
Contract # 0304-01

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Prepared for:

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EXECUTIVE SUMMARY

The 2021 Appropriations Act provided funding as well as a set of clear objectives to guide the North Carolina Division of Mitigation Services (DMS) in the implementation of the Stoney Creek Pilot Project. The legislation was initiated to develop one or more projects to address chronic flooding in the Stoney Creek watershed of Wayne County. This objective has been clearly asserted by DMS through the implementation process. This Mitigation Plan provides information on how this Pilot Project is being conducted, including the project goals and objectives, community engagement activities, analysis of watershed conditions, identification of problematic flooding areas, identification of potential flood mitigation sites, prioritization of potential flood mitigation sites, long-term management, as well as monitoring and performance standards. In addition, Supplement #1 is included as part of this document package and provides detailed information on the first site that EPR proposes for implementation under this project: Reedy 4 Site, located on the campus of Wayne Community College. Future sites proposed for implementation will be submitted to DMS as additional Mitigation Plan Supplement Documents following this format.

To evaluate current watershed conditions and provide a means of evaluating potential flood mitigation sites, EPR developed a detailed hydrologic and hydraulic model to provide a baseline for evaluating potential flood mitigation activities. The model analyses were used, in conjunction with information received from local staff and stakeholders, to identify priority areas of the watershed to focus flood mitigation projects. As potential flood mitigation sites are identified, the hydrologic and hydraulic models will allow EPR and DMS the ability to evaluate expected flooding benefits that can be achieved by implementing the projects.

Through its work to date, EPR has identified 16 potential sites that may offer opportunities for flood mitigation practices. Of these identified sites, one site (Reedy 4) is being advanced for initial implementation (see attached Supplement #1), and three others are being further evaluated for future implementation, provided sufficient funding is available. Future sites that are to be proposed for implementation will be submitted as additional Supplements to this Mitigation Plan Document. Flood mitigation sites implemented through this project will be monitored by EPR for a period of five years to evaluate stability and performance.

As this is a Pilot Project under a new DMS program, methods to provide long-term protections have been evaluated and are being finalized. This document describes the work performed to date and activities that are ongoing to provide necessary operations, maintenance, and long-term stewardship needs that will ensure project success.

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1.0 PROJECT INTRODUCTION

This Mitigation Plan presents project goals and objectives, community engagement, hydrologic and hydraulic modeling methods to assess current and future conditions, evaluation methods for specific flood mitigation sites, maintenance and long-term protection, and monitoring and performance standards. This plan provides the framework for assessment and implementation of flood mitigation sites, with additional site-specific plans provided as Supplements to this plan. **Figure 1.1** depicts the boundary of the Stoney Creek Watershed that this Mitigation Plan addresses.

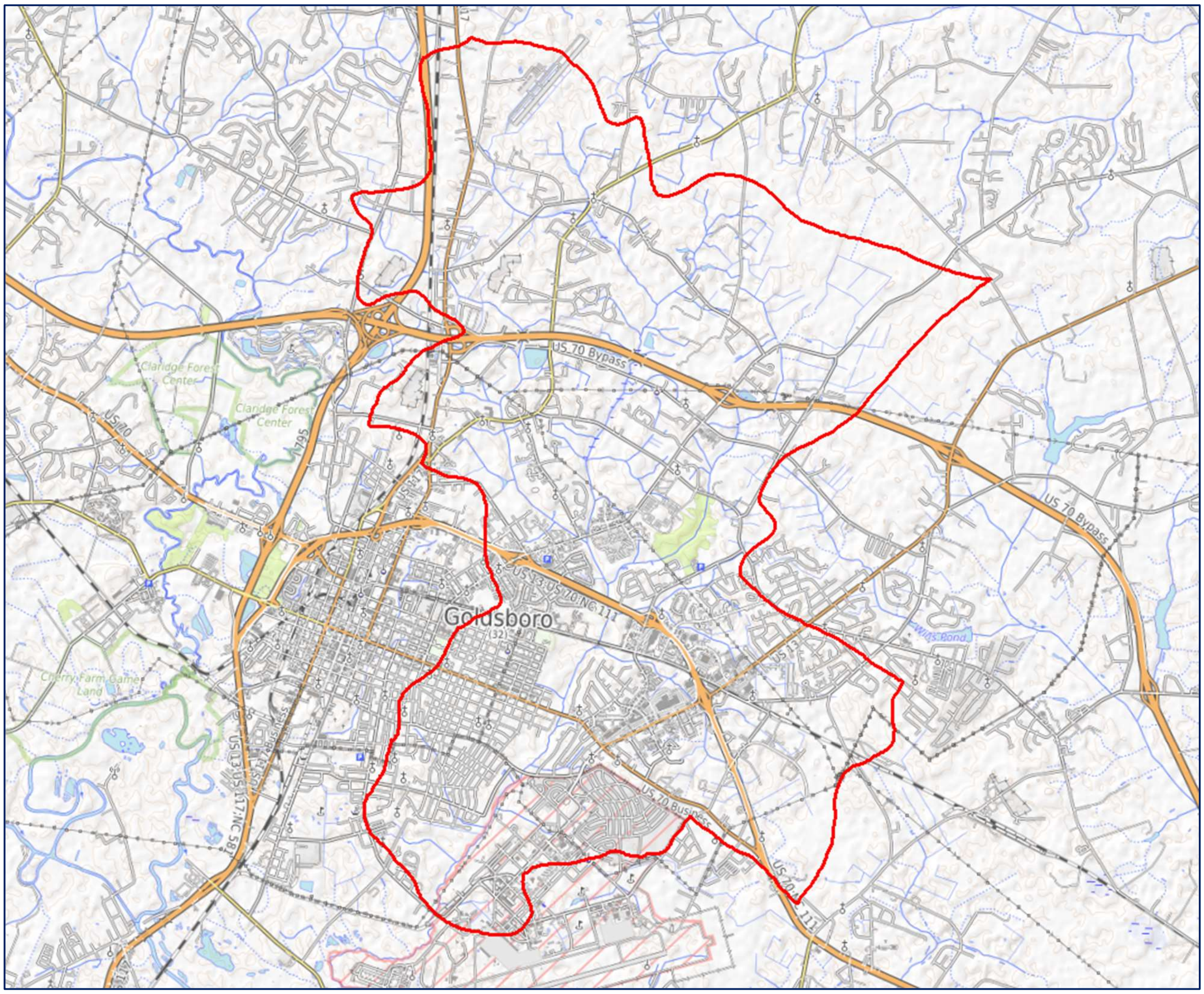

Figure 1.1. Stoney Creek Watershed.

2.0 GOALS AND OBJECTIVES

The 2021 Appropriations Act provided funding as well as a set of clear objectives to guide the North Carolina Division of Mitigation Services (DMS) in the implementation of the Stoney Creek Pilot Project. The legislation was initiated to develop one or more projects to address chronic flooding in the Stoney Creek watershed of Wayne County. This objective has been clearly asserted by DMS through the implementation process.

2.1 Programmatic Goals

The programmatic goals and objectives for the project were established as part of the Conceptual Plan Report, submitted July 2023, and are provided below for reference.

Goal: Engage government and community stakeholders within the Stoney Creek watershed to share project information, hear concerns, and receive input regarding potential project sites.

Objectives:

- Coordinate stakeholder meetings for public input to identify concerns and opportunities within the watershed.
- Discuss opportunities and implementation strategies with landowners within the watershed.
- Incorporate stakeholder concerns and values into nature-based solution design and decisions.

Goal: Implement one or more nature-based pilot projects to address chronic flooding in the Stoney Creek watershed impacting businesses, roadways, and access to emergency services in Wayne County and Goldsboro.

Objectives:

- Identify chronic flooding areas within the watershed and determine problem sources utilizing hydrologic and hydraulic modeling.
- Determine suitable nature-based solutions based on identified problems and sources, landscape variables, and land availability.
- Negotiate protection agreements with landowners for viable sites, and implement sites as project funding allows.

Goal: Evaluate project performance to determine effectiveness of flood resilience projects.

Objectives:

- Establish a monitoring plan for each implemented project site to quantify performance and to test model predictions.
- Evaluate lessons learned from this pilot project and provide observations and recommendations for future flood mitigation projects.

2.2 Site Specific Goals and Objectives

Site specific goals and objectives will be developed for each flood mitigation site that is proposed for implementation under this Mitigation Plan. Site specific goals will vary by site location, design approach, landowner needs and requirements, and performance requirements. Site specific goals will generally address the following project characteristics:

- Specific design approach to be used to provide flood mitigation benefits.
- Performance metrics to evaluate nature-based solutions/measures. These may vary by practice and project site, but may include reduced peak discharges, increased flood storage volume, decreased downstream inundation, etc.
- Any landowner requirements related to site protection measures and stewardship.
- Benefits of water quality, ecological, etc.
- Long-term maintenance and performance goals.

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3.0 COMMUNITY ENGAGEMENT

There has been considerable work performed by others regarding flood mitigation and stakeholder involvement in the Stoney Creek Watershed. Stakeholder involvement continues to inform processes for problem area identification and project selection. Ecosystem Planning and Restoration, PLLC (EPR), in conjunction with DMS, conducted a stakeholder meeting with federal, state, and local agencies and nonprofits on February 8, 2023. The feedback received during the meeting provided information concerning existing programs in the Stoney Creek watershed, consequential changes within the watershed, and some of the challenges that exist currently and may in the future. Throughout the remainder of 2023, EPR has maintained communication with other teams working on flood mitigation efforts in the Neuse River watershed, including the DMS Flood Mitigation Blueprint Team, Wayne County Flood Resilience Workgroup, and Environmental Defense Fund.

Additionally, EPR presented an overview of the Stoney Creek Watershed Pilot Project to the Wayne County Commissioners on March 21, 2023. Comments received during and after the meeting from Commissioners have been supportive of the Pilot Project, and EPR continues to keep the County Commissioners apprised of progress as the project continues.

EPR anticipates at least one additional stakeholder meeting with landowners and local business interests in the Stoney Creek Watershed, specifically focused upon the Wayne Memorial Drive area. The purpose will be to gain local perspective for the implementation of practices for the Pilot. This meeting is expected to occur during Spring 2024 after acceptance of this Mitigation Plan, and will provide an update on progress to date, as well as goals for implementation of flood mitigation sites in the watershed. EPR will work closely with DMS to develop an appropriate agenda and invitation list for the second stakeholder meeting.

EPR continues to provide periodic information to DMS on project progress, so they may update the Stoney Creek Pilot Project website. The website is used as a resource to keep local stakeholders and interested parties up to date with project progress.

4.0 WATERSHED ASSESSMENT – CURRENT CONDITIONS HYDROLOGIC MODELING

EPR prepared a detailed existing conditions hydrologic model of the Stoney Creek Watershed using HEC-HMS v11. HEC-HMS GIS tools were utilized to pre-process digital elevation model (DEM) terrain data and generate initial sub-basin, longest flow path, and routing reach spatial data that were refined for use in parameter development. The hydrologic parameters calculated for the existing conditions model are summarized in the sections below and provided in **Appendix 1**.

There are five main tributaries within the Stoney Creek watershed. HEC-HMS model elements were identified using an alpha-numeric label incorporating the stream name abbreviations listed in **Table 4.1**.

Table 4.1. Study Area Stream Abbreviations.

Stream Name	Abbreviation
Stoney Creek	SC
Stoney Creek Tributary	SCT
Howells Branch	HB
Reedy Branch	RB
Billy Bud Creek	BBC
Richland Creek	RC

4.1 Terrain and Sub-Basin Delineation

The terrain for the Stoney Creek Watershed model was developed using 5-meter DEMs derived from QL2 source data and downloaded from the North Carolina Spatial Data Download website. The DEM for the study area was processed using the Terrain Reconditioning tools in HEC-HMS v11. The general watershed limits were compared to Doll et al (2020) and FEMA study watershed delineations (**Figure 4.1**).

Sub-basins were delineated at a scale sufficient to predict flows along the primary tributaries and road crossings of interest. Additionally, the delineation required sub-basin drainage areas to be adequately refined to evaluate specific project sites that have been identified as potential sites for implementation of nature-based solution (NBS) flood mitigation solutions within the Stoney Creek watershed. Initial sub-basin delineations produced from HEC-HMS GIS tools were reviewed and revised based on knowledge of the watershed, evidence of storm sewer systems, and comparison to topographic data. The existing conditions hydrology model includes 116 sub-basins, compared to 37 sub-basins in the Doll et al (2020) model, and 30 sub-basins defined by the FEMA study. The existing sub-basin delineation for this study is shown on **Exhibit A2.1** and sub-basin drainage areas are provided in **Appendix 2**.

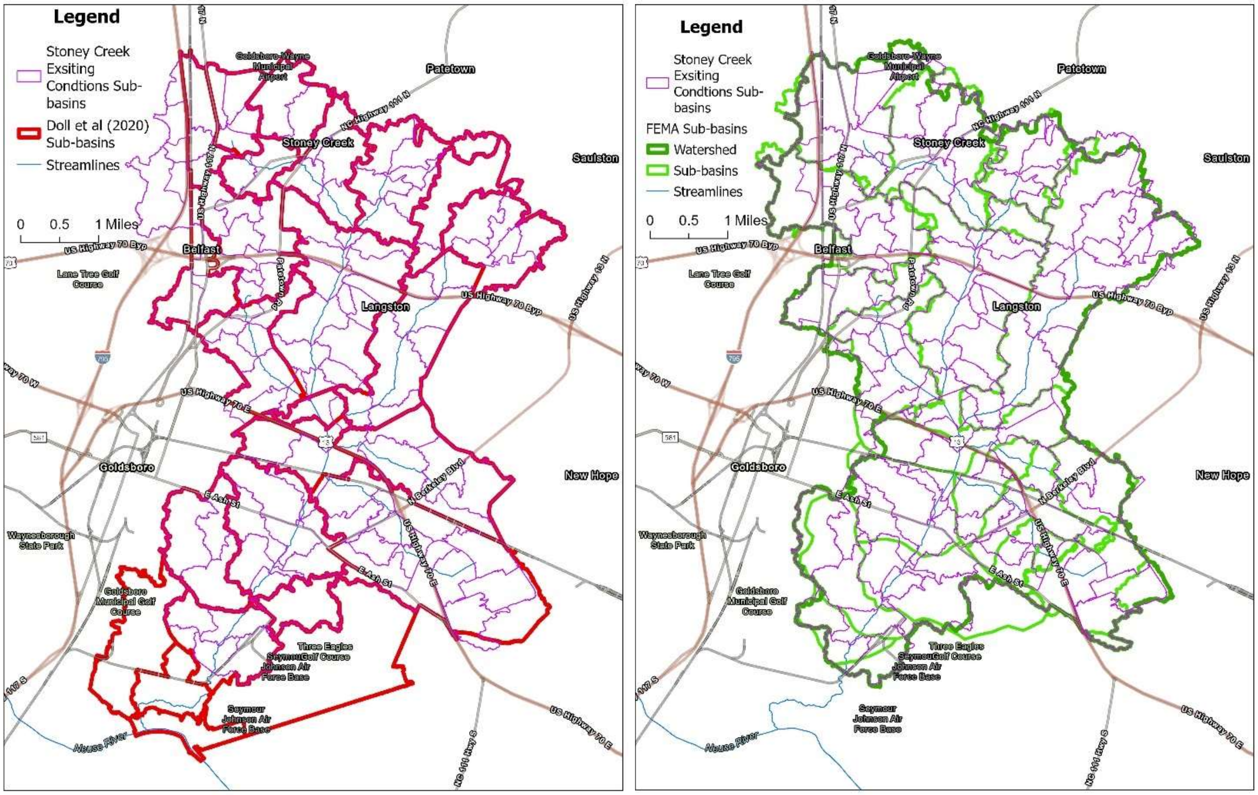

Figure 4.1. Sub-basin Delineation Comparison of Doll et al 2020 (left) and FEMA (right).

4.2 Land Use and Curve Numbers

The SCS Curve Number (CN) Loss Method was used to estimate runoff amounts and infiltration losses. The existing condition land use (**Exhibit A2.2 – Appendix 2**) was established using current aerial photography and spatial data from Wayne County, USGS, USFWS, and NCDOT and included zoning, parcel data, natural land cover, stream, and roadway datasets. Soils data were obtained from the NRCS Web Soil Survey website (**Exhibit A2.3 – Appendix 2**)

The land use categories were assigned using the National Land Cover Dataset (NLCD) standard land class cover classifications. Curve number values were assigned based on land use and hydrologic soil group using guidance in found in the NRCS Part 630 of the National Engineering Handbook Ch. 9 Hydrologic Soil-Cover Complexes 2017 ASCE-ASABE Proposed CN Update (Error! Reference source not found.). Weighted CN values were calculated using the HEC-HMS Curve Number calculator tool. The calculated CN values were reduced by 0.97 based on calibration methods detailed in Doll et al (2020) for the Stoney Creek watershed. Curve numbers for the sub-basins in the study area are shown in **Exhibit A2.4** provided in **Appendix 2**.

Table 4.2. Curve Numbers from NRCS Part 630 of National Engineering Handbook.

Land Use Classification	Hydrologic Soil Group			
	A	B	C	D
Open Water	100	100	100	100
Developed Open Space	31	52	67	74
Developed, Low Intensity	52	68	77	82
Developed, Med. Intensity	70	80	86	89
Developed, High Intensity	85	89	92	94
Barren Soil	70	81	88	91
Deciduous Forest	28	51	66	73
Evergreen Forest	28	51	66	73
Mixed Forest	28	51	66	73
Shrub Scrub	27	47	62	70
Grassland/Herbaceous	23	49	63	71
Pasture	31	52	67	74
Cultivated Crops	63	74	82	86
Woody Wetlands	86	86	86	86
Emerge Herb Wet	80	80	80	80
Streets	77	85	89	97

4.3 Time of Concentration and Lag Time

Longest flow paths were generated using HEC-HMS GIS tools and then reviewed to establish time of concentration flow paths. In certain areas of the study area, flow path determination was challenging due to flat topography, irrigation ditches that rerouted drainage patterns in agricultural areas, and lack of storm sewer system data. Storm sewer system networks were estimated based on what is visible on aerial photography, Google Street view, and limited field verification. In general, 300-ft was assumed for sheet flow in rural areas and 100-ft in developed areas (**Exhibit A2.5 – Appendix 2**). The SCS Unit Hydrograph transform method was selected to calculate the lag times for each sub-basin using the peak rate factor (PRF) of 250 and multiplying the lag time by 2.56 based on calibration method detailed in Doll et al (2020) for the Stoney Creek watershed. Time of concentration and lag time calculations are included in **Appendix 1**.

4.4 Modified Puls Routing

The Modified Puls routing method was selected to provide the best estimate of channel and floodplain storage within the watershed. Existing FEMA effective HEC-RAS hydraulic models were used for the Modified Puls routing data where available. For the purposes of this study, some effective models were combined if two models spanned one tributary reach. Additionally, some HEC-RAS models were extended upstream to provide the required routing information. Where there are no effective hydraulic models for a tributary routing reach, HEC-RAS models were developed by EPR. Additional details about the hydraulic model modifications and development are provided in Appendix 1 and 2 of this Mitigation Plan.

In HEC-RAS, a routing plan and steady flow file was added and used to develop the routing reach rating tables. The bounding cross sections of each routing reach were used to establish Volume-Flow Reaches within each HEC-RAS model. The volume outflow data were then exported to a DSS file. In HEC-HMS, routing reaches are linked to the appropriate DSS file using the paired data storage-discharge functions. A summary of the number of subreaches for each routing reach is provided in **Appendix 1**.

The HEC-HMS routing reach naming convention consists of an "R" followed by the stream name abbreviation listed in **Table 4.1**. For example, a routing reach in the Stoney Creek Tributary sub-watershed is labeled RSCT0002. Hydrologic model elements such as sub-basins, routing reaches, and junctions are provided in HEC-HMS model schematic in **Exhibit A2.6**.

4.5 Meteorological Method

The SCS Type II storm was selected as the meteorological model method. Precipitation data for the 1-, 2-, 5-, 10-, 25-, 50-, 100- and 500-year, 24-hour frequency events were obtained from the National Oceanic and Atmospheric Administration's (NOAA) Atlas 14, Volume 2, Version 3. Precipitation values selected for each frequency event is summarized in **Table 4.3**.

Table 4.3. Storm Frequency Precipitation.

Frequency	Depth (in)
1-year	3.04
2-year	3.69
5-year	4.78
10-year	5.72
25-year	7.16
50-year	8.42
100-year	9.84
500-year	13.90

4.6 Hydrologic Modeling Results

Summary tables of the results of the hydrologic analysis for peak flows calculated at sub-basin and junction model elements are provided in **Appendix 3**.

To compare this study hydrologic model results to the previous study, the Doll et al (2020) HEC-HMS model was run using SCS Type II storm and rainfall to produce 100-year comparable results. **Table 4.4** summarizes the comparison at spatially similar locations at junctions primarily along the main stem of Stoney Creek. Additionally, the hydrologic model results were compared to 100-year effective FEMA flows at spatially similar locations as summarized in **Table 4.5**. **Figure 4.2** shows the comparison between the studies as peak flow versus drainage area.

Table 4.4. Doll et al. (2020) and Stoney Creek Watershed 100-year Peak Flow Comparison.

Stoney Creek Watershed			Doll et al (2020)			*Diff in Peak Flow (%)*
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Flow (CFS)**	**Hydrologic Element**	**Drainage Area (mi^2)**	**Peak Flow (CFS)**	
JRC-0005	0.63	192	J127	0.94	261	*-36%*
JSC-1220B	25.97	6205	J130	25.34	5440	*12%*
JSC-1210A	24.72	6108	J135	24.10	5238	*14%*
JRC-1030A	2.09	891	J138	2.38	604	*32%*
JSC-1170	22.92	5876	J147	22.30	4978	*15%*
JSC-RC	22.24	5823	J152	21.62	4914	*16%*
JSC-1140	18.59	4995	J157	17.68	4058	*19%*
JSC-RB	16.37	4467	J162	15.54	3730	*17%*
JSC-HB	12.12	3432	J165	11.32	2782	*19%*
JHB-1010A	2.73	987	J170	2.19	574	*42%*
JSC-1080	6.85	2395	J173	6.55	1658	*31%*
JRB-0030	1.88	556	J178	2.11	534	*4%*
JSC-SCT	5.29	1986	J192	5.02	1383	*30%*
JSC-1020A	3.00	1376	J197	2.71	871	*37%*
JSC-1000	1.50	766	J200	1.20	358	*53%*

Table 4.5. Effective FEMA and Stoney Creek Watershed 100-year Peak Flow Comparison.

Stoney Creek Watershed			FEMA	*Diff in Peak Flow %*
Hydrologic Element	**Drainage Area (mi^2)**	**Peak Flow (CFS)**	**Peak Flow (CFS)**	
JRB-0030	1.8776	556.3	615	-10.6%
JRC-1030A	2.093	891.2	990	-11.1%
JSC-1020A	2.9991	1376.3	1640	-19.2%
JSC-SCT	5.2932	1985.8	2280	-14.8%
JSC-1080	6.8502	2394.9	2610	-9.0%
JSC-HB	12.1186	3432	3370	1.8%
JSC-RB	16.3676	4467.3	4000	10.5%
JSC-RC	22.244	5823.1	5260	9.7%
JSC-1210A	24.7227	6107.9	5590	8.5%

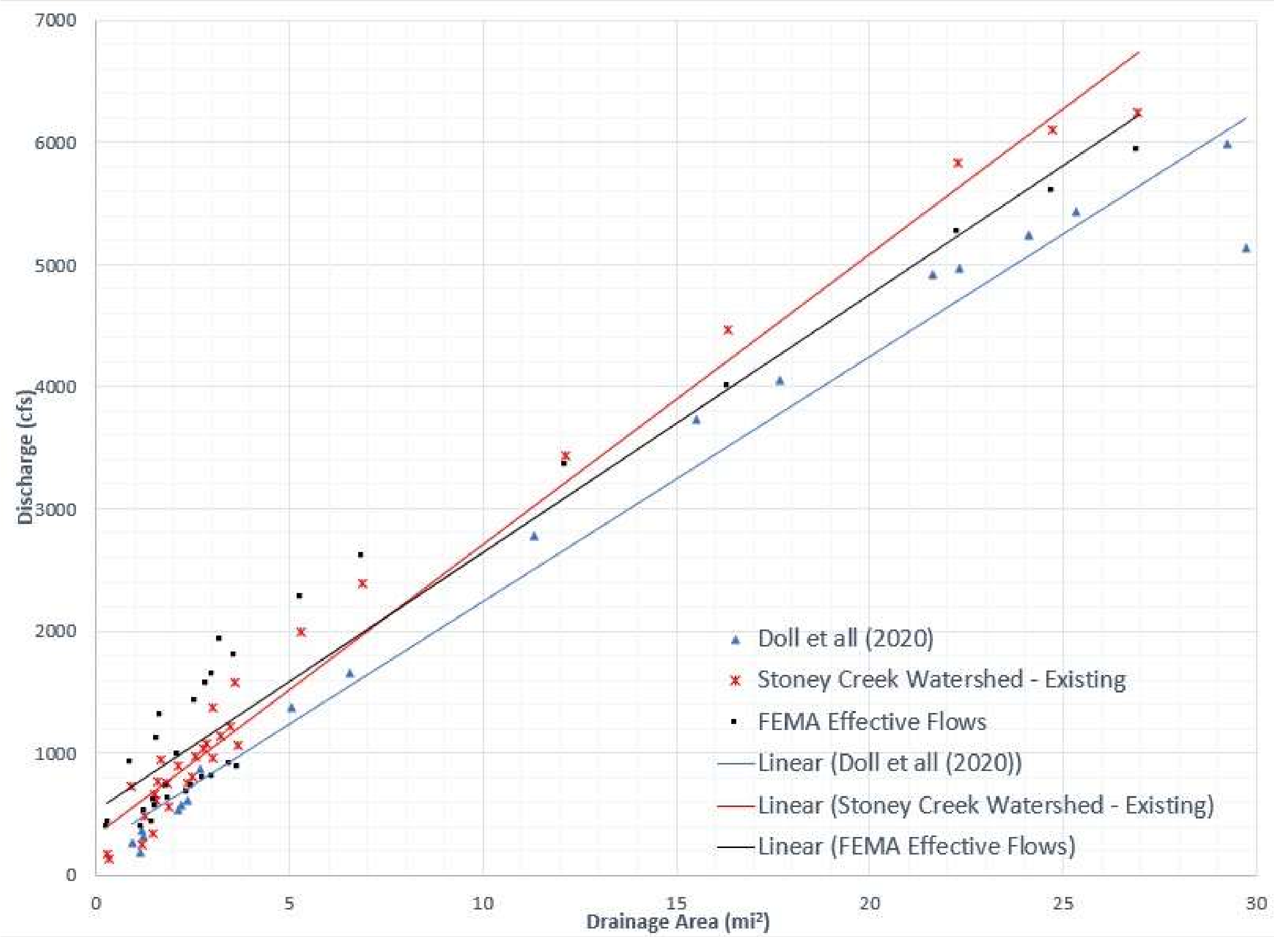

Figure 4.2. 100-Year Peak Flow Comparison.

As stated previously, the hydrologic model results were compared at junction locations primarily along the main stem of Stoney Creek. While spatially comparable, the contributing drainage areas at these locations vary between the studies due to differences in model drainage area delineations and level of refinement. Peak flows for drainage areas less than one square mile are comparable to the Doll et al (2020) model results. However, as contributing drainage area increases, this study produced higher flow rates compared to the Doll et al (2020) model. This can be attributed to the more refined sub-basin delineation (**Figure 4.1**), with detailed lag time and CN calculations accounting for more urban land use and storm drain flow paths, in this study compared to the Doll et al (2020) model. Additionally, this study used Modified Puls routing whereas Doll et al (2020) used Muskingum-Cunge routing. The Modified Puls method captures the channel and floodplain storage available within a reach using multi-section hydraulic models along the entire reach; whereas, Muskingum-Cunge uses one representative cross-section to estimate the available storage within a reach. In channelized systems, or system where the cross-sectional area, slope, and roughness are uniform throughout the entire reach, Muskingum-Cunge would be adequate for estimating storage. However, in natural systems with varying cross-sectional areas, roughness, and slopes, Modified Puls is considered more accurate in estimating the available storage.

Table 4.6 summarizes the differences in model refinement between the two studies. In summary, **Table 4.6** illustrates that the model analyses done for this Mitigation Plan was more detailed in regards to the number of sub-basins and routing of flows, as compared to the work previously performed by Doll et al (2020). Given the differences in refinement btween the two study models, the higher predicted flow rates with study results presented in this report appear reasonable.

Table 4.6. Model Refinement Comparison.

Model	Number of Sub-basins	Average Drainage Area (mi^2)	Average Lag Time (mins/hrs)	Average CN	Number of Routing Reaches
Stoney Creek Watershed	116	0.23	142/2.3	72	70
Doll et al (2020)	37	0.80	253/4.2	68	12

The peak flow rates in the FEMA effective models were established using USGS regression equations. Differences between the results of the hydrologic model developed as part of this study compared to USGS regression equation predictions are typical with a watershed of mixed rural and urban land uses. Generally, USGS regression equations overpredict peak flows for smaller drainage areas, and underpredict flows as drainage area increases, which is consistent with the results in **Table 4.5** and **Figure 4.2**.

5.0 WATERSHED ASSESSMENT – CURRENT CONDITIONS HYDRAULIC MODELING

Effective FEMA hydraulic models for the study area were downloaded from the NCFRIS website. According to the FEMA Flood Insurance Study for Wayne County, NC, the effective models were developed using detailed survey, limited detail survey, and LiDAR data. For tributaries with multiple models on a single study reach, the models were combined and run in HEC-RAS v6.4.1. Overbank cross section geometry was updated using 5-m DEM topographic data. Models were extended upstream using 5-m DEM topographic data to provide required information for the Modified Puls routing reaches as needed. HEC-RAS models were developed for tributaries with no effective models, using 5-m DEM data.

5.1 Hydraulic Modeling Results

The hydraulic models were updated with peak flows from the existing conditions hydrologic modeling. Summary tables of the results of the hydraulic modeling, including discharge rates, water surface elevations, and velocities, are provided in **Appendix 4**.

5.2 Roadway Inundation

The existing conditions hydraulic modeling established baseline water surface elevations and identified areas of concern. The HEC-RAS model results were used to identify what roadways were overtopped, at which storm event the overtopping begins, and Flood Severity Category (FSC). Only roadway structures that were included in the effective models were included in this analysis. A summary of how many structures are overtopped at each storm frequency is provided in **Table 5.1**.

Table 5.1. Roadway Overtopping Frequency Summary.

Storm Frequency	Number of Roadways That Begin to Overtop
1-yr	0
2-yr	0
5-yr	1
10-yr	0
25-yr	4
50-yr	5
100-yr	4
500-yr	6
Not Overtopped	1

Table 5.2. Roadway Overtopping Flood Severity* Values.

Location	Structure Type	5-yr Flood Severity* (ft^2/s)	10-yr Flood Severity* (ft^2/s)	25-yr Flood Severity* (ft^2/s)	50-yr Flood Severity* (ft^2/s)	100-yr Flood Severity* (ft^2/s)	500-yr Flood Severity* (ft^2/s)
Stoney Creek Church Rd (SC)	Culvert	0.1	0.6	1.3	1.8	2.5	3.8
North NC 111 Highway (SC)	Culvert	--	--	--	--	0.2	1.8
Tommy's Road (SR 1571) (SC)	Bridge	--	--	--	--	--	4.9
New Hope Road (SR 1003) (SC)	Culvert	--	--	--	--	--	2.5
Wayne Memorial Drive (SR 1556) (SC)	Culvert	--	--	--	2.2	4.0	10.6
East US 70 (SC)	Culvert	--	--	--	0.3	1.2	5.4
Royall Avenue (SR 1560) (SC)	Culvert	--	--	2.3	5.6	8.0	17.9
Ash Street (US 70 BUS) (SC)	Bridge	--	--	--	0.2	1.6	7.2
East Elm Street (SR 1900) (SC)	Bridge	--	--	2.2	5.6	8.5	17.2
Slocumb Street (SC)	Bridge	--	--	--	1.2	2.9	4.9
Church Road (SR 1547) (SCT)	Culvert	--	--	--	--	--	0.5
Patetown Road (NC 111) (HB)	Culvert	--	--	--	0.4	1.6	3.9
Wayne Memorial Drive (SR 1556) (HB)	Culvert	--	--	--	--	0.2	3.7
Wayne Memorial Drive (SR 1556) (RB)	Culvert	--	--	0.1	0.5	0.6	1.3
Tommy's Road (SR 1571) (RB)	Bridge	--	--	--	--	--	--
West New Hope Road (SR 1003) (RB)	Culvert	--	--	--	--	--	1.7
North Berkely Blvd (BBC)	Culvert	--	--	--	--	0.1	0.5
Summit Rd (RC)	Culvert	--	--	0.1	0.5	0.3	0.5
North Berkely Blvd (RC)	Culvert	--	--	0.1	1.1	0.5	0.5
Sunburst Dr (RC)	Culvert	--	--	--	--	0.1	0.5
N Spence Ave (RC)	Culvert	--	--	--	--	1.7	3.3

* Flood Severity = flooding depth (ft) x flow velocity (ft/sec), was established by FEMA to communicate the combined effect of depth and velocity in categories of Low, High, Very High and Extreme Hazard, and is estimated by multiplying average depth and velocity (FEMA, 2020).

Table 5.2 summarizes the maximum depth of overtopping, velocity over the roadway, and correlating FSC. The FSC was established by FEMA to communicate the combined effect of depth and velocity in categories of Low, High, Very High and Extreme Hazard, and is estimated by multiplying average depth and velocity (FEMA, 2020). The FSC is assigned based on the following ranges:

FSC	**Flood Severity Range (ft^2/sec)** ***(Depth * Velocity)***
Low	<2.2
Medium	2.2 – 5.4
High	5.4 – 16.1
Very High	16.1 -26.9
Extreme	>26.9

The FSC presents a better picture of the flood hazard at the roadway crossing than simply noting when roadways begin to overtop by storm frequency.

The model results were shared with staff from the Wayne County Planning Department and the City of Goldsboro Public Works Department. Local staff familiar with the Stoney Creek watershed indicated some differences between the overtopping predicted by the model and what they had observed during past severe storm events. There was a concern that the model was over-predicting flooding in some of the upper Stoney watershed and perhaps underpredicting flooding in the lower watershed. In particular, Wayne Memorial Drive, Patetown Road, Stoney Creek Church Road, and the City streets south of US 13, including Royal Street, East Ash Street, and East Elm Street were indicated as locations of ongoing flooding concerns during severe events. The model results presented here and the comments received from local stakeholders were reviewed and used to assess the priority areas identified in Section 6.2.

EPR made some modifications to the watershed model in an attempt to better match observed flooding conditions (see **Figure 5.1**). In general, the model predicts many of the same problem spots identified by local planning staff, but there are differences between the model predictions and the observations from local staff in regard to which crossings are most problematic. EPR used information from the model analyses and local staff observations to set the watershed priorities that are discussed in Section 6.2.

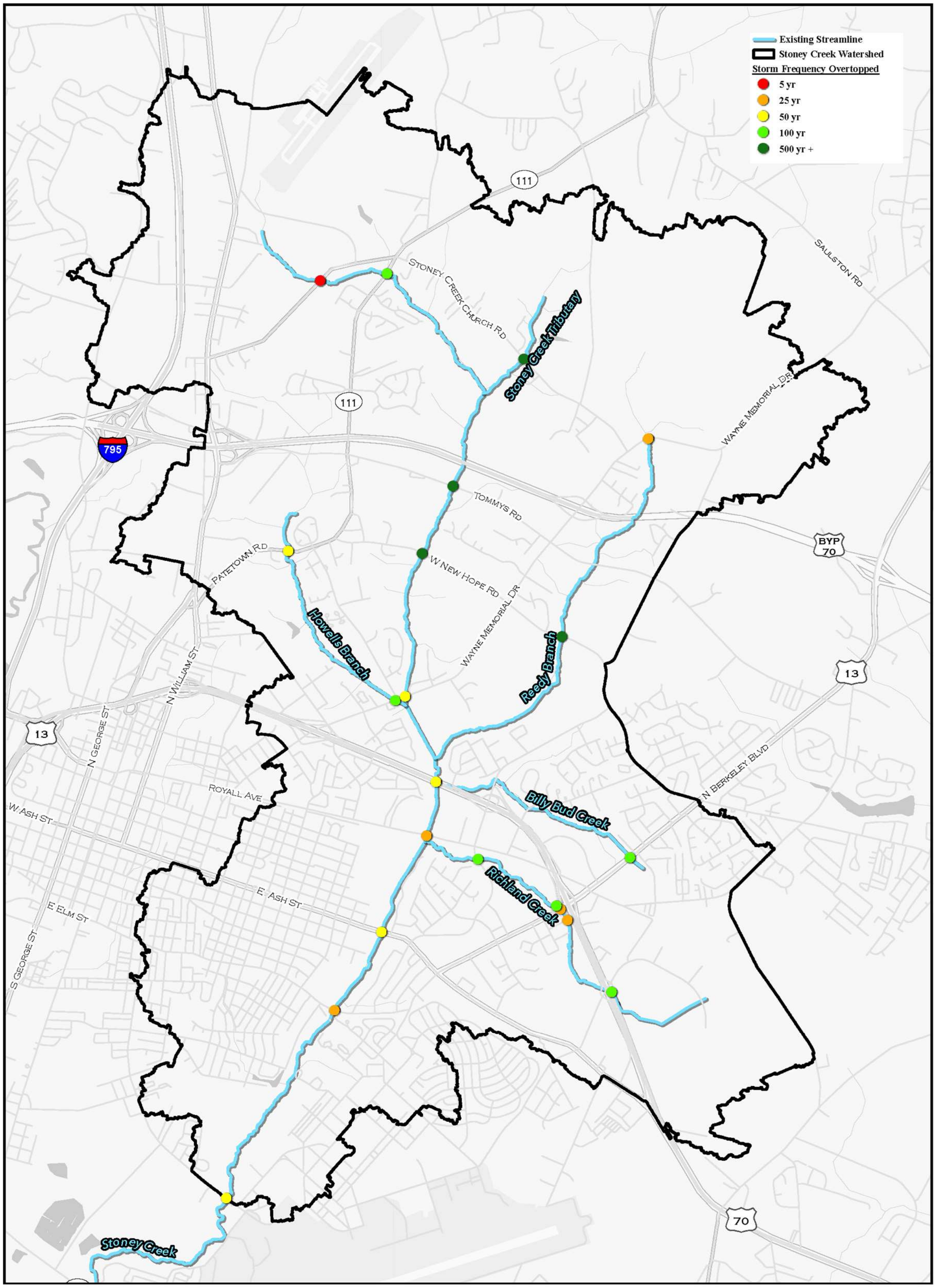

Figure 5.1. Roadway Flood Frequency Inundation, Based on Existing Condition Models.

6.0 Identification and Prioritization of Flood Mitigation Sites

6.1 Initial Identification of Potential Sites

Sixteen (16) potential sites for flood mitigation projects were identified while developing this Mitigation Plan. These sites were identified through a combination of desktop assessments, discussions with stakeholders, and meetings with watershed landowners. Initial site identification focused on:

- Sites that appeared to offer the opportunity to intercept flows and drainage from subwatersheds as well as water quality benefits,
- Sites that offered the opportunity to implement nature-based solutions that promote environmental, water quality, and ecological improvements in addition to flood mitigation benefits,
- Sites that appeared to have appropriate topography and soils (based on available mapping),
- Ownership by one, or at most two, landowners (to facilitate negotiations),
- Areas where the EPR Team has previous relationships and believe the landowners would likely be willing to implement the work identified.

These cursory site evaluations provided a starting point for a more detailed evaluation strategy. These initial 16 potential sites are summarized briefly in **Table 6.1**. Sites are named sequentially in accordance with the stream subwatershed to which they drain. **Figure 6.1** provides a map with the location of each proposed site.

As part of the landowner engagement process, EPR will attempt to secure Memorandums of Agreement (MOA) with landowners that are considered to have viable sites, prior to moving further into site evaluations or detailed landowner negotiations. The MOA documents that EPR has discussed the potential project with the landowner(s) and that landowner(s) are interested in continuing discussions to see if the project can ultimately be implemented. **Table 6.1** includes the status of MOAs secured at the time of this Mitigation Plan completion; however, attempts to secure MOAs for viable properties will continue.

Table 6.1. Summary of 16 Potential Sites Identified During Mitigation Plan Development.

Site Name	Opportunity	Viability	Status	Executed MOA *
Howell 1	Adjacent to Howell Branch, is an existing pond that could potentially be modified for more flood capacity.	Unlikely	Increasing capacity would be limited due to inflow topography and watershed that drains to the site.	No
Howell 2	Open field with ditches, apparently receiving drainage from upstream development	Maybe	While enhancement of stormwater functions may make this site attractive for further evaluation, the landowner has not been responsive thus far. EPR will continue to attempt to make positive contact with owner.	No
Howell 3	Existing pond that receives drainage from upstream development. Could potentially increase capacity.	Maybe	Further investigation has determined that the site is currently under consideration for residential housing. EPR has been in contact with the owner/developer and has completed an onsite review. While the topography of the site and drainage from the adjacent proposed Goldsboro Business Park continues to make this site an interesting opportunity, there is a utility (water or sewer) line adjacent to the existing ditch, an area of prime opportunity for flood retention. Maintenance requirements of the utility line may complicate this site to be used in this Pilot.	No
Howell 4	EPR has a longstanding relationship with the landowner and is evaluating the possibility of flood retention on the property.	Maybe	EPR has done preliminary site visits. There are questions about the cost-benefit of the project, as it is at the top of the watershed.	Yes
Stoney 1	Adjacency to the Goldsboro Wayne Municipal Airport. Area appears to receive drainage from the airport.	Unlikely	This site does not appear to be viable due to the adjacent houses and possibilities of hydrologic trespass.	No
Stoney 2	Existing pond at two headwater reaches of Stoney Creek. Capacity could possibly be increased for flood retention.	Maybe	EPR is attempting to contact the landowner(s).	No

Site Name	Opportunity	Viability	Status	Executed MOA *
Stoney 3	The site is located adjacent to HWY 795 and is a barrow pit pond from the highway construction.	Unlikely	Site appears to have a limited drainage area that could be collected and attenuated.	No
Stoney 4	This site appears to have several drainage ditches through an existing agricultural field and could be carrying drainage from an adjacent neighborhood.	Maybe	EPR is attempting to contact the landowner(s).	No
Stoney 5	The site is located adjacent to a mall shopping area and appears to receive impervious surface runoff.	Likely	EPR is attempting to contact the landowner(s) for detailed discussions. Preliminary site visits have already been conducted.	No
Stoney 6	EPR identified this site through contact with landowners in the Stoney Creek watershed. Opportunity for flood retention from farm and developed land.	Likely	EPR has done preliminary analyses of this site and it appears feasible. Landowner discussions have also been positive.	No
Stoney 7	EPR identified this site through contact with landowners in the Stoney Creek watershed. Opportunity for riparian wetland restoration.	Maybe	EPR has talked with the landowners and they would likely agree to a project, but effectiveness of the site needs to be evaluated.	Yes
Reedy 1 & 2	The topography and the confluence of multiple headwater channels of Reedy Branch create the opportunity for significant flood retention.	Maybe	EPR has had initial discussions with the landowner(s) and is continuing these discussions to determine interest.	No
Reedy 3 & 4	These sites are located behind the college along an existing greenway. The opportunity to attenuate stormwater from the college may impact Reedy Branch peak flow.	Likely	EPR has had initial discussions with the college and is continuing these discussions to determine interest.	No
Reedy 5	EPR identified this site through contact with landowners in the Stoney Creek watershed. Opportunity for flood retention from agricultural lands	Likely	EPR has conducted preliminary site visits and had preliminary discussions with the landowner(s).	Yes

** Indicates status of executed MOA at publication of this report.*

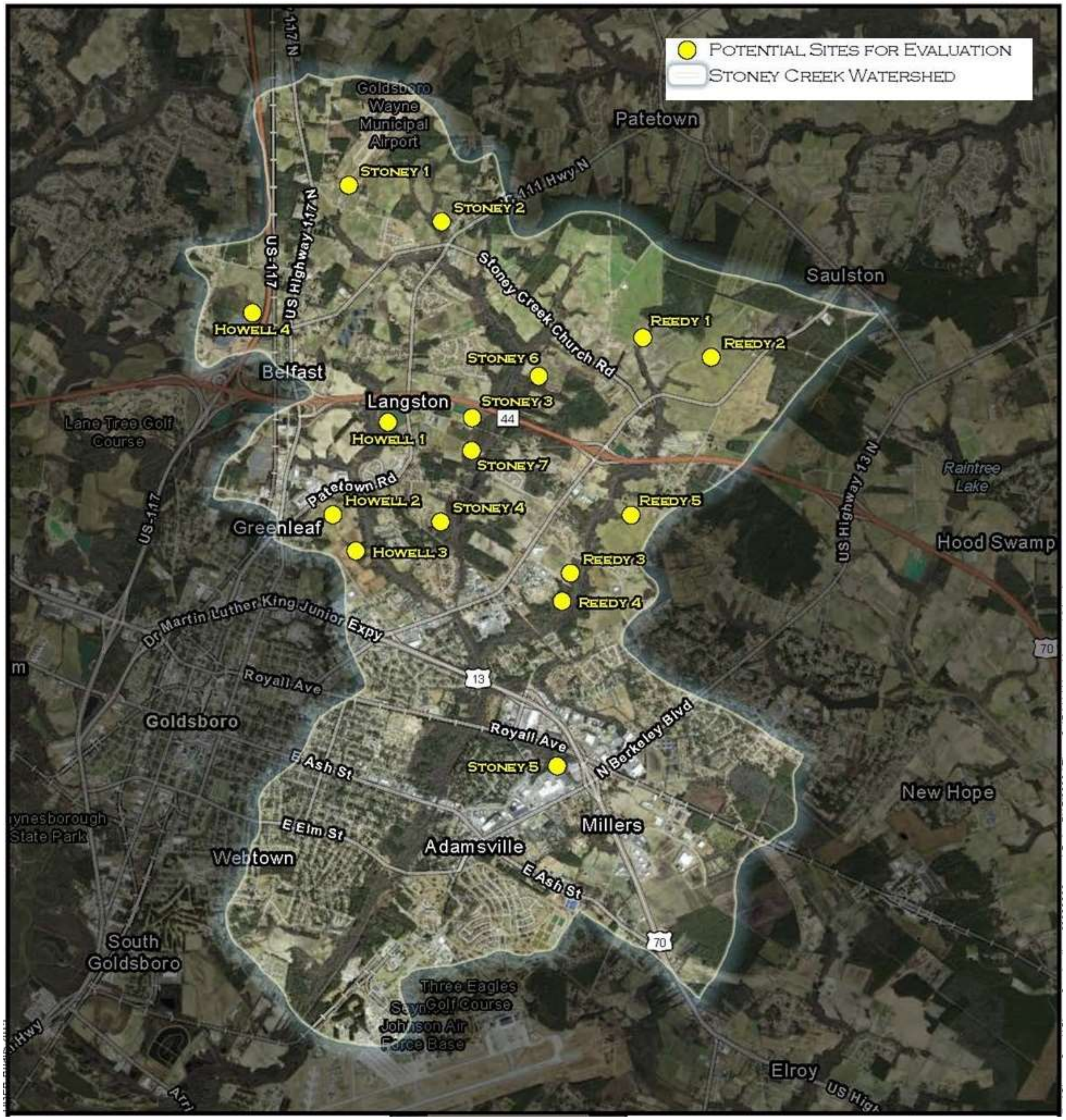

Figure 6.1. Potential Sites Identified in the Stoney Creek Watershed for Evaluation.

6.2 Methodology for Prioritizing and Implementing Flood Mitigation Sites

EPR proposes to use the following methodology to prioritize potential nature-based solutions sites for inclusion in the overall Stoney Creek Watershed effort:

1. Prioritize watershed areas upstream of road bridge/culvert crossings where flooding is indicated to be particularly problematic. Based on the model analyses, watershed information assessed, and information from local stakeholders, the following crossings are being prioritized for the Stoney Creek Watershed. Note that crossings downstream of these prioritized locations should also benefit from reduced flooding at these locations:
   - Wayne Memorial Drive (as specified in the original project RFP) is identified as a priority area. The model analyses indicate that Wayne Memorial Drive has the potential to overtop at a 25-year storm event on Reedy Branch, and a 50-year storm on Stoney Creek. Local observations indicate that actual flooding frequencies may be more often.
   - Stoney Creek Church Road in the upper portion of the watershed demonstrates the potential for Stoney Creek to overtop in a 5-year storm, causing access and flooding concerns for local homeowners and landowners.
   - Patetown Road on Howells Branch demonstrates the potential for flooding at the 50-year storm event based on model analyses, yet local accounts indicate the potential for more frequent flooding.
   - Royal Avenue and East Elm Street on Stoney Creek have potential to overtop at the 25-year storm event based on model analyses, and should benefit from any practices that are installed upstream to benefit the previously listed crossings. East Ash Street should be included as well based on local observations.
   - North Berkley Boulevard has the potential to overtop in a 25-year storm event on Richland Creek, causing transportation safety concerns for area businesses.

2. Evaluate the potential sites (see Section 6.1) to determine which of the sites are 1) upstream of the identified problem areas to be prioritized (Step #1 above), and 2) would allow for implementation of flood mitigation practices that are likely to provide flood mitigation benefits.

   For this initial Mitigation Plan effort, a site located at Wayne Community College (Reedy 4 – **Figure 6.1**) has been chosen to be implemented first for the following reasons:

   - The site is located on Community College land, offering the opportunity to develop a demonstration site that is accessible by the public and offers educational opportunities;
   - The site will capture runoff from an area of public land that is highly developed, offering the ability to detain stormwater runoff and provide water quality benefits;
   - The site will provide benefits to downstream areas along Reedy Branch and Stoney Creek through the City of Goldsboro.

Additionally, EPR has identified three additional sites that will be further evaluated and prioritized for potential implementation after, or in conjunction with, the Reedy 4 site. These sites are located upstream of Wayne Memorial Drive, and therefore offer opportunities to benefit this priority area:

- Stoney 6
- Howell 3
- Howell 4

3. Submit this Mitigation Plan Document to NCDMS for review and approval.

4. Continue landowner negotiations for sites identified above.

5. As landowner agreements are secured, EPR will prepare detailed assessments and design plans for each site that will be submitted to DMS as supplements to this Mitigation Plan Document. These supplements will document the detailed information for each project site to be implemented.

   As part of this Mitigation Plan document development, EPR has developed the attached Supplement 1 – Reedy 4 Site, that includes detailed information on the assessment and proposal of the Reedy 4 site, as described above.

6. EPR will work through the steps of securing easements, implementation, and monitoring sites that are advanced. EPR will work to secure and implement sites as project funds allow.

7. It is possible that additional project sites may need to be identified, if landowner interest is low and/or reaching landowner agreements is difficult. If EPR exhausts the four sites proposed above, and still has project funds available, then new sites will be identified for evaluation, either from the original list of 16 potential sites or additional sites that are identified through other means. It is anticipated that the site identification process will be slightly modified from the steps presented above:

7.0 LONG-TERM PROTECTION AND MANAGEMENT

Long-term protection of projects implemented as part of this pilot project is paramount to their continued success. It is of upmost importance to ensure processes and documentation for long-term protection and stewardship are memorialized at project implementation. Failure to do so could result in misguided expectations, the compromise of project success, and difficulty in enforcement.

The most effective long-term protection mechanism may be conservation easement. Conservation easements are recorded agreements between a landowner (grantor) and easement holder (grantee) in which the grantee retains certain rights within specified boundaries of a fee-simple property holding. The State of North Carolina, through DMS, currently holds hundreds of conservation easements and has a longstanding track record establishing, managing, and enforcing. Utilizing this knowledge base, a draft easement template has been completed in conjunction with DMS and DEQ Office of General Counsel (**Appendix 5**). This draft conservation easement template considers water management, requirements of both grantee and grantor, and opportunities for maintenance anticipated for the Pilot project sites. This draft conservation easement template is being reviewed for approval by NCDMS at the submittal of this Mitigation Plan document.

Each project implemented through this pilot project may require an operation and maintenance plan to ensure viability and effectiveness of the practice in the future. Most existing DMS conservation easements have limited to no maintenance requirements. For this pilot project, the most effective process would be to identify, prior to project implementation, a Long-Term Easement Manager to provide the operation and maintenance services. Currently, the DEQ Stewardship Program holds most long-term management responsibilities for most DMS easements. However, like most Long-Term Easement Managers, the DEQ Stewardship Program may not be well equipped to implement the maintenance activities that will be needed for these pilot projects. It is suggested that a local Operation and Maintenance Steward be identified and secured at project implementation to work in concert with the Long-Term Easement Manager. Considering there is currently no third party easement holder requirement for these flood resiliency projects, easement management and operation/maintenance stewardship could be completed internal to DMS until processes have been fully vetted and determined.

The term of the project conservation easements could be permanent, or a term specified and agreed upon by DMS and the landowner (e.g., 30 years). A term easement may be advantageous in certain circumstances. EPR will provide recommendations to DMS for each project to consider term or permanent conservation easement options.

It is further recommended that DMS establish a non-wasting endowment at project implementation for long-term easement compliance and maintenance. This non-wasting endowment fund could be managed by the Long-Term Easement Manager with funds dispersed to the Operation and Maintenance Steward.

Finalizing these long-term protection processes is of the upmost importance for the Stoney Creek Pilot and other flood relief projects that DMS may be initiating.

8.0 MONITORING AND PERFORMANCE STANDARDS

A key component of the Stoney Creek Pilot is the evaluation of project performance for each practice and project site implemented. It will be important to develop a suite of metrics ensuring site stability after construction, measurement of stage/capacity/discharge, and provide data for model verification. Monitoring efforts will continue from the date of construction and extend for five (5) years.

Performance monitoring will vary depending upon the practice implemented. Site stability evaluations will include at least biannual (twice per year) inspections with photo documentation of any outfalls, embankments, and any other structures installed to maintain the slope, dimension, and stability at or near conditions post construction. Inspections will also be conducted after major storm events (25-year return period storm and larger). Reductions and improvements at Wayne Memorial Drive or other targeted infrastructure will be discussed in the annual reporting.

Stage/capacity verification will be provided with as-built surveys conducted after construction completion. Data loggers may be utilized within the constructed area to provide a comparison of actual project retention and attenuation values with modeled, pre-project values. EPR anticipates monitoring equipment will be downloaded and maintained at least quarterly.

The monitoring data collected is expected to better inform future projects and accurately document the benefits of practices installed within the Stoney Creek Pilot Project. Based upon findings, EPR will provide recommendations to DMS that will inform programmatic decisions for similar future flood attenuation projects.

9.0 REFERENCES

AECOM Technical Services of North Carolina, Inc., April 2022. North Carolina 2D Flood Mitigation Study, Engineering Report For Walnut Creek-Neuse River Basin, HUC 0302020201.

Doll, B., D. Line, and J. Kurki-Fox. 2020. Evaluating the Capacity of Natural Infrastructure for Flood Abatement at the Watershed Scale: Goldsboro, NC Case Study. Final Report. Environmental Defense Fund. Raleigh, NC.

FEMA, December 2020. Guidance for Flood Risk Analysis and Mapping, Flood Depth and Analysis Rasters.