

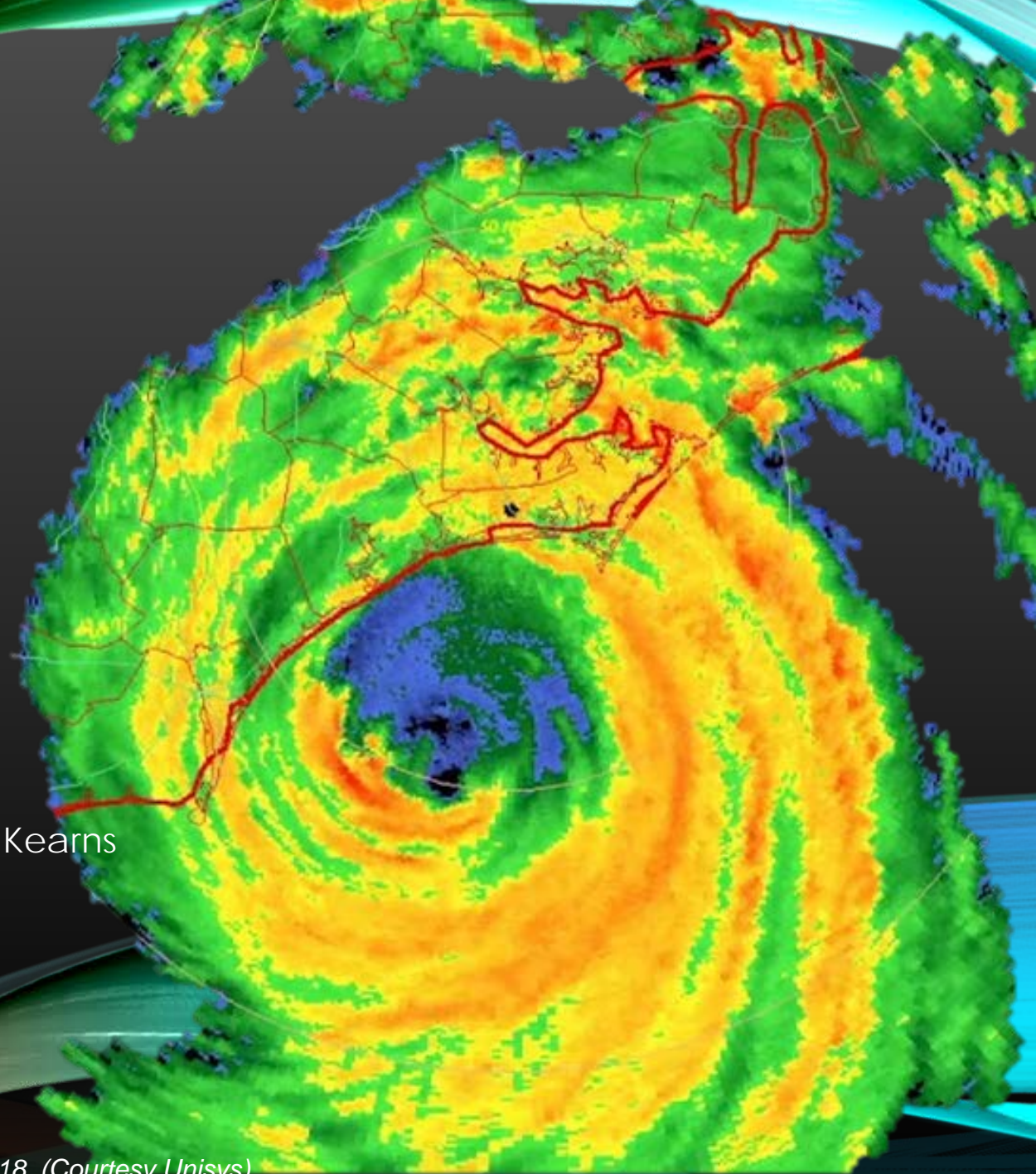
COMMUNICATING FLOOD RISK DURING HURRICANE FLORENCE

Belkys Melendez, Sarah Jamison¹, Katie Edwards² and Shane Kearns

National Weather Service, Newport/Morehead City

¹ National Weather Service, Cleveland, OH

² National Weather Service Headquarters, Silver Spring, MD



Eye of Hurricane Florence approaching the Wilmington area early Friday September 14, 2018. (Courtesy Unisys)

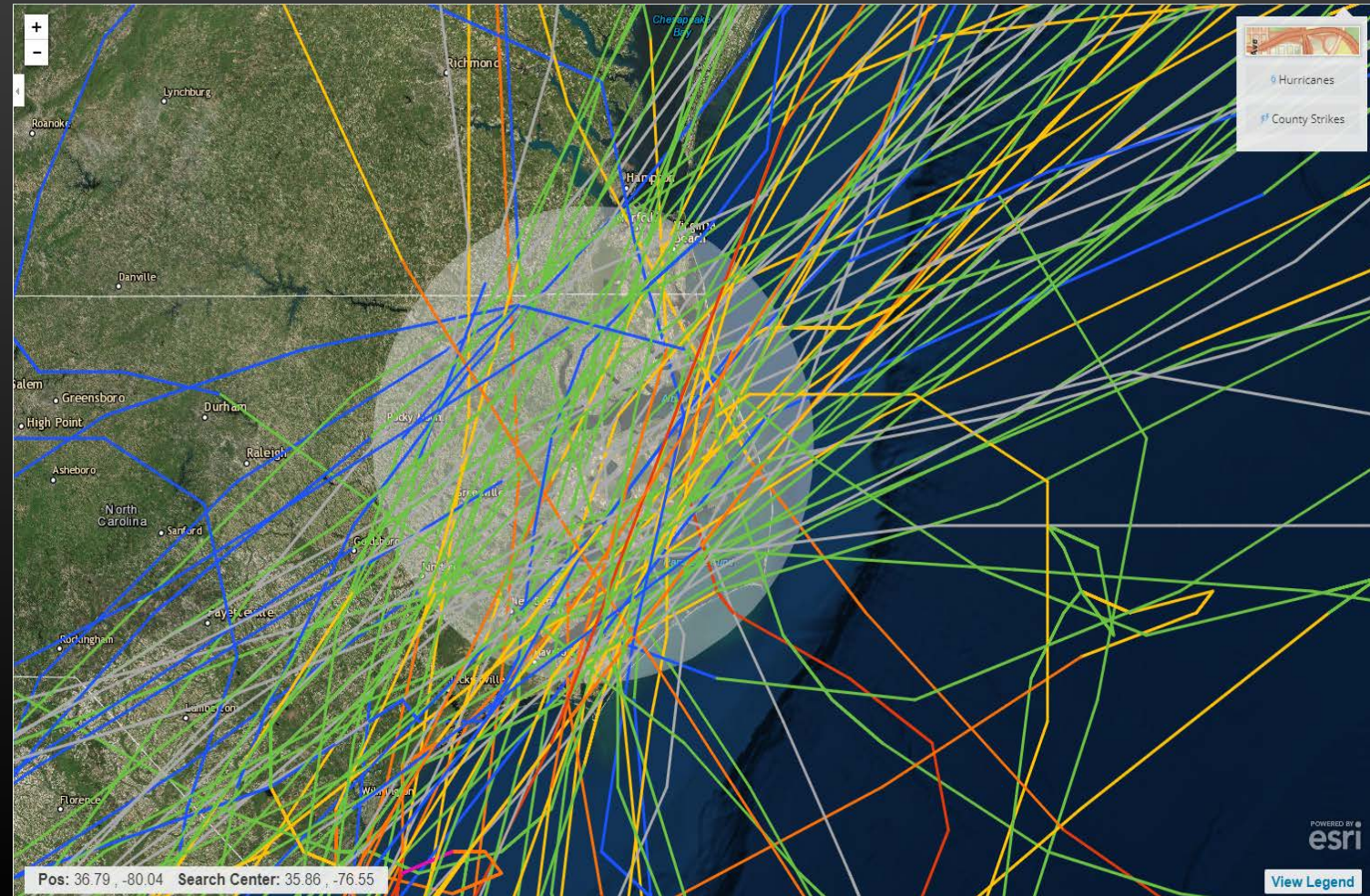
NC HURRICANE HISTORY

- NC is in the Top 5 for the most tropical cyclone.

1950-2010 Hurricane Climo

- **Direct Landfall:** 83 (total)
-1 storm every 2 years.
- **Indirect:** 299 (within 150 miles)

Florence was a unique storm even for Hurricane prone North Carolina





National Weather Service Newport/Morehead City, NC



Time Issued: 5:00 PM Thursday September 6th, 2018

Prepared by: Erik Heden/Shane Kearns

Situational Awareness Overview For Hurricane Florence

Overview: Hurricane Florence now situated over the central Atlantic, will continue to move west-northwest through this weekend. There is much uncertainty as to where Florence will track after this weekend, and if any impacts will be felt along the North Carolina coast.

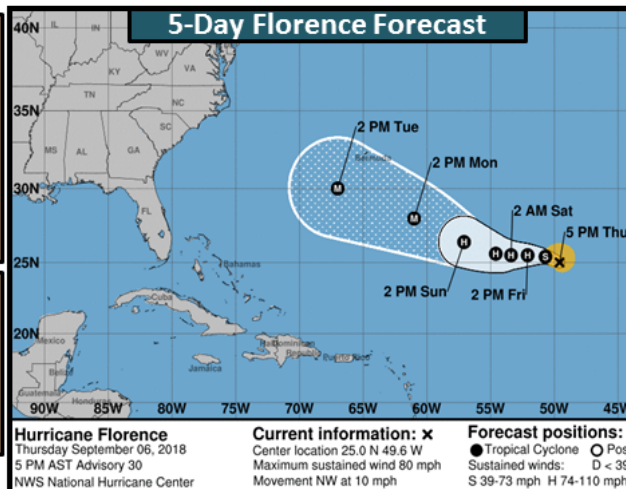
Impacts: Too early to detail any potential direct impacts. However, rough surf and dangerous rip currents are likely beginning late this weekend

Timing: If the storm does impact the North Carolina coast, it would be around the middle of next week.



Key Points

- Too early to determine track but never too early to go over your hurricane plan.
- Monitor trusted, official sources of information through the weekend.
- Next briefing on Friday



Before the Storm



US National Weather Service Newport/Morehead City NC

Published by Sean Bandy [?] · September 9, 2018 ·

9/9/18 600 PM Update

Life threatening impacts from Florence including storm surge at the coast and inland freshwater flooding are increasing

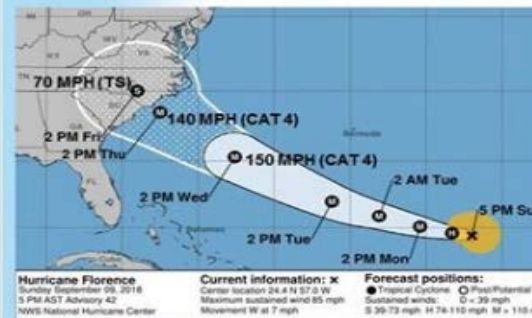
Remember the forecast cone shows the most probable path for the center of the storm but impacts will occur well away from the center. While uncertainty still exists in the track, the risk for Florence to be a major hurricane (CAT 3 or higher) when it makes landfall is increasing.
... See More



NATIONAL WEATHER SERVICE



Situational Overview Hurricane Florence



- Florence continues to strengthen, now up to 85 MPH winds
- Forecast landfall would be sometime Thursday afternoon or Friday as a major hurricane
- The window for ensuring you are prepared is getting smaller.

NOTE: Do not focus on the exact track. Impacts can occur well outside the area enclosed by the cone.

Weather Forecast Office
Morehead City, NC

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9/9/2018 5:57 PM



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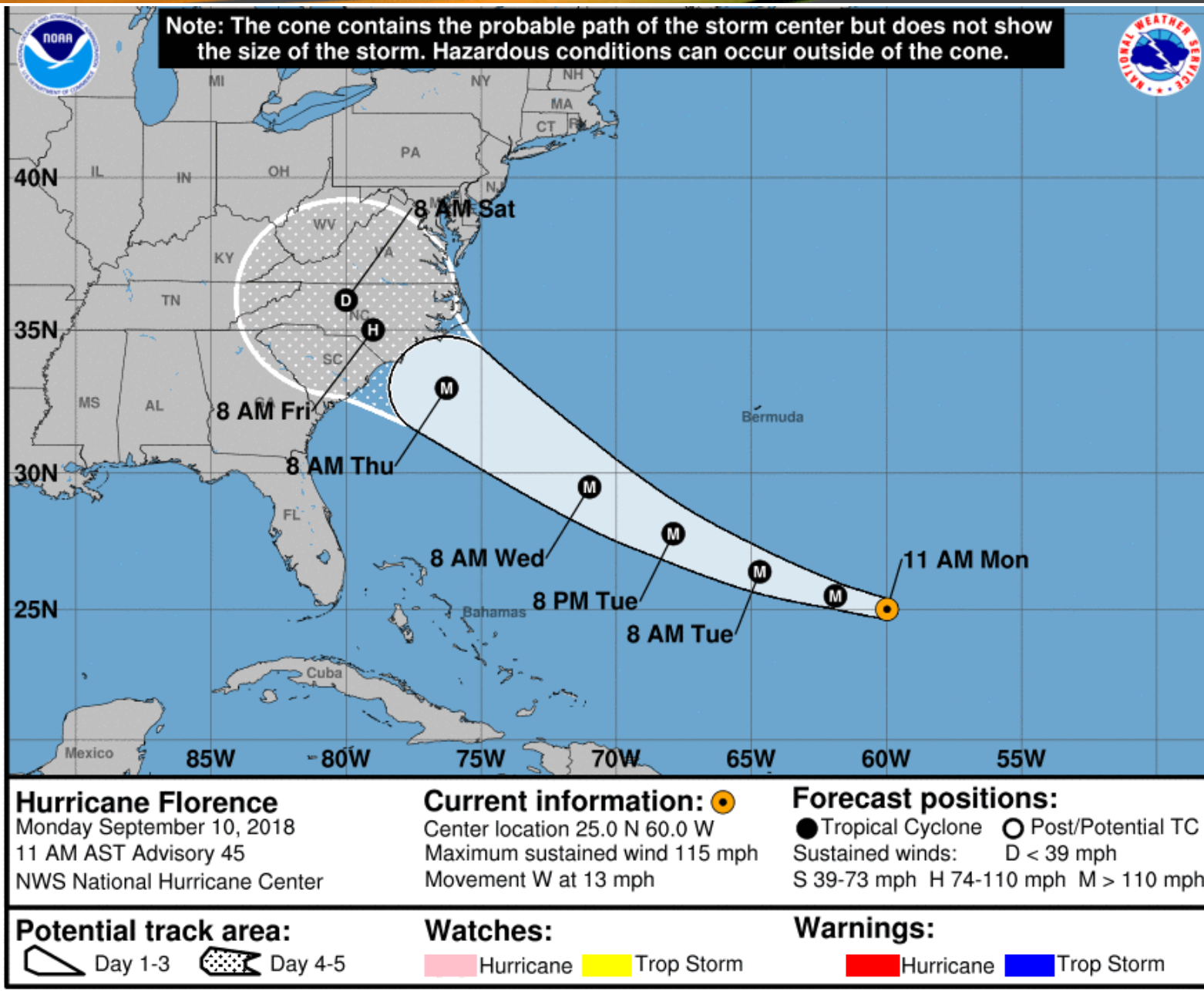


fb.com/NWSMoreheadCity



[@NWSMoreheadCity](https://twitter.com/NWSMoreheadCity)

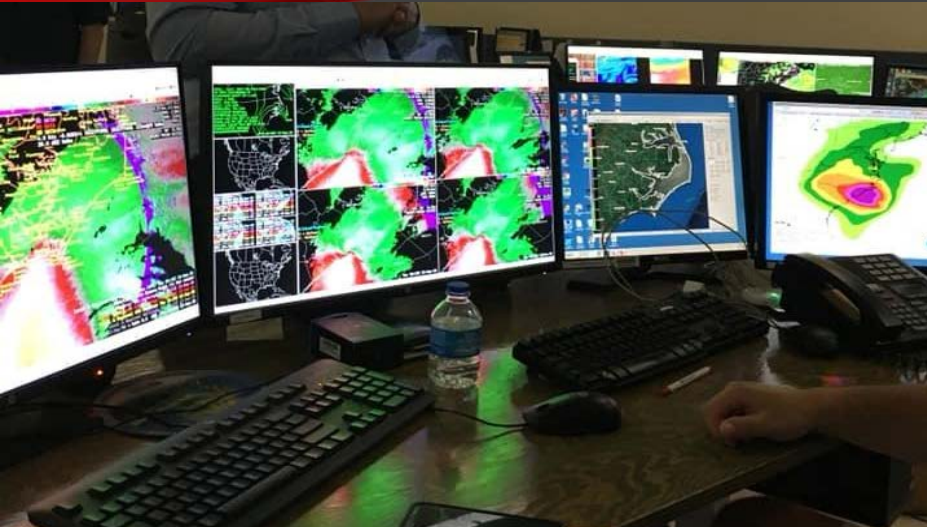
For the latest updates, please visit our website and social media outlets:



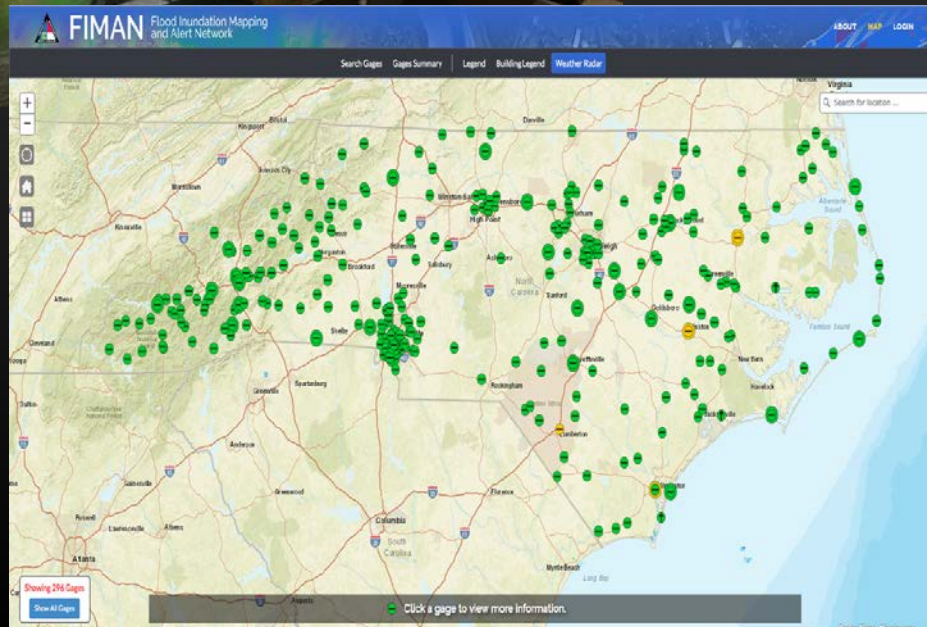
NHC ADVISORY

- Florence strengthened rapidly on September 10, becoming a Cat 4 with max sustained winds of 130 mph.
- Major hurricane status triggered voluntary evacuations along the Outer Banks.
- September 11, 2018, mandatory evacuation orders.

FLOOD PARTNER COORDINATION

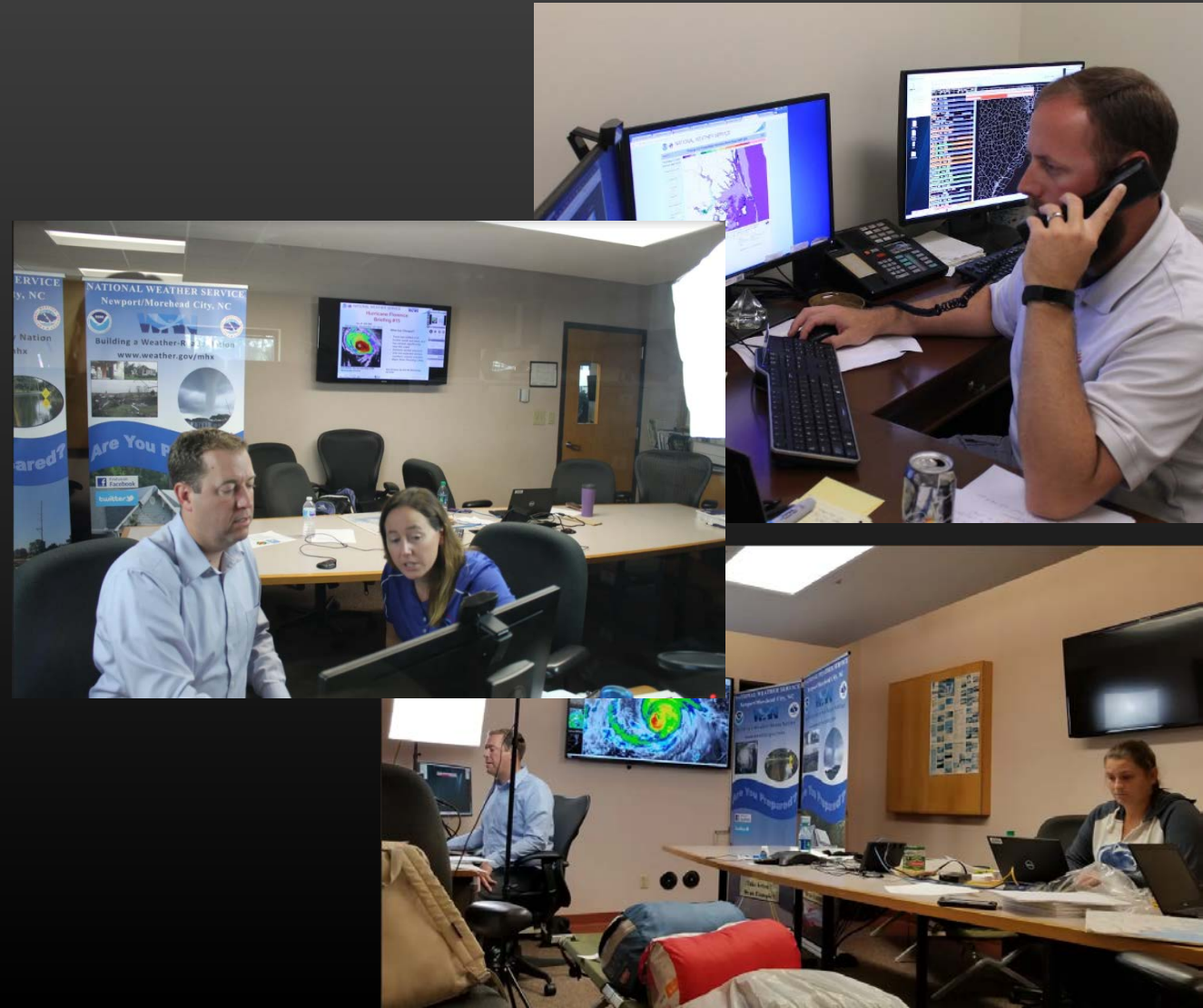


- Southeast River Forecast Center
- USGS Rapid Deploy Gages
- NC Emergency Management-
Flood Warning Engineer

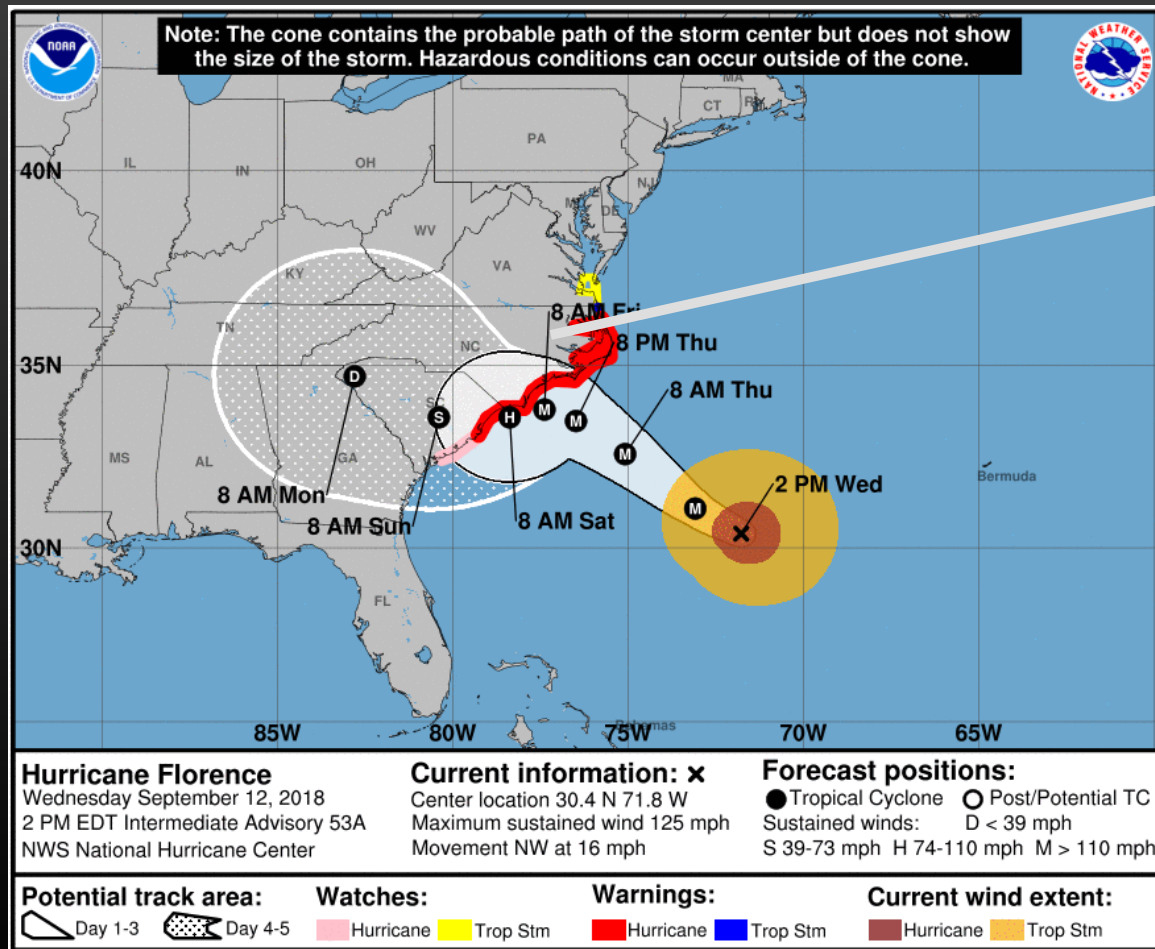


CORE PARTNER BRIEFINGS

- All together we conducted 31 briefings and 14 webinars/conference call with our emergency partners, including our River –Flooding briefings.
- Via SKYPE had multiple interview with major networks.



CONVEYING FLOOD RISK

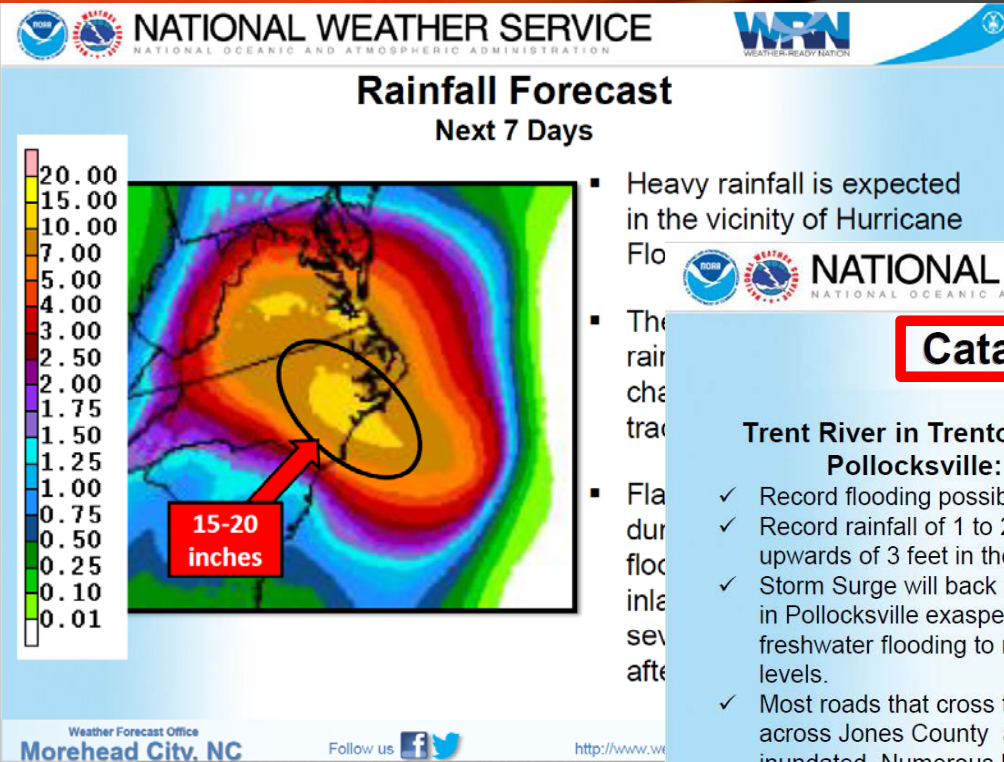


“We aren’t in the cone! Guess we are out of the woods!!”
Emergency Manager in eastern NC

Only deemed a Category 1 at landfall, many people decided to ride it out instead of evacuate.

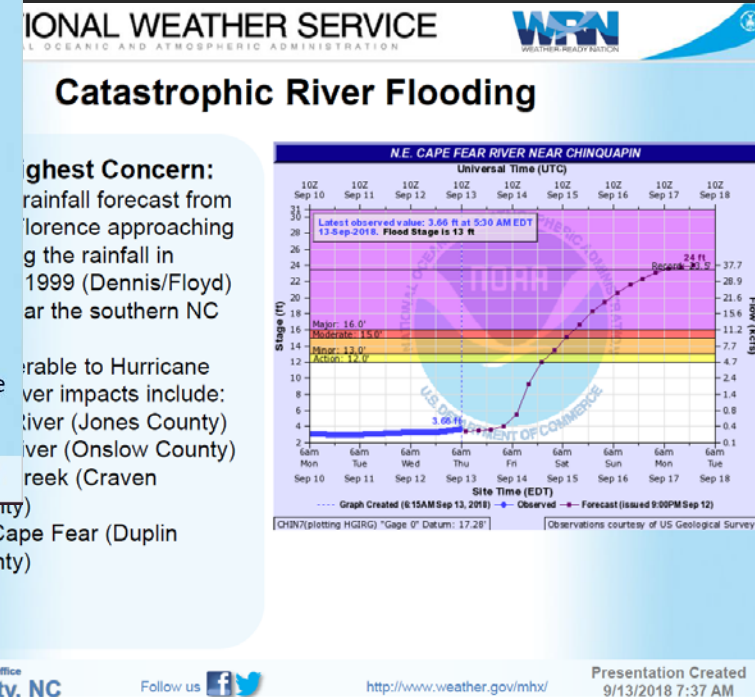
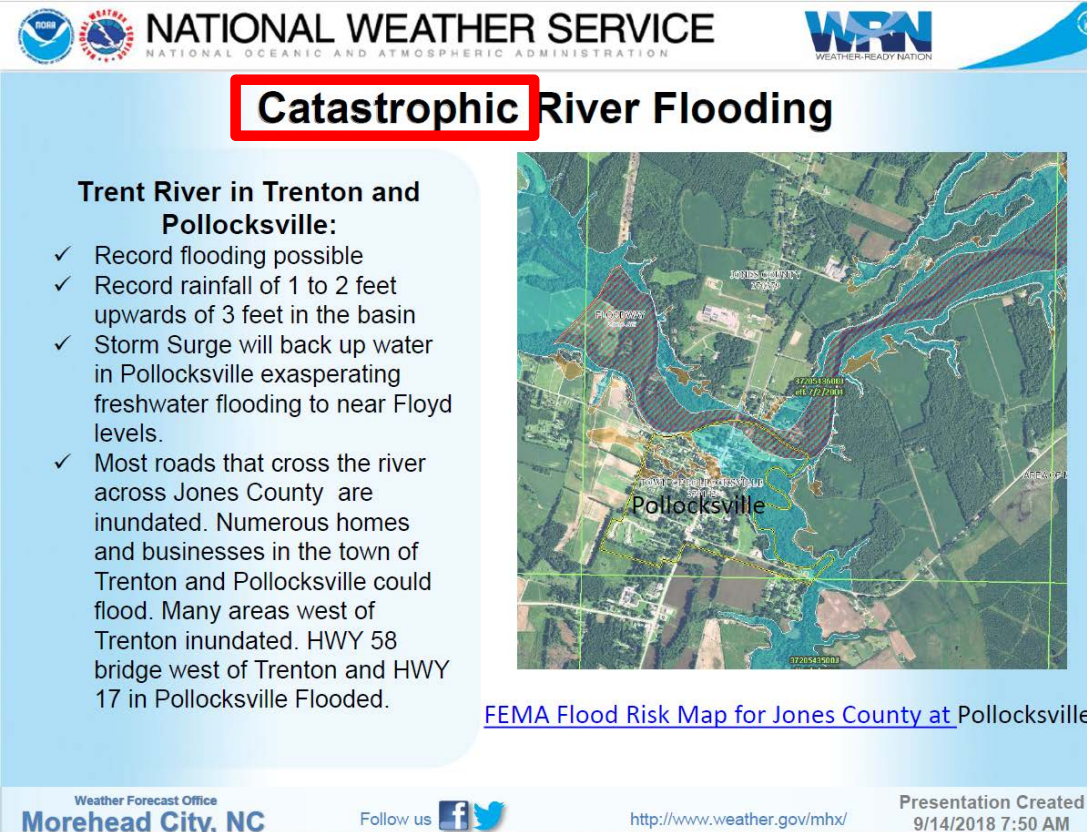
With Florence, the rain was the story.

CORE PARTNER BRIEFINGS



- Heavy rainfall is expected in the vicinity of Hurricane Florence
- The rainfall is characterized by heavy rain

- Flood damage is expected during the next several days
- Trent River in Trenton and Pollocksville:**
 - Record flooding possible
 - Record rainfall of 1 to 2 feet upwards of 3 feet in the basin
 - Storm Surge will back up water in Pollocksville exasperating freshwater flooding to near Floyd levels.
 - Most roads that cross the river across Jones County are inundated. Numerous homes and businesses in the town of Trenton and Pollocksville could flood. Many areas west of Trenton inundated. HWY 58 bridge west of Trenton and HWY 17 in Pollocksville Flooded.





CONVEYING FLOOD RISK

Flood Duration

- 1st storm surge
- 2nd flash flooding
- 3rd river flooding which was expected to last for over a week
 - Emphasized impact river flooding would have on returning evacuees!
 - Most major thruways were expected to be cut off for around a week

CONVEYING FLOOD RISK

Devastating flooding across much of Duplin county. Travel will be nearly impossible with numerous roads countywide impassable or washed out. Many homes across the county are inundated.


Relate this storm to historic events


Main Access Routes Impacted from River Flooding:

- ✓ Hwy 24 in Onslow and Carteret County
- ✓ Hwy 70 in Carteret County at Newport
- ✓ Hwy 17 and 58 in Jones County
- ✓ I-40 Duplin County

Residents know the impact of flooded thruways

FEMA Flood Risk Maps

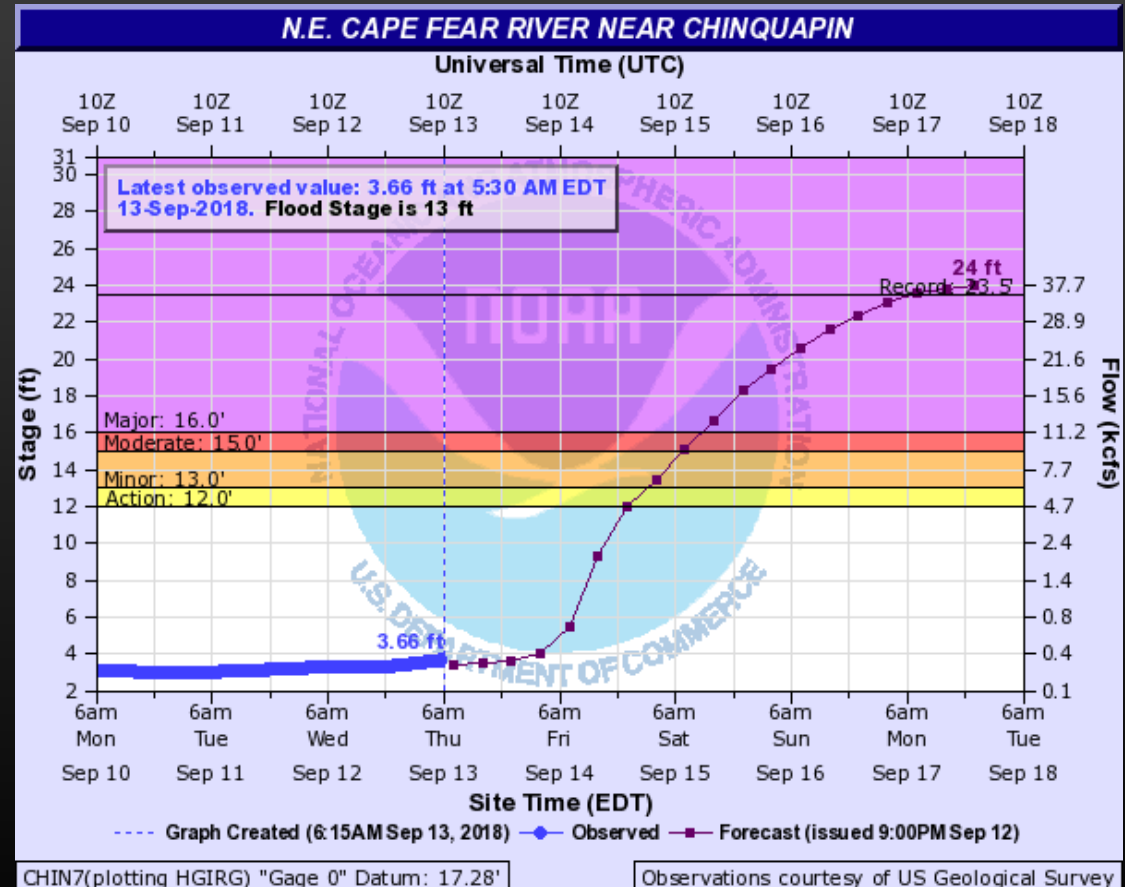
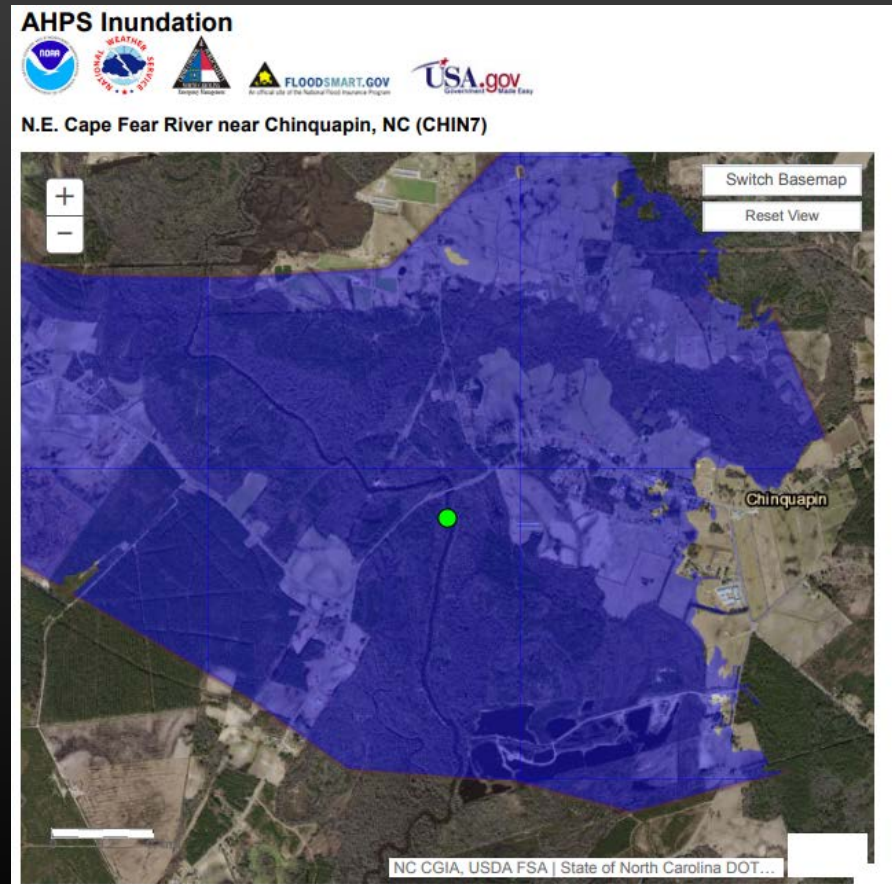


 **FEMA**

Are you in a floodplain? Search FEMA Flood Risk Maps by your address at:
<https://msc.fema.gov/portal/search>

Visuals!!

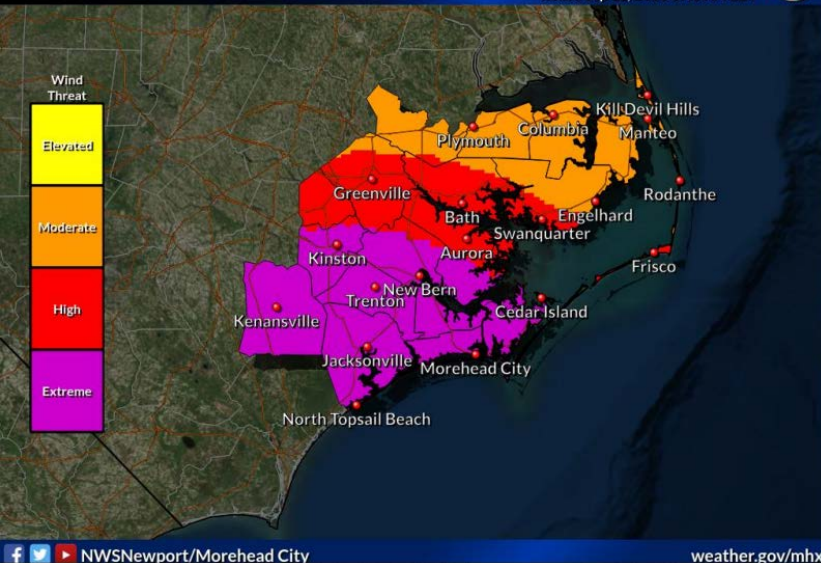
CONVEYING FLOOD RISK



AHPS Inundation Maps

Wind Threat

Weather Forecast Office
Newport/Morehead City, NC
Issued Sep 12, 2018 6:41 AM EDT



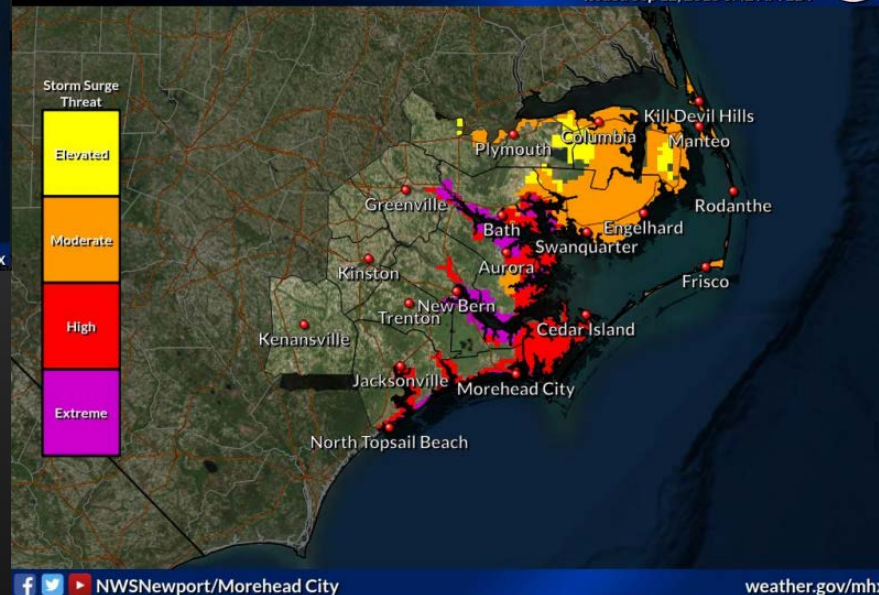
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CONVEYING RISK TO THE PUBLIC

Storm Surge Threat

Weather Forecast Office
Newport/Morehead City, NC
Issued Sep 12, 2018 6:42 AM EDT

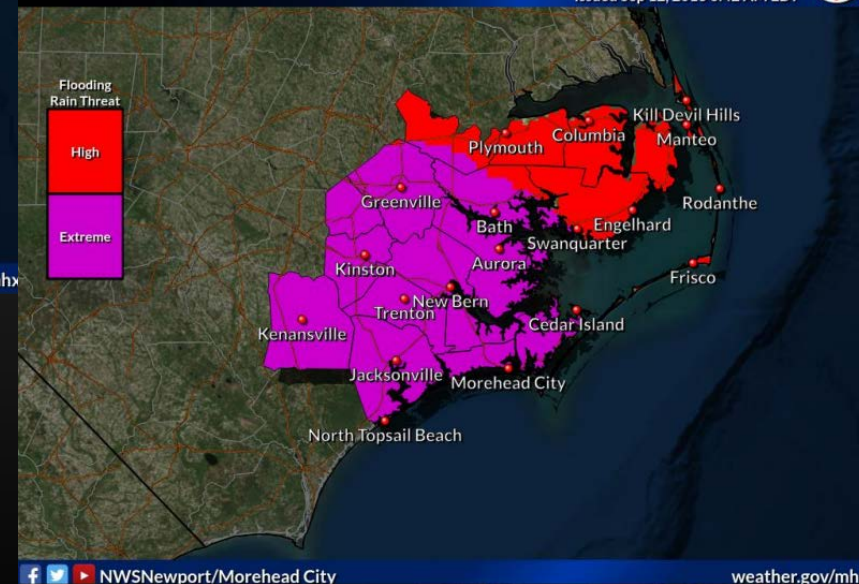


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weather.gov/mhx

Flooding Rain Threat

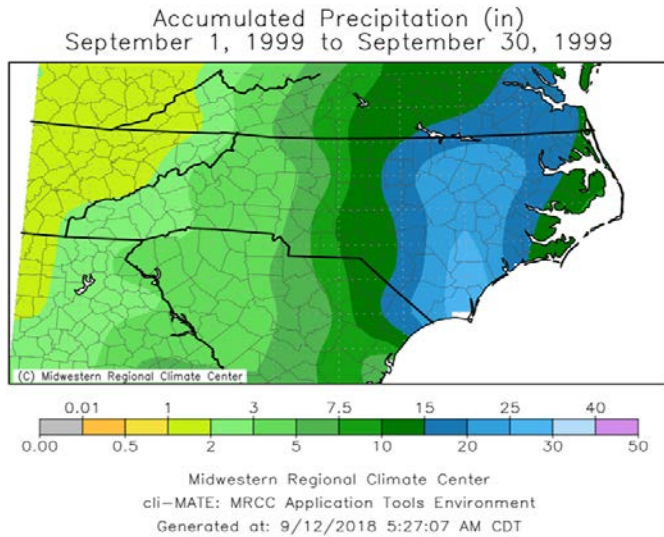
Weather Forecast Office
Newport/Morehead City, NC
Issued Sep 12, 2018 6:42 AM EDT



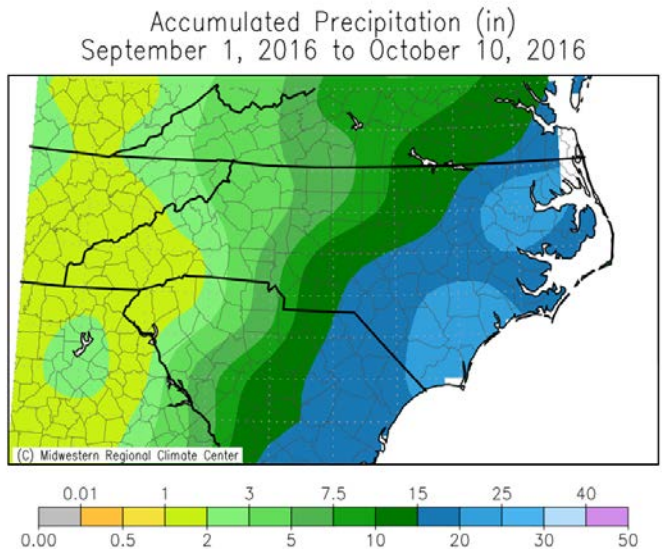
f t NWSNewport/Morehead City

weather.gov/mhx

NC Historic Flood Events



Hurricane
Dennis and
Floyd's
Rainfall

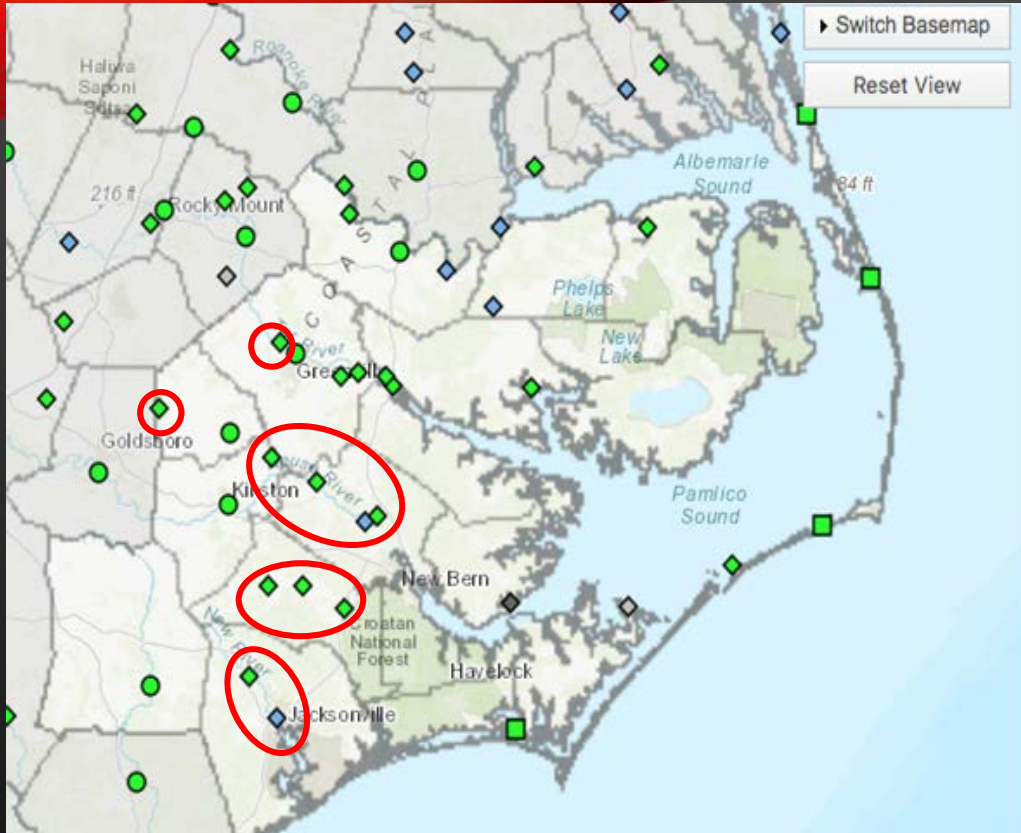


Hurricane
Matthew
and
Antecedent
Rainfall

CONVEYING FLOOD RISK

How did we inform the
public/decision makers on which
areas would flood and how bad?

- Used historic flood events and
examine extent of flooding from
those events



...The Flood Warning continues for the following rivers in North Carolina for historic flooding..

Northeast Cape Fear River Near Chinquapin affecting Duplin County
 Contentnea Creek Near Hookerton affecting Greene...Lenoir and Pitt Counties
 Neuse River At Kinston affecting Lenoir County
 Neuse River At Fort Barnwell affecting Craven County
 New River At Gum Branch affecting Onslow County
 Trent River At Pollocksville affecting Jones County
 Chicod Creek Near Simpson affecting Pitt County
 Swift Creek Near Streets Ferry affecting Craven County
 Trent River At Trenton affecting Jones County

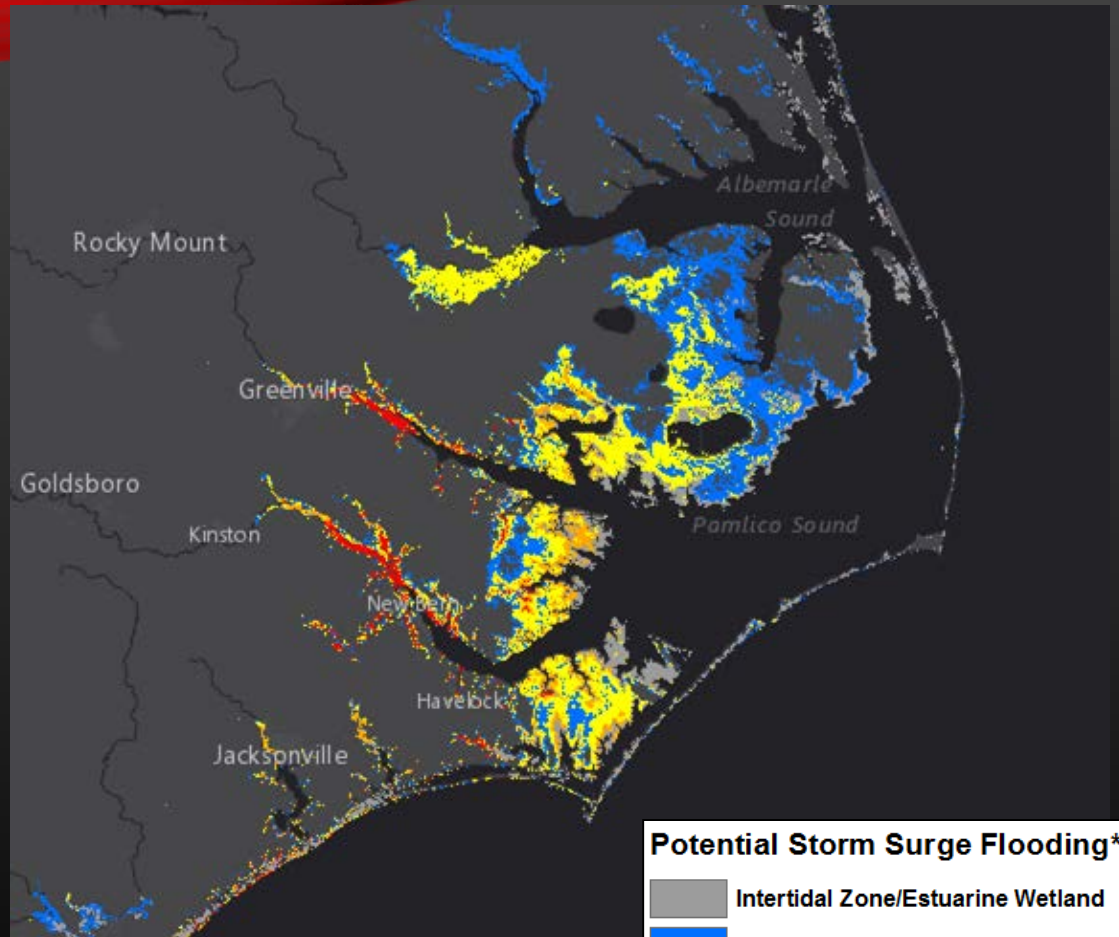
CONVEYING FLOOD RISK

We provided additional decision support to our partners by calculating estimates for the crests of non-forecast river points for this historic event.

- Used USGS historical streamflow data and National Water Model to estimate flows/crests/timing of floods on river gages in the area
- Used FEMA flood insurance studies and NC FIMAN to calculate flood levels for new gages without historic flows

CONVEYING FLOOD RISK

Storm surge inundated well upstream on the freshwater rivers, exasperating flooding



Potential Storm Surge Flooding*

- Intertidal Zone/Estuarine Wetland
- Greater than 1 foot above ground
- Greater than 3 feet above ground
- Greater than 6 feet above ground
- Greater than 9 feet above ground

SOCIAL MEDIA

US National Weather Service Newport/Morehead City NC ...
Published by Sean Bandy [?] · September 14 · 🌐

9/14/18 1145 PM

With both flash flood emergency and flash flood warnings in effect now, here is the difference and how it impacts you. Please, please stay off the roads.

Flash Flood EMERGENCY

ISSUED FOR...
Exceedingly rare situations when a severe threat to human life and catastrophic damage from a flash flood is happening or will happen soon.

This is a life-threatening situation! Do not attempt to travel unless you are fleeing an area subject to flooding or under an evacuation order.

Flash Flood WARNING

ISSUED WHEN...
Dangerous flash flood or will happen soon. Homes may flood.

Move to high ground. Never drive through floodwaters.

US National Weather Service Newport/Morehead City NC ...
Published by Sean Bandy [?] · September 12 · 🌐

#Florence will cause catastrophic quick onset flash flooding and river flooding across eastern NC, along with extreme storm surge beginning Thursday evening. Evacuate now if ordered, and once it starts, seek safe shelter and stay put! #TurnAroundDontDrown

Don't underestimate the power of water!

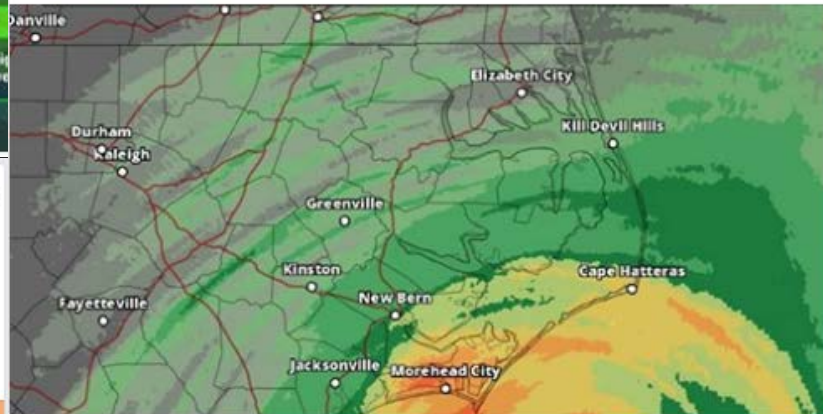
6 inches of fast-moving water can knock over and carry away an adult.

12 inches of fast-moving water can carry away a small car.

18-24 inches of fast-moving water can carry away most large SUVs, vans, and trucks.

US National Weather Service Newport/Morehead City NC ...
Published by Sean Bandy [?] · September 13 · 🌐

Hurricane #Florence has brought heavy rains to eastern NC. The storm has slowed, and heavy rain will continue overnight into Friday. #NCwx NC Emergency Management



LAND FLOODING

hurricane to cause sea. Even relatively can produce vast inland from the ating flooding.

Storm Surge along the Coast

Your Location

Flooding from Heavy Rain



US National Weather Service Newport/Morehead City NC ...
Published by Sean Bandy [?] · September 13 · 🌐

#Florence is forecast to drop 12-24 inches of rain, with isolated areas of 30 inches by this weekend! Take care and know the impacts. #WRN #NCwx

What are the impacts of 15-25 inches of rain?

- Homes and businesses will be flooded.
- Flooding will prompt evacuations and rescues.
- Flooded roads could make travel and potential evacuations difficult.
- Some roads may erode from underneath creating hidden dangers.
- Locations that normally don't flood will be covered in water.

Photo: U.S. Army National Guard

US National Weather Service Newport/Morehead City NC ...
Published by Sean Bandy [?] · September 13 · 🌐

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Photo: U.S. Army National Guard

NWS Products

Flash Flood Watch

URGENT - IMMEDIATE BROADCAST REQUESTED

Flood Watch

National Weather Service Newport/Morehead City NC

312 PM EDT Thu Sep 13 2018

...EXTREMELY HEAVY RAIN ASSOCIATED WITH HURRICANE FLORENCE WILL
LIKELY PRODUCE LIFE THREATENING FLASH FLOODING...

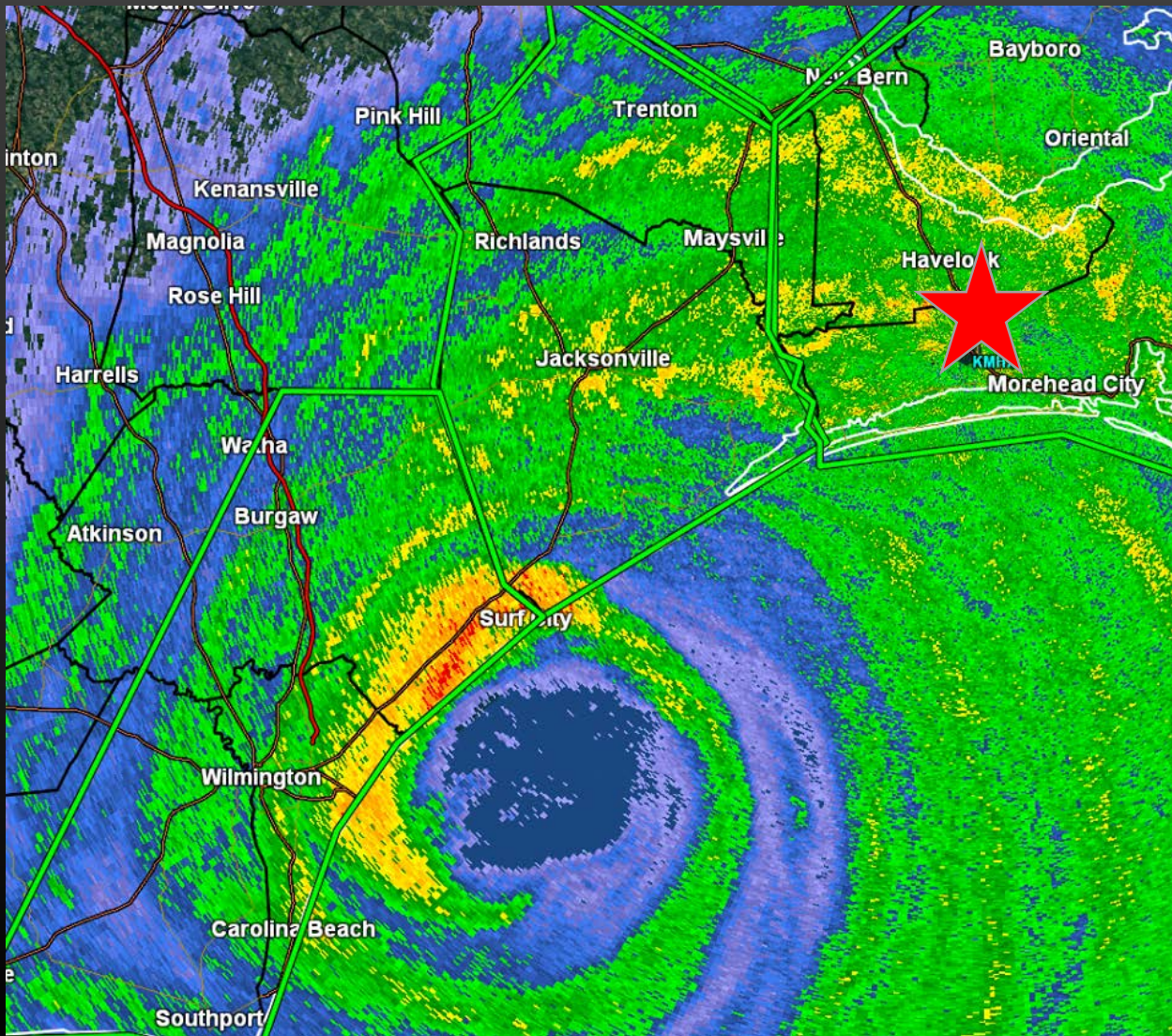
.Hurricane Florence will impact the area into the weekend,
bringing potentially historic rainfall amounts and unprecedented
flooding across southern portions of eastern North Carolina.

NWS Products

- Initially in the HLS (Hurricane Local Statement) we messaged rainfall totals of 15 to 20 inches with locally higher amounts up to 30 inches
- As we got closer to landfall, we transitioned to the wording of “feet” of rainfall expected (1 to 2 ft. with higher amounts 3 ft.) to call attention to the unprecedented amount of rainfall possible.
- We described the **historic flood potential with catastrophic impacts** throughout the event in the HLS. See following example from first HLS.

The potential for historic flooding exists across portions of Eastern North Carolina due to the slowing down or stalling of Florence near the area. The current rainfall forecast indicates widespread amounts of 1 to 2 FEET with locally higher amounts over 3 FEET of rain possible. The heavy rain will start Thursday afternoon and continue through the weekend. These rainfall amounts would cause catastrophic flash flooding during the storm, followed by significant and prolonged river flooding lasting well into next week.

THE STORM HITS



...FLASH FLOOD EMERGENCY FOR CARTERET COUNTY...

The National Weather Service in Newport has extended the

* Flash Flood Warning for...

Southeastern Jones County in eastern North Carolina...
Southeastern Craven County in eastern North Carolina...
Carteret County in eastern North Carolina...
Pamlico County in eastern North Carolina...

* Until 900 AM EDT Saturday.

* At 659 PM EDT, unprecedented rainfall nearing two feet across Carteret County has resulted in widespread flooding of homes, businesses, and roads. Flash flooding is already occurring. Residents across the county who have never witnessed flooding prior to this event have been forced to seek refuge in emergency shelters. An additional 4 to 8 inches of rainfall is possible through tonight. The same torrential rainband is likely to cause similar conditions across portions of Craven, Jones, and possible Pamlico Counties as well.

This is a FLASH FLOOD EMERGENCY for Carteret County. This is a PARTICULARLY DANGEROUS SITUATION. Numerous roads across the county are impassable. If you need emergency assistance call 911 and seek safety in the highest floor of your building.

* Some locations that will experience flooding include...

New Bern, Havelock, Morehead City, Newport, Cedar Island, Harkers Island, James City, Trent Woods, River Bend, Stella, South River, Cape Carteret, North River, Davis, Straits, Atlantic, Sealevel, Marshallberg, Smyrna and Merrimon.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

Move to higher ground now. This is an extremely dangerous and life-threatening situation. Do not attempt to travel unless you are fleeing an area subject to flooding or under an evacuation order.

Please report flooding to your local law enforcement agency when you can do so safely.

NWS Products

BULLETIN - EAS ACTIVATION REQUESTED

Flash Flood Warning

National Weather Service Newport/Morehead City NC

1037 PM EDT FRI SEP 14 2018

...FLASH FLOOD EMERGENCY FOR PORTIONS OF JONES, LENOIR, ONSLOW, AND DUPLIN COUNTIES...

The National Weather Service in Newport has issued a

* Flash Flood Warning for...

Jones County in eastern North Carolina...
Southwestern Lenoir County in eastern North Carolina...
Northeastern Onslow County in eastern North Carolina...
Northeastern Duplin County in eastern North Carolina...

* Until 430 AM EDT Saturday.

* At 1029 PM EDT, emergency management reported extremely heavy rain across the warned area associated with a nearly stationary rain band from Tropical Storm Florence. Since yesterday 10 to 18 inches have fallen across the area. Life threatening flash flooding is occurring with numerous impassable due to high water. It is imperative that residents remain off the roads, and only venture outside if there is a threat to your well being. Additional rainfall amounts of 5 to 10 inches are possible tonight across the warned area.

This is a FLASH FLOOD EMERGENCY for portions of Jones, Lenoir, Onslow, and Duplin counties. This is a PARTICULARLY DANGEROUS SITUATION. SEEK HIGHER GROUND NOW!

* Some locations that will experience flooding include...

Jacksonville, Kinston, Pumpkin Center, Piney Green, Half Moon, Camp Lejeune Center, New River Station, Mount Olive, Swansboro, Phillips Crossroads, Hubert, Kornegay, Richlands, Deep Run, Maysville, Silverdale, Kellum, Midway Park, Comfort and Belgrade.

STORMS OVER...ONGOING FLOODING



HURRICANE FLORENCE-RECORD RAINFALL AND FLOODING



Florence Preliminary Storm Total Rainfall Reports
Created: 9/19/2018 3:44 PM

Totals From 8 AM Thursday – 8 AM Tuesday

Swansboro, NC	34.14"
Jacksonville, NC	30.65"
Albertson, NC	26.26"
Newport NWS, NC	25.62"
Emerald Isle, NC	23.49"
Trenton, NC	19.42"
MCAS New River, NC	19.35"
Kinston, NC	18.92"
New Bern, NC	15.17"
Winterville, NC	13.24"

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TRENT RIVER AT POLLOCKSVILLE



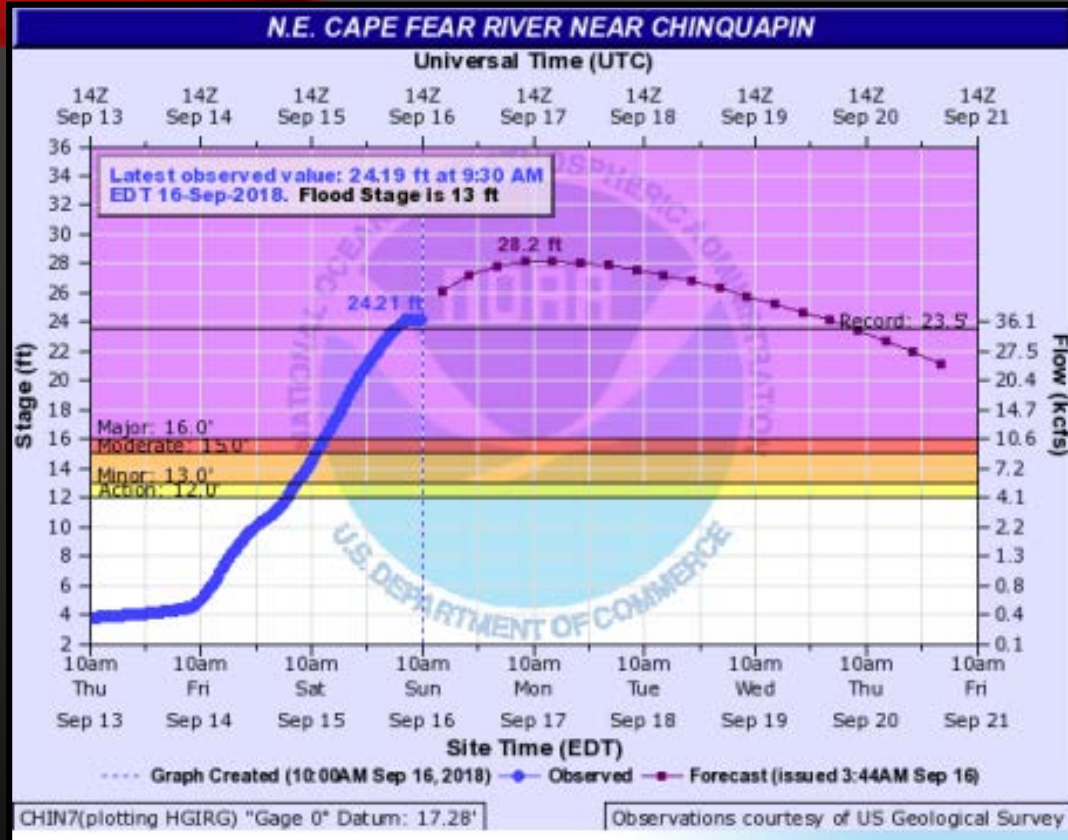
Florence Crest: 20.48 ft.

ONGOING FLOODING

**Exceeded
Hurricane Floyd (flood
of record) level**

**Extensive flash flooding
caused numerous road
washouts**

N.E. CAPE FEAR RIVER NEAR CHINQUAPIN



**Exceeded
Hurricane Floyd (flood
of record) level**

ONGOING FLOODING

**Extensive flash flooding
caused numerous road
washouts**



QUESTIONS?



Belkys.Melendez@noaa.gov

Sarah.Jamison@noaa.gov