

Lessons Learned

from

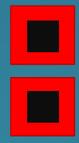
Hurricane Florence & Michael

Debora L. Chance

IT Security & Compliance Specialist
FEMA Master Continuity Practitioner

October 18, 2018





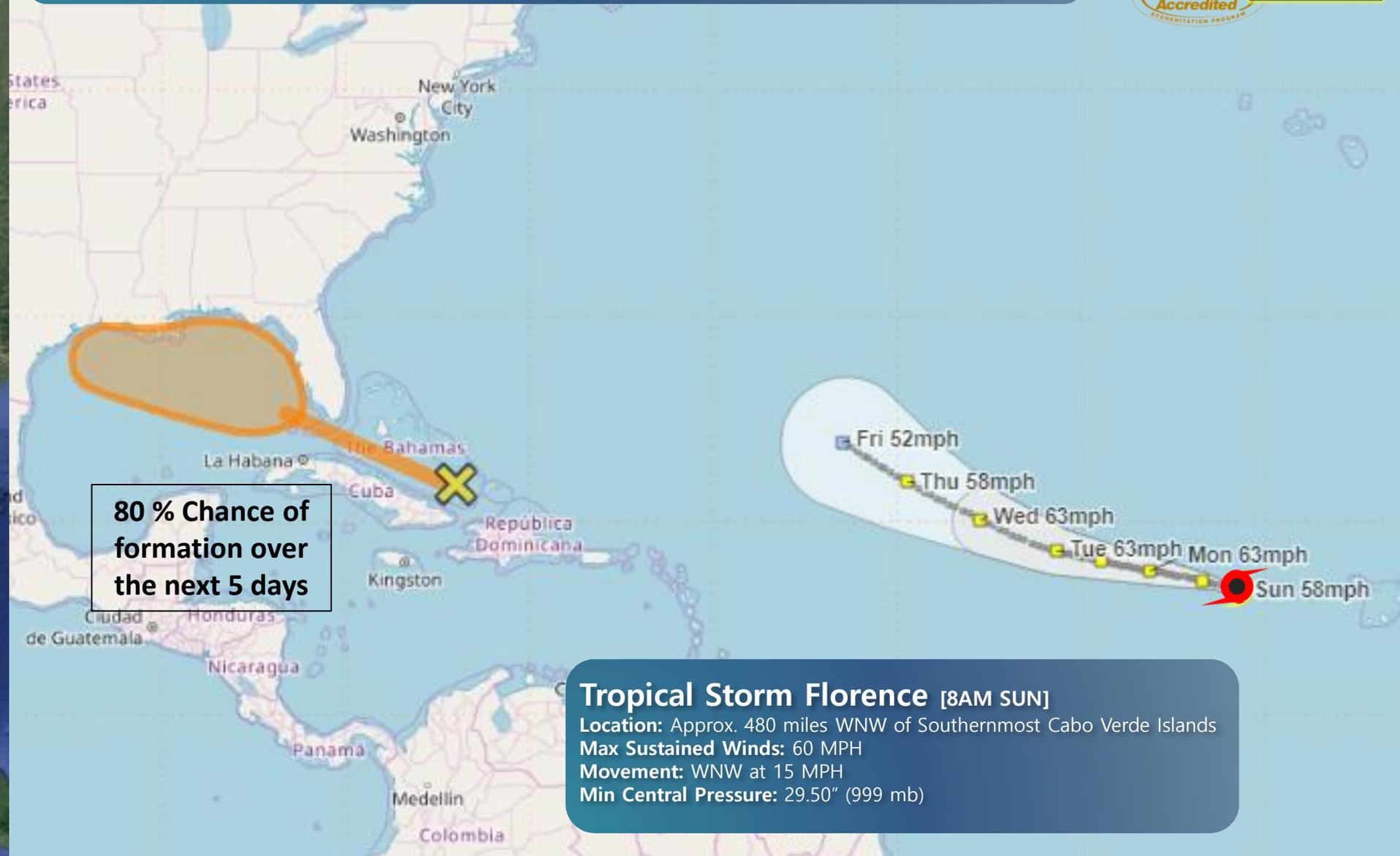
SEPTEMBER 2, 2018



- 12 Days Before Landfall
- Increasing potential for direct impacts to NC

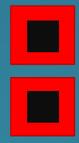
TROPICAL OUTLOOK

September 2, 2018 – 8AM



80 % Chance of formation over the next 5 days

Tropical Storm Florence [8AM SUN]
Location: Approx. 480 miles WNW of Southernmost Cabo Verde Islands
Max Sustained Winds: 60 MPH
Movement: WNW at 15 MPH
Min Central Pressure: 29.50" (999 mb)



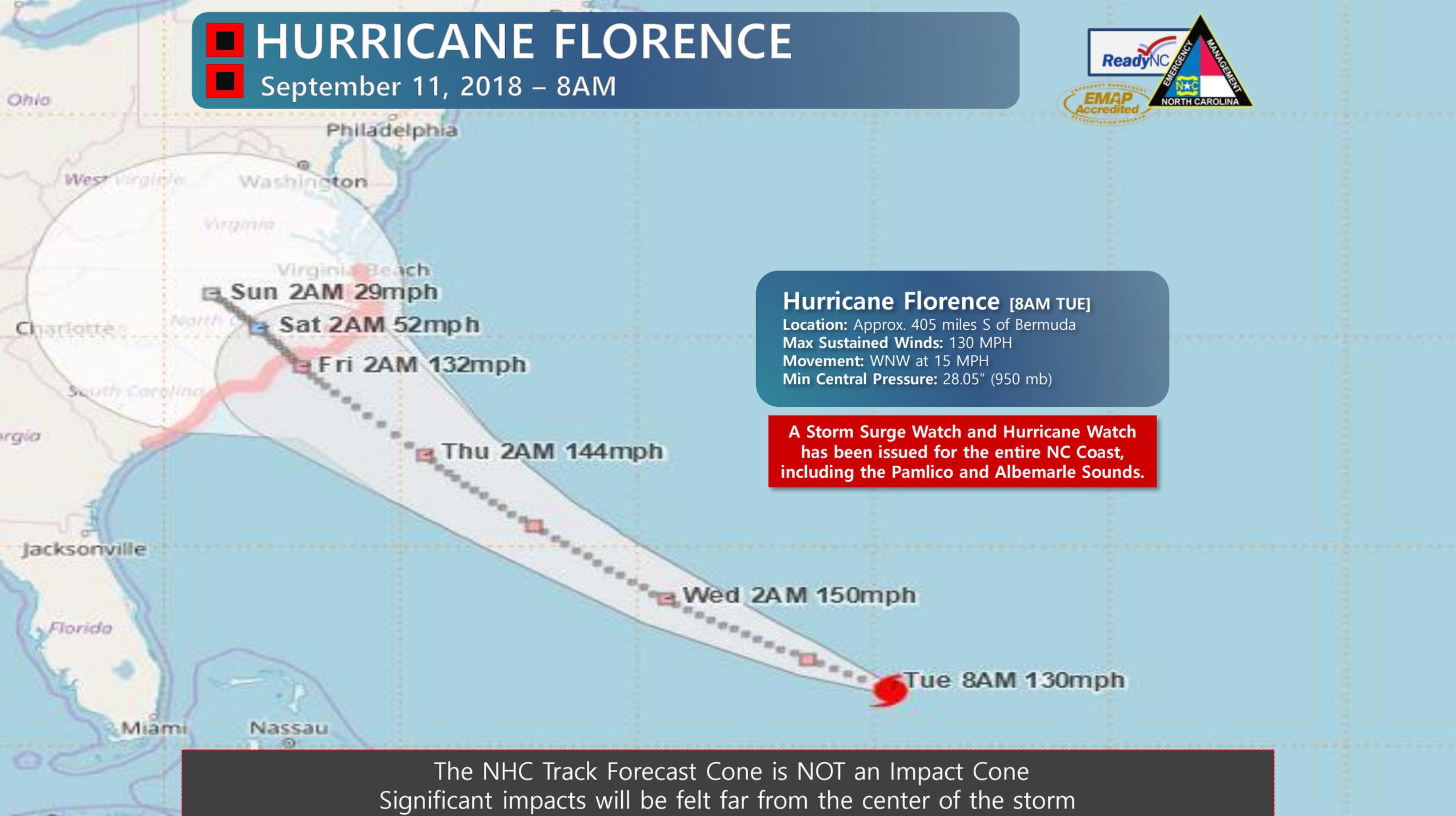
SEPTEMBER 11, 2018



- 3 Days Before Landfall
- Rapidly intensified (130mph)
- Extended Precipitation forecast: Measurements in feet
- Storm Surge Watch Issued to NC Coast
- Began messaging:
 - Extreme Storm Surge
 - Significant Inland Flooding
 - Hurricane-Force Winds
 - Tornadoes threat

HURRICANE FLORENCE

September 11, 2018 – 8AM



Hurricane Florence [8AM TUE]

Location: Approx. 405 miles S of Bermuda
Max Sustained Winds: 130 MPH
Movement: WNW at 15 MPH
Min Central Pressure: 28.05" (950 mb)

A Storm Surge Watch and Hurricane Watch has been issued for the entire NC Coast, including the Pamlico and Albemarle Sounds.

The NHC Track Forecast Cone is NOT an Impact Cone
Significant impacts will be felt far from the center of the storm

HAZARDS SUMMARY

HURRICANE FLORENCE

September 11, 2018 – 8AM

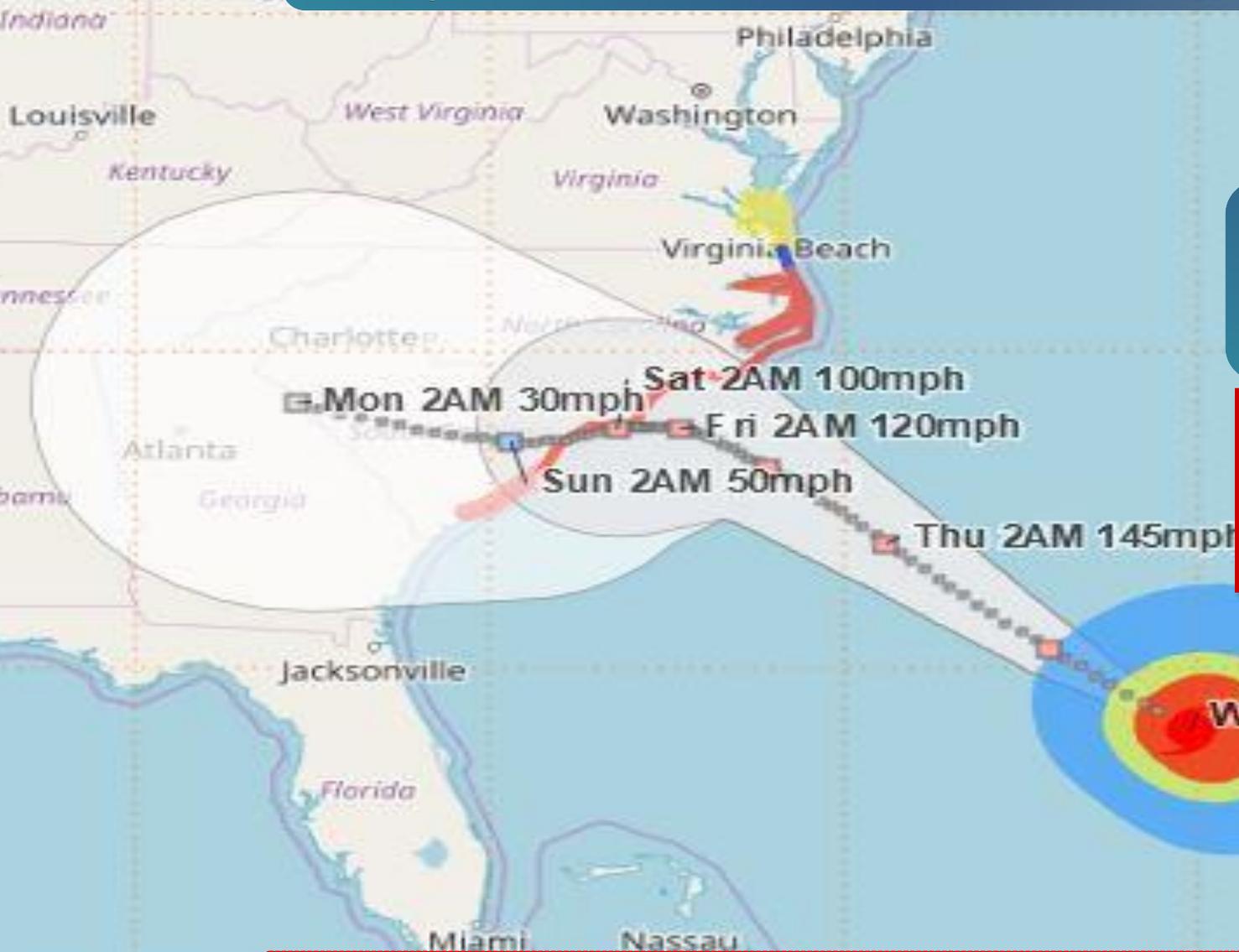


HAZARD	DETAILS	IMPACTS	THREAT
Storm Surge	S of Cape Fear: 4-6' Cape Fear-Cape Lookout: 6-12' (Neuse & Pamlico Rivers) Cape Lookout-Ocracoke Inlet: 5-8' N of Ocracoke Inlet: 3-5'	Very dangerous inundation amounts are expected along the NC coast Thu-Sat.	Extreme
Inland Flooding	Portions of Eastern NC: 15-20+" Central/Eastern: 6-15" (Up to 30" along track)	Sig. threat to life and property; impassable roads; road wash-outs. Heavy rain will begin Thu and could continue through the weekend. Longer-term river flooding likely, and mountain landslides possible.	Extreme
Damaging Winds	Hurricane-Force winds are likely near the coast Tropical Storm-Force winds likely across much of state	Significant downed trees and widespread/prolonged power outages across the state; significant structure damage possible as Florence could make landfall as a Category 4 hurricane.	Extreme
Tornadoes	A few tornadoes are possible Thu and Fri, especially across eastern NC. Tornadoes in tropical systems are typically short-lived and weak.		Moderate
Marine & Coastal	Life-threatening surf and rip currents will continue for much of the week.		Extreme

Threat Levels:	None	Low	Moderate	High	Extreme
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HURRICANE FLORENCE

September 12, 2018 – 5AM



Hurricane Florence [5AM WED]

Location: Approx. 575 miles SE of Cape Fear, NC
Max Sustained Winds: 130 MPH
Movement: WNW at 17 MPH
Min Central Pressure: 27.94" (946 mb)

A Storm Surge Warning and a Hurricane Warning is in effect for all areas south of Duck, NC including the Albemarle & Pamlico Sounds as well as the Neuse & Pamlico Rivers.

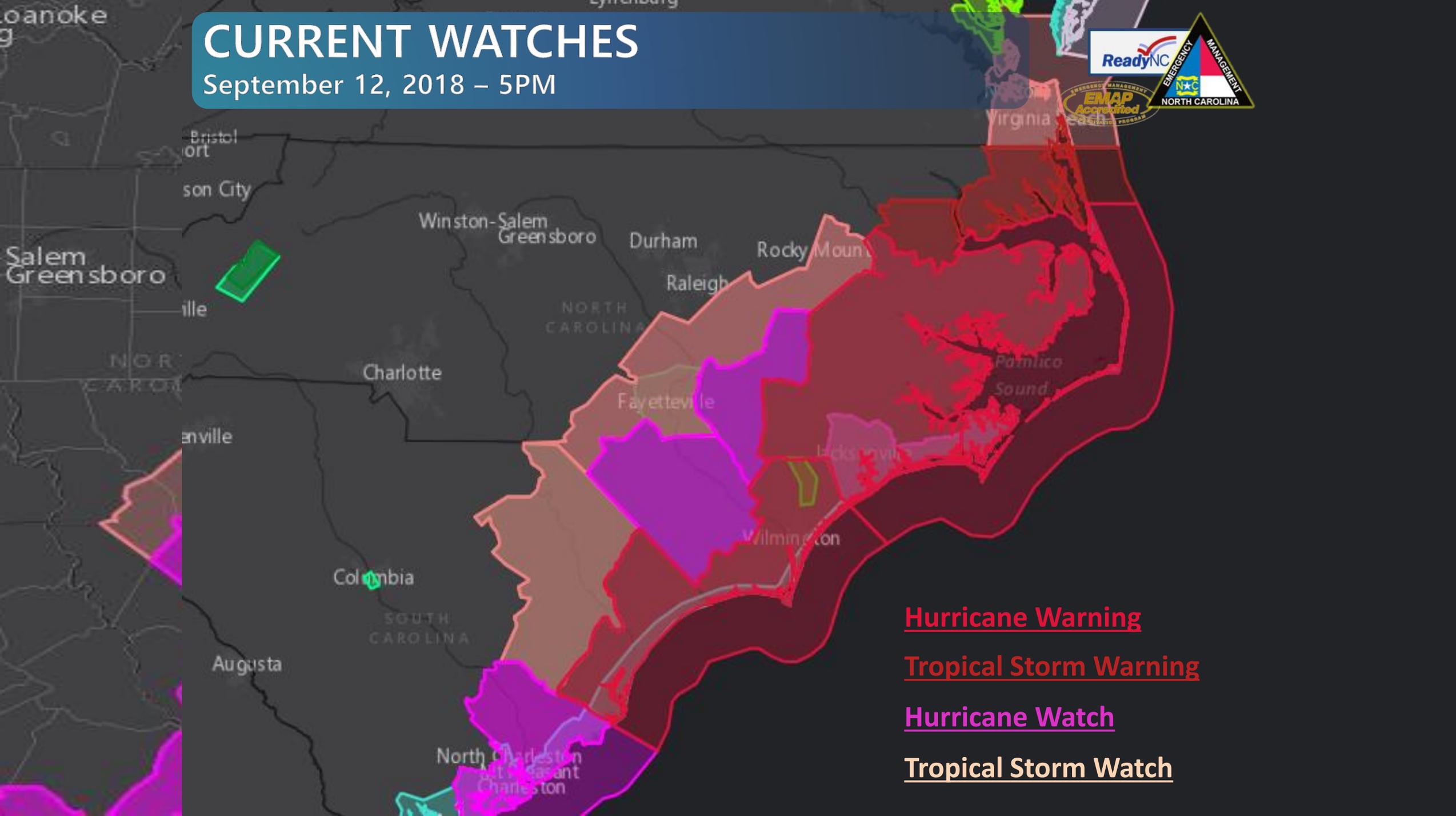
A Storm Surge Watch and Tropical Storm Warning is in effect for areas north of Duck.

Wind Speed		
≥ 34 kt / 39 mph	≥ 50 kt / 58 mph	≥ 64 kt / 74 mph
Tropical Storm	Strong Tropical Storm	Hurricane

The NHC Track Forecast Cone is NOT an Impact Cone
Significant impacts will be felt far from the center of the storm

CURRENT WATCHES

September 12, 2018 – 5PM



Hurricane Warning

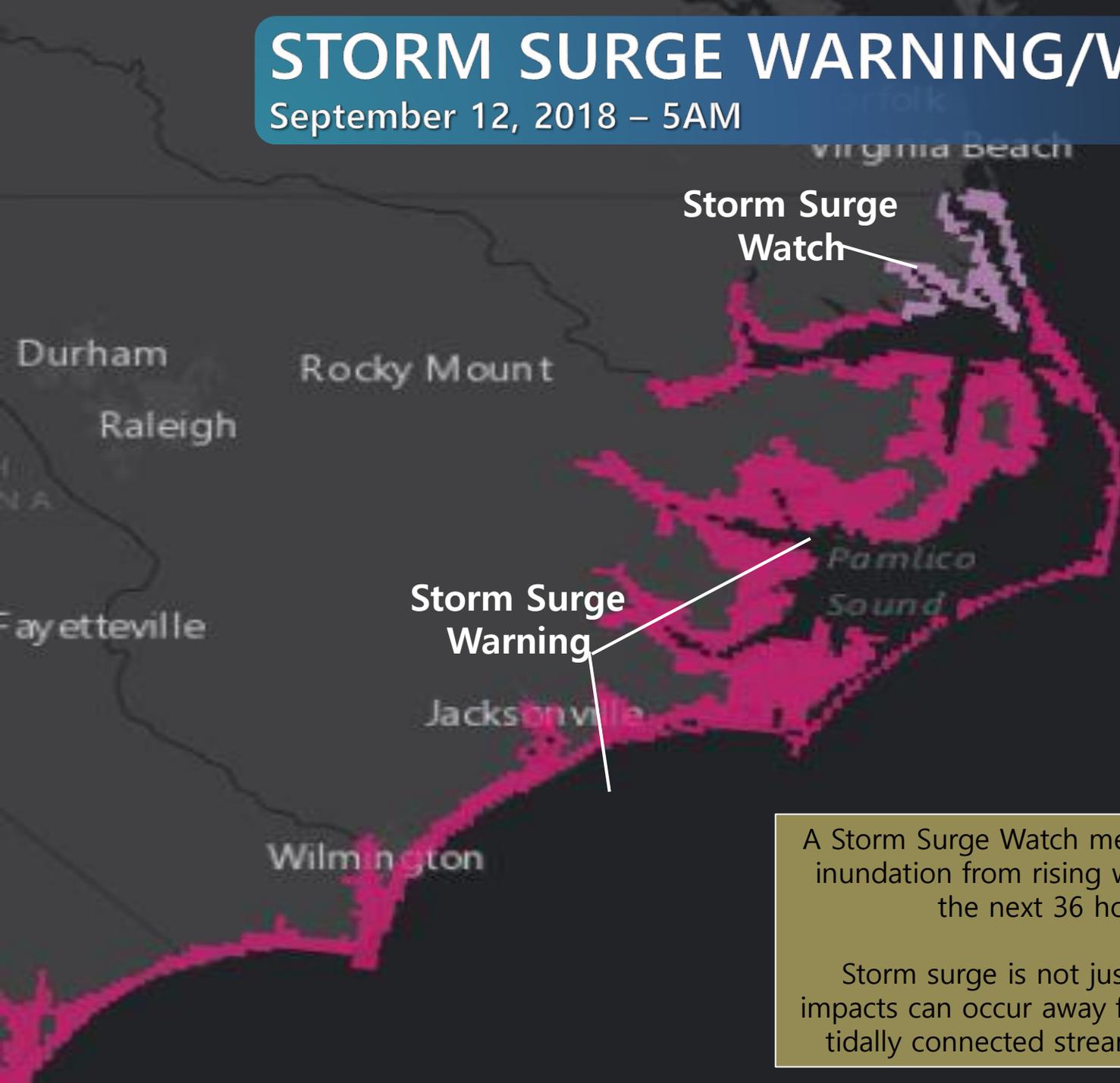
Tropical Storm Warning

Hurricane Watch

Tropical Storm Watch

STORM SURGE WARNING/WATCH

September 12, 2018 – 5AM



Storm Surge
Watch

Storm Surge
Warning

Potential Storm Surge Amounts:

6-9' South of Cape Fear

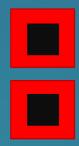
9-13' Cape Fear - Cape Lookout and
along the Neuse, Pamlico, Pungo, &
Bay Rivers

6-9' Cape Lookout - Ocracoke Inlet

4-6' North of Ocracoke Inlet

A Storm Surge Watch means there is a danger of life-threatening inundation from rising water moving from the coastline, during the next 36 hours in the indicated locations.

Storm surge is not just an ocean front phenomenon. Surge impacts can occur away from the coast, especially along/near any tidally connected streams, creeks, rivers, waterways, and bays.



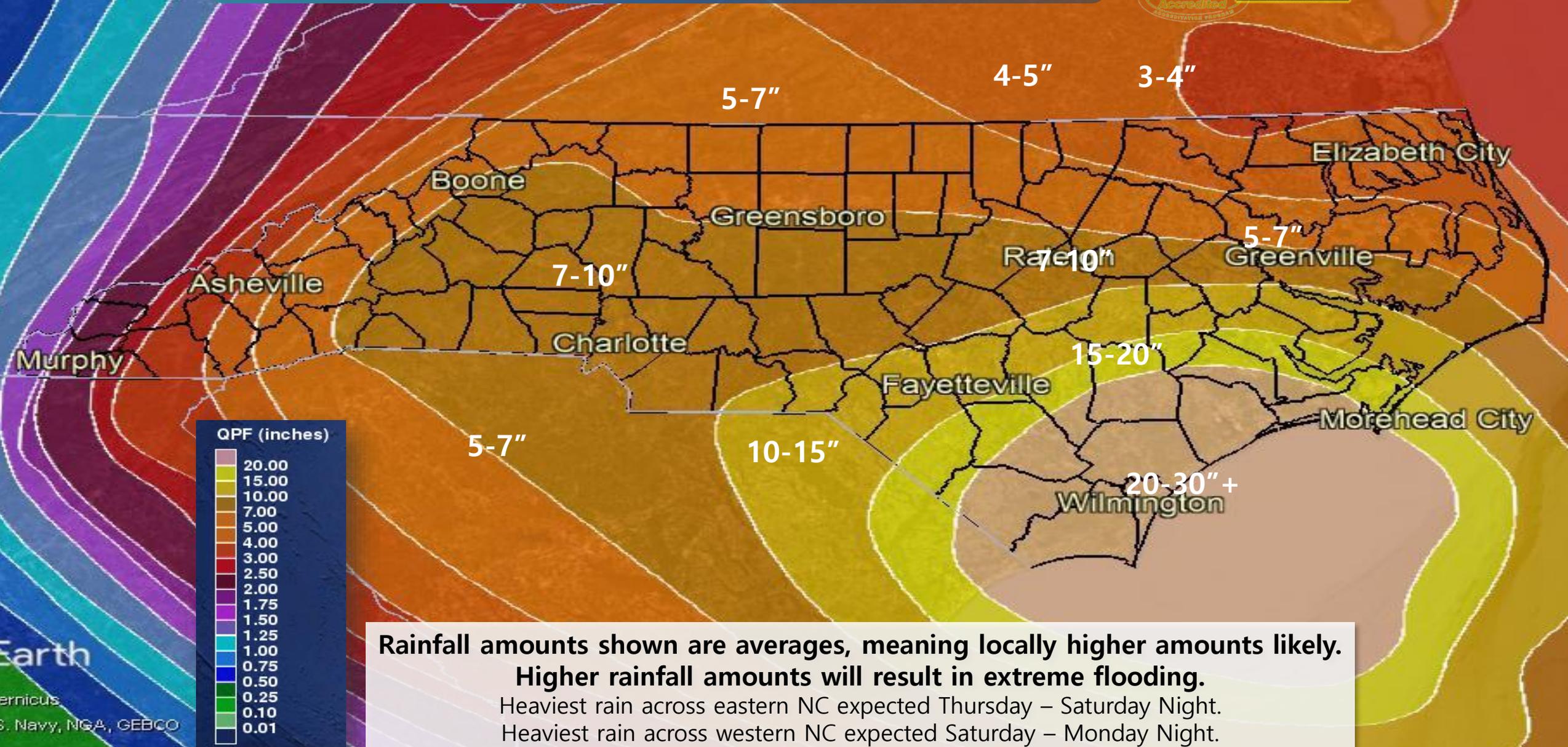
SEPTEMBER 13, 2018



- 1 Day Before Landfall (outer rain bands reaching Outer Banks)
 - Weakening (110 mph), but extreme impacts remain
 - Signatures of southward turn – increased rainfall
 - 20-30” of rain forecast for SE
- Storm Surge observed Thursday night
- 4 days total of High Risk for Flash Flooding
 - VERY Rare – indicative of dangerous, significant, & impactful event
- Severe weather threat Thursday & Friday (Tornadoes)

7-DAY RAINFALL FORECAST

8AM September 13, 2018 to 8AM September 20, 2018



Rainfall amounts shown are averages, meaning locally higher amounts likely.
Higher rainfall amounts will result in extreme flooding.
Heaviest rain across eastern NC expected Thursday – Saturday Night.
Heaviest rain across western NC expected Saturday – Monday Night.

FLASH FLOODING POTENTIAL

September 13, 2018 – 5AM

NOAA/NWS/NCEP/WPC



High Risk Days are Rare, Dangerous, Significant, and Impactful



Thursday



Friday

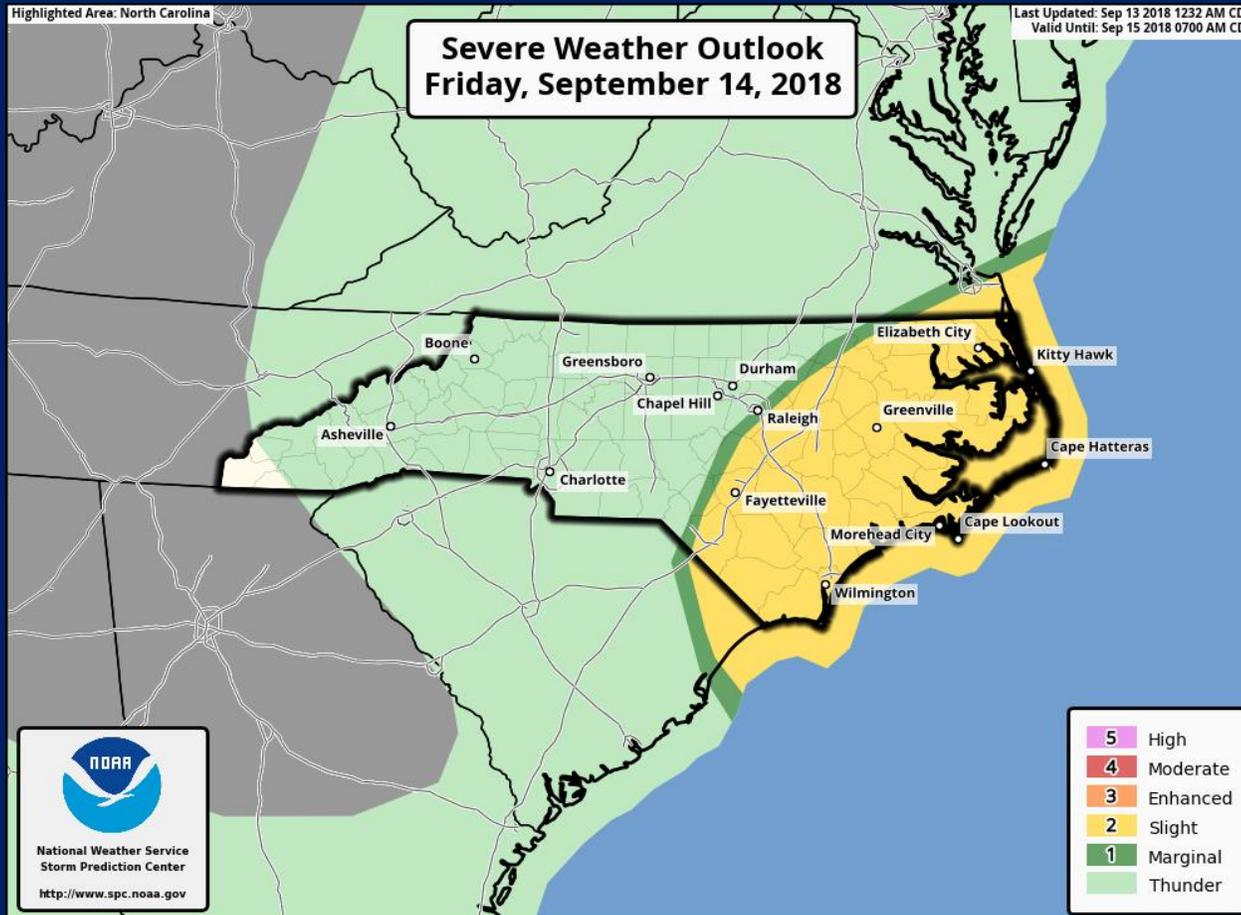


Saturday

5%: Marginal	20%: Moderate
10%: Slight	50%: High

FRIDAY'S SEVERE STORM THREAT

STORM PREDICTION CENTER (VALID 8AM 9/14/18 – 8AM 9/15/18)



THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)
No severe* thunderstorms expected	Isolated severe thunderstorms possible	Scattered severe storms possible
Lightning/flooding threats exist with <u>all</u> thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible
<ul style="list-style-type: none"> Winds to 40 mph Small hail 	<ul style="list-style-type: none"> Winds 40-60 mph Hail up to 1" Low tornado risk 	<ul style="list-style-type: none"> One or two tornadoes Reports of strong winds/wind damage Hail ~1", isolated 2"
3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
Numerous severe storms possible	Widespread severe storms likely	Widespread severe storms expected
More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense
<ul style="list-style-type: none"> A few tornadoes Several reports of wind damage Damaging hail, 1 - 2" 	<ul style="list-style-type: none"> Strong tornadoes Widespread wind damage Destructive hail, 2" + 	<ul style="list-style-type: none"> Tornado outbreak Derecho

Tornado potential extends into Friday and expands westward.

Tornadoes in tropical systems are typically weak and short-lived, but often do not offer much warning time.



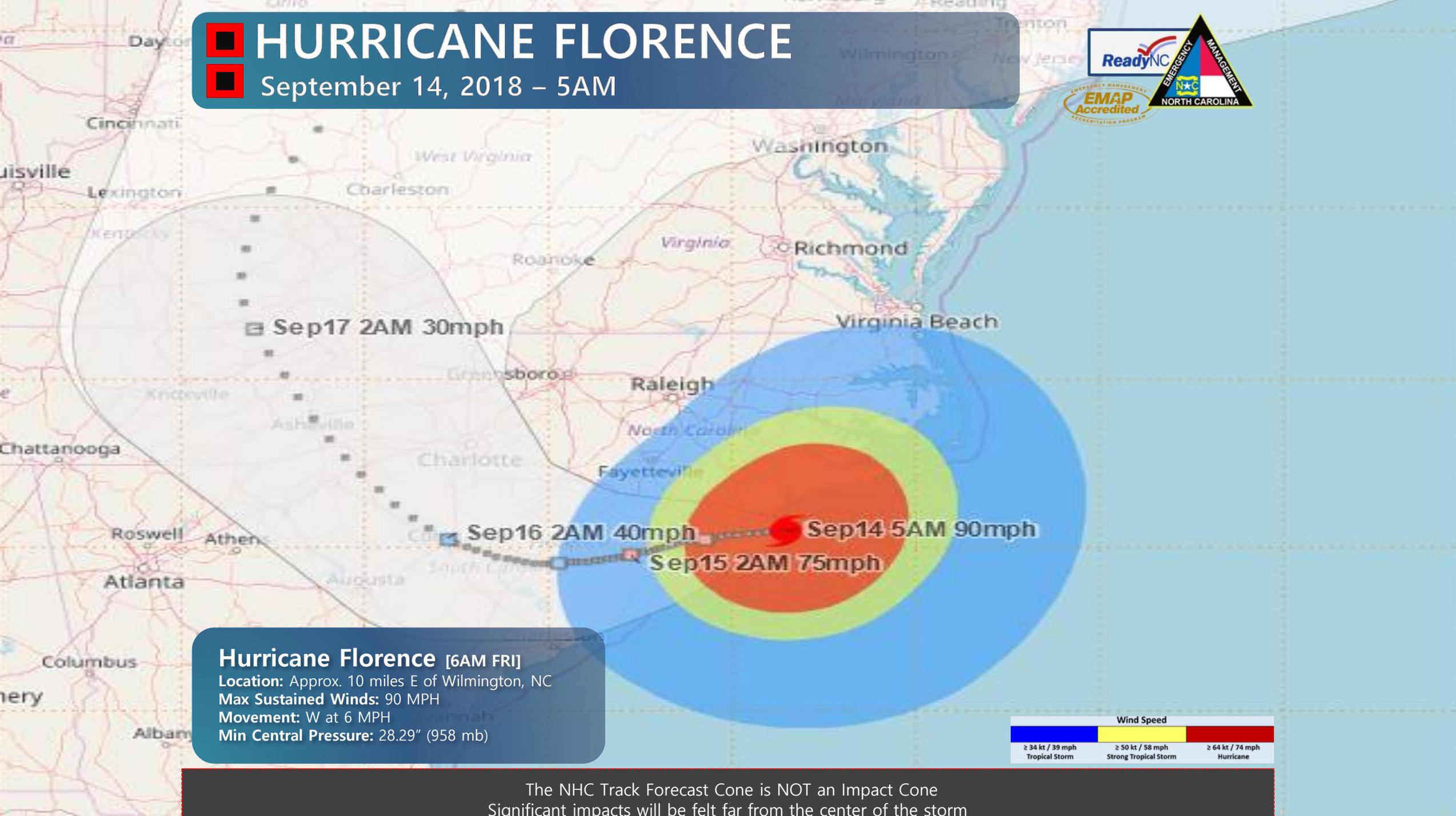
SEPTEMBER 14, 2018



- Day of Landfall (0715 90 mph max winds)
- Slow forward speed (6 mph) – widespread rainfall
- Spreading wind field
 - 105 mph winds in Wilmington
- Continued flooding, increased river levels statewide
- Additional rain expected

HURRICANE FLORENCE

September 14, 2018 – 5AM



Hurricane Florence [6AM FRI]

Location: Approx. 10 miles E of Wilmington, NC

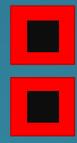
Max Sustained Winds: 90 MPH

Movement: W at 6 MPH

Min Central Pressure: 28.29" (958 mb)

Wind Speed		
≥ 34 kt / 39 mph	≥ 50 kt / 58 mph	≥ 64 kt / 74 mph
Tropical Storm	Strong Tropical Storm	Hurricane

The NHC Track Forecast Cone is NOT an Impact Cone
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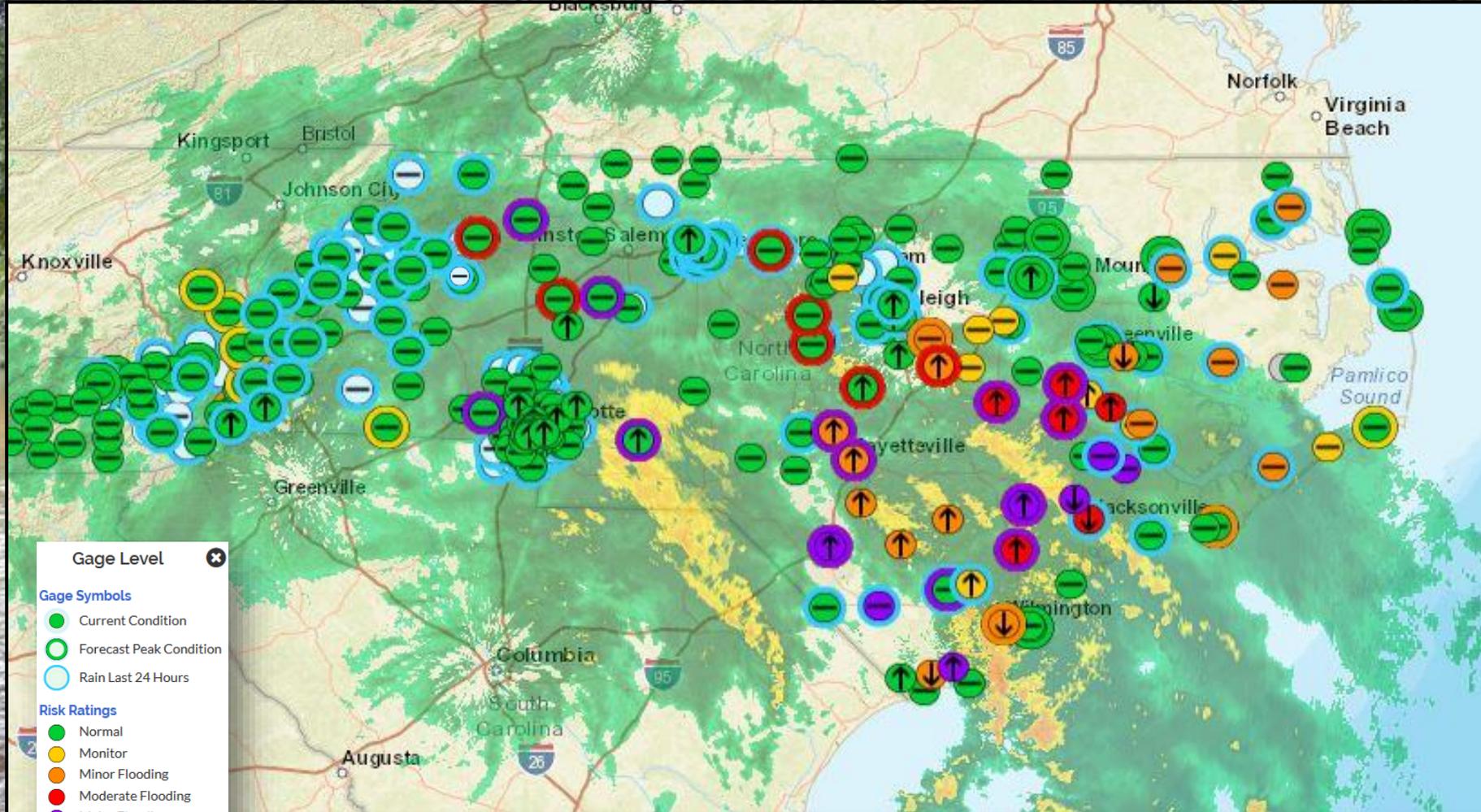
SEPTEMBER 15-17, 2018



- 2-4 Days After Landfall
- 5 Confirmed tornadoes (Wayne, Sampson, New Hanover, and Wilson Counties)
- Additional rain in Piedmont and Mountains
- Rivers rising statewide, increased inland flooding
- Peak river number of rivers flooded (16 Major and 16 Moderate)

RIVER FLOOD OUTLOOK

September 16, 2018 – 6:00AM



Gage Level ⓘ

Gage Symbols

- Current Condition
- Forecast Peak Condition
- Rain Last 24 Hours

Risk Ratings

- Normal
- Monitor
- Minor Flooding
- Moderate Flooding
- Major Flooding
- Not Risk Rated
- Out of Service

Trend

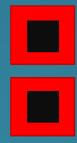
- ↑ Rising
- ↓ Falling
- Constant

MAJOR RIVER FLOODING SUMMARY

September 17, 2018 – Peak Flood Risk



EM Brand	County	Gage Name	Gage Ty	Flood Risk			Flood Timing		Flood Stage (ft)		
				Current	Forecast	Trend	Peak	Monitor/Norm	Current	Forecast	Change
Eastern	Sampson	Black River near Tomahawk	Riverine	Major		Rising			28.7		
Eastern	Hoke	Flat Creek near Inverness	Riverine	Major		Constant			9.2		
Eastern	Cumberland	Little River at Manchester	Riverine	Major	Major	Rising	Mon (09/17 PM)	TBD	33.5	34.4	0.9
Eastern	Brunswick	Lockwoods Folly River @ SR-211	Coastal	Major		Falling			12.9		
Eastern	Robeson	Lumber River at Lumberton	Riverine	Major	Major	Constant	Mon (09/17 PM)	TBD	22.2	25	2.8
Eastern	Lenoir	Neuse River at Kinston	Riverine	Major	Major	Constant	Tue (09/18 AM)	TBD	22.2	24.5	2.3
Eastern	Wayne	Neuse River near Goldsboro	Riverine	Major	Major	Rising	Tue (09/18 PM)	TBD	25	26.1	1.1
Eastern	Craven	Neuse River near Fort Barnwell	Riverine	Major		Constant			17		
Eastern	Duplin	NE Cape Fear River near Chinquapin	Riverine	Major	Major	Constant	Mon (09/17 PM)	TBD	24.2	28.2	4
Eastern	Pender	Northeast Cape Fear River near Burgaw	Riverine	Major	Major	Rising	Thu (09/20 AM)	TBD	22.8	24.2	1.4
Eastern	Columbus	Soules Swamp at S. Madison St in Whiteville	Riverine	Major		Constant			12.5		
Eastern	Jones	Trent R. at Trenton at N. Weber St	Riverine	Major		Constant			28.8		
Eastern	Pender	Black River at NC 210	Coastal	Moderate		Rising			14.7		
Eastern	Cumberland	Cape Fear River at Fayetteville	Riverine	Moderate	Major	Rising	Tue (09/18 AM)	Sat (09/22 AM)	50	61.8	11.8
Eastern	Bladen	Cape Fear River Lock near Tarheel	Riverine	Moderate	Major	Rising	Tue (09/18 PM)	TBD	30.7	68	37.3
Eastern	Greene	Contentnea Creek at Hookerton	Riverine	Moderate	Major	Constant	Tue (09/18 PM)	TBD	17.8	18.4	0.6
Eastern	Onslow	New River near Gum Branch	Riverine	Moderate		Falling			21.8		
Eastern	Onslow	New River at Old Bridge St. in Jacksonville	Coastal	Moderate		Constant			4.5		
Eastern	Jones	Trent R. at Pollockville	Riverine	Moderate		Falling			12		
Central	Randolph	Deep River at Ramseur	Riverine	Major		Rising			25.6		
Central	Montgomery	Little River near Star	Riverine	Major		Rising			21.9		
Central	Durham	THIRD FORK CREEK AT M.L. KING PARKWAY AT DURHAM, NC	Riverine	Major		Constant			8.3		
Central	Orange	Booker Creek at E. Franklin St	Riverine	Moderate		Falling			16.2		
Central	Lee	Deep River at Moncure	Riverine	Moderate	Moderate	Rising	Mon (09/17 PM)	Thu (09/20 AM)	14.7	16	1.3
Central	Moore	Drowning Creek near Hoffman	Riverine	Moderate		Rising			10.4		
Central	Durham	Eno River near Durham	Riverine	Moderate		Falling			22.1		
Central	Durham	Flat River at Dam near Bahama	Riverine	Moderate		Rising			19.1		
Central	Chatham	Haw River near Bynum	Riverine	Moderate	Major	Constant	Mon (09/17 PM)	Wed (09/19 AM)	15.9	17.2	1.3
Central	Wilson	Hominy Swamp at Forest Hills Rd near Wilson	Riverine	Moderate		Falling			7.2		
Central	Rockingham	Mayo River near Price	Riverine	Moderate		Constant			11.2		
Central	Johnston	Neuse River at Smithfield	Riverine	Moderate	Moderate	Constant	Crested	Wed (09/19 PM)	18.8	18.8	0
Western	Stanly	Rocky River near Norwood	Riverine	Major	Major	Rising	Crested	Tue (09/18 AM)	36.4	35.2	-1.2



PRELIMINARY OBSERVATIONS



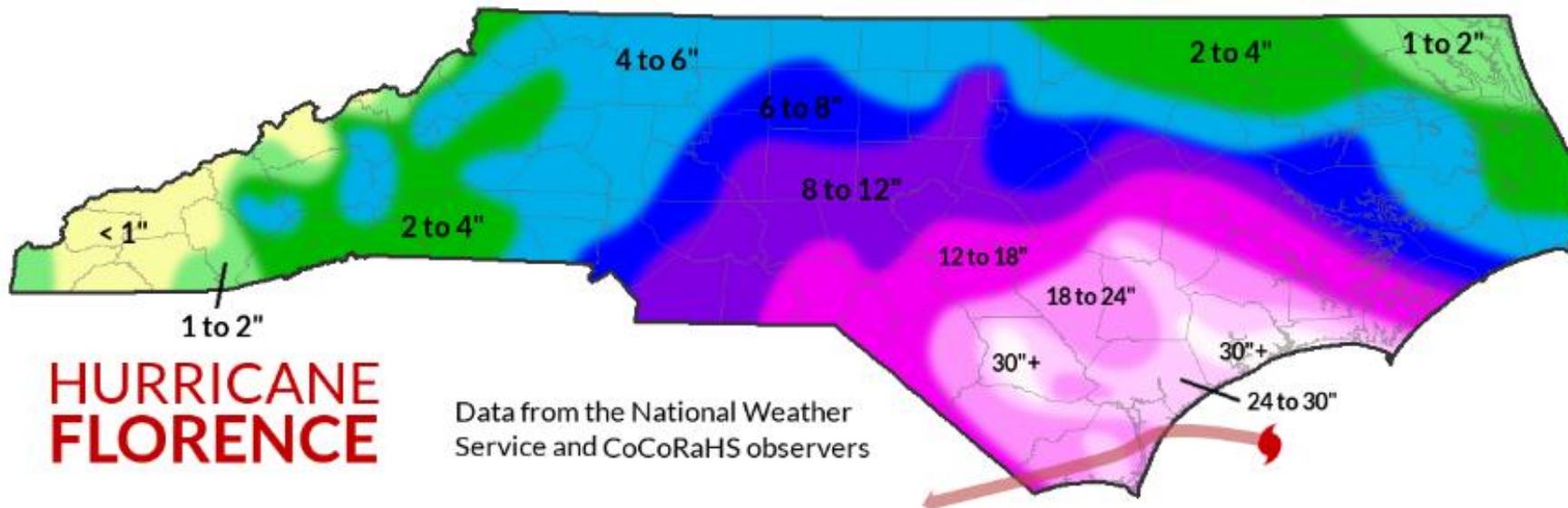
- 30”+ in portions of Onslow, Bladen, Pender, New Hanover, and Brunswick Counties
- Maximum wind gusts 105 mph in Wilmington
- Phenomenally accurate 5-day rainfall forecast with nearly 3’ of rain in portions of NC

PRELIMINARY RAINFALL



Total Precipitation (in.)

Sep. 13-17, 2018



HURRICANE FLORENCE

Data from the National Weather Service and CoCoRaHS observers

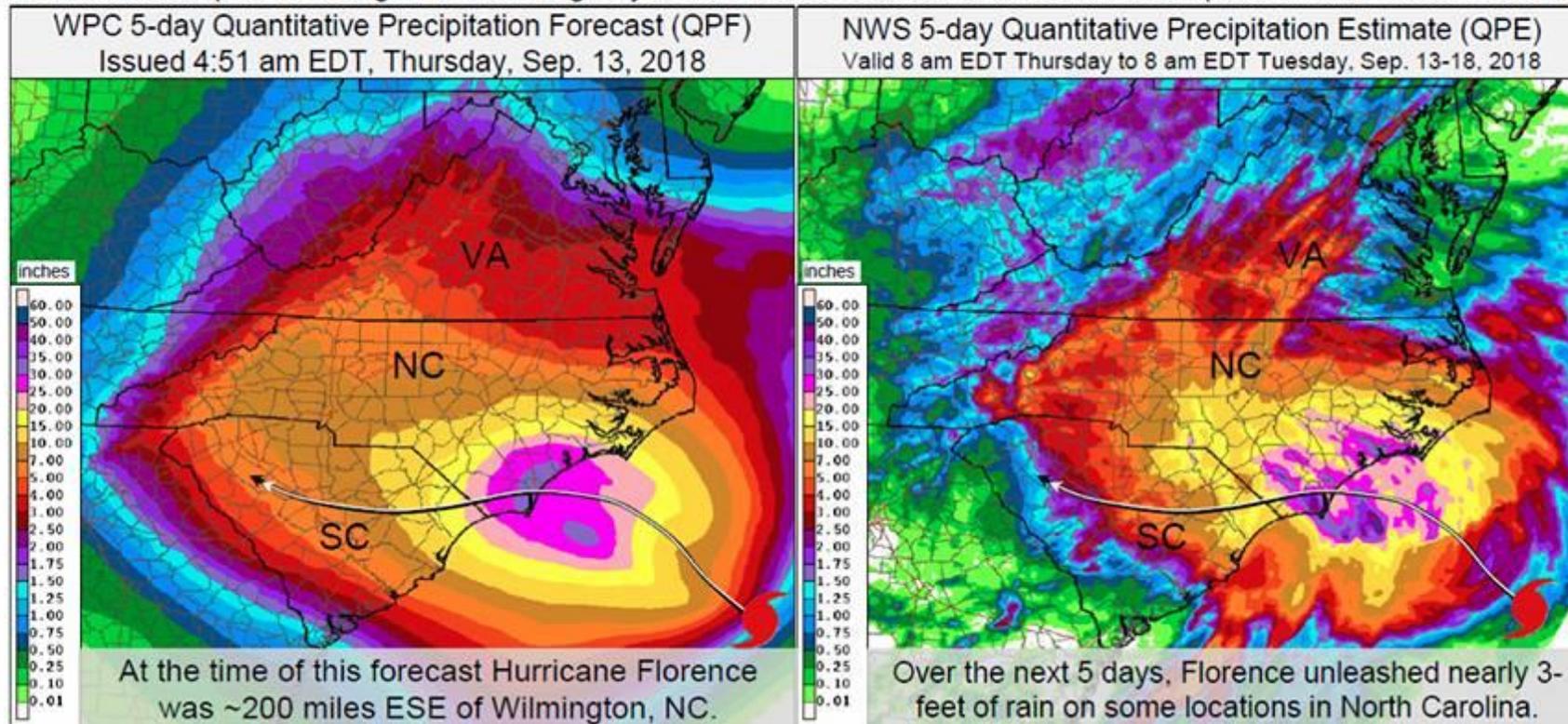
Total precipitation reported during Hurricane Florence.

FORECAST VS OBSERVED

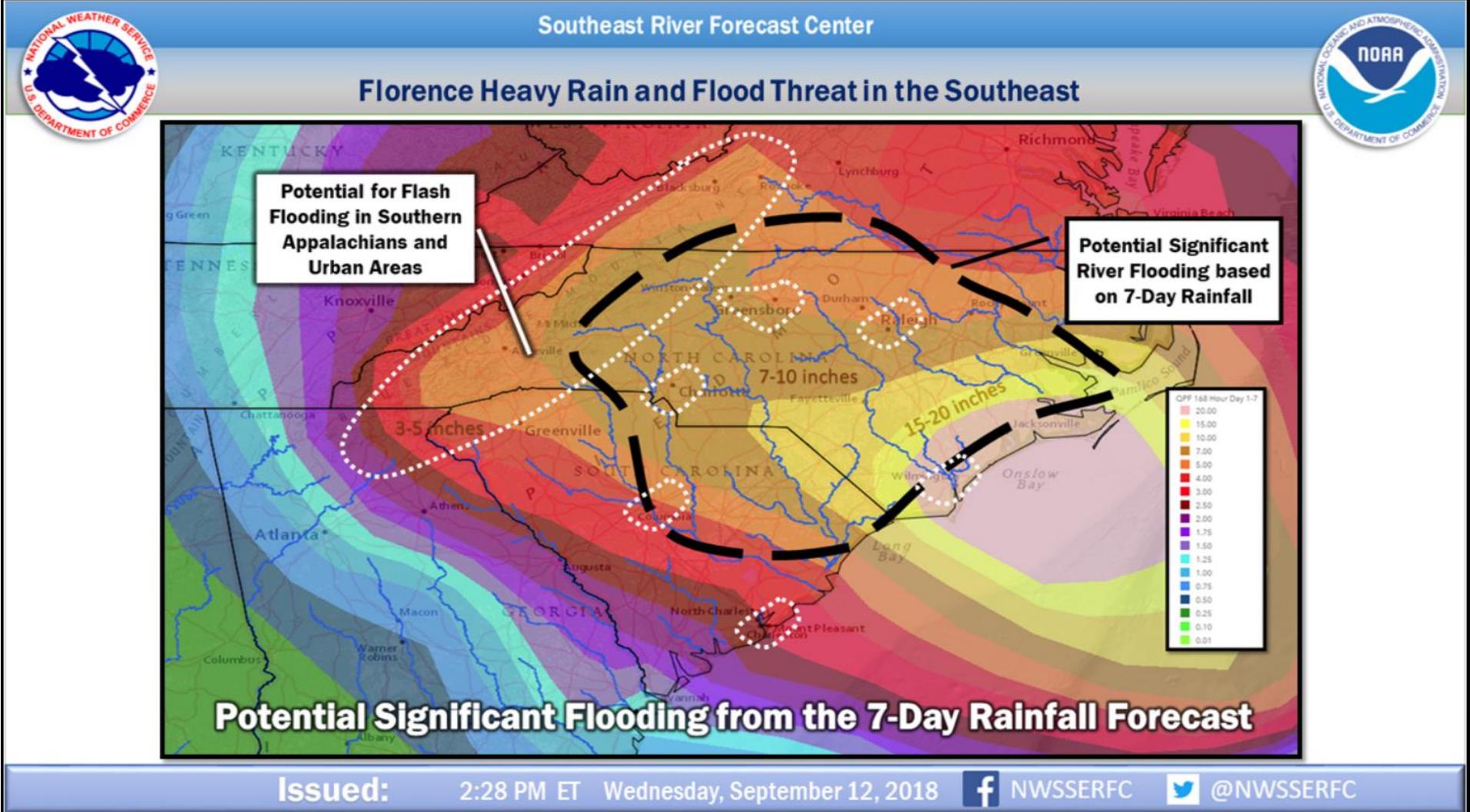


5-Day Forecast vs. Observed Rainfall

As Hurricane Florence approached the North Carolina Coast last Thursday, Sep. 13, 2018, the NWS was forecasting extreme rainfall and catastrophic flooding in the coming days. Here's a look at how the forecast compares with the estimated rainfall.



Cascading Effects



Source: NOAA





WRAL Weather

5 hrs • 🌐



Here's the flood information for the Cape Fear River at Fayetteville. The crest is expected on Monday with a level higher than what we saw with Matthew in 2016.
@WRALWeather



School Systems



Brunswick County Schools have placed dehumidifiers at Town Creek Elementary School and other facilities to ensure its schools are safe for students upon return. (Port City Daily photo/Courtesy Brunswick County Schools)



Hurricane Florence

Demographics Snapshot of Disaster-Impacted Counties	
Medicaid	<ul style="list-style-type: none">• 700,000 people enrolled in Medicaid• 30,000 children enrolled in CHIP
Uninsured	<ul style="list-style-type: none">• 13.1% uninsured (277,000)• Almost 45% of uninsured fall below 138% of poverty line
Disabled	<ul style="list-style-type: none">• 19% over the age of 18 (363,000)
Public Assistance	<ul style="list-style-type: none">• 17% of households receive FNS benefits (174,000)
Elderly	<ul style="list-style-type: none">• 16% over age of 65 (420,000)• 27% of households have at least one person over the age of 65 (270,000)

Table courtesy of the NC Department of Health and Human Services and the Governor's Office.

Hurricane Florence

Preliminary Damage and Needs Estimate (Millions)						
Category	Direct	Indirect/ Induced	Total Impact	Federal Funding	Private Funding	Unmet Impact
Health Care Facilities*	\$50.5	\$40.1	\$90.6	\$0.0	\$72.5	\$18.1
Public Health	\$8.5	\$0.0	\$8.5	\$5.6	\$0.0	\$2.9
Social Services	\$29.0	\$0.0	\$29.0	\$18.4	\$0.0	\$10.6
Health Needs	\$104.4	\$0.0	\$104.4	\$52.8	\$0.0	\$51.6
Subtotal	\$192.4	\$40.1	\$232.5	\$76.8	\$72.5	\$83.2
Resiliency efforts	\$0.0	\$0.0	\$0	\$0.0	\$0.0	\$0
Total	\$192.4	\$0.0	\$232.5	\$76.8	\$72.5	\$83.2

**Note: Figure only includes estimates to private hospitals, and doesn't include health care safety net sites in impacted counties (rural health centers, free and charitable clinics, small rural hospitals, critical access hospitals, and school-based health centers).*

Table courtesy of the NC Department of Health and Human Services and the Governor's Office.





Cape Fear Strong 2

Share



Cape Fear Strong 2

Share

Waffle House Index

The **Waffle House Index** is an informal [metric](#) used by the [Federal Emergency Management Agency](#) (FEMA) to determine the effect of a storm and the likely scale of assistance required for disaster recovery.^[1]

Levels

The index has three levels, based on the extent of operations and service at the restaurant following a storm:^{[2][3]}

GREEN: full menu - restaurant has power and damage is limited or no damage at all.

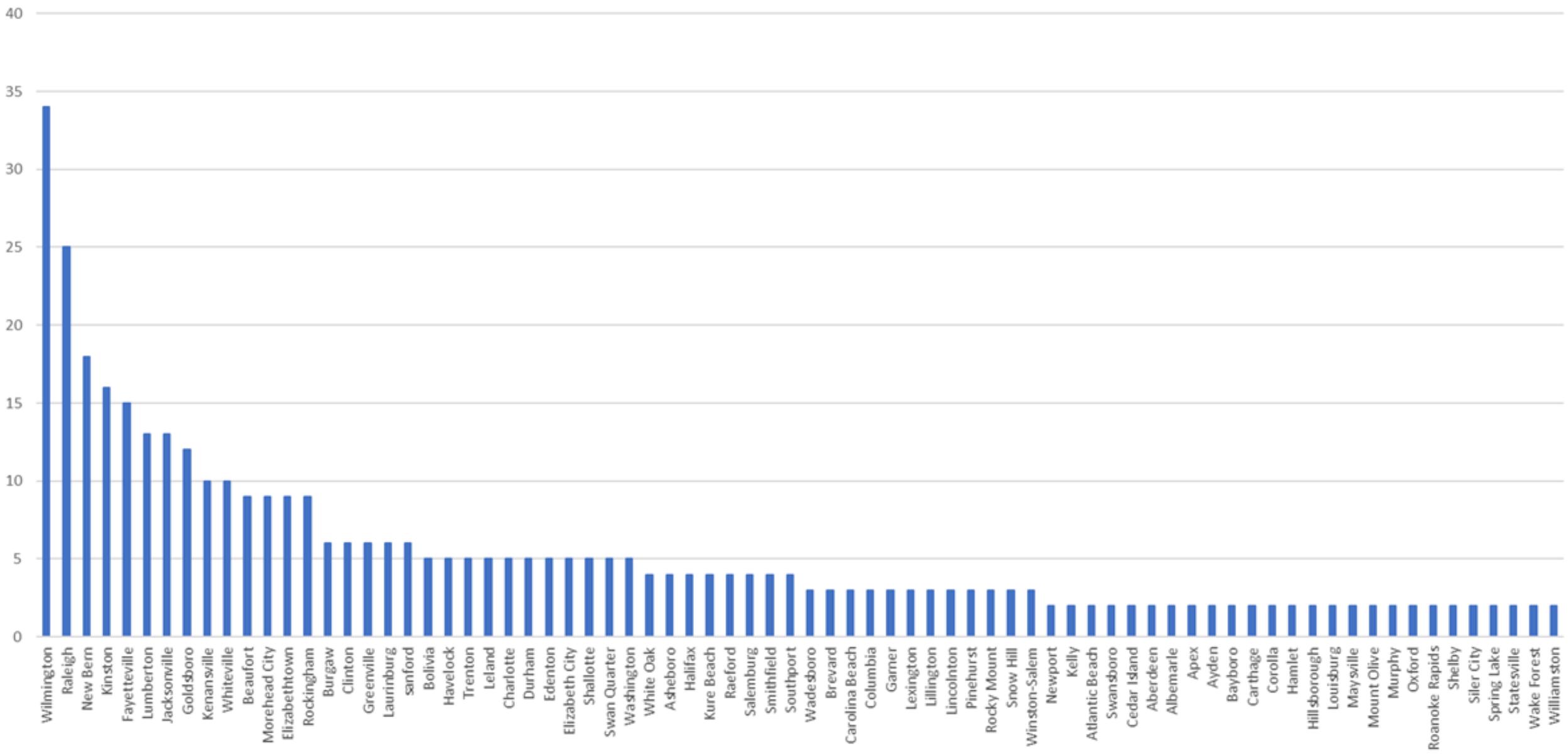
YELLOW: limited menu - no power or only power from a generator, or food supplies may be low.

RED: the restaurant is closed - indicating severe damage or severe flooding

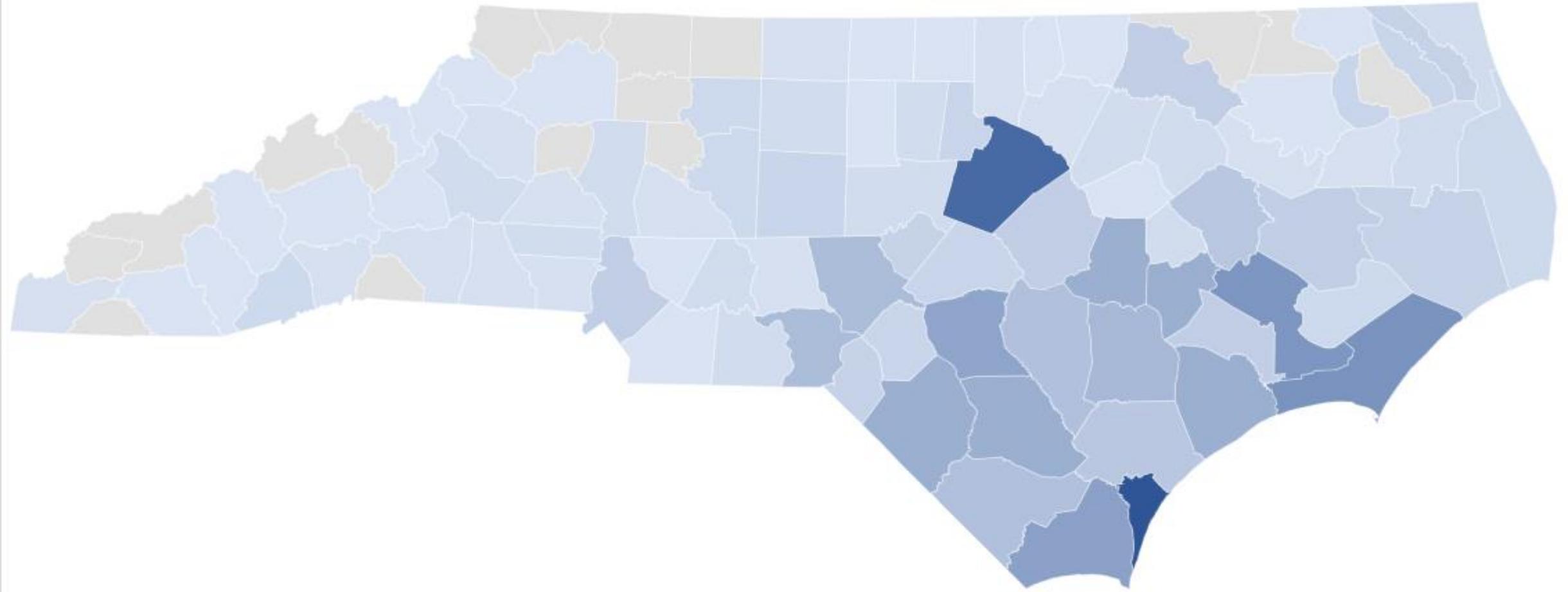
Source: Wikipedia



NC Cities with 2 or More Sites Impacted



Counties with Sites Impacted

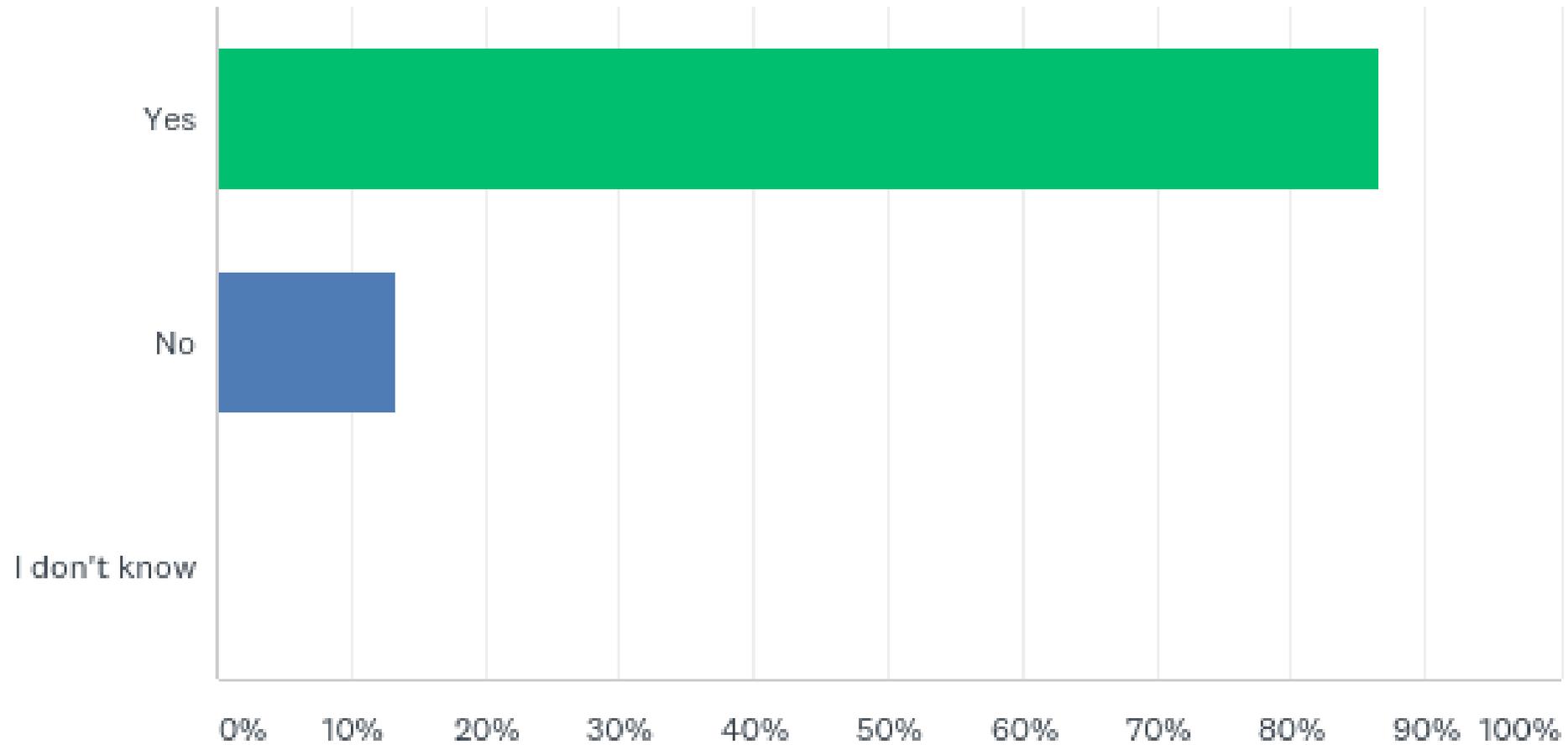


Lightning Poll Results

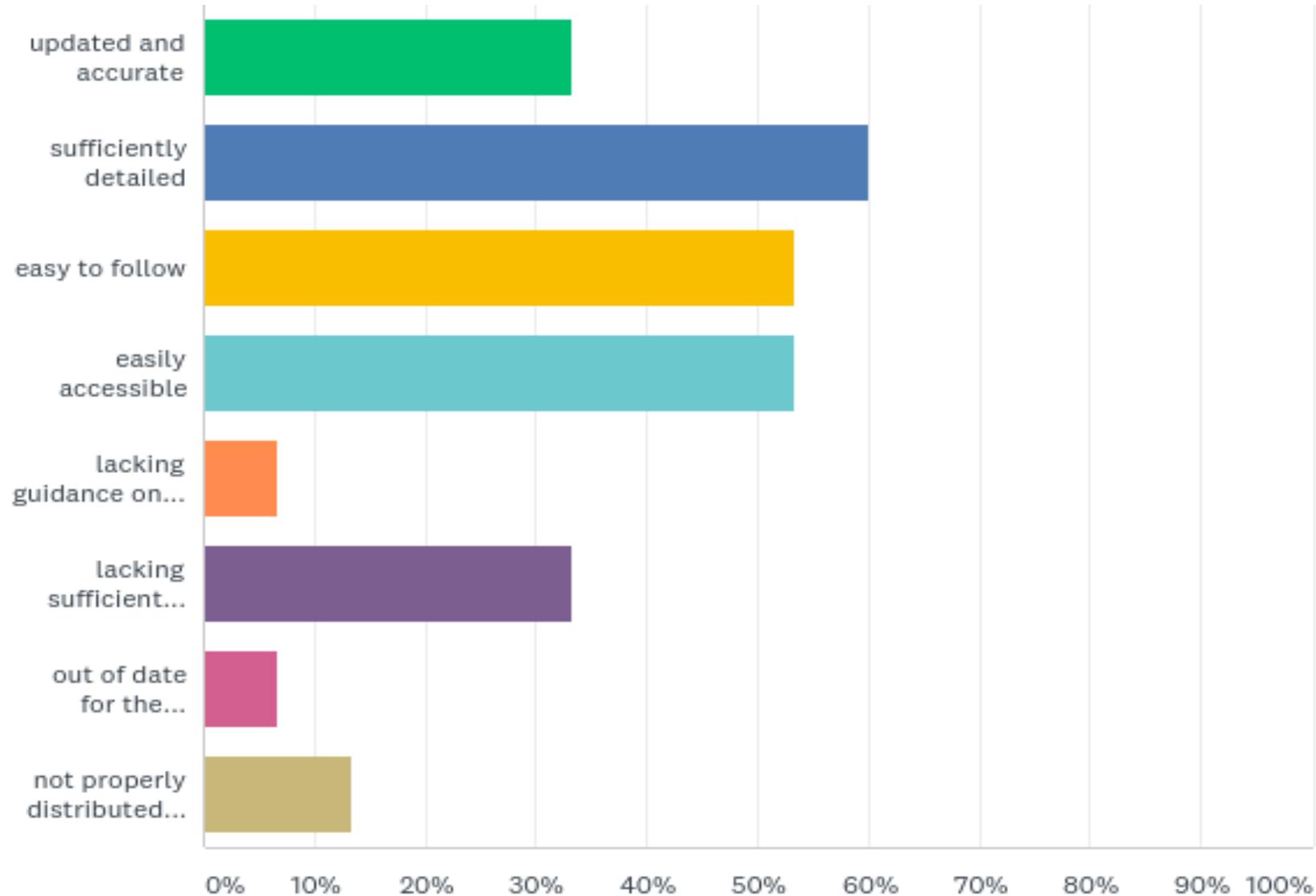
October 16th



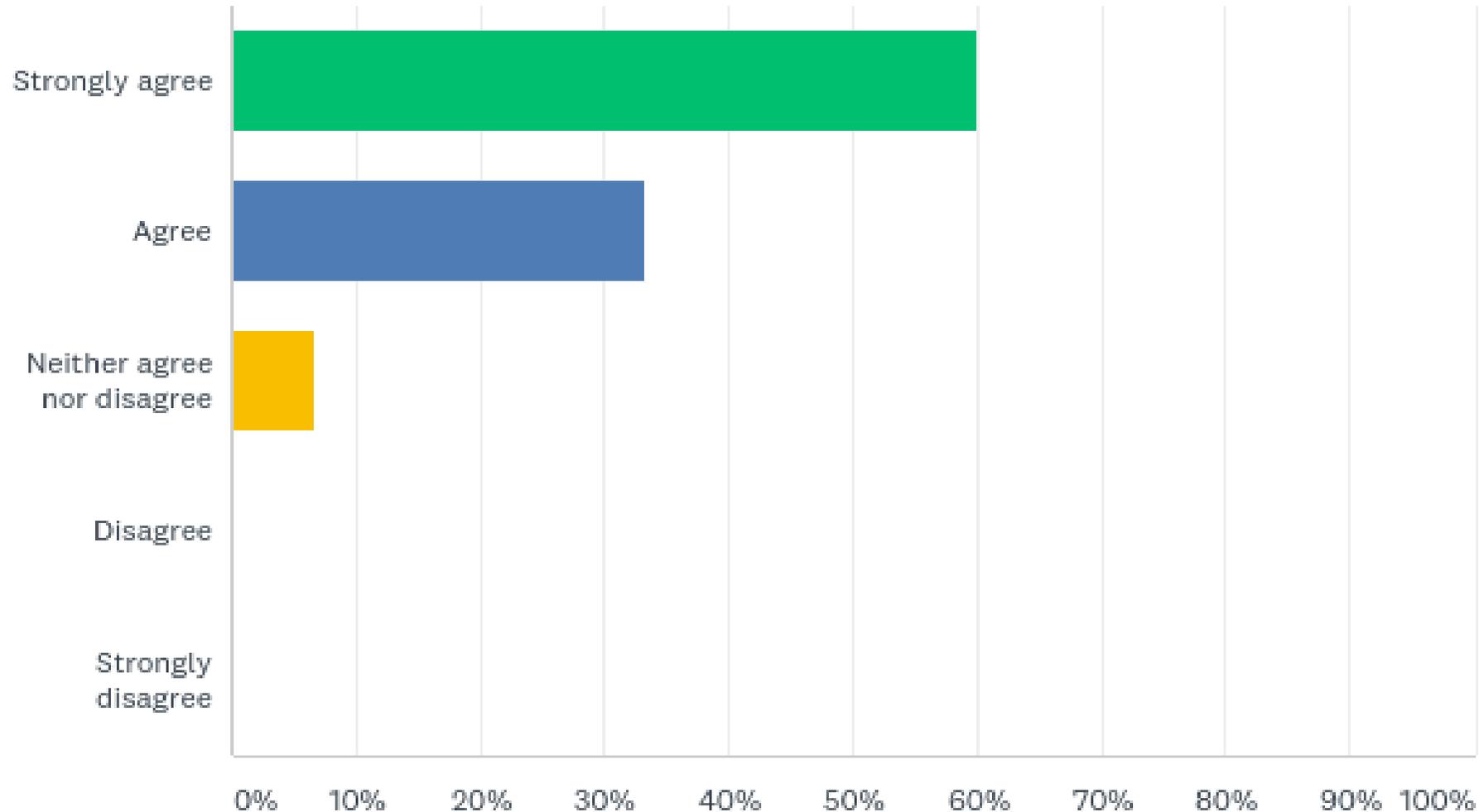
Our organization activated portions of or all of our Business Continuity (BC) / Disaster Recovery (DR) / Continuity of Operations (COOP) Plan(s).



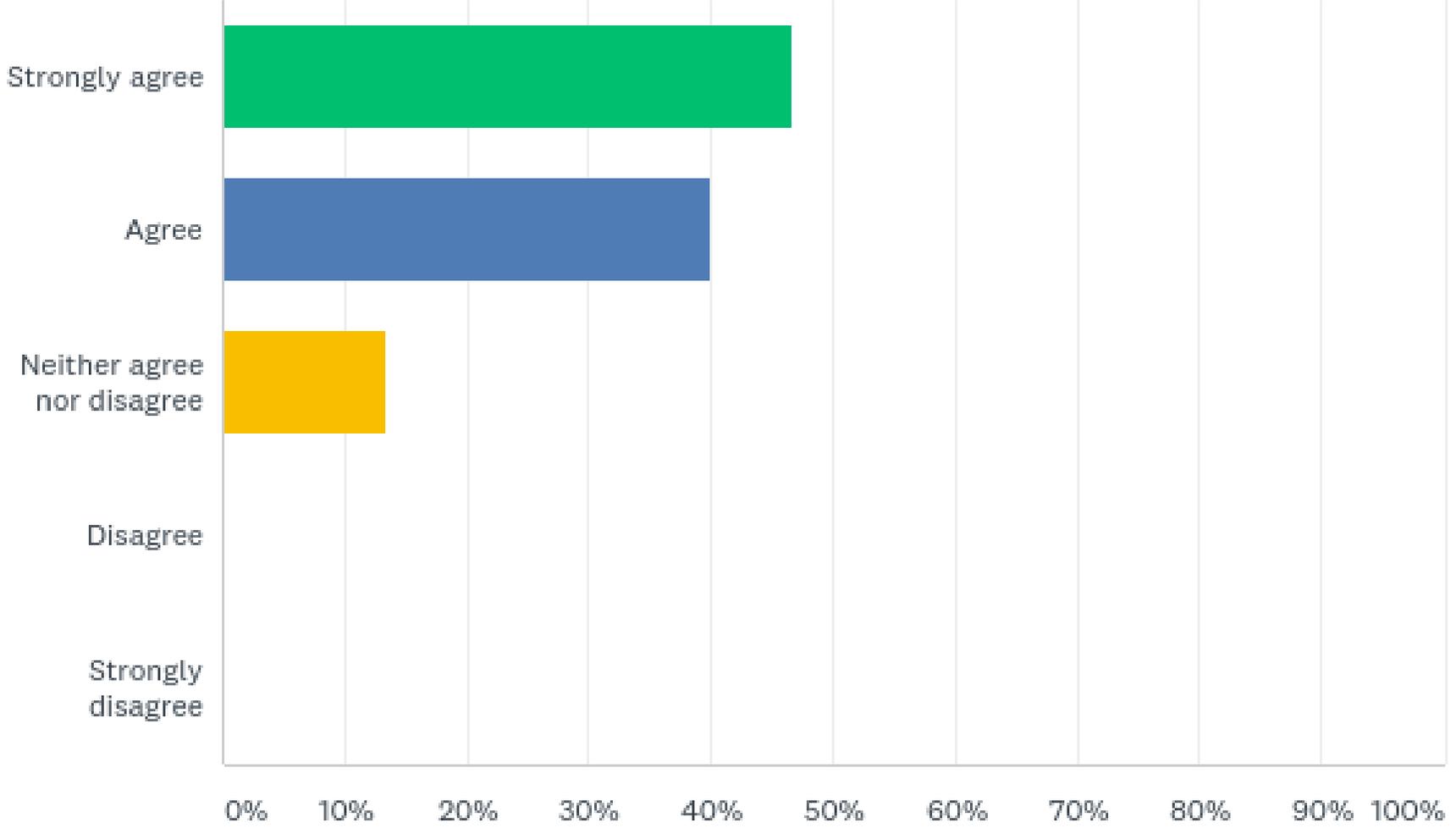
Our Plan was (select all that apply)



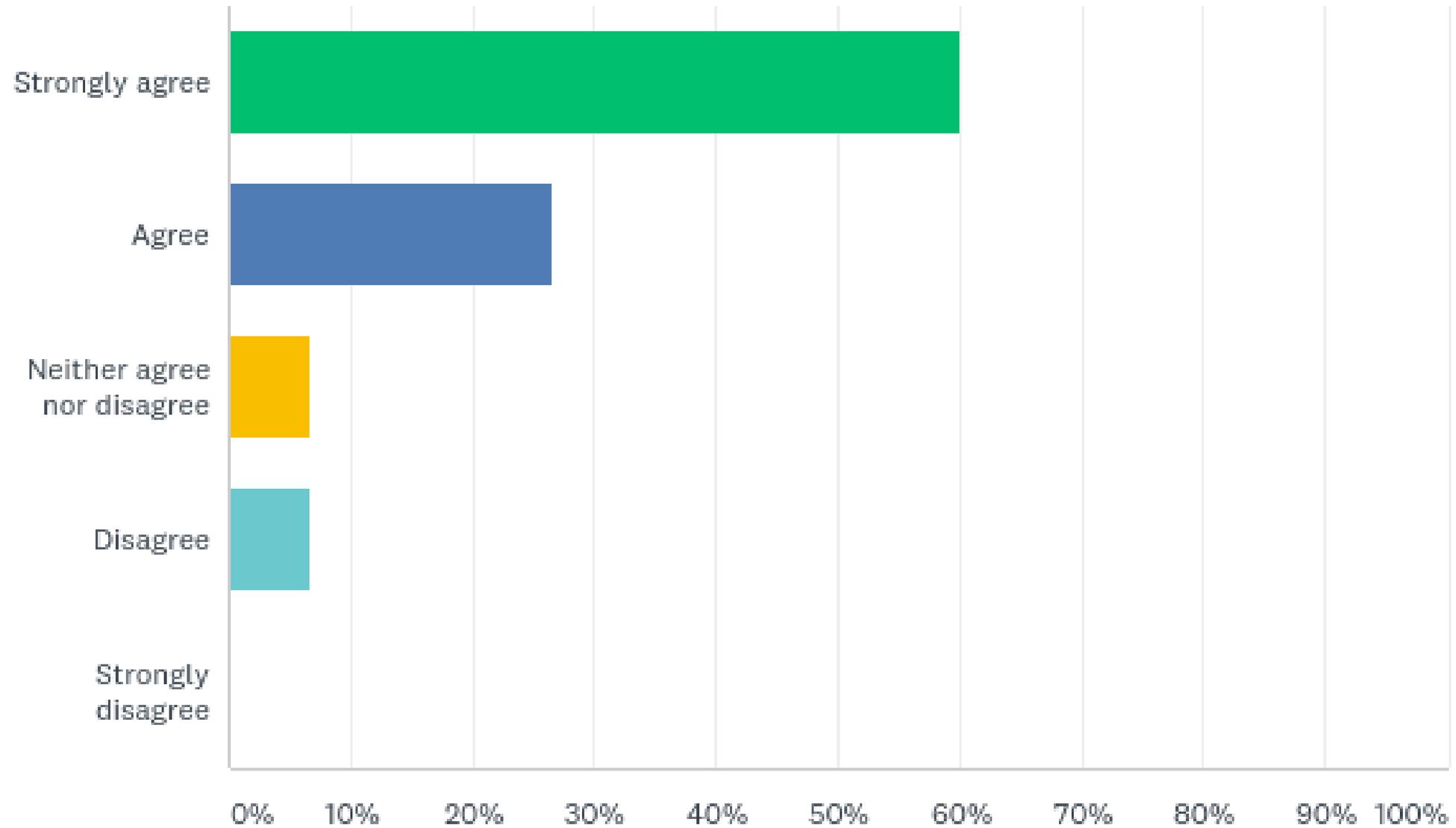
Contact information for key resources is accurate and up-to-date in our Plan



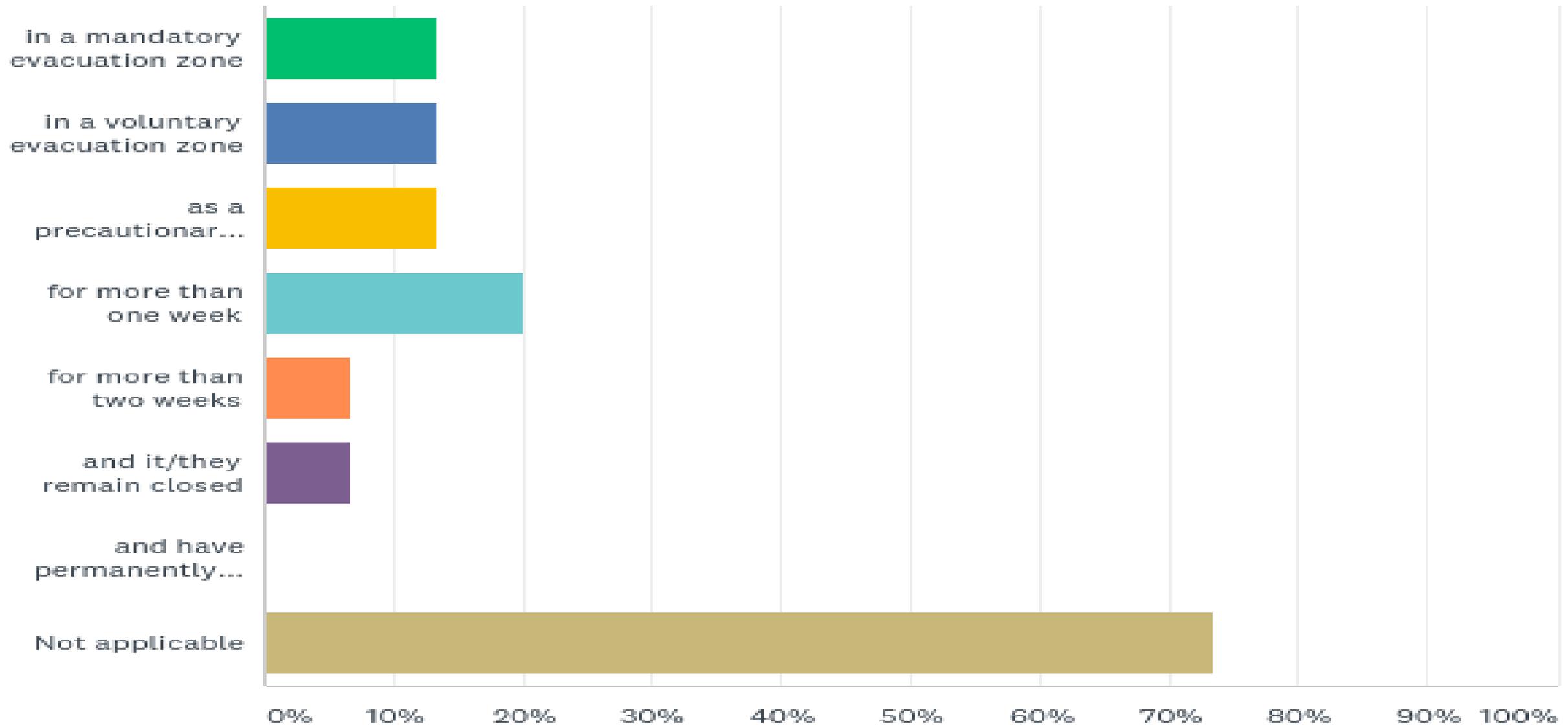
Our communication strategies were effective



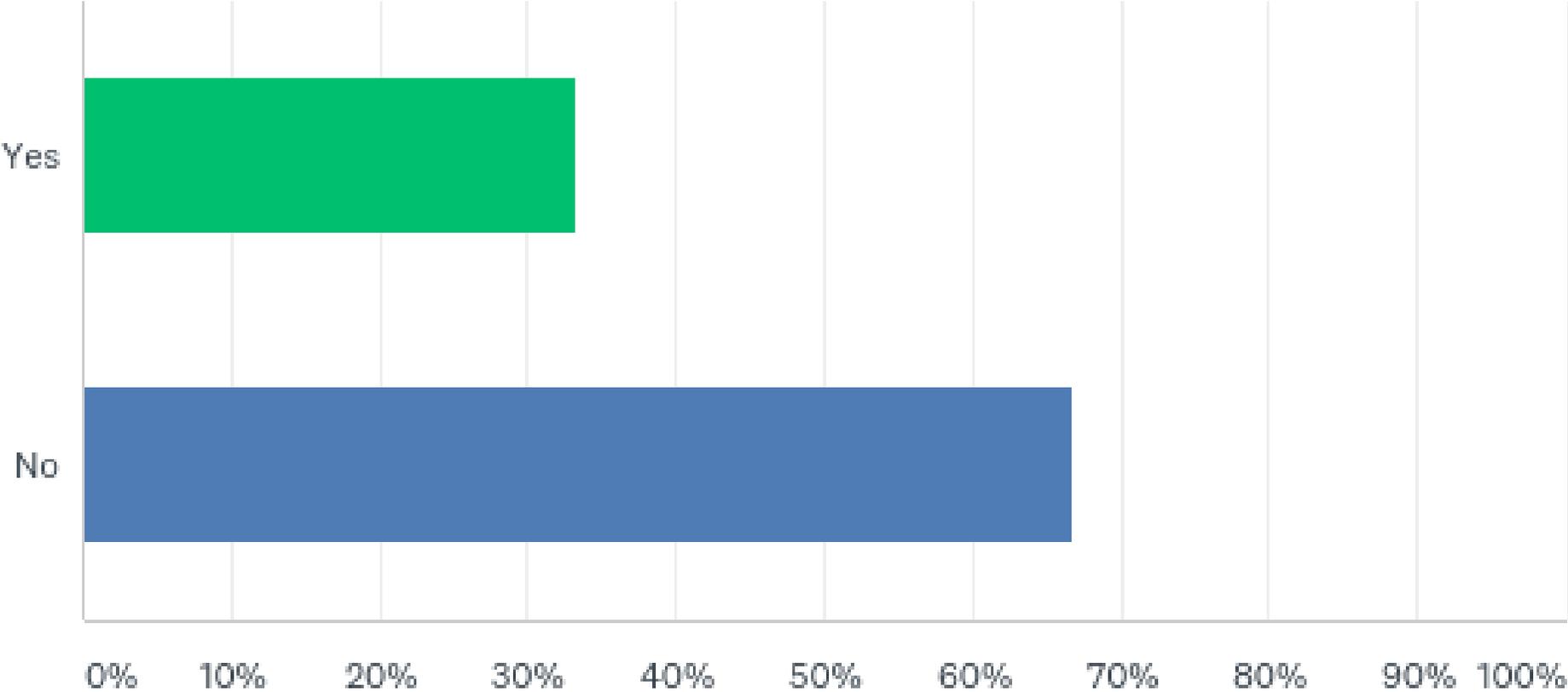
We are confident in our ability to send messages



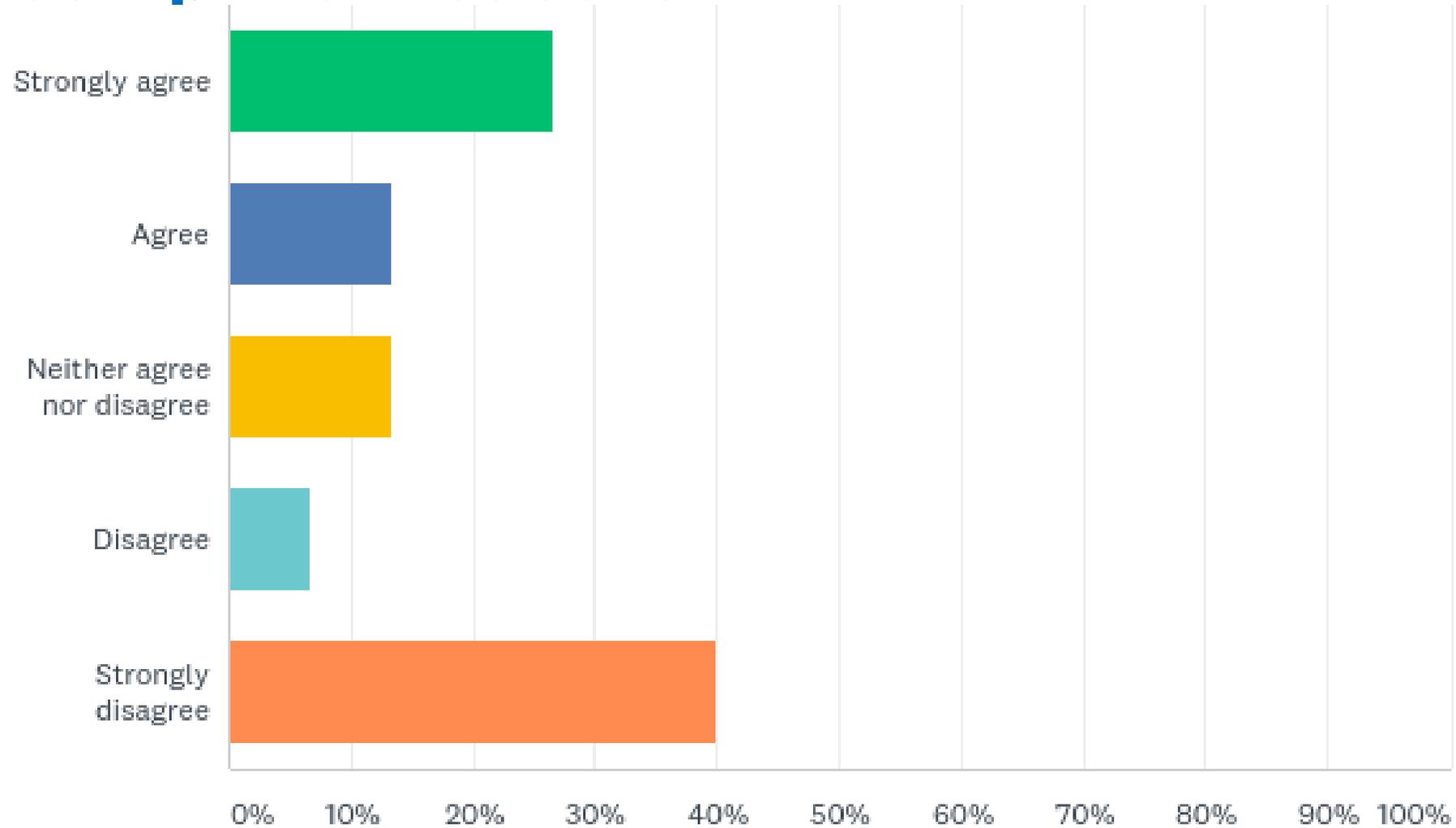
We closed one or more offices....



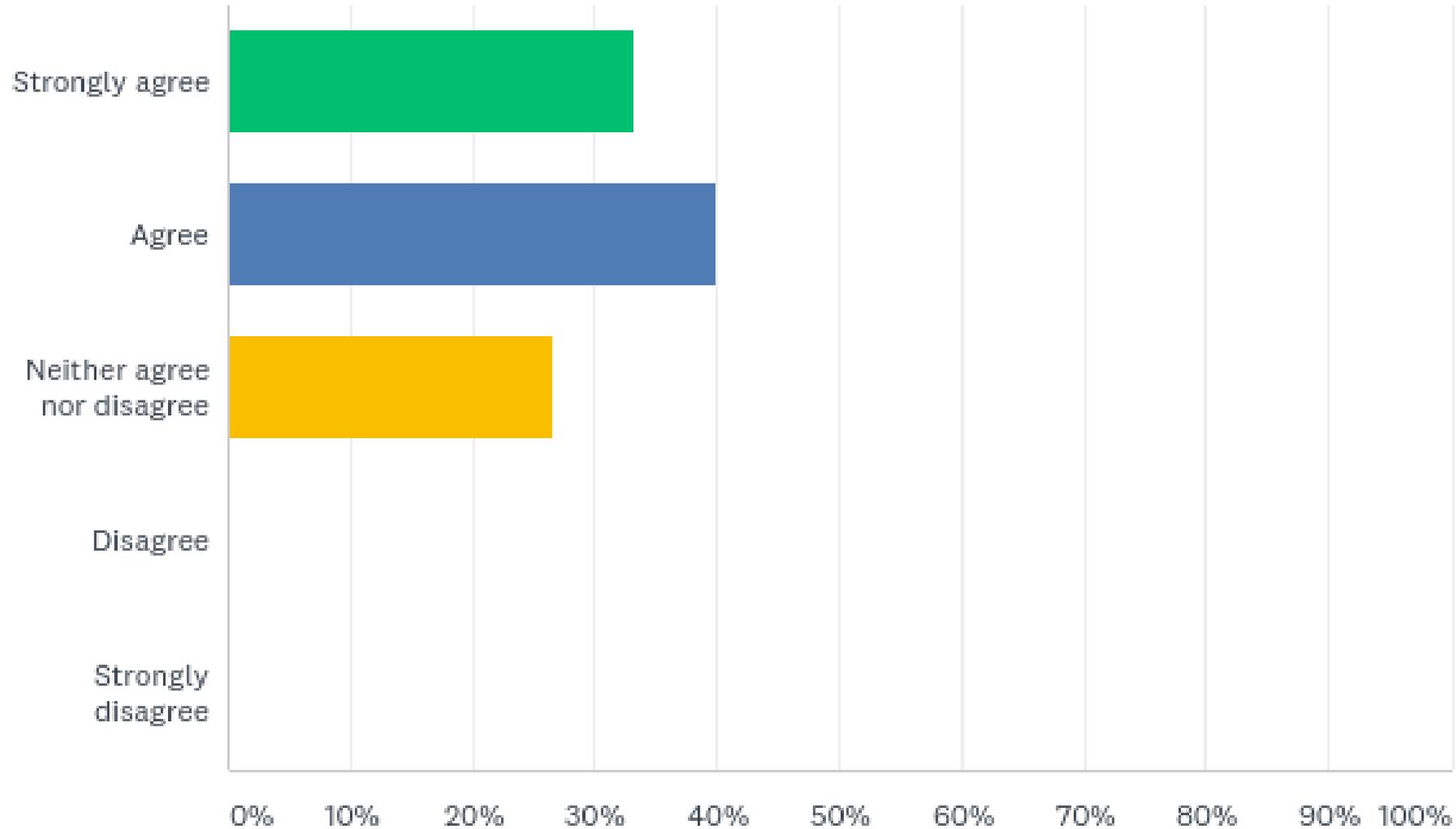
Some or all of our employees reported to a temporary alternate work location



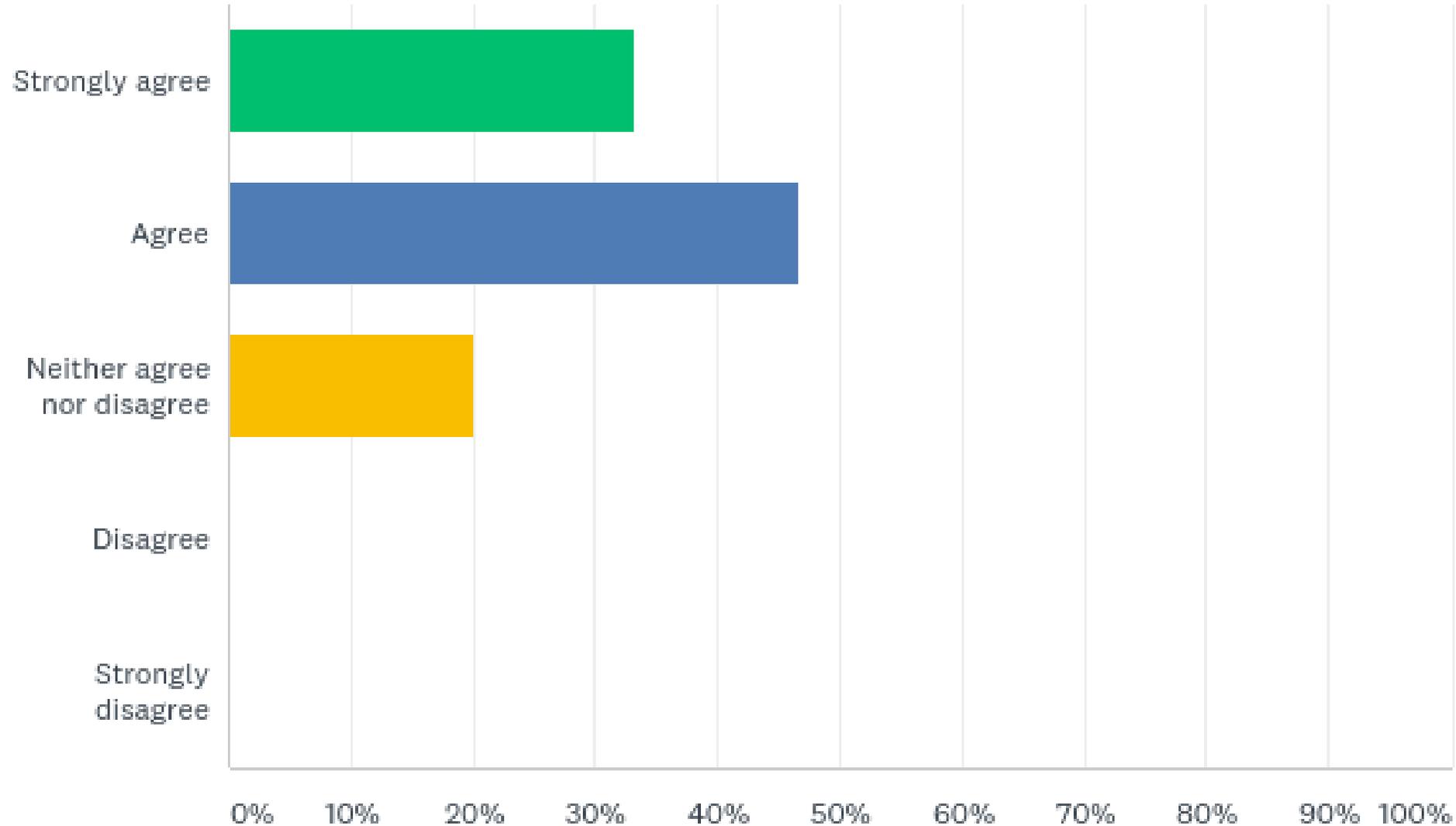
We powered down critical equipment as a preemptive measure



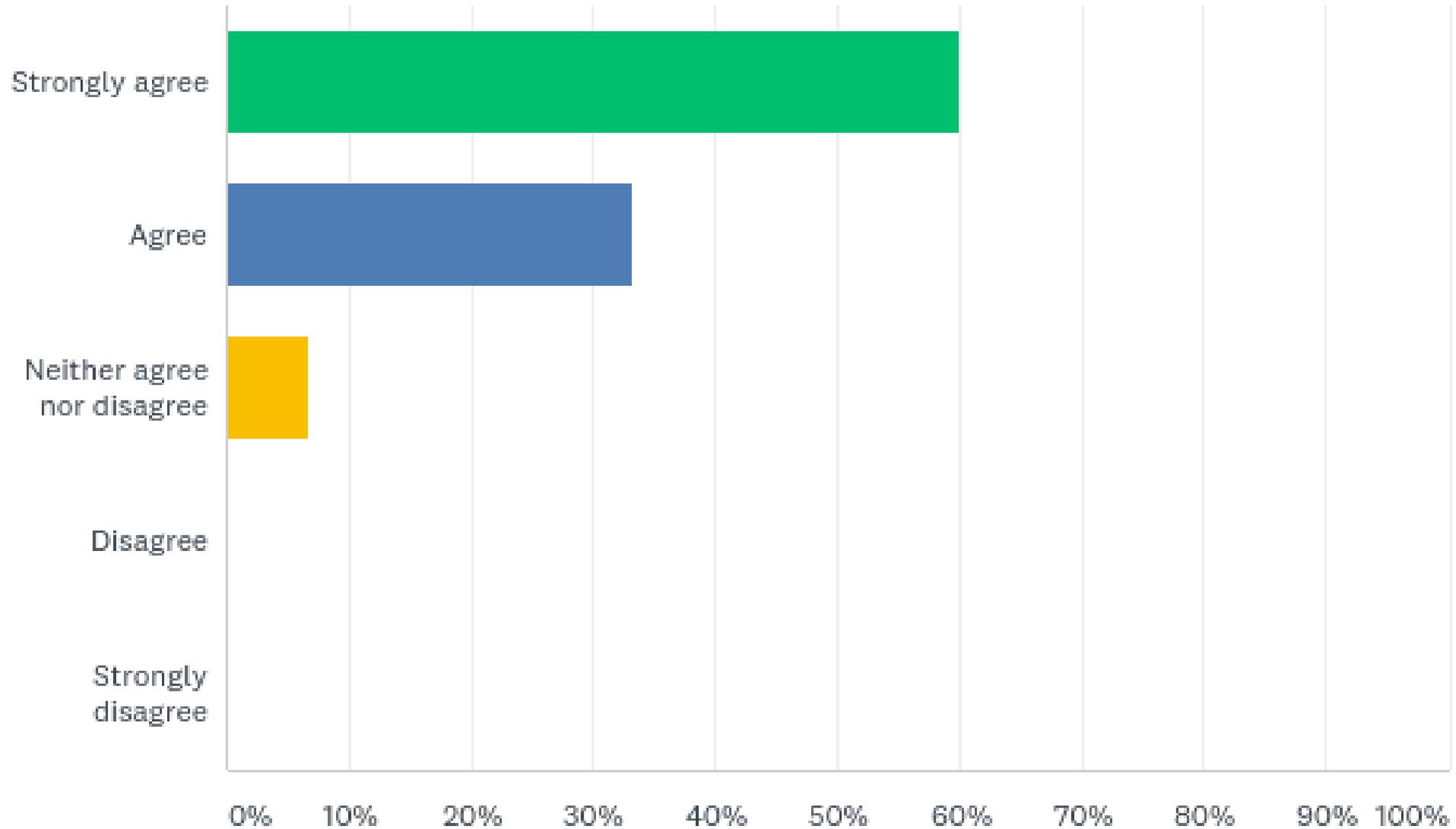
Our BC/DR/COOP Plan(s) improved our response / recovery confidence



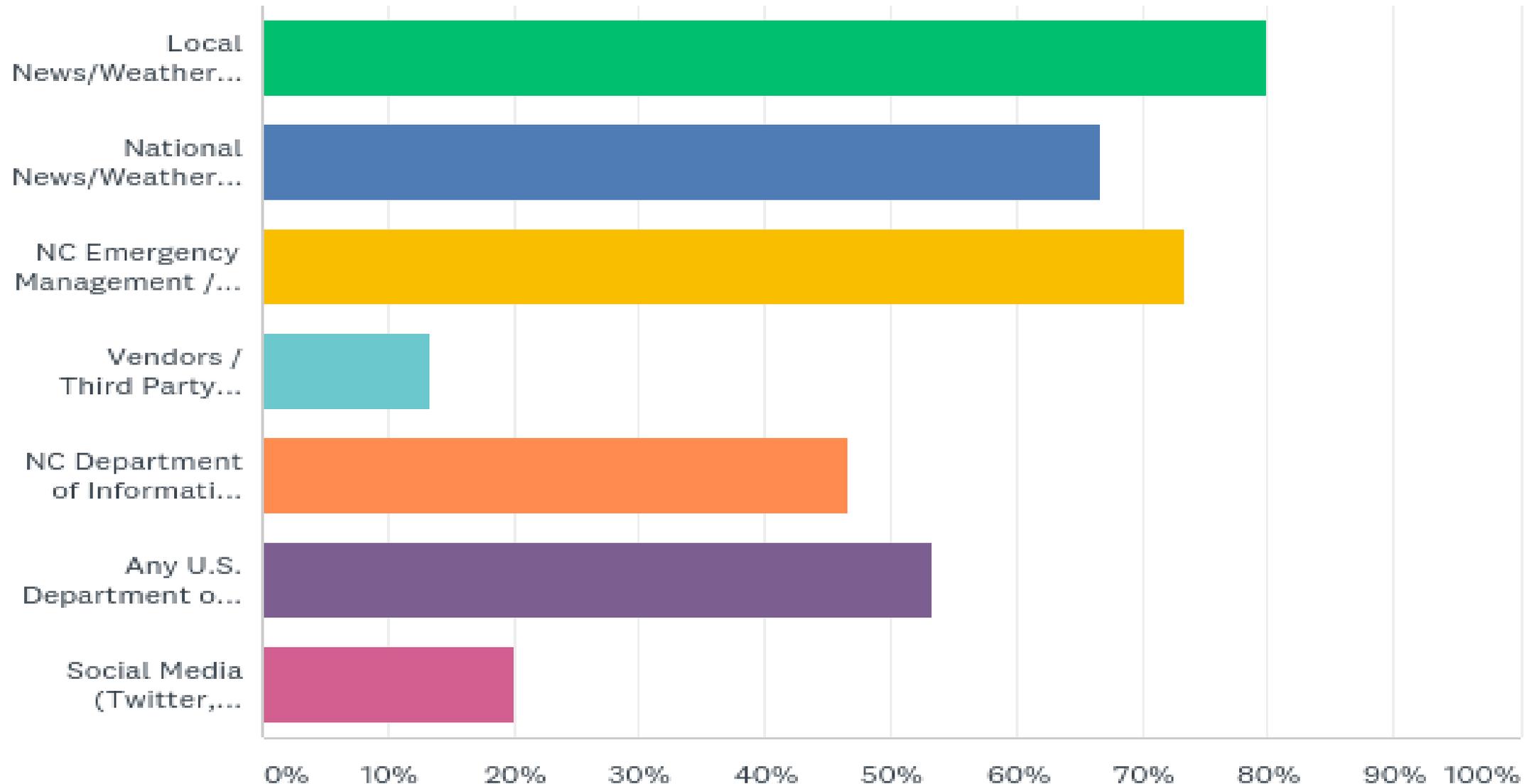
We had a better picture of what was at risk based on the contents of our Plan



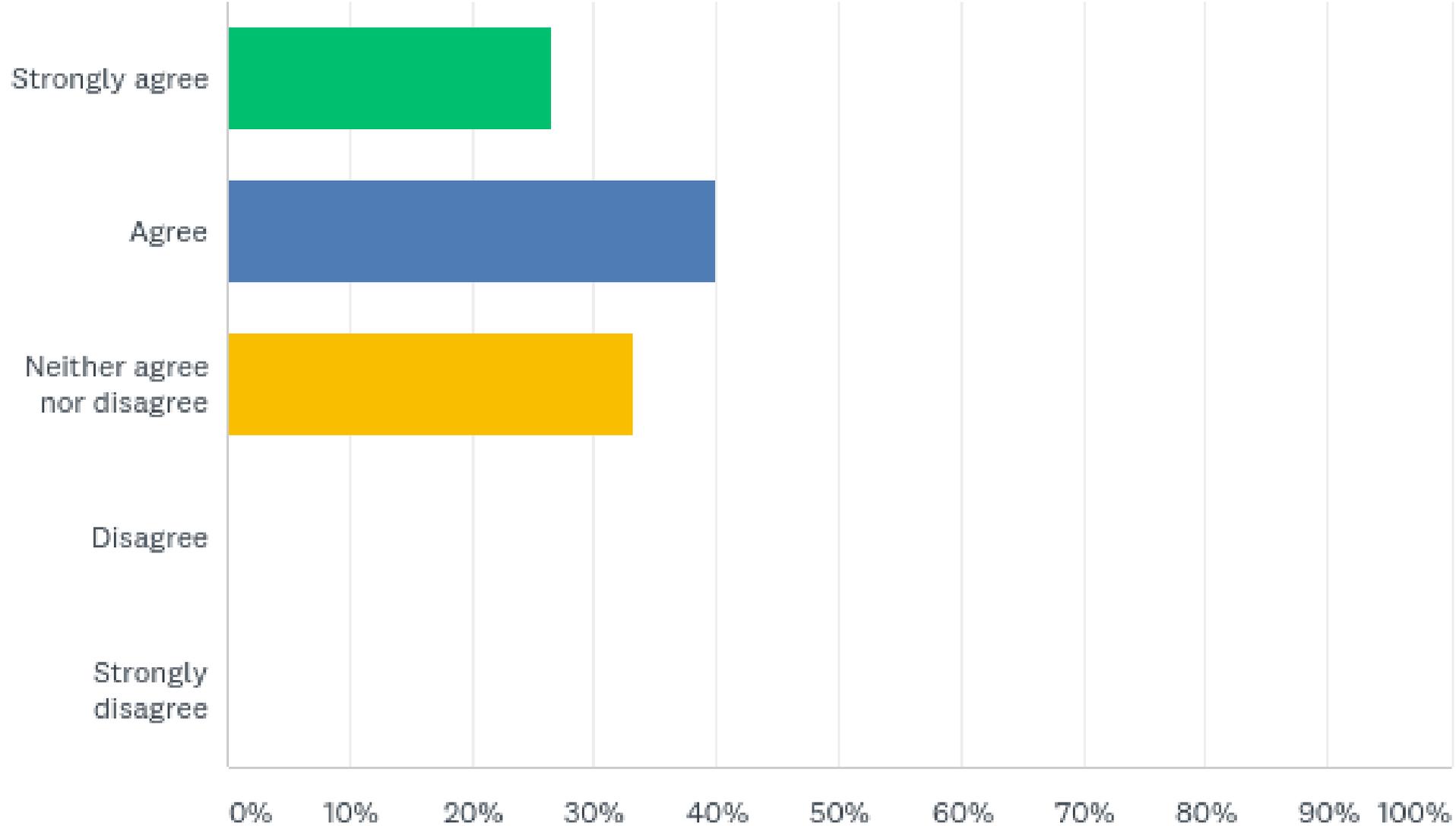
Our organization has returned to normal operations



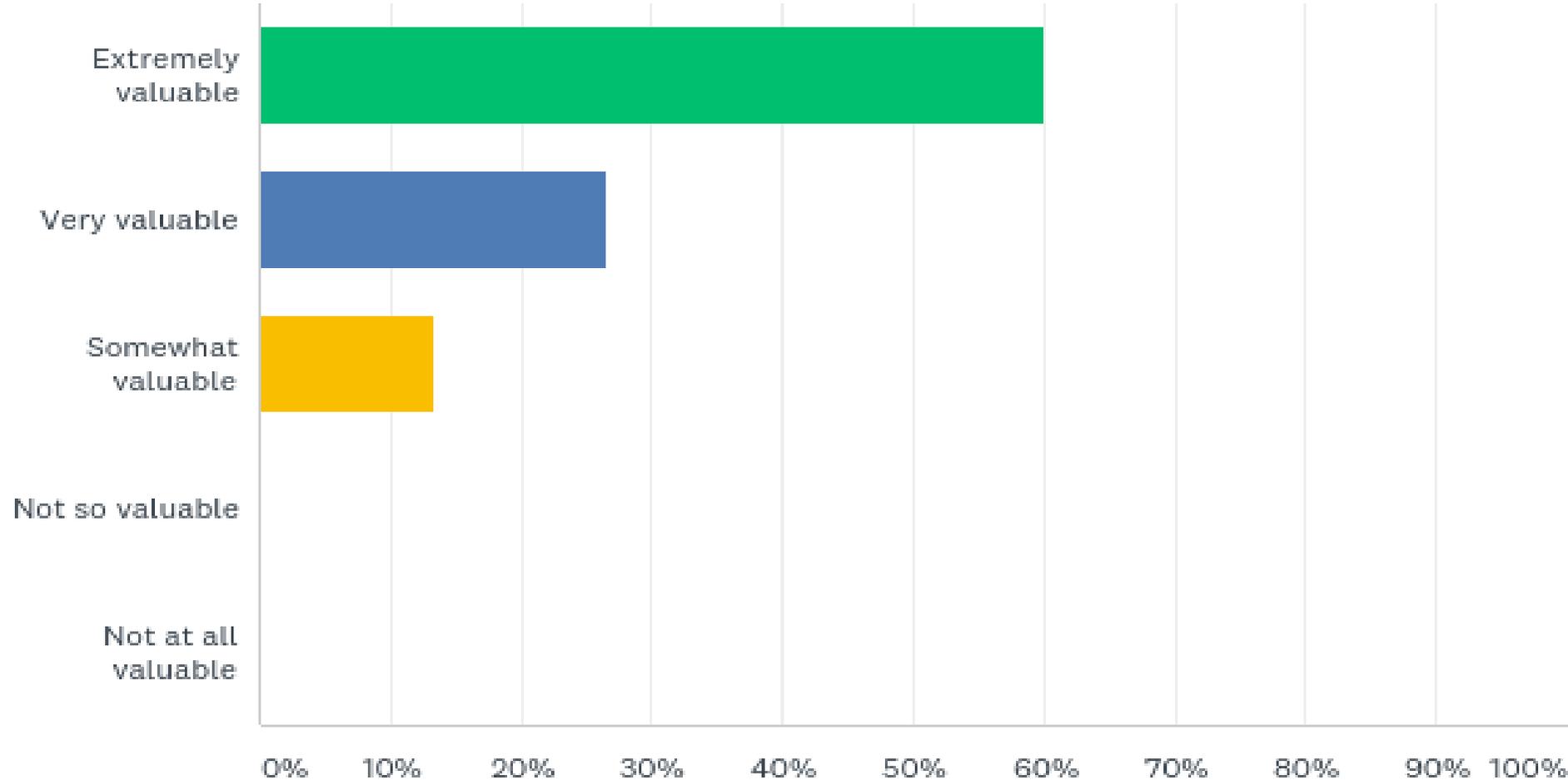
Which of the following sources does your agency rely on / trust for situational awareness communications?



We identified areas for improvement in our Plan



Conducting a post-event hot wash/briefing, evaluating procedures, documenting an After-Action Report, and incorporating lessons learned into our Plan(s) is _____ to our agency



Q & A



Let's Connect!



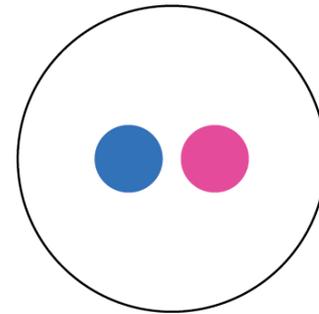
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**NC Department
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