

## CHAPTER 14

# SYSTEM RESILIENCE





A PRODUCT OF THE  
**Western Piedmont**  
Council of Governments

**Greater Hickory Metropolitan  
Planning Organization**

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The Fixing America’s Surface Transportation Act, or “FAST Act” states that MPOs are required to include resilience as a planning factor in plans (23 USC 134, 23 CFR 450); should consult agencies responsible for natural disaster risk reduction (23 CFR 450.316(b); and that MPOs shall include an assessment of capital investment and other strategies to... reduce the vulnerability of the existing transportation infrastructure to natural disasters (23 CFR 450.324(f)(7)).

In addition to these federal requirements, North Carolina Executive Order 80 states that “Cabinet agencies shall integrate climate adaptation and resiliency planning into their policies, programs, and operations (i) to support communities and sectors of the economy that are vulnerable to the effects of climate change and (ii) to enhance the agencies’ ability to protect human life and health, property, natural and built infrastructure, cultural resources, and other public and private assets of value to North Carolinians.”

The GHMPO region’s economic and social health depends on the ability of our multimodal transportation network to function properly.

Disruptions from extreme events – even for short periods of time – will likely result in economic losses to businesses and hardships for residents.

Prioritizing transportation improvements that improve the reliability and resilience of the GHMPO’s transportation system will help reduce negative impacts to regional commerce and economic development resulting from extreme events.

CHART 14-1. MPO REQUIREMENTS FOR TRANSPORTATION PLANNING

Planning factor on resiliency, reliability, and stormwater mitigation	Consult agencies responsible for natural disaster risk reduction	Assess strategies to reduce vulnerability to natural disasters
The metropolitan transportation planning process shall be continuous, cooperative, and comprehensive and provide for consideration and implementation of projects, strategies, and services that will <b>improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation.</b>	In developing metropolitan transportation plans and transportation improvement programs (TIPs), MPOs should consult with agencies and officials responsible for other planning activities within the metropolitan planning area that are affected by transportation (including State and local planned growth, economic development, tourism, <b>natural disaster risk reduction</b> , environmental protection, airport operations, or freight movements) or coordinate its planning process (to the maximum extent practicable) with such planning activities.	Metropolitan transportation plans shall include an assessment of capital investment and other strategies to preserve the existing and projected future metropolitan transportation infrastructure, provide for multimodal capacity increases based on regional priorities and needs, and <b>reduce the vulnerability of the existing transportation infrastructure to natural disasters.</b>
23 CFR 450.306(b)(9)	23 CFR 450.316(b)	23 CFR 450.324(f)(7)

WHAT IS RESILIENCE?

The FHWA defines resilience as:

***“The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.”***

In terms of project development and prioritization, this plan will focus on planning for investments that will help mitigate the effects of extreme weather events and natural disasters. The GHMPO’s transportation network is vulnerable to several threats from extreme weather events, which are summarized in Chart 14-2 below.

## CHART 14-2: POTENTIAL DISRUPTIONS TO GHMPO REGION TRANSPORTATION NETWORK

Facility Type	Extreme Rainfall	Extreme Heat	Wildfires	Tornados
Highways/Roads	Inundation, Washout, Rockslides/Landslides/Mud slides	Buckled pavement	Damaged pavement	Damaged pavement
Railroads	Inundation, Washout	Buckled rails	Damaged rails	Damaged rails
Bridges	Inundation, Washout, Damaged/destroyed pavement/supports	Buckled pavement	Damaged supports/pavement	Damaged pavement/supports
Airports	Inundation, Washout	Buckled pavement	Damaged pavement	Damaged pavement
Intermodal Connectors	Inundation, Washout	Buckled pavement	Damaged pavement	Damaged pavement

Several recent extreme weather events have caused disruptions to the GHMPO transportation network:

- » 2003 landslide in the Black Bear Store area of US 321 in Caldwell County – closed in both directions for 3 weeks, cutting off access to/from the High Country
- » 2013 presidential disaster declaration in Caldwell County due to severe storms, flooding, landslides, and mudslides
- » 2017 tornado destroyed 2 aircraft hangars and several aircraft at Hickory Regional Airport
- » 2020 flooding from extreme rainfall in the Hiddenite area of Alexander County – loss of life and bridge washouts
- » 2020 flooding from extreme rainfall in Catawba and Hickory – state of emergency declaration; road and bridge damage
- » 2019 flooding from extreme rainfall in Caldwell County – state of emergency declaration; road and bridge damage
- » 2020 flooding from extreme rainfall in Burke County – state of emergency declaration; road and bridge damage

While the GHMPO transportation network remains vulnerable to many potential disruptions due to extreme weather events, flooding is the most common disruptive threat to the region. However, this does not imply that planners should not consider other types of disruptions when evaluating potential projects.

Chart 14-3, page 3, lists flood and flash flood events in the GHMPO from 2017 – 2021. These events accounted for 6 deaths and \$1.8 million in private property damage in the region.



## CHART 14-3. GHMPO FLOOD AND FLASH FLOOD EVENTS, 2017 - 2021

County	Location	Date	Type	Deaths	Property Damage		Report Source	Cause
					Amount (Est.)			
CALDWELL CO.	WHITNEL	7/27/2017	Flash Flood	0	\$500		Fire Department/Rescue	Heavy Rain
CALDWELL CO.	COLLETTSVILLE	10/23/2017	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	10/23/2017	Flood	0	\$1,000		Official NWS Observations	Heavy Rain
BURKE CO.	GLEN ALPINE	4/15/2018	Flash Flood	0	\$1,000		Amateur Radio	Heavy Rain
CALDWELL CO.	EDGEMONT	5/18/2018	Flash Flood	0	\$50,000		Emergency Manager	Heavy Rain
BURKE CO.	JOY	5/18/2018	Flood	0	\$5,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	EDGEMONT	5/19/2018	Flood	0	\$5,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	YADKIN VLY	5/29/2018	Flash Flood	0	\$2,000		County Official	Heavy Rain
BURKE CO.	TABLE ROCK	5/29/2018	Flash Flood	0	\$3,000		County Official	Heavy Rain
CALDWELL CO.	EDGEMONT	5/29/2018	Flash Flood	0	\$2,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	COLLETTSVILLE	5/30/2018	Flood	0	\$500		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	5/30/2018	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	EDGEMONT	5/31/2018	Flash Flood	0	\$5,000		911 Call Center	Heavy Rain
BURKE CO.	PLEASANT GROVE	9/16/2018	Flash Flood	0	\$1,000		Trained Spotter	Heavy Rain
CALDWELL CO.	EDGEMONT	9/16/2018	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	9/17/2018	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	9/23/2018	Flash Flood	0	\$2,000		Public	Heavy Rain
CALDWELL CO.	EDGEMONT	10/11/2018	Flash Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	10/11/2018	Flood	0	\$2,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	EDGEMONT	10/11/2018	Flood	0	\$500		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	12/21/2018	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	12/28/2018	Flood	0	\$2,000		River/Stream Gauge	Heavy Rain
CATAWBA CO.	BROOKFORD	6/7/2019	Flash Flood	0	\$5,000		Amateur Radio	Heavy Rain
BURKE CO.	CALVIN	6/8/2019	Flash Flood	0	\$50,000		Emergency Manager	Heavy Rain
CALDWELL CO.	LENOIR	6/8/2019	Flash Flood	0	\$10,000		Amateur Radio	Heavy Rain
CATAWBA CO.	LONGVIEW	6/8/2019	Flash Flood	0	\$50,000		Amateur Radio	Heavy Rain
CALDWELL CO.	EDGEMONT	6/8/2019	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	6/8/2019	Flood	0	\$2,000		River/Stream Gauge	Heavy Rain
CATAWBA CO.	CATAWBA	6/9/2019	Flood	0	\$250,000		Emergency Manager	Heavy Rain
CATAWBA CO.	OYAMA	6/9/2019	Flash Flood	0	\$10,000		911 Call Center	Heavy Rain
ALEXANDER CO.	BETHLEHEM	6/9/2019	Flash Flood	0	\$10,000		Fire Department/Rescue	Heavy Rain
CATAWBA CO.	OYAMA	6/9/2019	Flood	0	\$1,000		911 Call Center	Heavy Rain
ALEXANDER CO.	BETHLEHEM	6/9/2019	Flood	0	\$1,000		Fire Department/Rescue	Heavy Rain
CALDWELL CO.	EDGEMONT	6/9/2019	Flash Flood	0	\$30,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	6/9/2019	Flash Flood	0	\$2,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	1/12/2020	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
CATAWBA CO.	CONOVER	2/6/2020	Flash Flood	0	\$10,000		Newspaper	Heavy Rain
BURKE CO.	BRINDLETOWN	2/6/2020	Flash Flood	0	\$25,000		911 Call Center	Heavy Rain
CALDWELL CO.	LENOIR	2/6/2020	Flash Flood	0	\$2,000		911 Call Center	Heavy Rain
ALEXANDER CO.	TAYLORSVILLE	2/6/2020	Flash Flood	0	\$2,000		Newspaper	Heavy Rain
BURKE CO.	JOY	2/6/2020	Flood	0	\$25,000		911 Call Center	Heavy Rain
CATAWBA CO.	CATAWBA	2/6/2020	Flood	0	\$50,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	GLOBE	4/13/2020	Flash Flood	0	\$100,000		Emergency Manager	Heavy Rain
BURKE CO.	JOY	4/13/2020	Flash Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	4/13/2020	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
CATAWBA CO.	PROBST	6/19/2020	Flash Flood	0	\$500		Broadcast Media	Heavy Rain
CATAWBA CO.	DRUMS	8/6/2020	Flash Flood	0	\$500		Fire Department/Rescue	Heavy Rain
CATAWBA CO.	HICKORY	8/15/2020	Flash Flood	0	\$50,000		Broadcast Media	Heavy Rain
CALDWELL CO.	YADKIN VLY	10/29/2020	Flash Flood	0	\$3,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	10/29/2020	Flash Flood	0	\$5,000		Emergency Manager	Heavy Rain
CALDWELL CO.	WHITNEL	10/29/2020	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	10/29/2020	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	RICHLAND	11/12/2020	Flash Flood	0	\$50,000		River/Stream Gauge	Heavy Rain
ALEXANDER CO.	VASHTI	11/12/2020	Flash Flood	5	\$350,000		Emergency Manager	Heavy Rain
CATAWBA CO.	CATAWBA	11/12/2020	Flash Flood	0	\$500,000		River/Stream Gauge	Heavy Rain
BURKE CO.	CHESTERFIELD	11/12/2020	Flash Flood	0	\$10,000		River/Stream Gauge	Heavy Rain
CATAWBA CO.	LONGVIEW	11/12/2020	Flash Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
ALEXANDER CO.	VASHTI	11/12/2020	Flood	1	\$100,000		Emergency Manager	Heavy Rain
CATAWBA CO.	CATAWBA	11/12/2020	Flood	0	\$10,000		River/Stream Gauge	Heavy Rain
CALDWELL CO.	COLLETTSVILLE	8/17/2021	Flood	0	\$500		River/Stream Gauge	Heavy Rain
BURKE CO.	JOY	8/17/2021	Flood	0	\$1,000		River/Stream Gauge	Heavy Rain
BURKE CO.	ENOLA	10/7/2021	Flash Flood	0	\$10,000		911 Call Center	Heavy Rain
<b>Totals</b>				<b>6</b>	<b>\$1,821,000</b>			

Source: National Weather Service.

## FLOODPLAINS

Floodplains are commonly classified as “100-year floodplains” and “500-year floodplains.” These names refer to the chance of a flood occurring in any given year – they do not refer to the timing of a flood.

Therefore, transportation facilities located in the 100- year floodplain have a 1 in 100 chance of being flooded in any given year. Transportation facilities located in the 500-year floodplain have a 1 in 500 chance of being flooded in any given year.

It is important to acknowledge that a significant amount of flooding frequently occurs outside of officially-designated floodplain areas. As development (ex. housing, roads, and parking lots) occurs, changes to landscapes can substantially alter the probability of flooding.

### IT'S ABOUT CHANCE:

- A 100-year flood event has a 1 in 100 chance of occurring in a given year.
- A 500-year flood event has a 1 in 500 chance of occurring in a given year.

## IMPERVIOUS SURFACES, STORMWATER AND FLOODING

Impervious surfaces (ex. pavement) prevent rainfall from sinking into the ground, accelerate stormwater runoff, and contribute to increased stream flow and flooding. Because of their hard surfaces, nearly all transportation projects are impervious. Whether located in a floodplain or not, transportation projects increase stormwater runoff, and if located in a floodplain, can significantly worsen flooding.

The Federal Highway Administration (FHWA) has recommended that “Nature-Based Solutions” be incorporated into transportation projects in order to reduce stormwater runoff and lessen the severity of flood events. Nature-based solutions (ex. swales, bio retention ponds, etc.) capture and hold stormwater runoff on site, so that stormwater can filter into the ground rather than flowing rapidly to low-lying areas or streams.

### EXAMPLES OF NATURE-BASED SOLUTIONS:



Nature based solution under construction next to highway on-ramp.



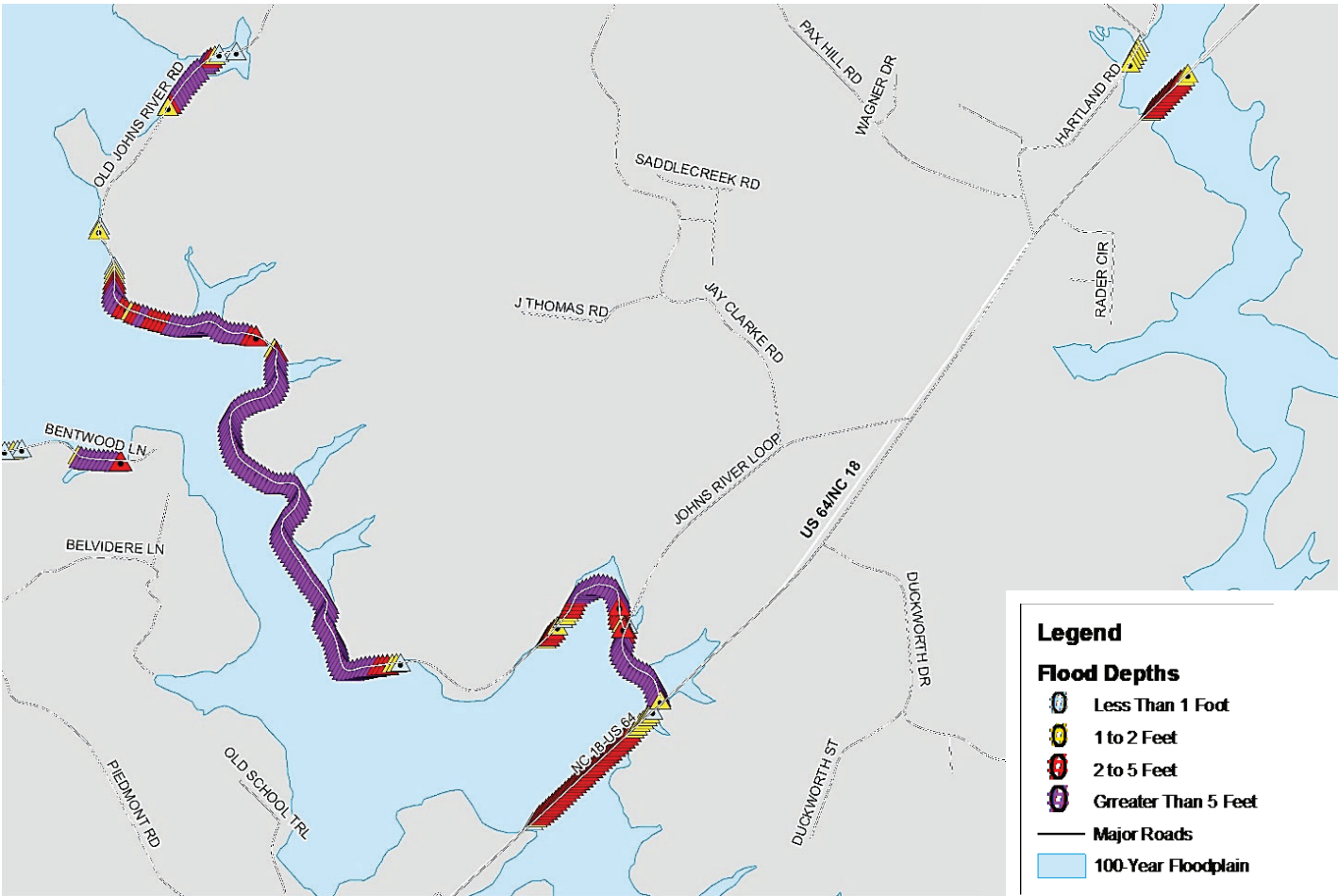
A “bioswale” next to a road.

The following 8 maps show approximate flood depths for portions of GHMPO roads that are located in the 100 and 500-year floodplains. GHMPO and NCDOT planners should refer to these maps early in the project screening process and during the project prioritization phase in order to better understand a project’s potential flood-related impacts. More detailed maps are available from GHMPO staff.

The close up image of the 100-year floodplain along route 64/18 in Burke County below shows how the maps can be used during the project screening and prioritization phases. For example, portions of Johns River Loop and route 64/18 are located in the 100-year floodplain.

Route 64/18 is a major thoroughfare that could be prioritized for improvements in the future. By using the map, planners can visualize the extent of potential flood impacts - not only on route 64/18, but on nearby roads that may also need to be considered in a project's overall scope.

**FLOOD MAP SAMPLE DETAIL – FLOOD DEPTHS ON ROUTE 64/18 IN BURKE COUNTY**



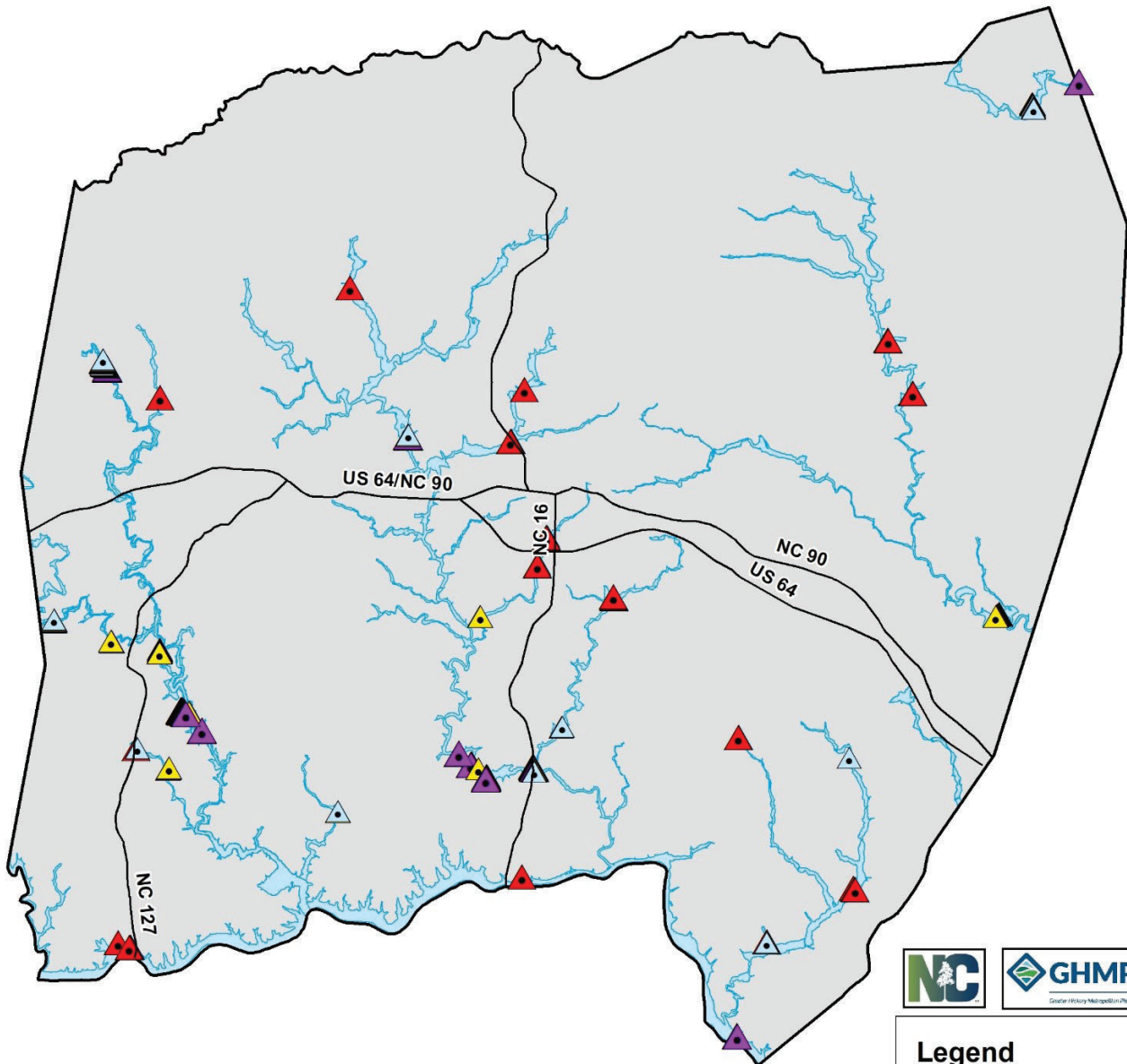
For example, planners could consider if a proposed project on route 64/18 near Johns River Loop would worsen the already significant flooding concerns in the area – and if so, whether or not the proposed project might need to include flood mitigation components.

Using these maps will help the GHMPO apply key resilience planning principles to transportation improvement projects, and also help improve the GHMPO's overall system resilience.



# Road Segments in 100 and 500 Year Floodplains

## Flood Depths on Alexander County Roads: 100-Year Floodplain



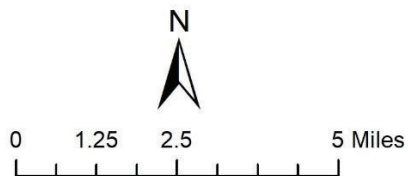
### Legend

#### Flood Depths

- Less Than 1 Foot
- 1 to 2 Feet
- 2 to 5 Feet
- Greater Than 5 Feet

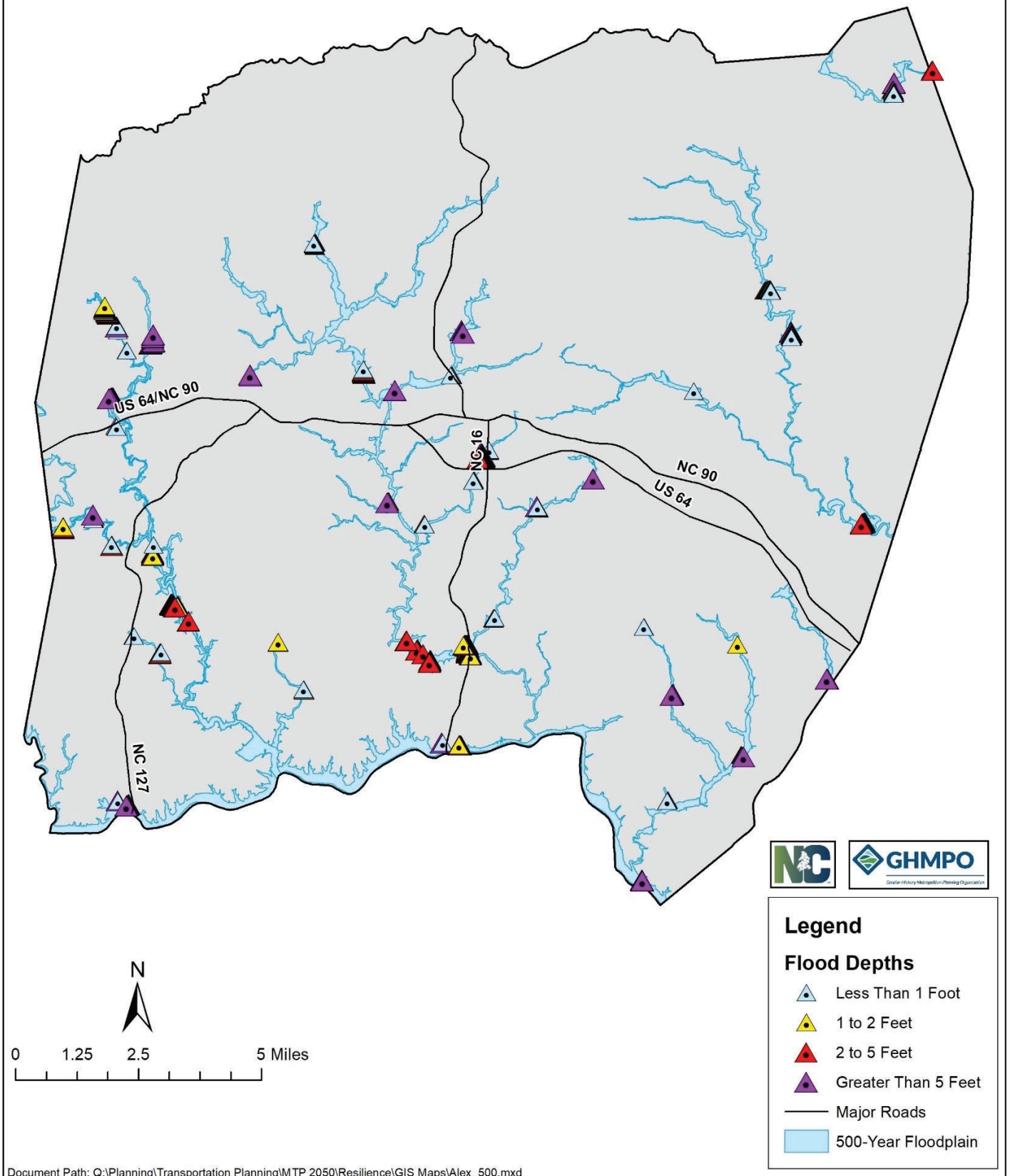
Major Roads

100-Year Floodplain



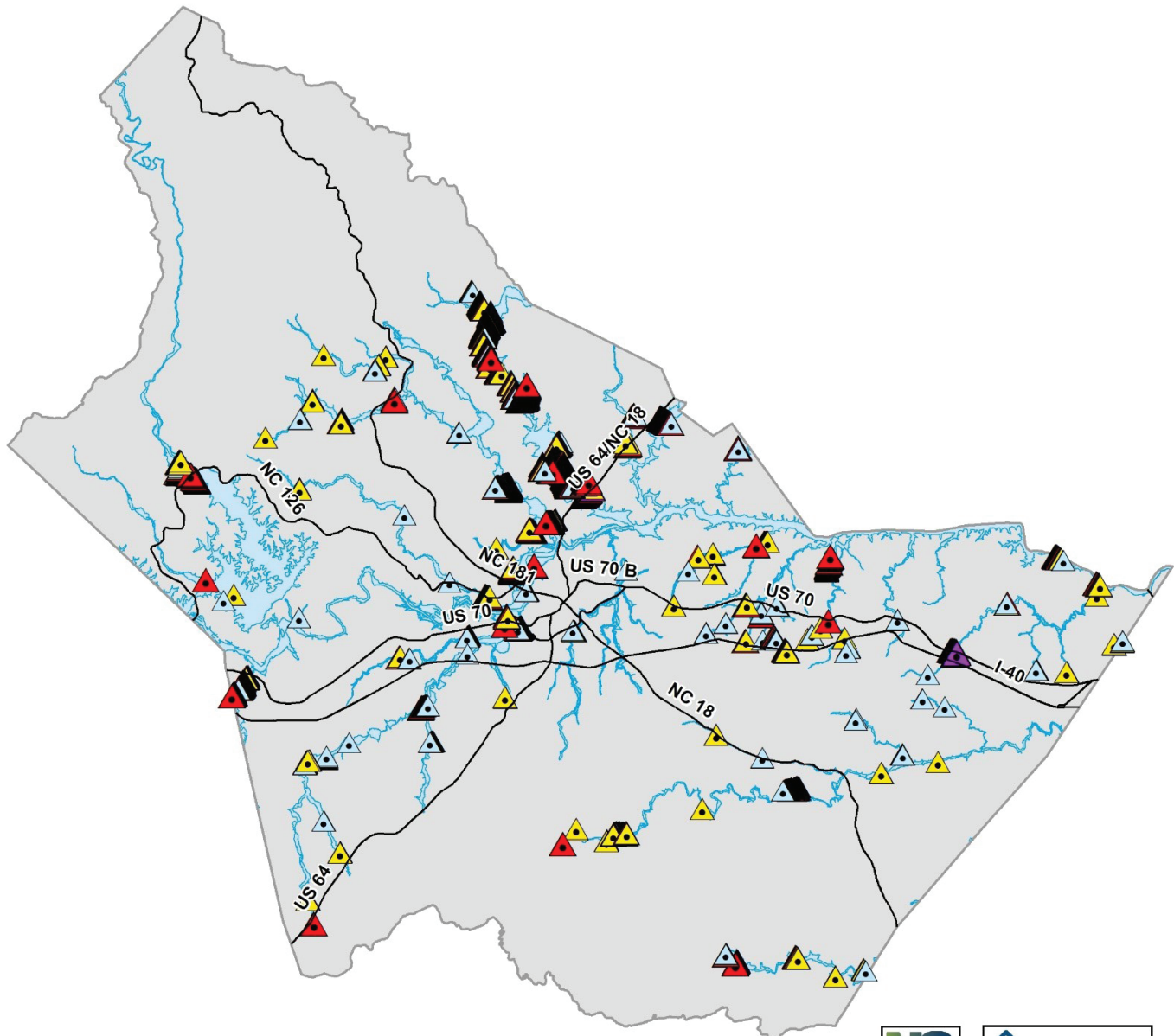
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## Flood Depths on Alexander County Roads: 500-Year Floodplain





## Flood Depths on Burke County Roads: 100-Year Floodplain

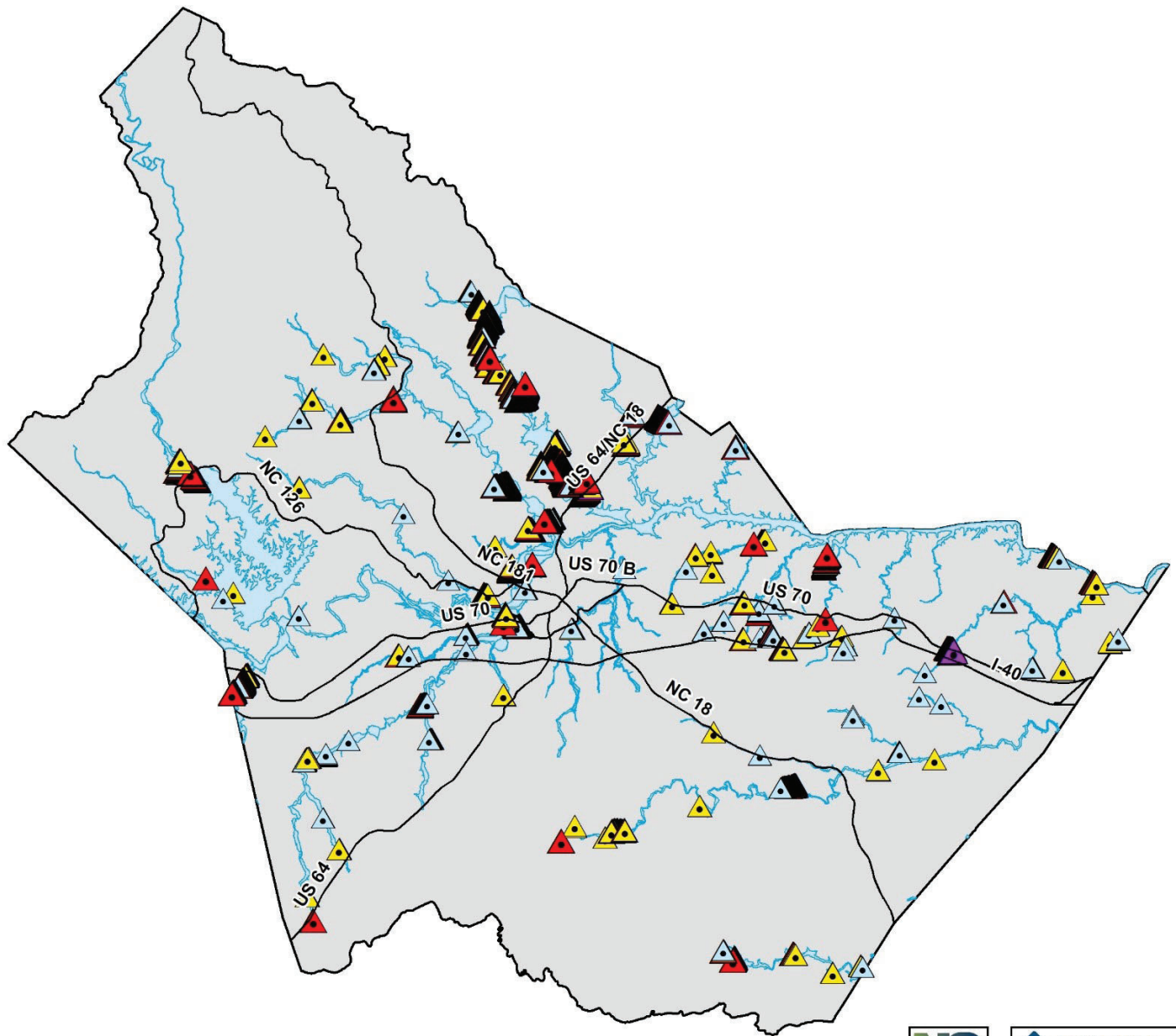


### Legend

- Less Than 1 Foot
- 1 to 2 Feet
- 2 to 5 Feet
- Greater Than 5 Feet
- Major Roads
- 100-Year Floodplain

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## Flood Depths on Burke County Roads: 500-Year Floodplain



### Legend

#### Flood Depths

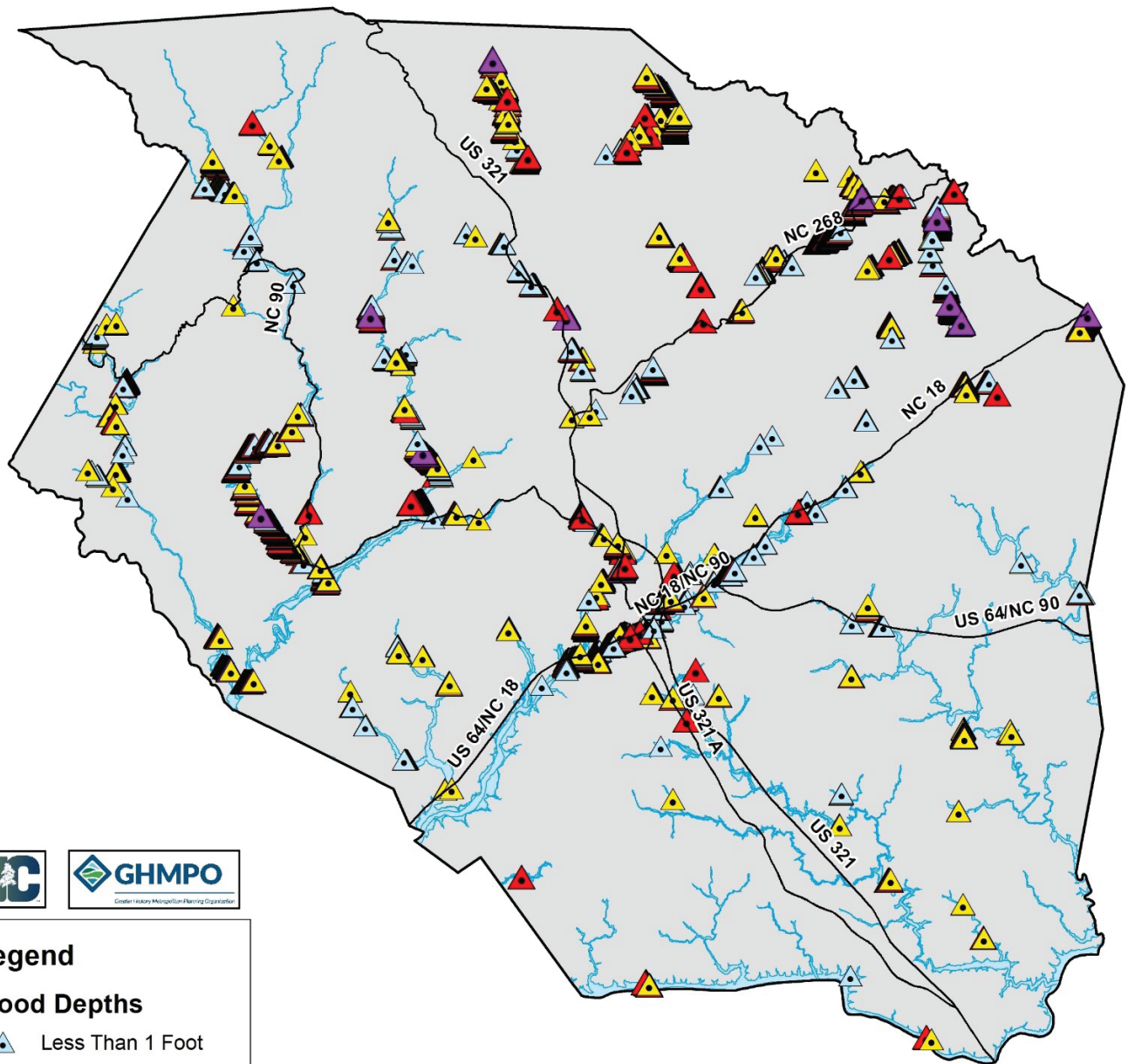
- Less Than 1 Foot
- 1 to 2 Feet
- 2 to 5 Feet
- Greater Than 5 Feet

— Major Roads

500-Year Floodplain

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## Flood Depths on Caldwell County Roads: 100-Year Floodplain



### Legend

#### Flood Depths

- Less Than 1 Foot
- 1 to 2 Feet
- 2 to 5 Feet
- Greater Than 5 Feet

Major Roads

100-Year Floodplain

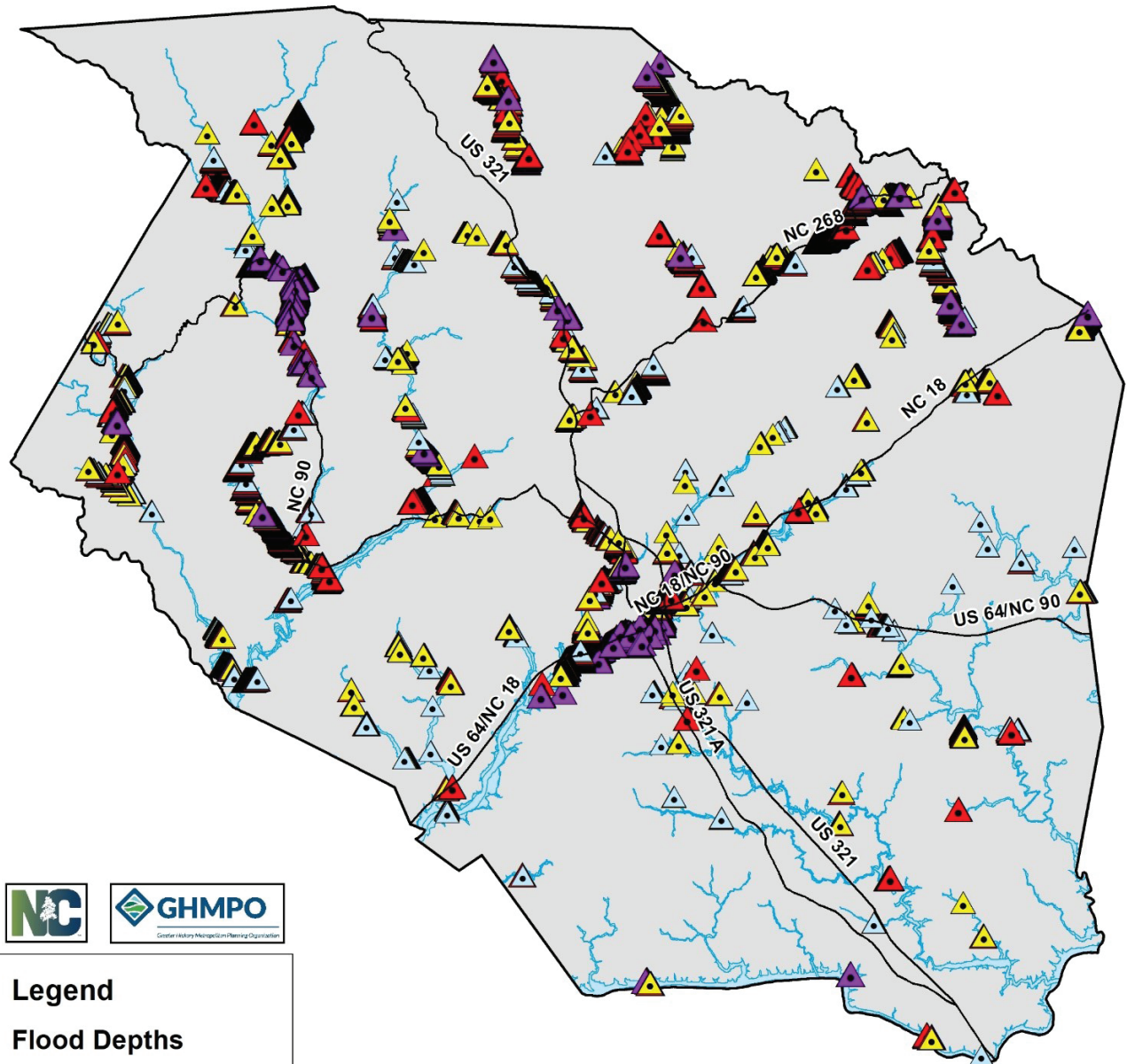


0 1.25 2.5 5 Miles

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## Flood Depths on Caldwell County Roads: 500-Year Floodplain



### Legend

#### Flood Depths

- Less Than 1 Foot
- 1 to 2 Feet
- 2 to 5 Feet
- Greater Than 5 Feet

Major Roads

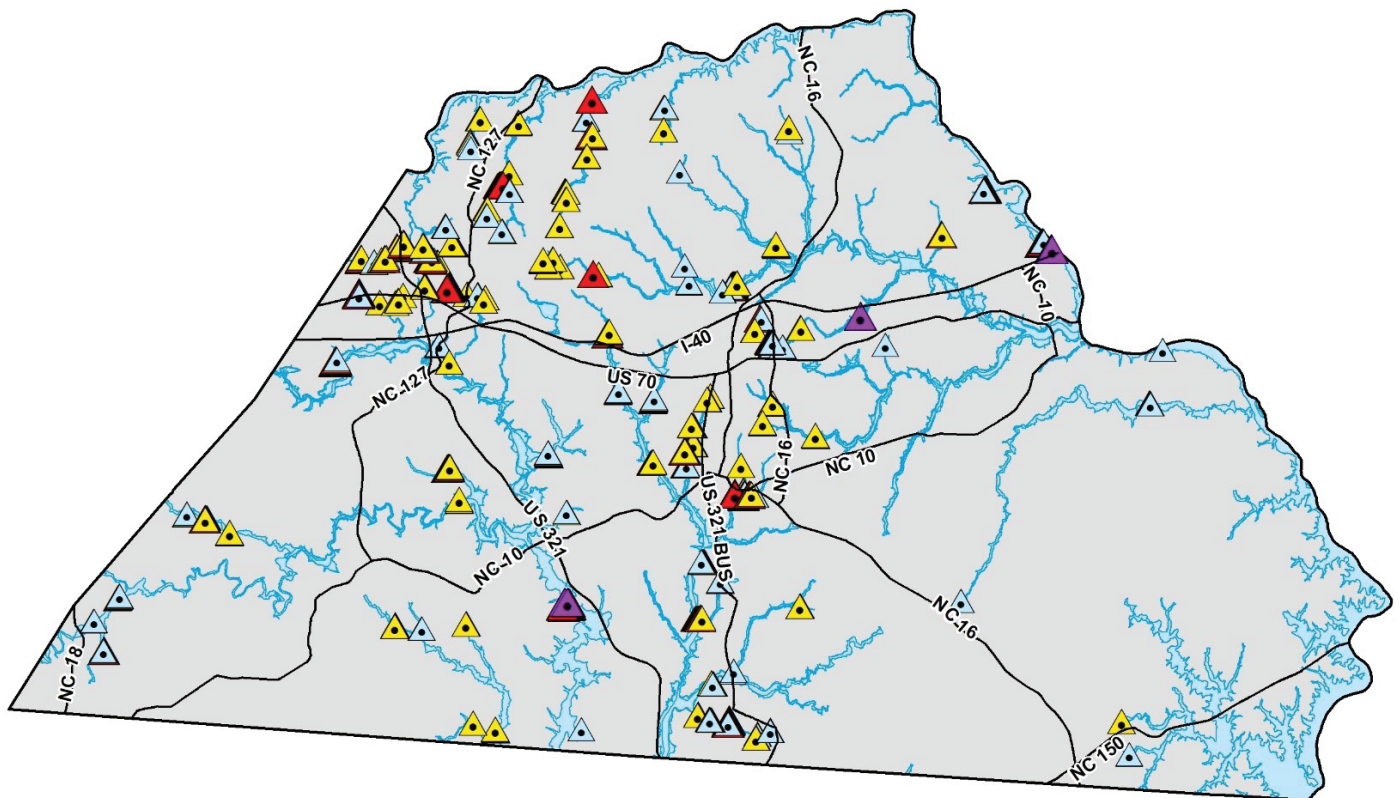
500-Year Floodplain



0 1.25 2.5 5 Miles

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## Flood Depths on Catawba County Roads: 100-Year Floodplain



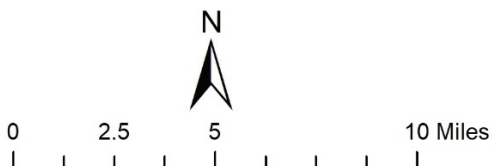
### Legend

#### Flood Depths

- Less Than 1 Foot
- 1 to 2 Feet
- 2 to 5 Feet
- Greater Than 5 Feet

Major Roads

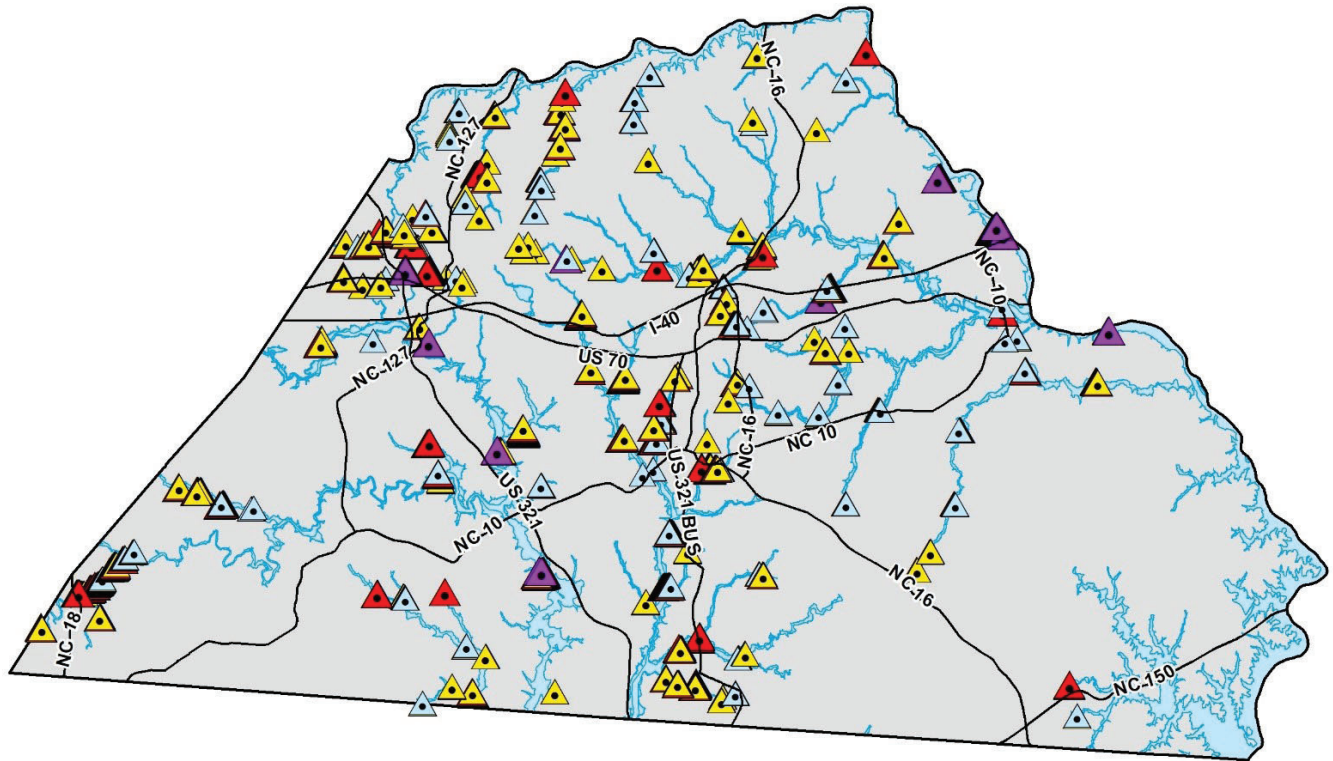
100-Year Floodplain



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## Flood Depths on Catawba County Roads: 500-Year Floodplain



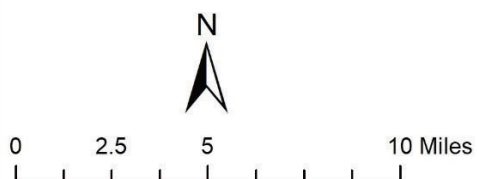
### Legend

#### Flood Depths

- Less Than 1 Foot
- 1 to 2 Feet
- 2 to 5 Feet
- Greater Than 5 Feet

— Major Roads

500-Year Floodplain

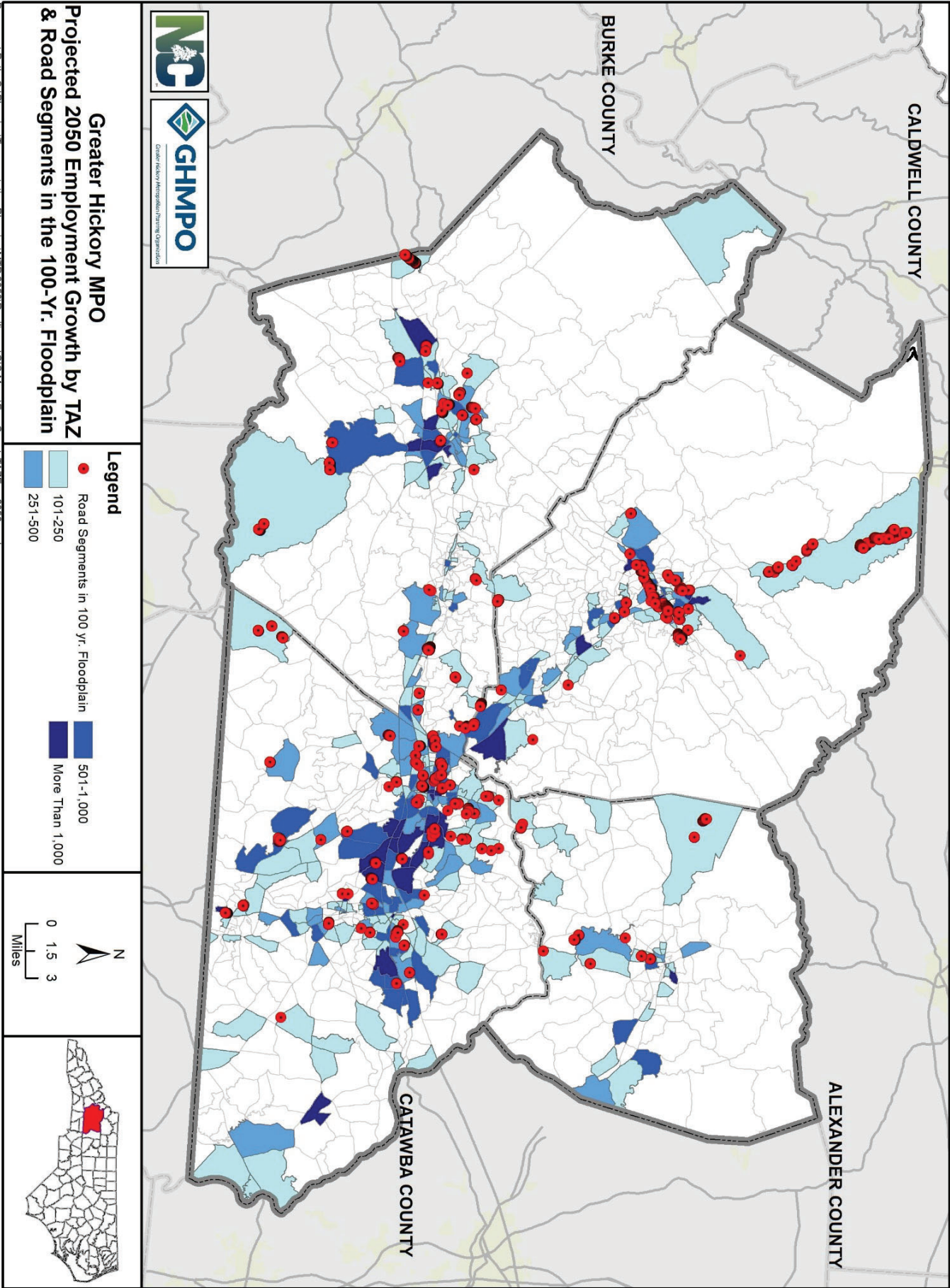


The next 2 maps show road segments that are within the 100-year floodplain overlaid onto the GHMPO's Traffic Analysis Zone projected growth maps (TAZs). The map on page 15, shows projected employment growth within the TAZs and the map on page 16, shows projected population density within the TAZs.

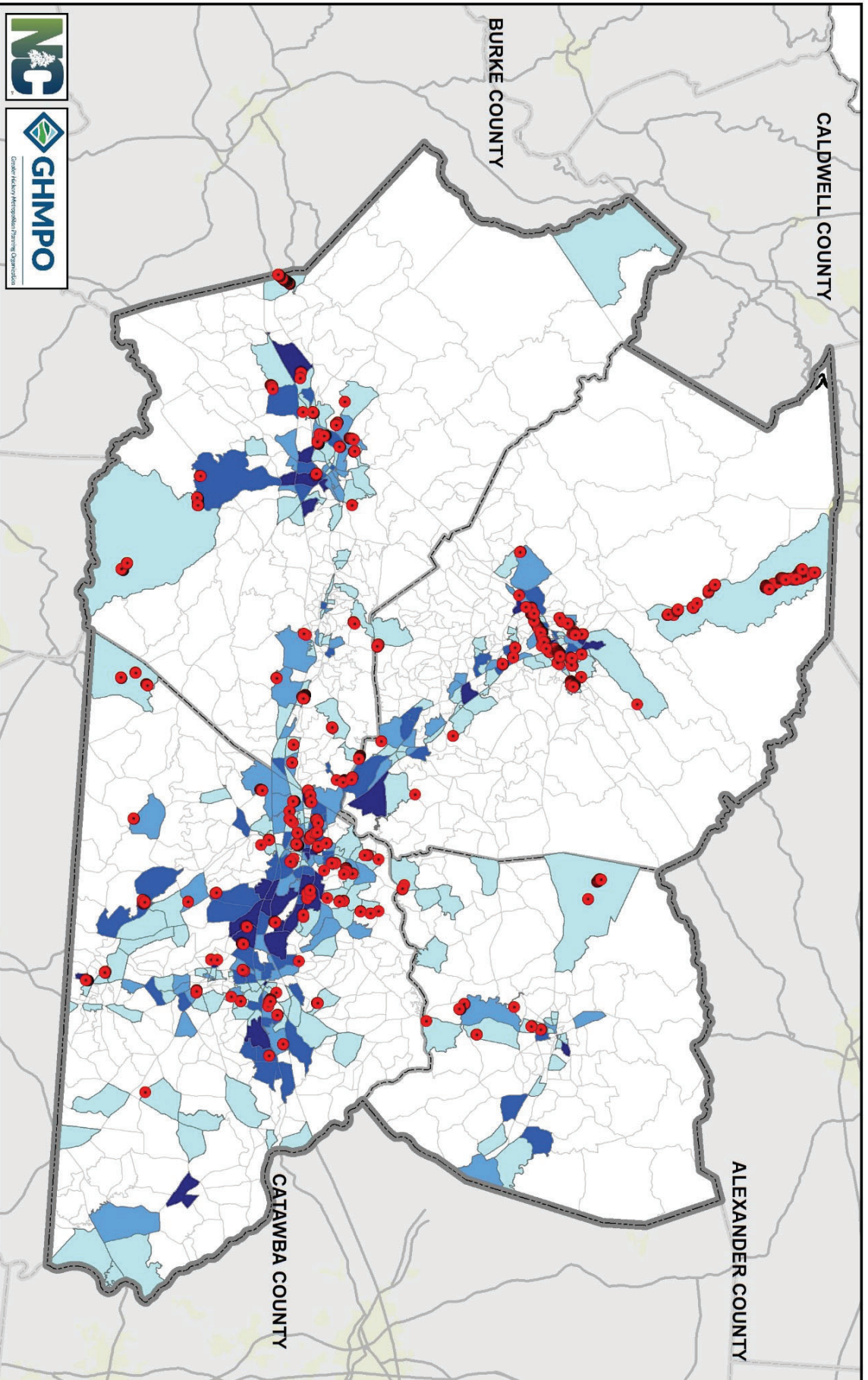
Darker shaded TAZs indicate higher growth projections. Higher employment growth and population density typically leads to more demand for transportation infrastructure (impervious surfaces).

Looking at the maps, it is clear that many road segments that are within the 100-year floodplain are also located within high projected growth TAZs.

# TAZ Growth Projections and Road Segments in 100 Year Floodplain







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When evaluating proposed projects, GHMPO planners should pay close attention to the potential cumulative impacts of increased stormwater runoff and flooding resulting from new projects – both within the immediate proposed project vicinity and in adjacent areas.

In consultation with NCDOT, GHMPO planners should discuss the feasibility of incorporating nature-based solutions or other mitigation methods into projects that are located in high growth TAZs or other areas. Doing so will help the region as it works to balance opportunities for growth and economic development with the need to lessen the potentially disastrous impacts resulting from extreme weather events.

GHMPO staff also met with NCDOT staff to identify locations throughout the region that are prone to flooding, mudslides, rockslides, and landslides. The information below can be used in conjunction with the flood maps in this chapter when screening and prioritizing potential projects.

## **Alexander County**

### **Prone to flooding:**

- » NC 16 and Millersville Road
- » Dover Church Road and Duck Creek, near the Caldwell County line
- » Rink Dam Road near Rink Dam
- » Smith Grove Church Road at Third Creek
- » Pilgrim Church Road at Smith Grove Church Road

### **Prone to mud slides:**

- » Barrett Mountain Road
- » Moore Mountain Road
- » Old NC 16
- » Dover Church Road
- » Houcke Mountain Road

## **Burke County**

### **Prone to flooding:**

- » 64/18 near Chesterfield Fire Department
- » Johns River Loop at 64/18
- » Spainhour Road and Bost Road Creek
- » Spainhour Road between Bost Road and Warrior Road
- » Lost Corner Road at bridge
- » Antioch Road at Lower Creek
- » Hartland Road at Bristol Creek
- » Kayga Avenue and Fish Hatchery Road area

## **Caldwell County**

### **Prone to flooding:**

- » NC 268 between Buffalo Cove Road and Steeltown Road
- » Riverside Drive below dam near Buffalo Cove Road
- » Brown Mountain Beach Road south of NC 90
- » NC 90 in Collettsville
- » Indian Grave Road bridge area
- » 4 bridges along Johns River Road in Collettsville
- » CC Camp Road
- » Upton Place and Globe Road
- » Adako Road to Playmore Beach Road

### **Prone to rock/landslides:**

- » US 321 near Blowing Rock
- » US 321 near Black Bear Store
- » Buffalo Cove Road



## Catawba County

### Prone to flooding:

- » NC 10 west of US 321 near truck stop
- » US 321 along Henry Fork
- » Kool Park Road bridges
- » Business 321 at Catawba County Courthouse area
- » Snow Creek Road at Snow Creek area
- » I-40 rest area near Lyle Creek in Claremont
- » US 321 near Rocky Ford Road bridge

## RECOMMENDATIONS

- » Identify transportation facilities that will be impacted by flooding
- » Identify floodplains in proposed project areas during initial project screening/prioritization phases
- » Share flood data and growth projections from this chapter with local governments to assist them with development proposal reviews
- » Reach out to local emergency managers for input during initial project screening/prioritization phases
- » In consultation with NCDOT, discuss potential solutions to mitigate project impacts (nature-based solutions, hardening, raising bridges, etc.) during initial project screening/prioritization phases
- » Assess availability of alternative routes during initial project screening/prioritization phases
- » Account for potential future environmental conditions when evaluating proposed projects or creating corridor plans
- » Avoid projects in areas that are subject to impacts from extreme weather events when feasible
- » In consultation with local emergency managers and NCDOT, continue to assess the GHMPO transportation system's vulnerability to floods, extreme heat, wildfire, tornados, security threats, etc.

