

# National Weather Service Flood Class



*2020 Season*



# Tonight's Topics

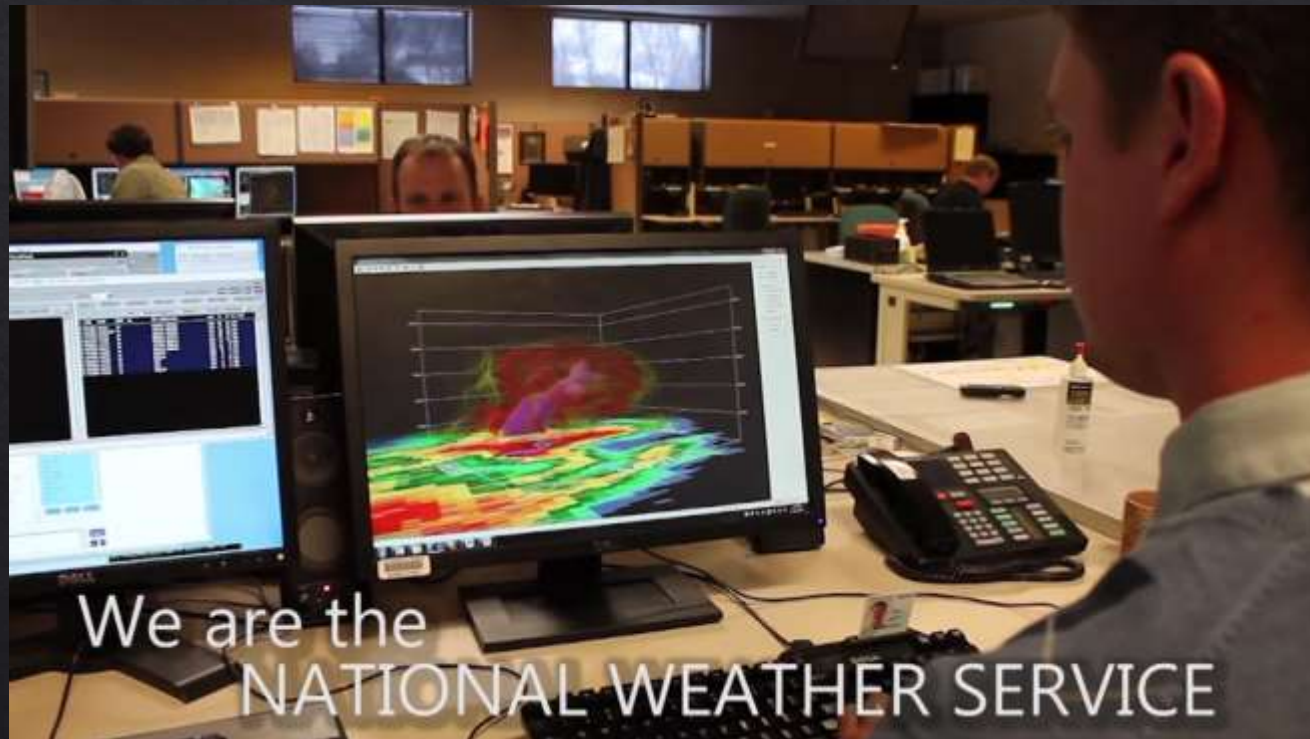
- ◇ NWS Operations Overview
- ◇ Flood Facts & Flood Safety
- ◇ Types of Flooding
- ◇ Basic Hydrology
- ◇ What Causes Floods Here?
- ◇ Observations
- ◇ What to Report
- ◇ Quiz!
- ◇ Review / Q&A
- ◇ There will be a break midway through tonight's presentation!





# National Weather Service Mission

- ◇ Provide weather, **water**, and climate **data, forecasts and warnings for the protection of life and property** and enhancement of the national economy.



# The *National Weather Service* is Local!





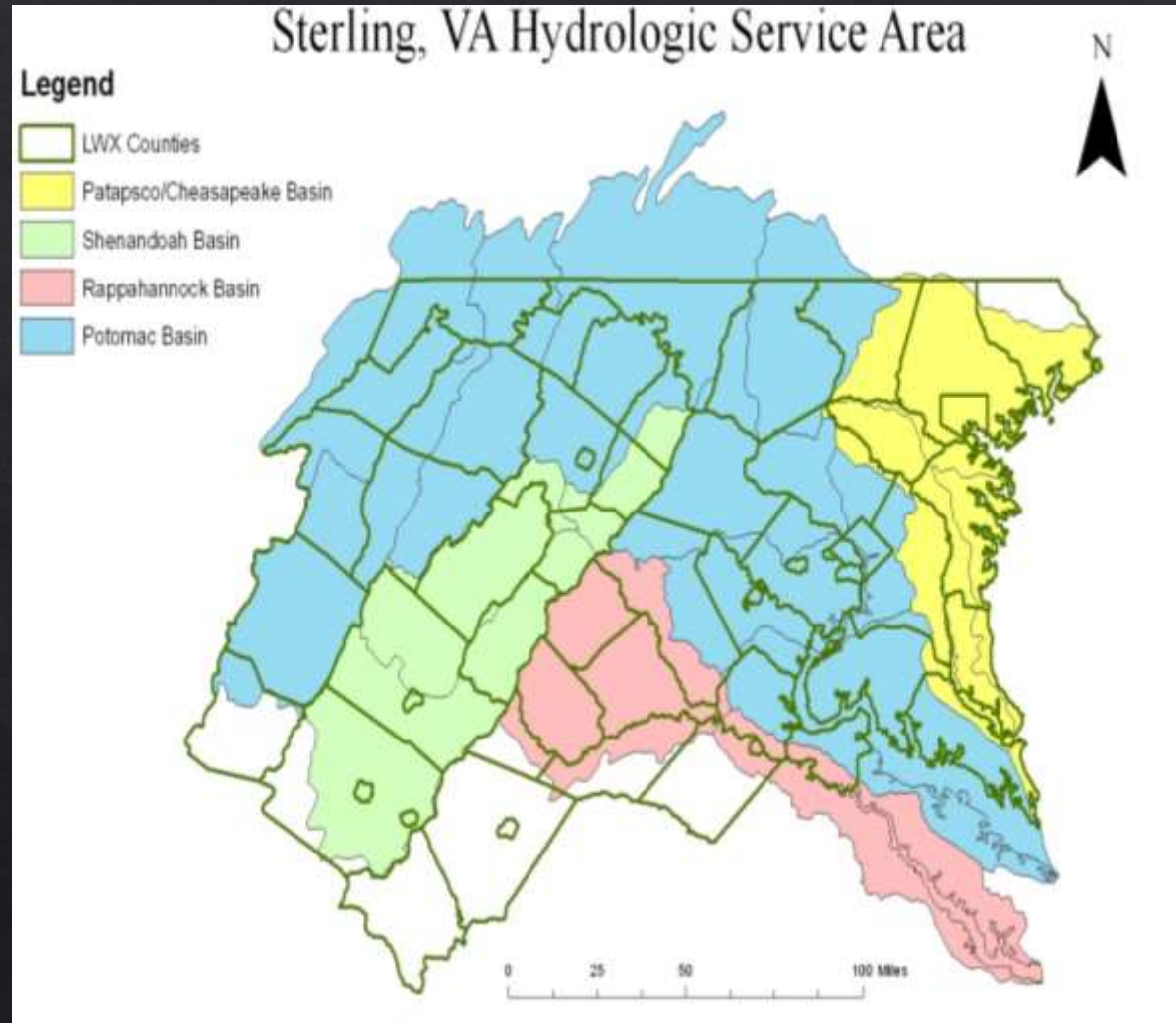
# Areas of Responsibility

## ◇ County Warning Area (CWA) Flash Flood

- ◇ 43 Counties in 3 states
- ◇ District of Columbia
- ◇ 12 Independent Cities
- ◇ MD Chesapeake Bay

## ◇ Hydrologic Service Area (HSA) River Flood

- ◇ Potomac Basin
- ◇ Shenandoah Basin
- ◇ Rappahannock Basin
- ◇ West Chesapeake



# Flood History

## ◈ Did you know?

The first recorded floods in this region were in **1748**!

- ◈ *A teenaged George Washington, working as a land surveyor, could not cross the Potomac River at Berkeley Springs due to flooding from snowmelt. Washington instead spent time at the "Medicinal Springs" (today's Berkeley Springs).*
- ◈ *As the flood (maybe the same one, we're not sure) moved down the Potomac, Robert Harper – the namesake of Harpers Ferry – had to leave his log cabin and move into a barn up on the hill.*

**<http://www.weather.gov/washington/FloodTimeline>**



# Don't let this be you! (Or anyone you know.)



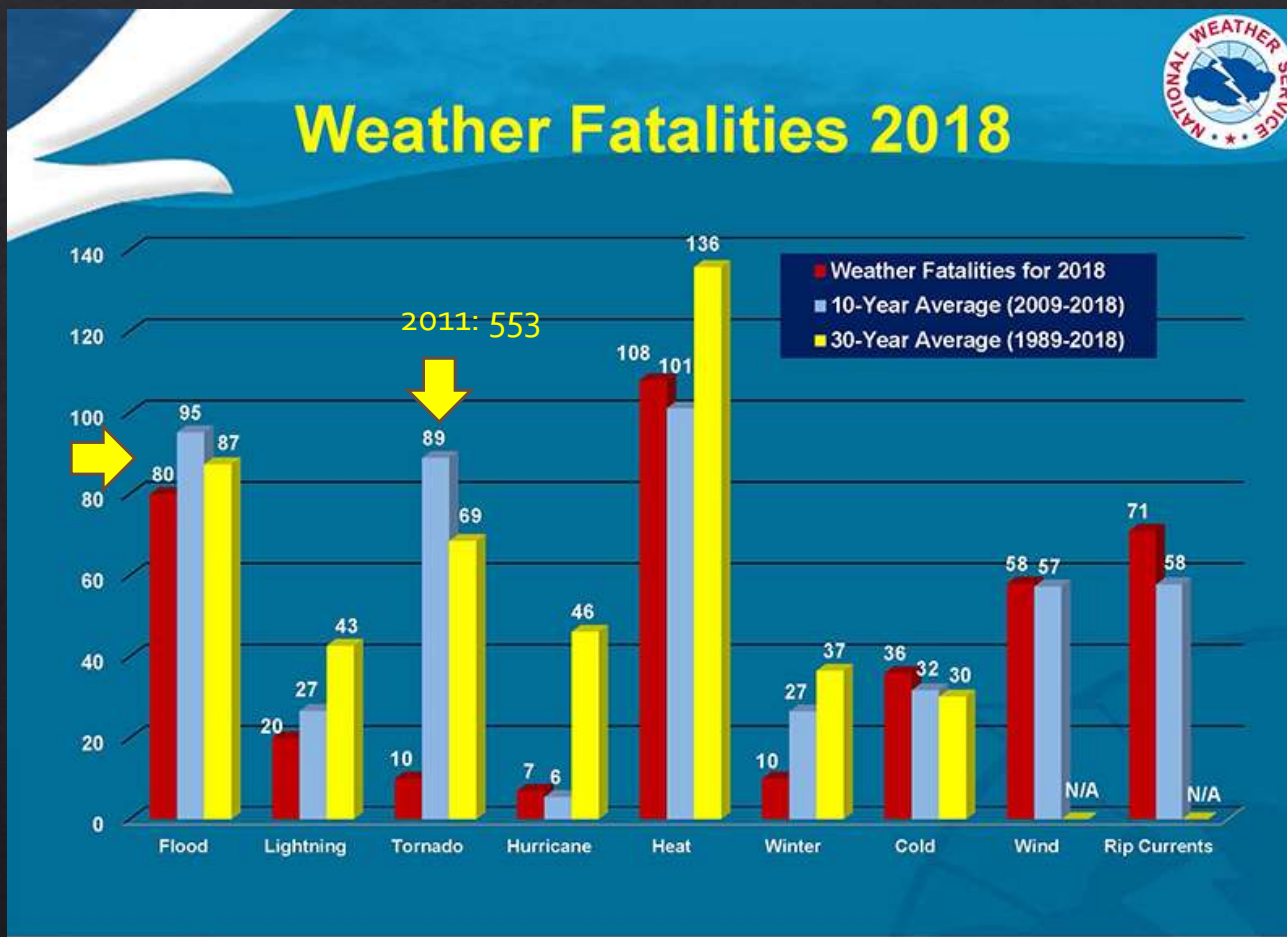
National Weather Service Baltimore/Washington



# Floods – a major weather killer

- On a long-term basis, floods are the #2 cause of death when weather plays a role, behind heat. *(2019 data not yet finalized)*

Preliminary  
flood  
fatalities  
in 2019:  
92





# Flood Facts

- ◇ Most flood fatalities:
  - ◇ occur in cars
  - ◇ occur at night
  - ◇ *are the result of bad decisions*

*Upper Marlboro, MD &  
Fairfax, VA – Sept. 2011*



National Weather Service Baltimore/Washington

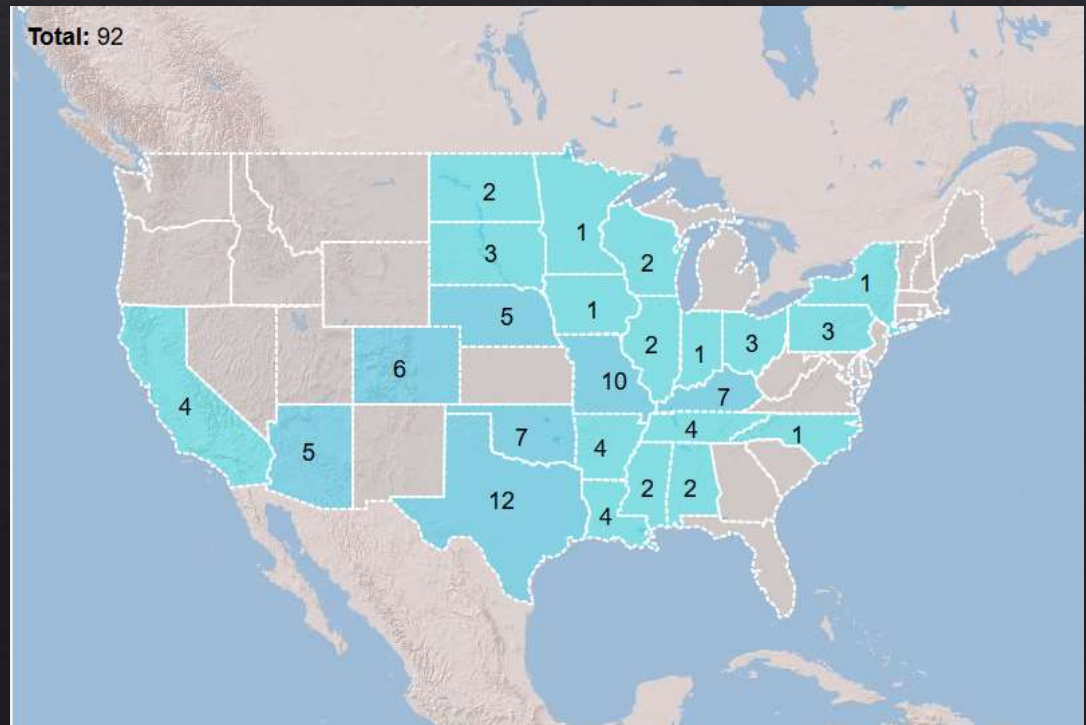


# Flood Fatalities

- ◆ In 2019, there were 92 flood fatalities (right around the long-term average).
- ◆ Around two-thirds (68%) were male and around two-thirds (66%) were vehicle-related

**This is consistent  
year after year**

- ◆ None in our area,  
after a difficult  
2018





# Flood Damages

- ◇ 10 year average: \$9 billion per year!

  - ◇ 2017: \$60.7 billion

  - 2018: \$1.6 billion

- ◇ Most Presidentially-declared disasters are at least in part flood-related

Ellicott City, MD  
2016



# Flood Safety

- ◆ **Take Appropriate Action!**
- ◆ Never try to drive, swim, walk, or run through a flooded area.
- ◆ Know the flood prone areas on your daily commute – and avoid them if they're flooded! (Know at least one alternate route that doesn't flood!)
- ◆ Plan ahead – Identify where to go if told to evacuate. Choose several places (a friend's home or a hotel, or a designated shelter)
- ◆ Children should not play in or near flooded areas, especially in ditches or moving water

**Fall Hill Road, Fredericksburg, VA  
June 2018**

***Photo courtesy City of Fredericksburg***





# Turn Around, Don't Drown!

- ❖ If you come upon flood waters,  
**STOP! TURN AROUND AND GO ANOTHER WAY!**
- ❖ Only 6 inches of fast-moving water can knock you off your feet
- ❖ 2 feet of moving water will float almost any vehicle...*less water for smaller cars*
- ❖ The road under the water might be compromised
- ❖ Bottom line: never assume there is a safe way to drive through water



Share information with your family & friends: <https://www.weather.gov/safety/flood>



**WARNING**

**MATH  
PROBLEM  
AHEAD**

# Physics of Floating Cars

## Vehicle weights:

Smart Car:  
2,072 pounds

Nissan Versa:  
2,395 pounds

Toyota Corolla:  
2,800 pounds

Hyundai Kona:  
3,276 pounds

Honda CR-V:  
3,410 pounds

Ford F-150:  
4,850 pounds

Chevy Suburban:  
5,808 pounds

Water weighs 62.4 lbs per cubic foot and in a flood can flow downstream at 5 to 10 mph.



When a vehicle stalls in the water, the water's momentum is transferred to the car. For each foot the water rises, 500 lbs of lateral force are applied to the car.



The biggest factor is buoyancy. For each foot the water rises up the side of the car, the car displaces 1500 lbs of water. In effect, the car weighs 1500 lbs less for each foot the water rises.



Two feet of water will carry away most automobiles!





# The Physics of Floating Cars



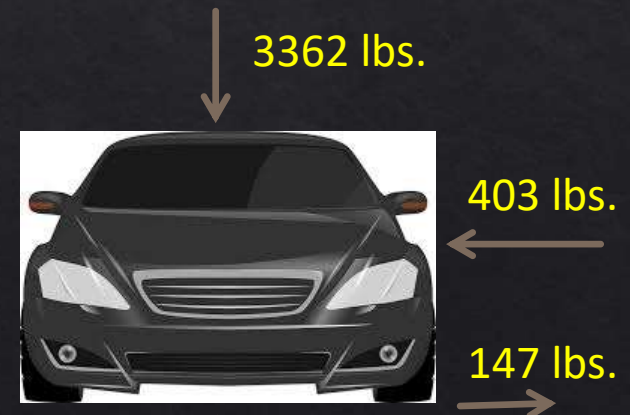
- The Honda Accord weighs 3,362 pounds
- $\frac{1}{2}$  foot of water displaced by this vehicle weighs  $(6 * 16 * 0.5 * 62.4) = 2995$  pounds

- ▶ Water Depth = 1 foot
- ▶ Width: 6 feet
- ▶ Length: 16 feet
- ▶ Clearance: 6 inches
- ▶ Weight: 3,362 pounds
- ▶ Net Depth = 0.50 foot

Net Weight :  $3,362 \text{ lbs} - 2,995 \text{ lbs} = 367 \text{ lbs}$

Friction Force:  $0.4 \times 367 \text{ lbs} = 147 \text{ lbs}$

Once the vehicle floats, the friction force no longer matters, but the stream force could be enough to affect the vehicle even before it floats!



If this number  $\rightarrow$  is greater than the weight of your car, it's floating!



# Not Just Hazards for Cars



WFTS-TV

# Know Your Risk

- ◆ Check the FEMA Flood Maps to see if you are in a flood zone...

- ◆ Maryland: <http://www.mdfloodmaps.net/map/>

- ◆ Virginia: <http://dcr.virginia.gov/vfris>

- ◆ West Virginia: <http://www.mapwv.gov/flood/>

- ◆ DC: <https://dcfloodrisk.org>

- ◆ National: <https://www.floodsmart.gov>

- ◆ Flooding is not limited to these flood zones!  
Always consider flood insurance!



# Types of Flooding



Flash Flooding

Tidal Flooding

Street Flooding

River Flooding



# Flood vs. Flash Flood

- ❖ **Flash Flood** - a *rapid and extreme* flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, *which requires immediate action to protect life and property* (e.g., intense rainfall, dam failure, ice jam). Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters.
- ❖ **Flood** - any high flow, overflow, or inundation by water which causes or threatens damage.

**Source: NWS Instructions 10-950 and 10-922**

# What makes a flash flood?

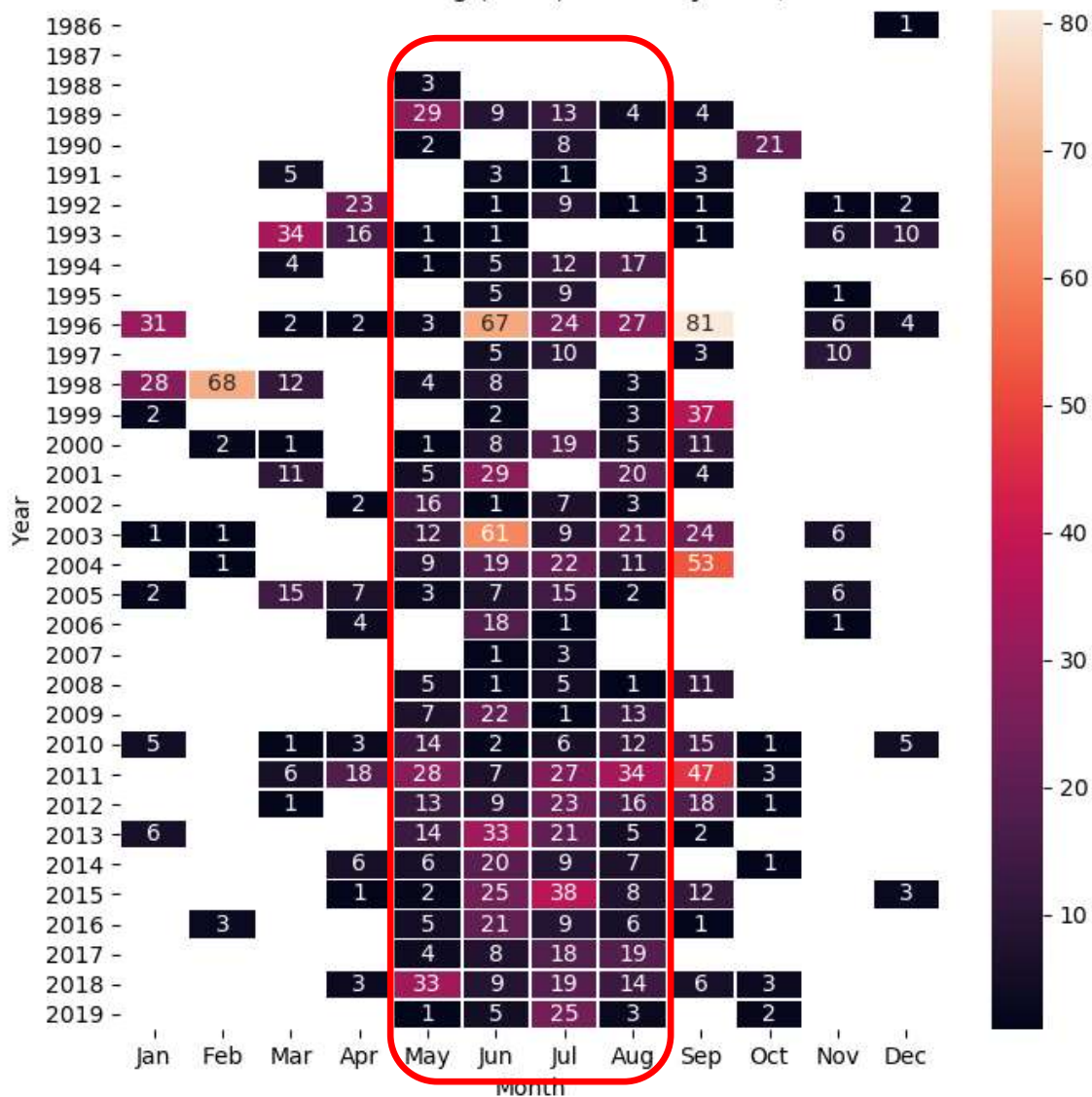
- ❖ Caused by convection (thunderstorms or intense showers)
- ❖ More isolated compared to general flooding
- ❖ Response time is short, usually 1-2 hours, but as little as 15 mins. in urban areas (compared to longer timescales for flooding)
- ❖ Swift Water  
Rescues, road closures, creeks and streams flood within an hour or two of the causative event

**Maryland Route 180 after a  
Flash Flood – May 2018**

***Photo from MD Lt. Gov. Boyd Rutherford***



NWS Baltimore Md/ Washington Dc  
Flash Flood Warning (FF.W) Issued by Year,Month



Generated at 18 Feb 2020 1:03 PM CST in 1.80s

IEM Autoplot App #171

National Weather Service Baltimore/Washington

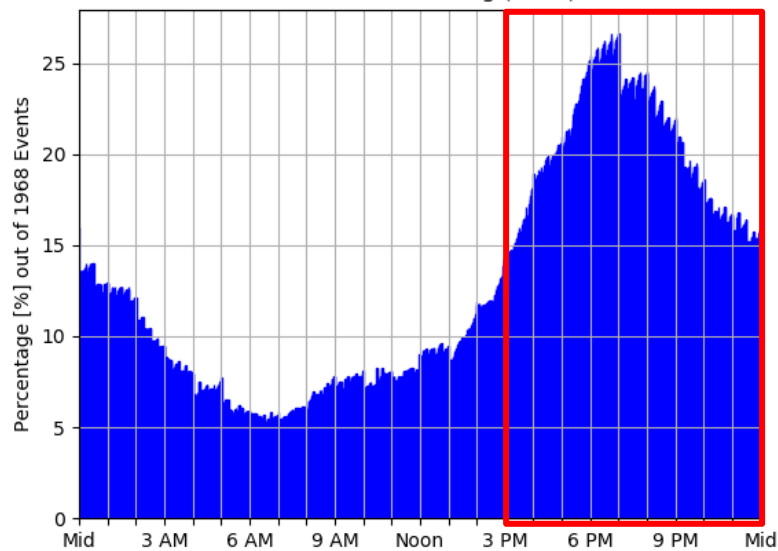




# When does flash flooding occur?

- ◇ Can occur anytime – day or night.
- ◇ Many flash floods occurs at night (or around sunset).
- ◇ **Most flash flood fatalities occur at night!**

[LWX] Baltimore Md/ Washington Dc :: Time of Day Frequency  
Flash Flood Warning (FF.W)



Generated at 27 Feb 2019 12:56 PM CST in 2.69s IEM Autoplot App #72



# Special Cases – Debris Jams

- ❖ Occasionally, floating debris or ice can accumulate at a natural or man-made obstruction and restrict the flow of water.
- ❖ Water held back by the ice jam or debris dam can cause flooding upstream.
- ❖ Subsequent flash flooding can occur downstream if the obstruction should suddenly release.





# Special Cases – Ice Jams



*Chunks of ice collect in river channels and may ultimately stop the flow of water.*

*Ice can collect at a bridge and create an ice jam.*

*Water backs up behind the ice jam and subsequent flooding results.*





# Special Cases – Ice Jams



# Special Cases – Mudslides/Landslides

- ❖ In significant rain events in higher terrain, a mudslide or landslide can be triggered.
- ❖ This isn't the rain rushing down the slope; it's the land rushing down the slope.

*Photo courtesy TN Dept. of Transportation; landslide map from USGS*



## Landslide Incidence and Susceptibility

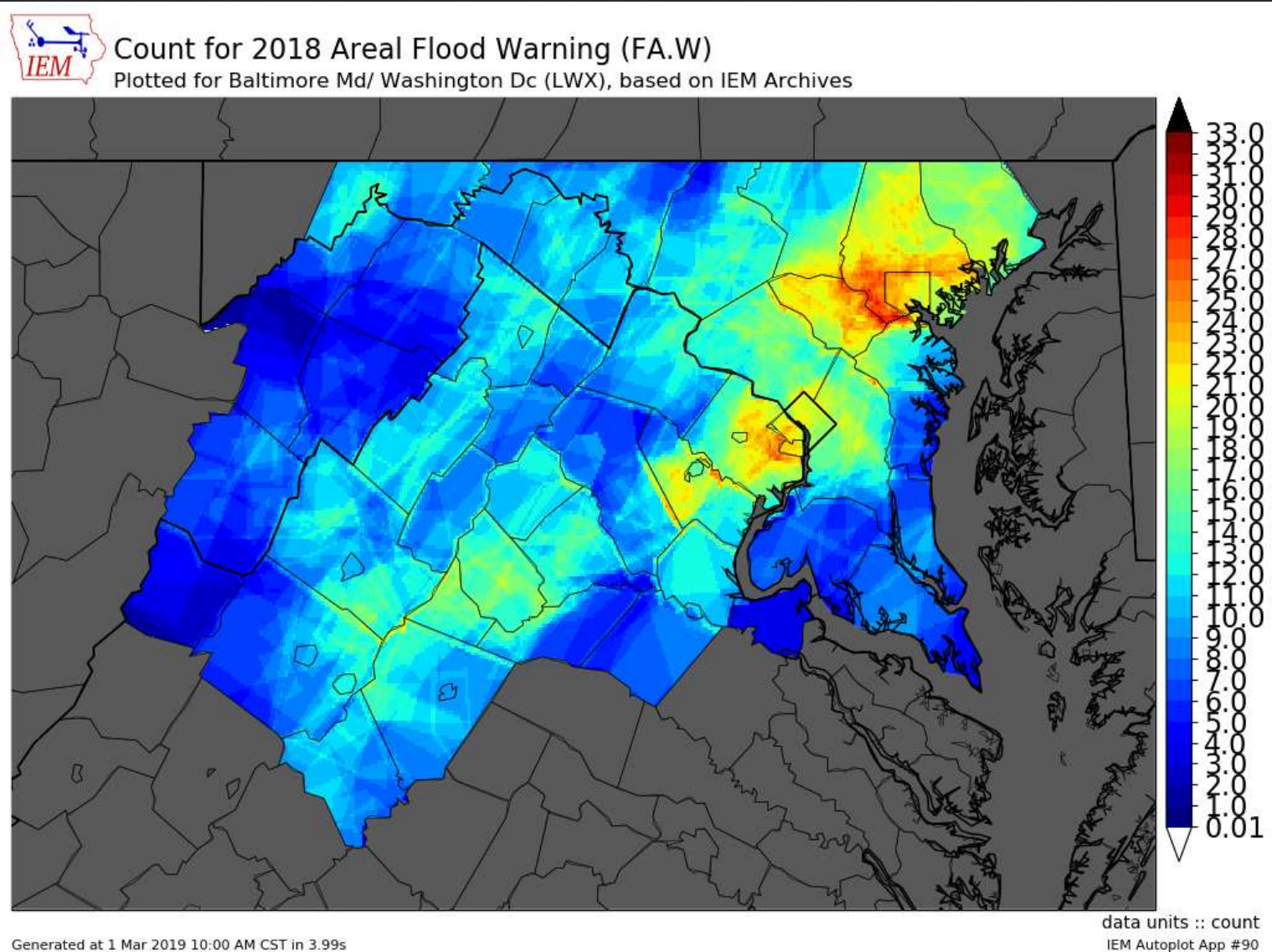
- High incidence
- High susceptibility, moderate incidence
- High susceptibility, low incidence
- Moderate incidence
- Moderate susceptibility, low incidence
- Low incidence



# “Areal” Flood?

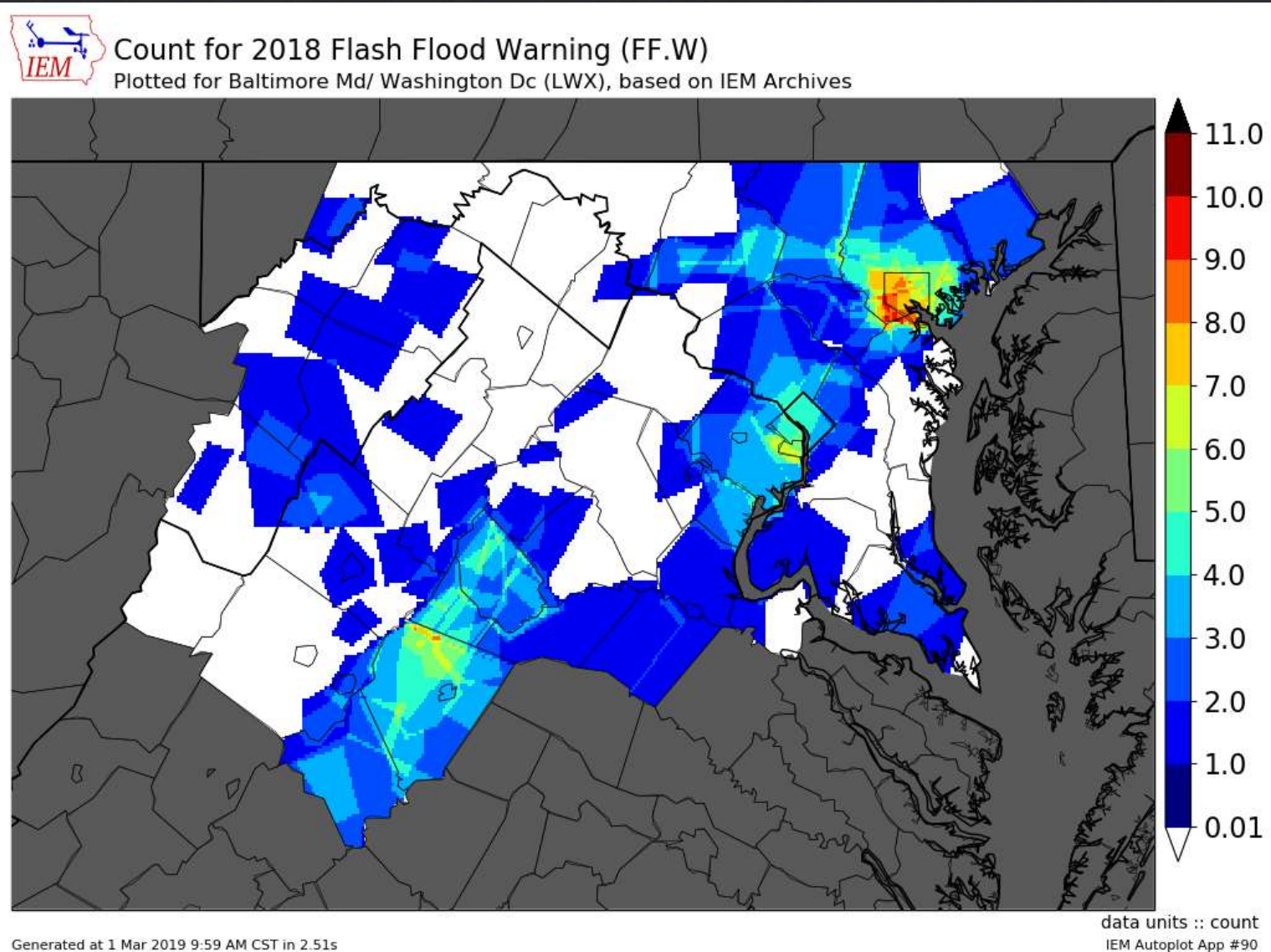
- ◇ We are in the process of eliminating this terminology (in favor of just saying “flood warning”); however, you may still sometimes see it.
- ◇ **NOT** = “a real” flood
- ◇ **NOT** = “aerial” flood
- ◇ Flooding that covers an area.
- ◇ Flash Flooding typically affects a *very* small area very quickly. Areal flooding is slower to rise or develop and often affects more or larger areas.
- ◇ But...the ultimate severity and effects can be exactly the same.

# Flash Floods vs. Areal Floods (2018)



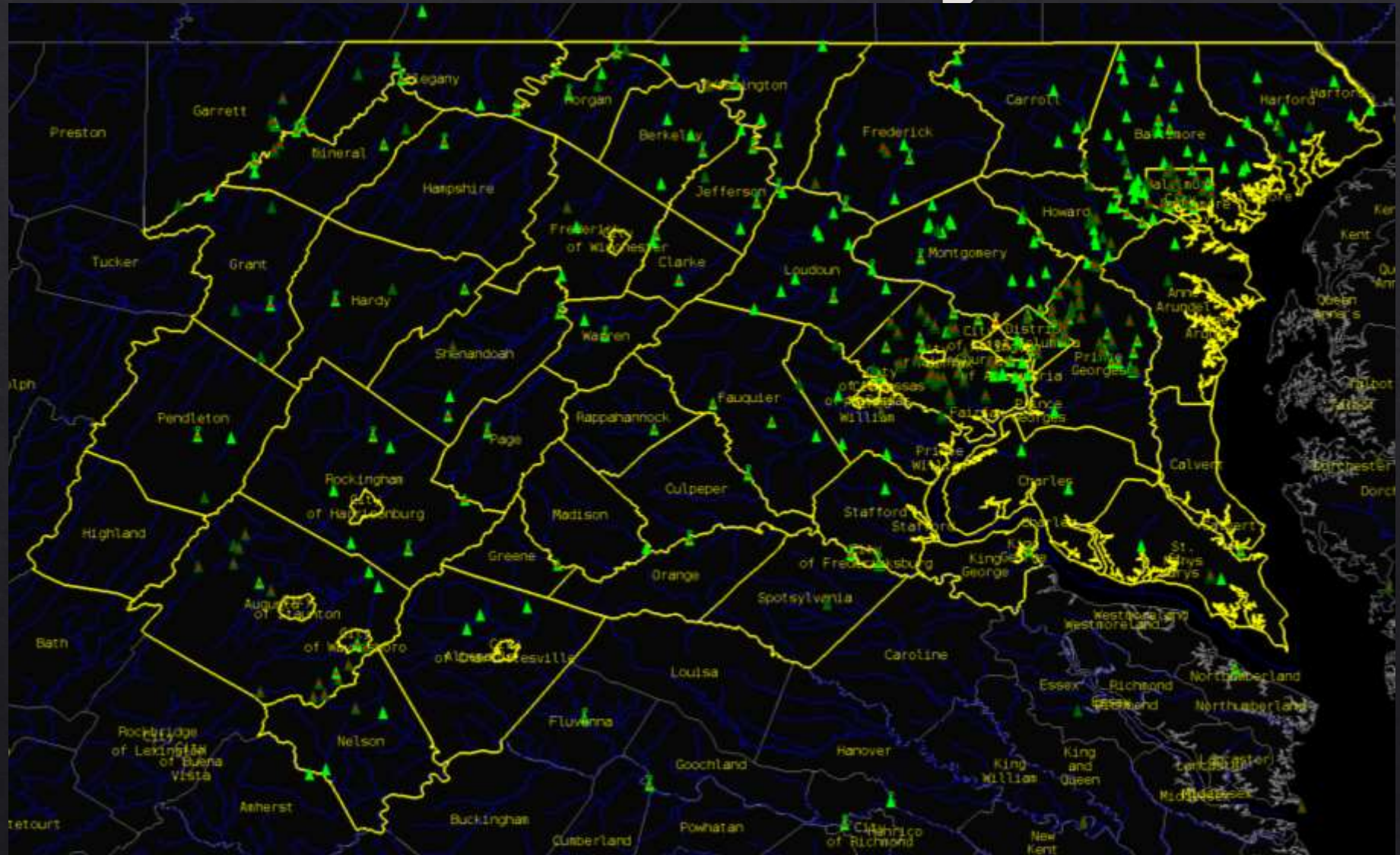


# Flash Floods vs. Areal Floods (2018)

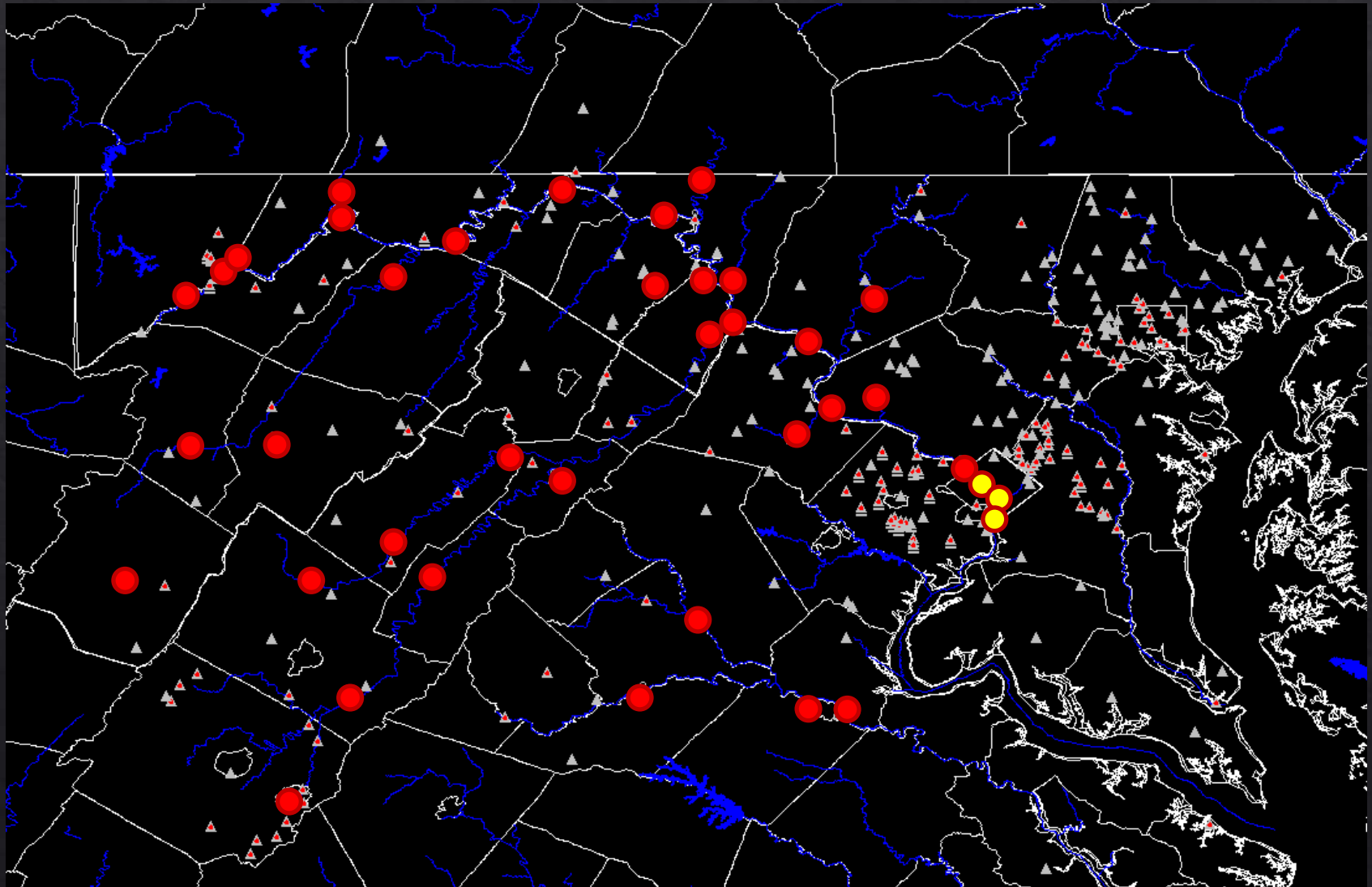




# River & Lake Gauges



# River Flood Forecast Points

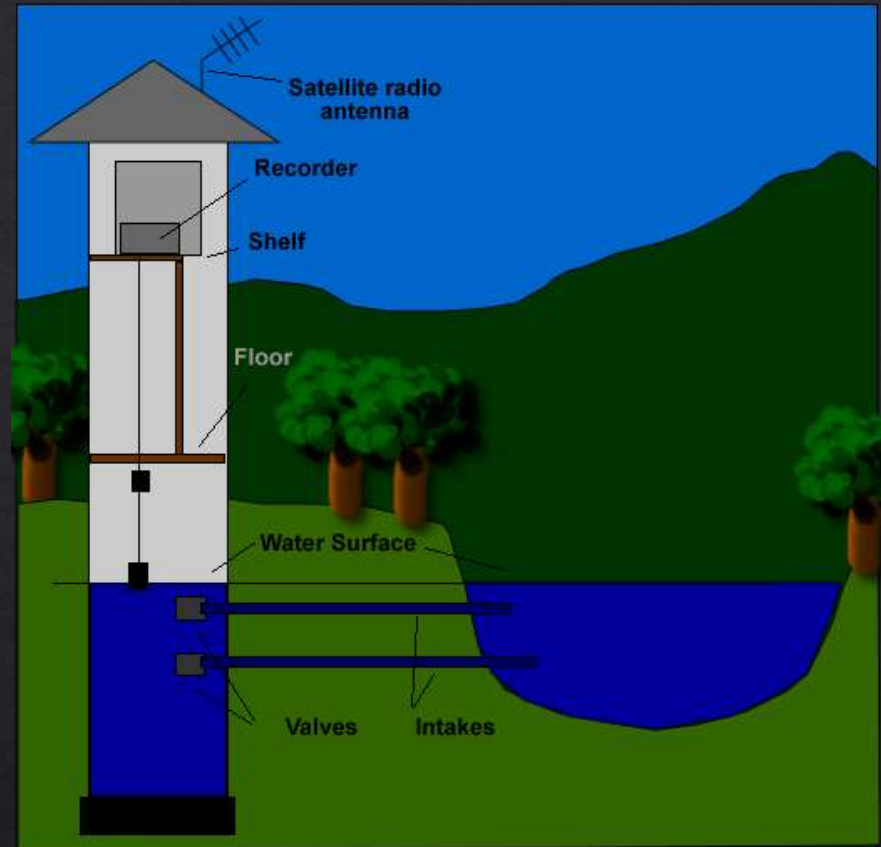




# How are water levels measured?

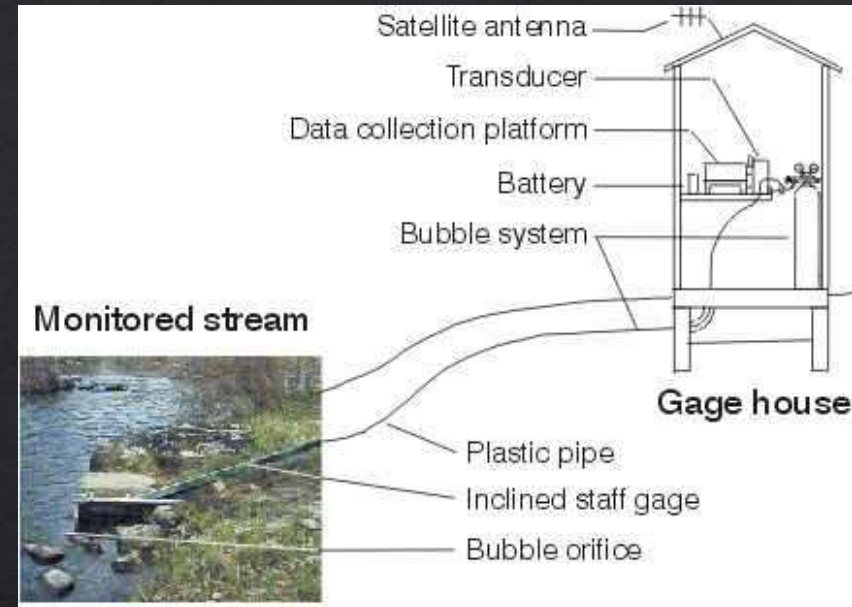
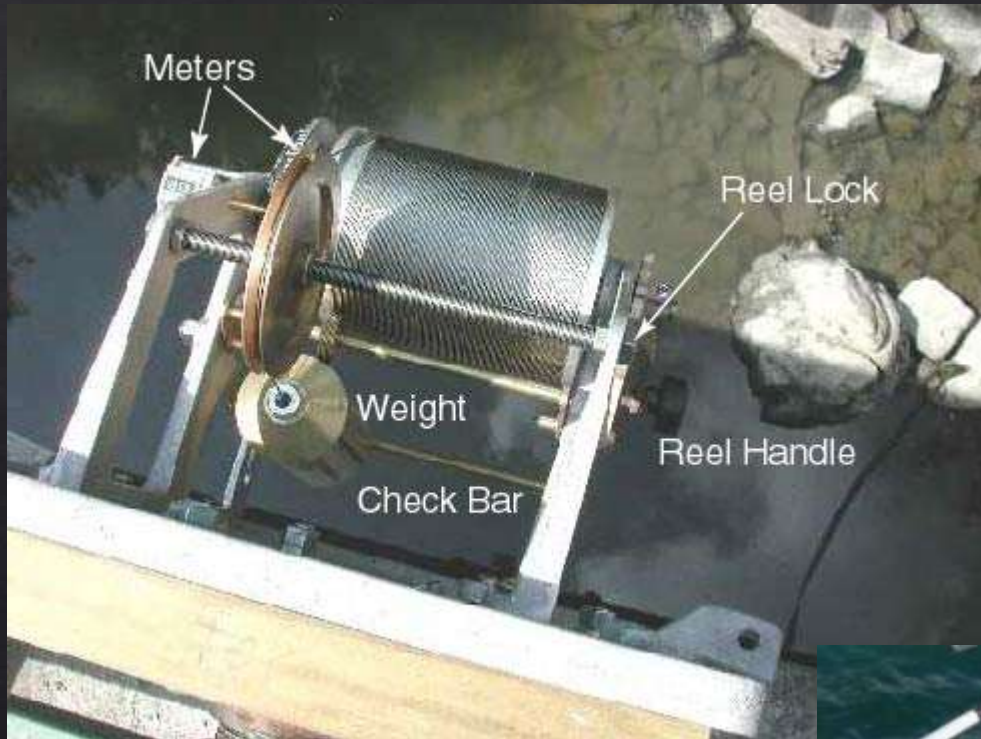


From left:  
Staff Gauge  
Crest Gauge  
Stilling Well / Float





# How are water levels measured?



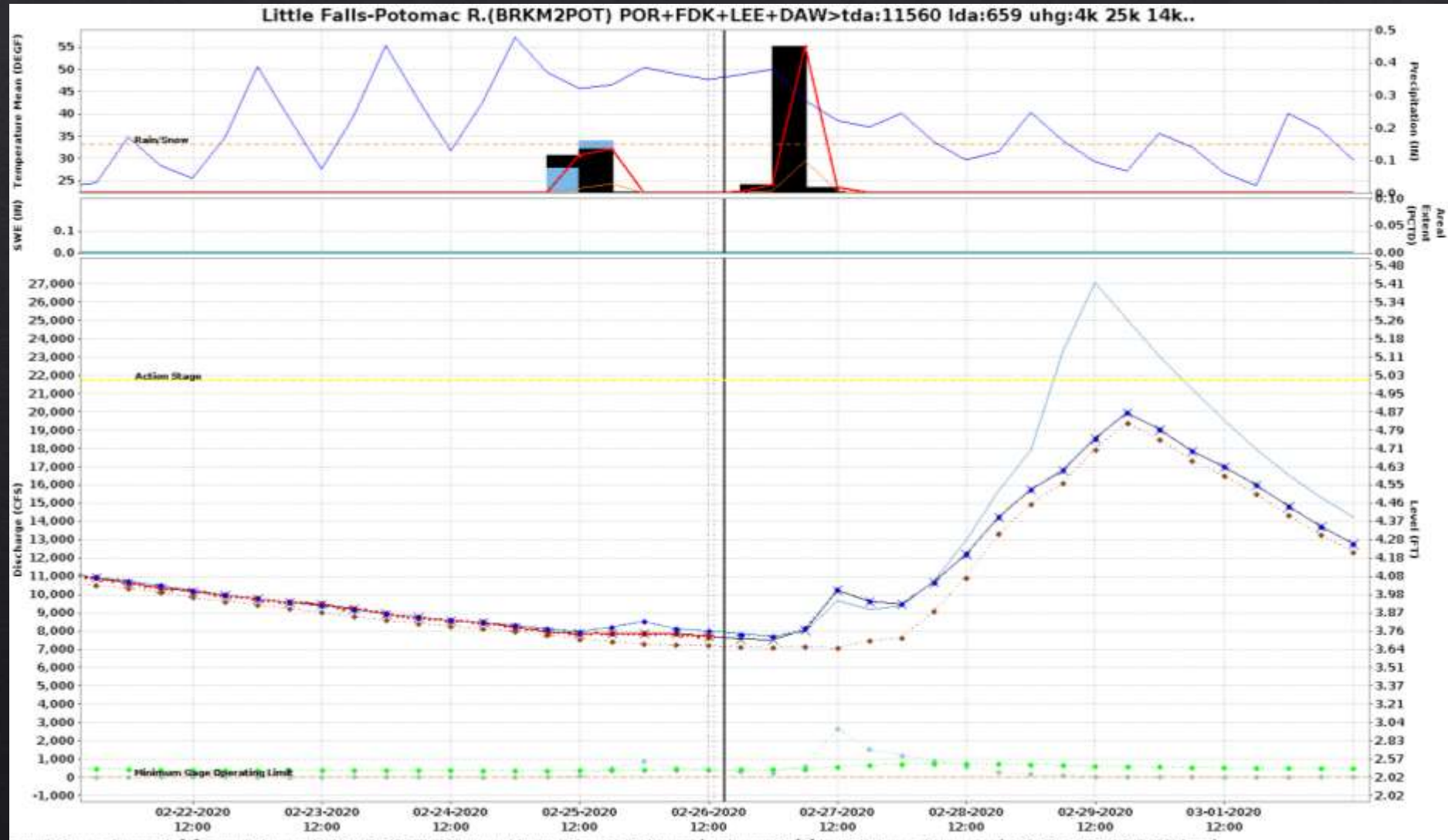
From left:  
Wire Weight Gauge  
Radar Gauge  
Pressure Transducer /  
"Bubbler"

# Where does it flood most often?

- ◇ Robinson River near Locust Dale, VA (LOCV2) – 2.4x / year *Madison & Culpeper Co.*
- ◇ **Cacapon River near Great Cacapon, WV (GCPW2) – 2.3x / year** *Morgan County*
- ◇ **Opequon Creek near Martinsburg, WV (MBGW2) – 2.3x / year** *Berkeley & Jefferson Co.*
- ◇ Western Branch at Upper Marlboro, MD (UPRM2) – 1.8x / year *Prince George's County*
- ◇ Whitemarsh Run at White Marsh, MD (WHMM2) – 1.7x / year *Baltimore County*
- ◇ **Shenandoah River near Millville, WV (MILW2) – 1.6x / year** *Jefferson & Clarke Co.*
- ◇ **Seneca Creek at Dawsonville, MD (DAWM2) – 1.6x / year** *Montgomery County*
- ◇ Otter Point Creek at Edgewood, MD (EDGM2) – 1.6x / year *Harford County*
- ◇ Mechums River near White Hall, VA (MECV2) – 1.5x / year *Albemarle County*
- ◇ St. Mary's River at Great Mills, MD (GMRM2) – 1.4x / year *St. Mary's County*
- ◇ Monocacy River at Bridgeport, MD (BDGM2) – 1.4x / year *Frederick County MD*

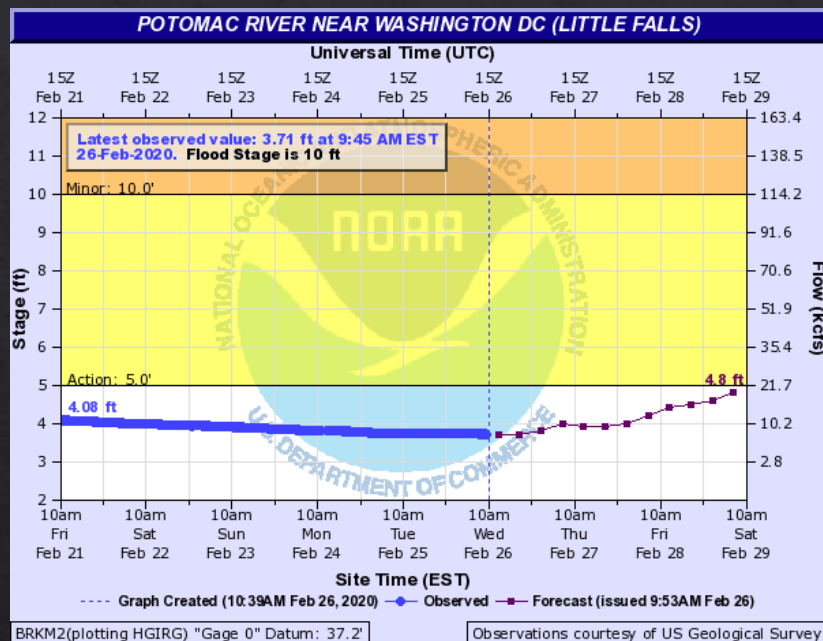


# River Forecast Creation



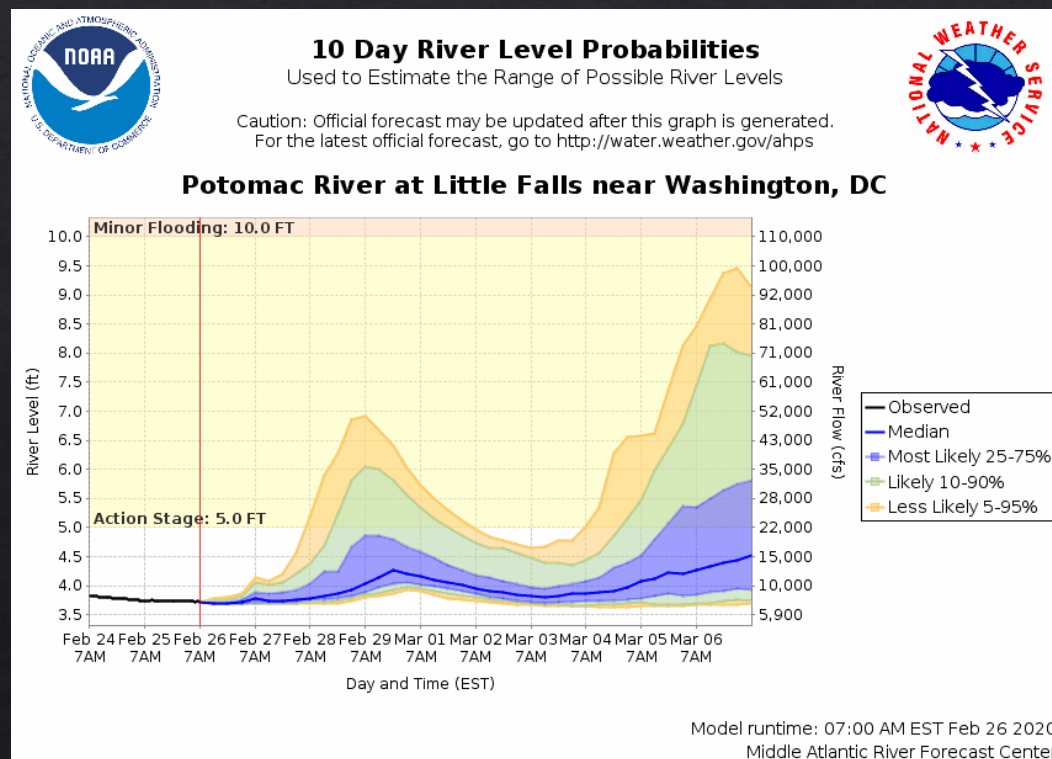


# River Forecasts

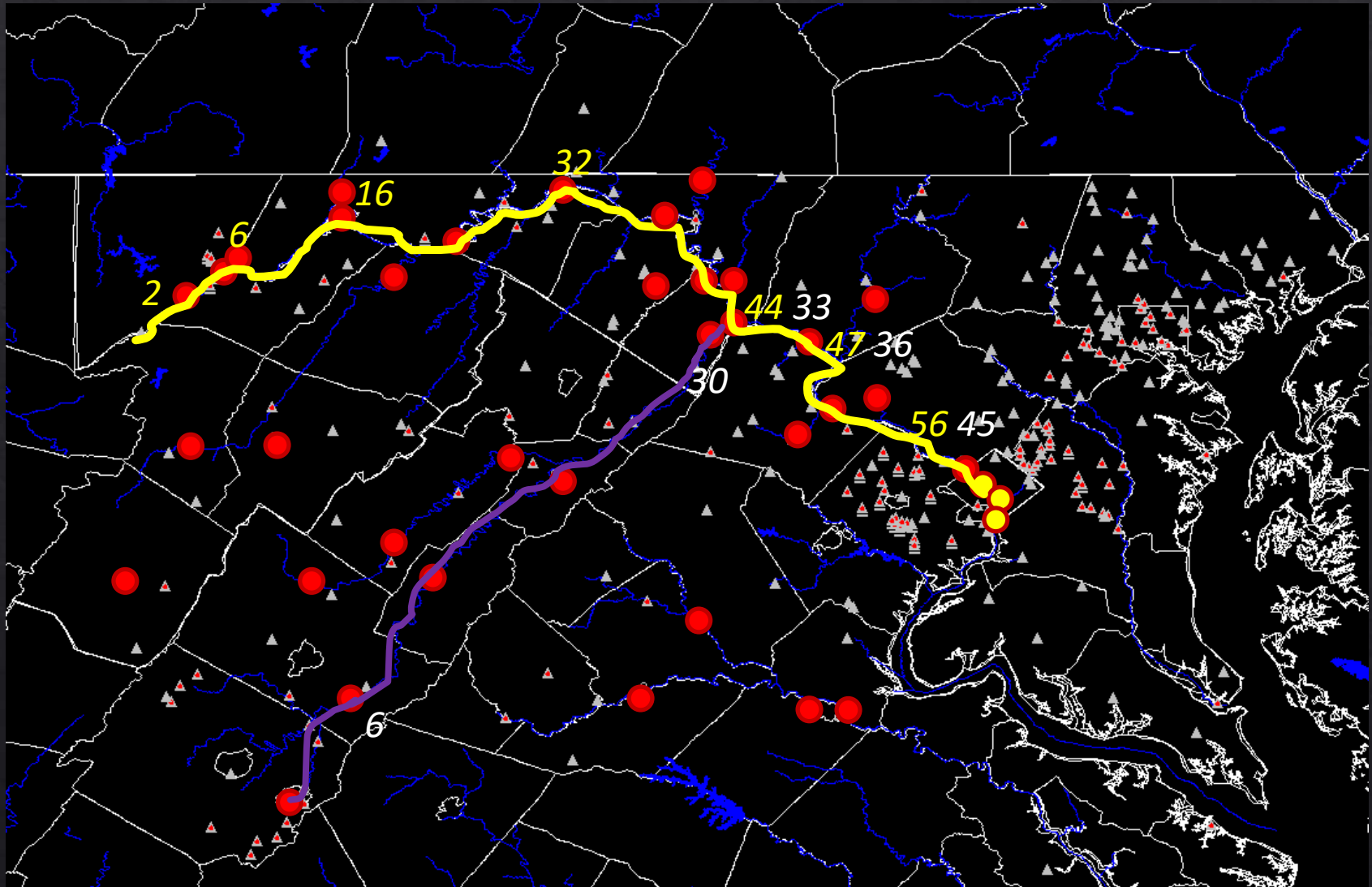


“Probabilistic”  
(range of possibilities)

“Deterministic”  
(one forecast value)



# Travel Times (in hours)

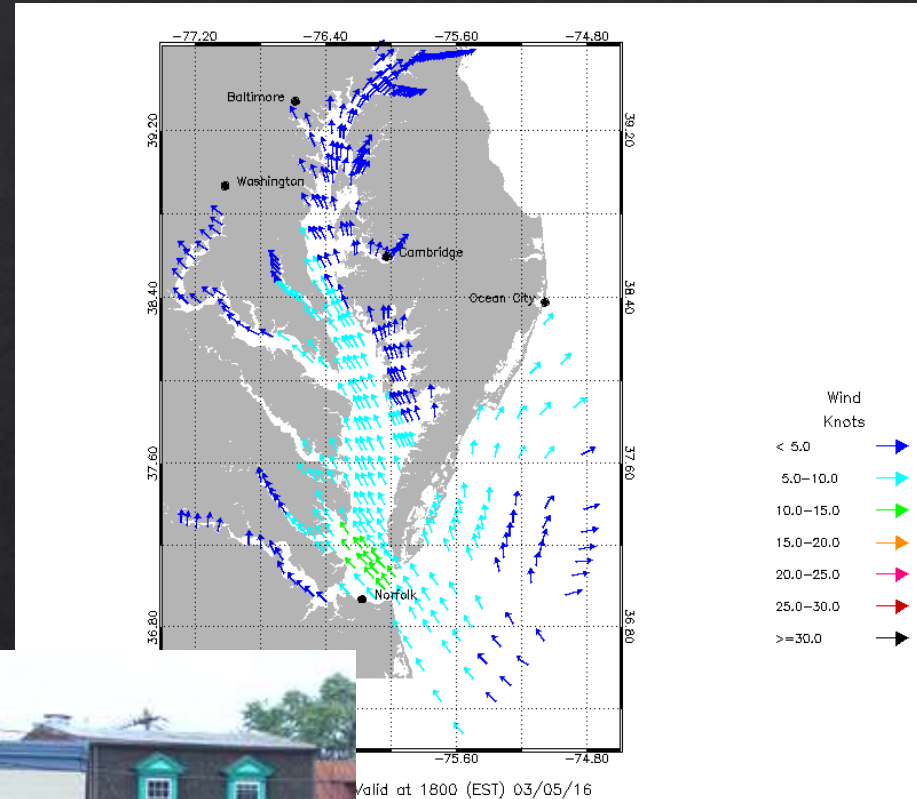


# Tidal / Coastal Flooding

- ◇ Prolonged onshore flow
- ◇ Storm Surge from Tropical Systems



Annapolis, MD





# Coastal Flooding

Tidal / Coastal Flooding  
can be just a nuisance...

...or it can be something  
quite significant...

**Minor Coastal Flooding at the  
US Naval Academy**



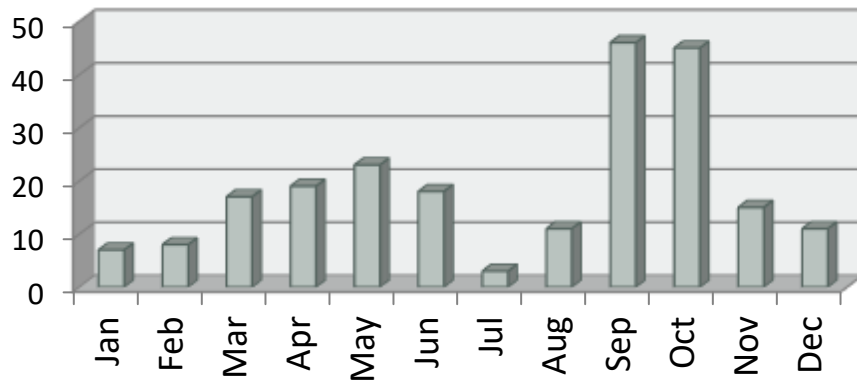
**Flooding at the Annapolis Boat  
Show in 2017 (happened again  
in 2019 and was even worse!)**



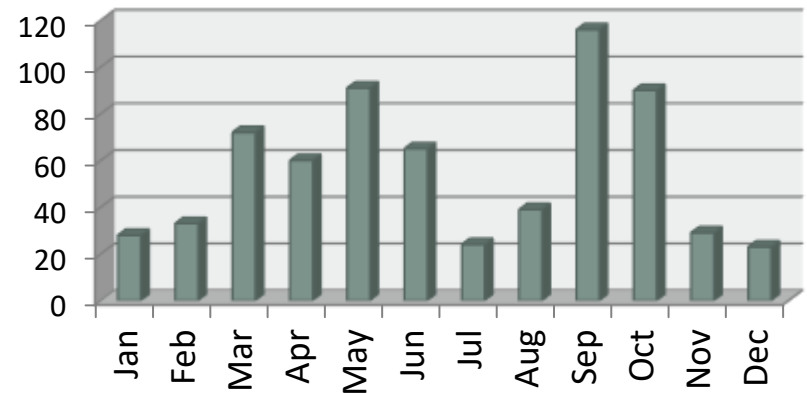
# Coastal Flooding

- ◆ Two distinct peaks for positive departures  
*May/June & September/October*
- ◆ September stands out due to tropical systems  
(but they are not necessary to cause flooding)

**Number of Flood Occurrences by Month (1996-2015) in Baltimore, MD**



**Number of Flood Occurrences by Month (1996-2015) in Washington, DC**



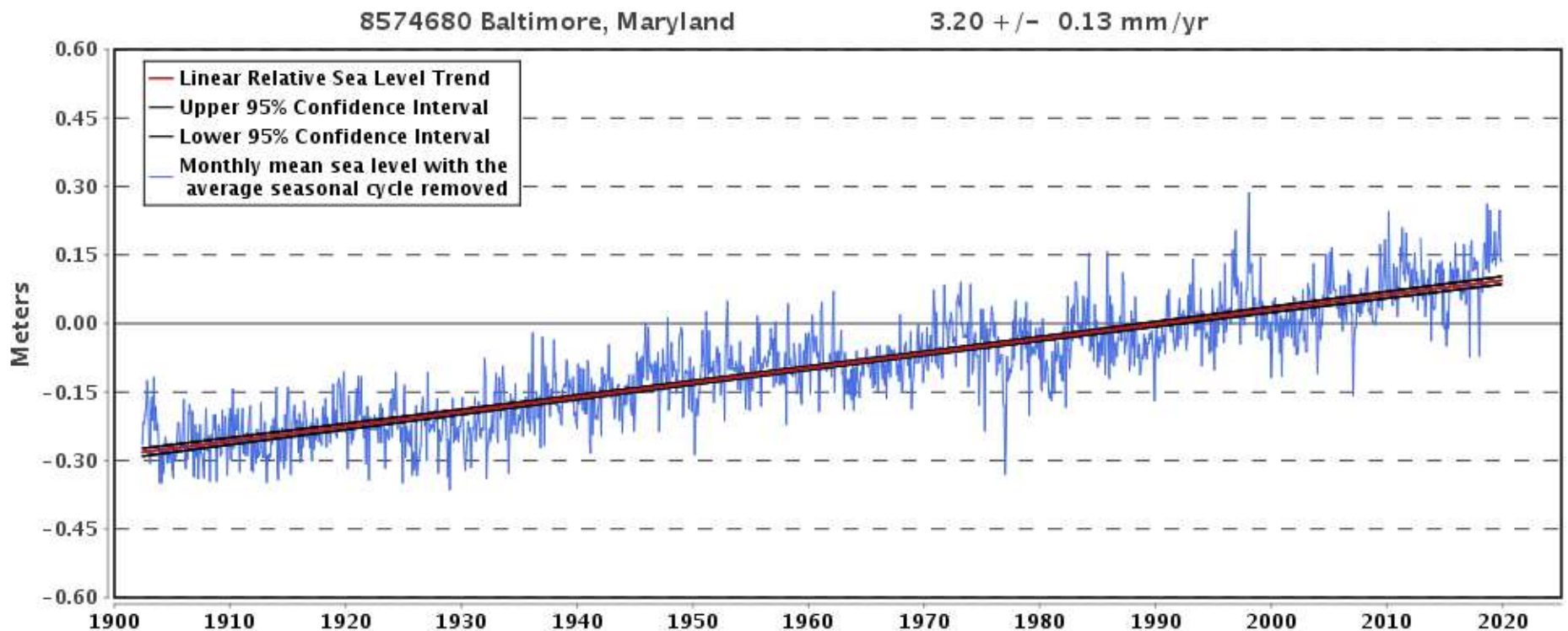
# Coastal Flooding





# On the Rise

- ◇ Mean Sea Level (MSL) is steadily rising... (average rate ~1 foot/century)
- ◇ Note the last few years have been above the trendline

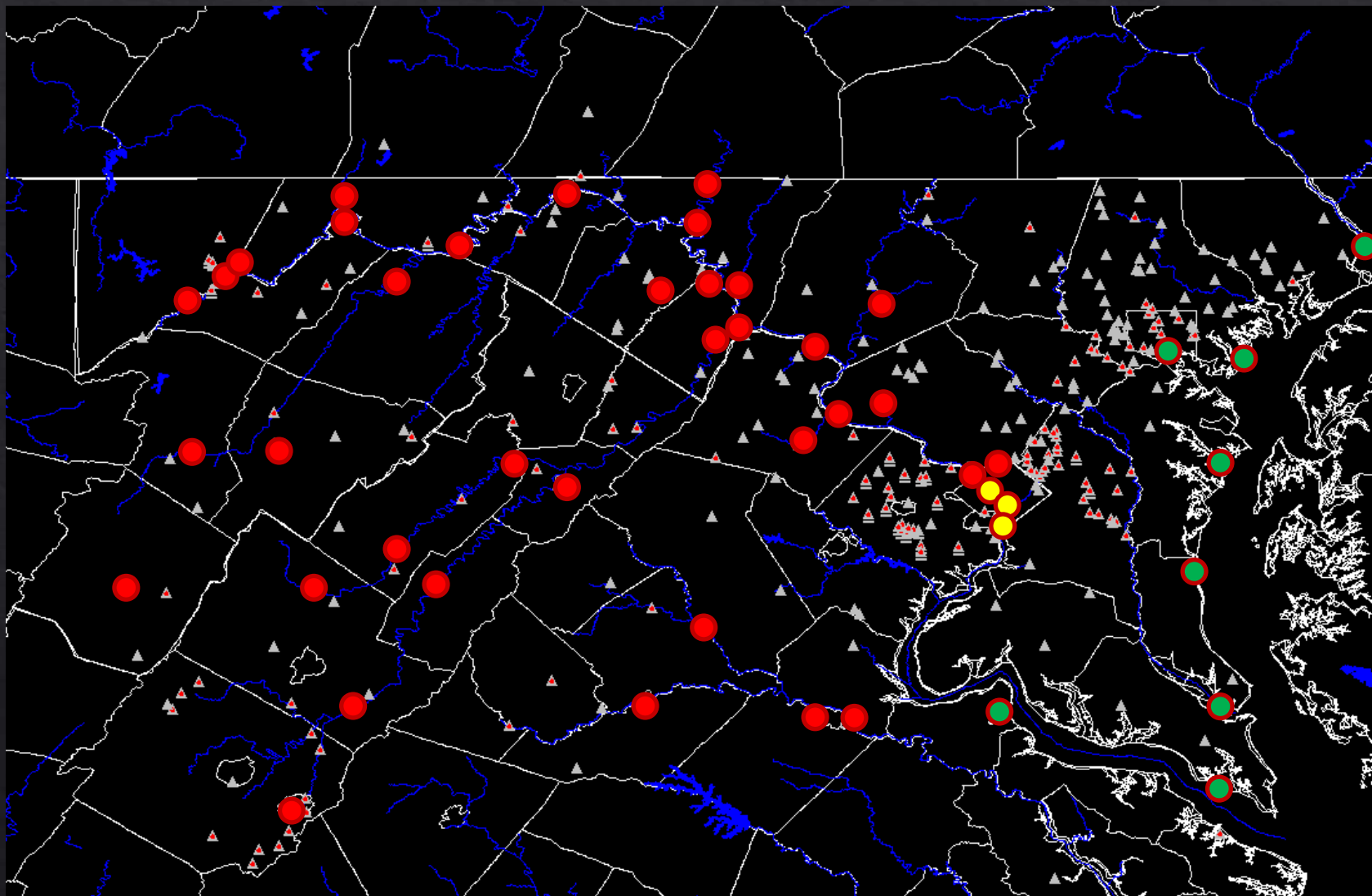


# More of a Nuisance

- ◆ A NOAA study finds that nuisance flooding (defined as reaching our NWS 'minor flood' level) has substantially increased in the last 50 years.
- ◆ This is due to a rise in the base water level, not due to increased storms.

City	Average nuisance flood days (1957-63)	Average nuisance flood days (2007-13)	Percent increase
Annapolis	3.8	39.3	925%
Baltimore	1.3	13.1	922%
Washington	6.3	29.7	373%

# Flood Forecast Points





# Flood Type Summary

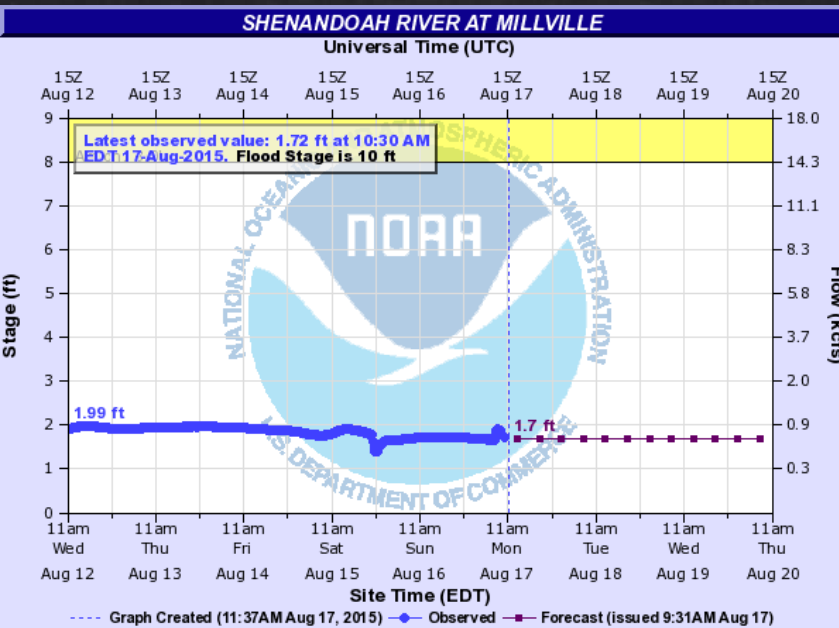
- ◇ In a single event, we must consider:
  - ◇ Flash Flooding
  - ◇ Stream/"Areal" Flooding
  - ◇ Nuisance/Street Flooding
  - ◇ Tidal Flooding
- ◇ ...often all at the same time...and at the same time as severe weather or other hazardous weather...
- ◇ ...and ensure the public is properly notified of any/all of these threats that may affect them!

# When reporting flooding to us...

- ◆ Don't worry about characterizing the type of flooding. Just give the facts, as specifically as possible, and we can do the characterization.
- ◆ More on that later!

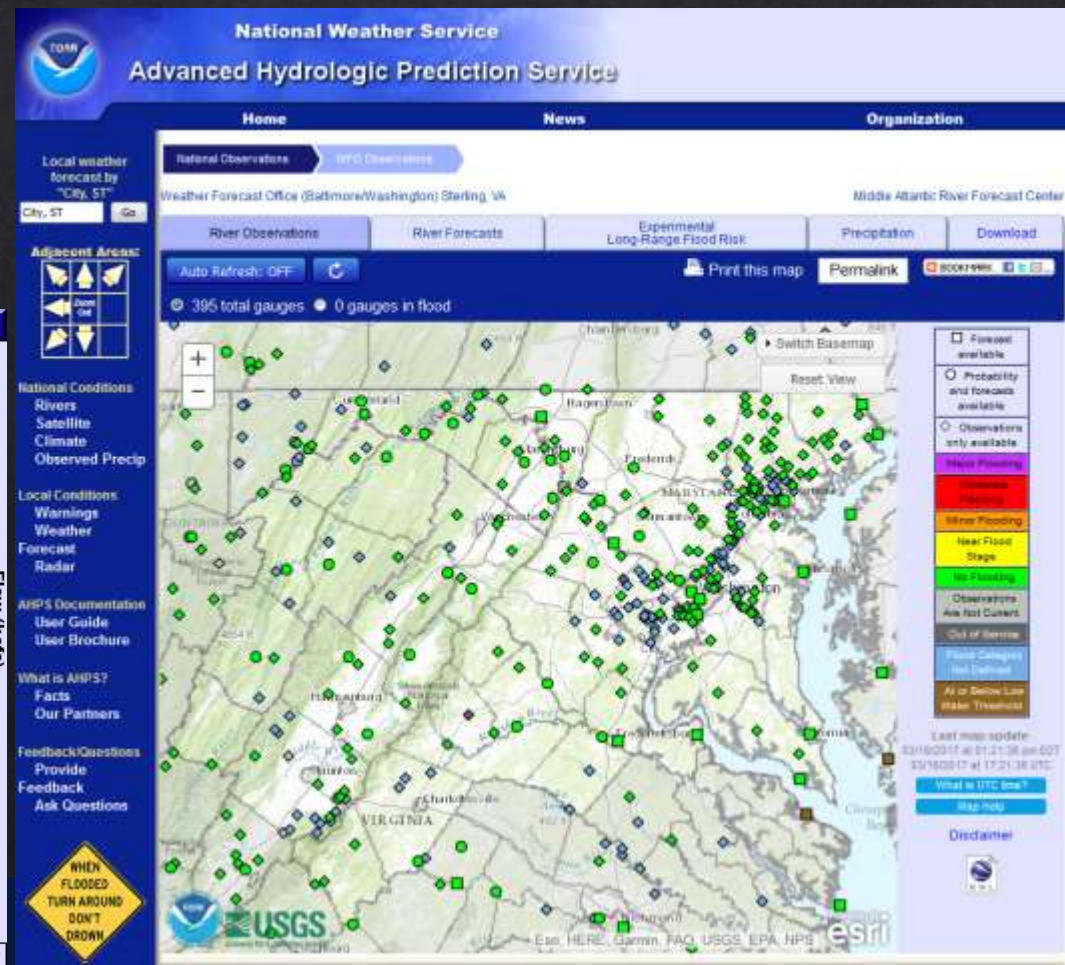
# Viewing live river data & forecasts

<http://water.weather.gov>



MILW2(plotting HGIRG) "Gage 0" Datum: 293.32'

Observations courtesy of US Geological Survey





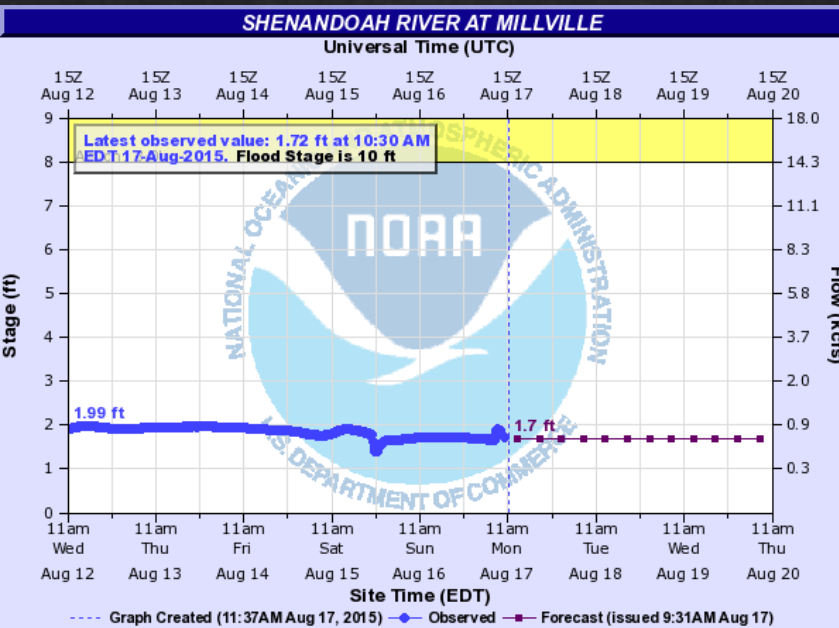
# Break time!

Please return in 10 minutes



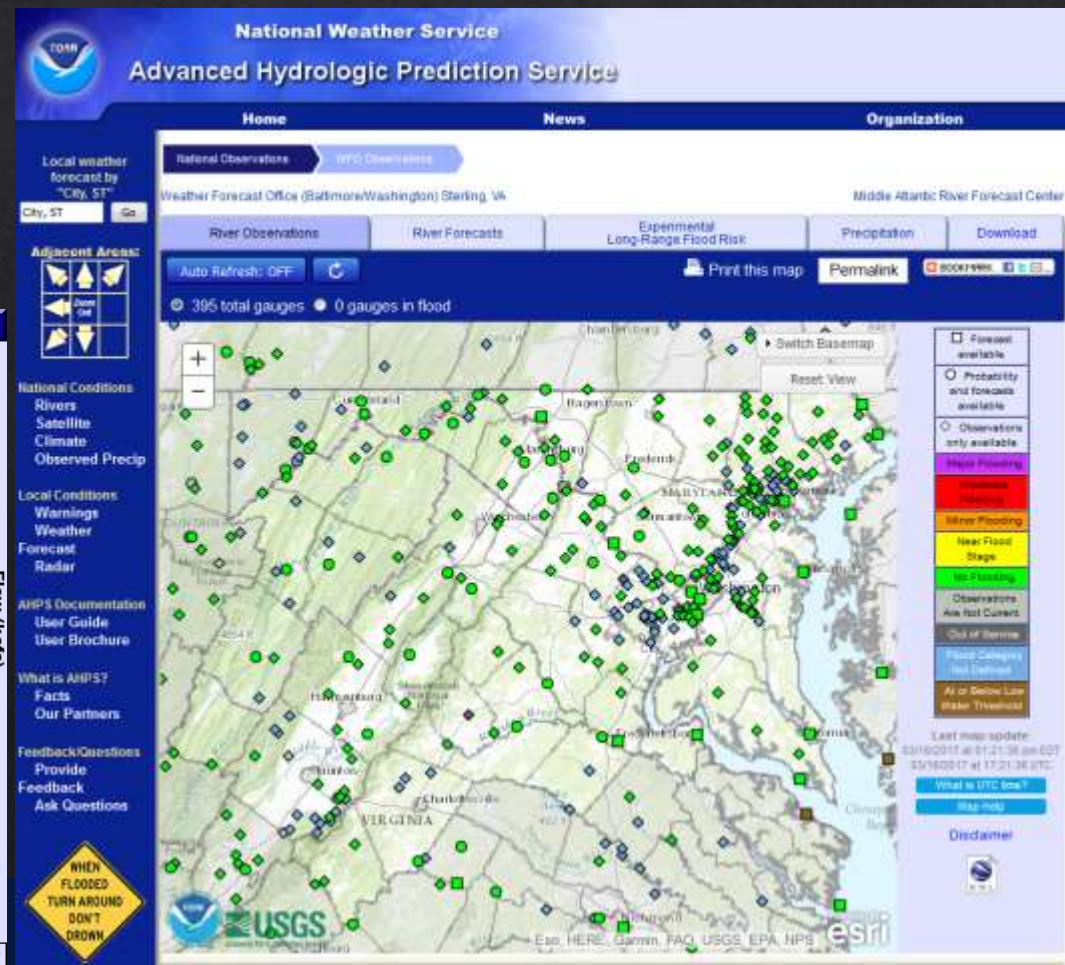
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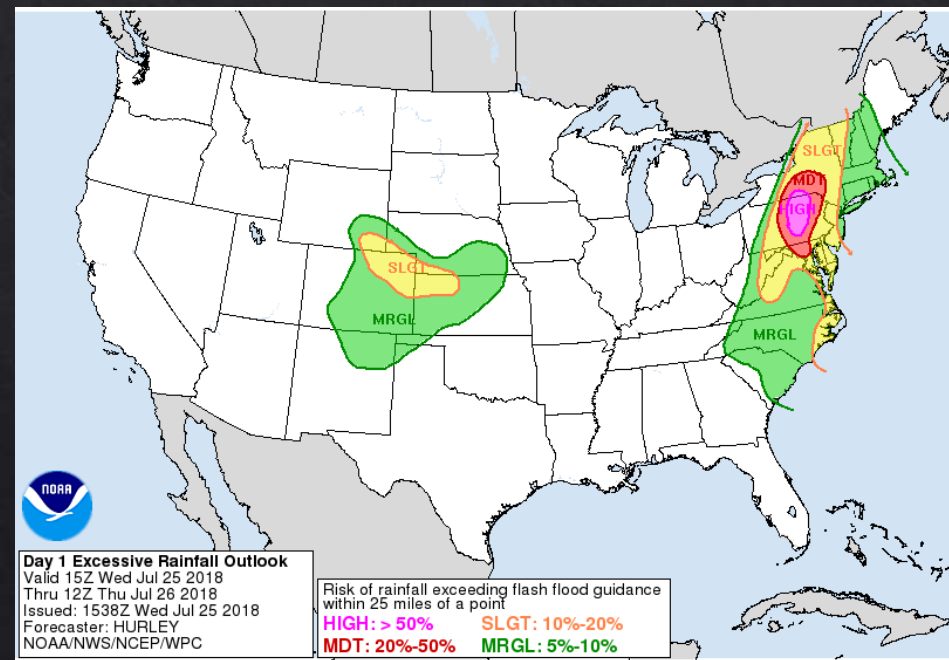
# Our Products





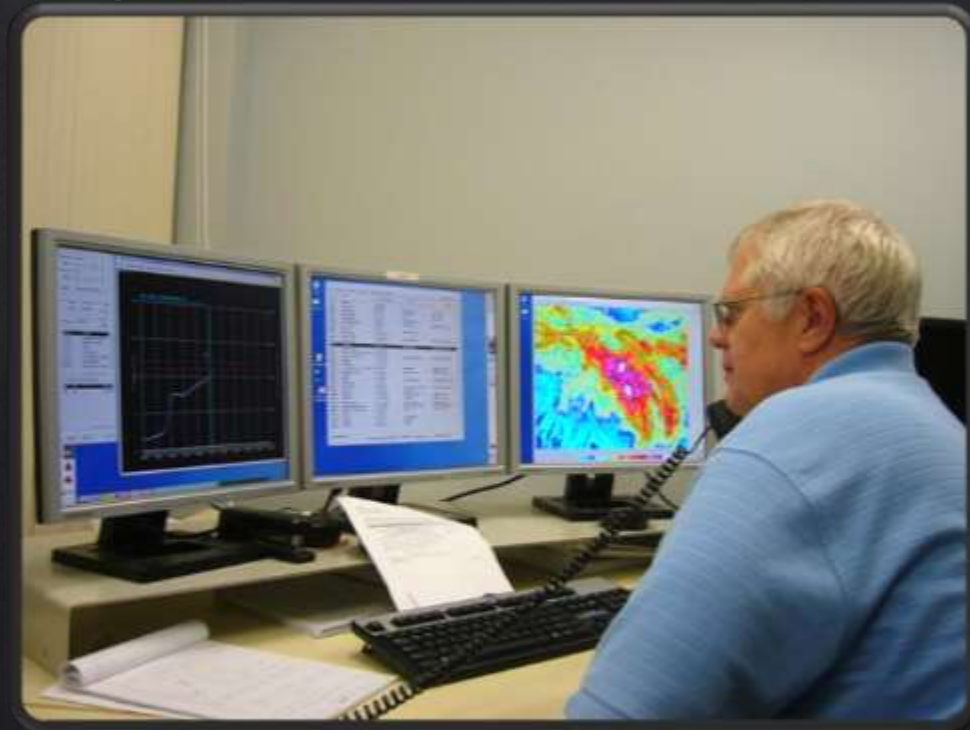
# Outlook Phase

- ❖ The Hazardous Weather Outlook will mention:
  - ❖ Flood potential in the Day 3-7 period
  - ❖ Flood potential in the first 48-72 hours, if confidence is too low for a watch
  - ❖ Coastal flood potential for moderate flooding or greater only at any time in the seven day forecast.
- ❖ The Weather Prediction Center (WPC) issues Excessive Rainfall Outlooks for Days 1-3. These are not an indication of expected flood coverage, not severity!
- ❖ HIGH risks matter!

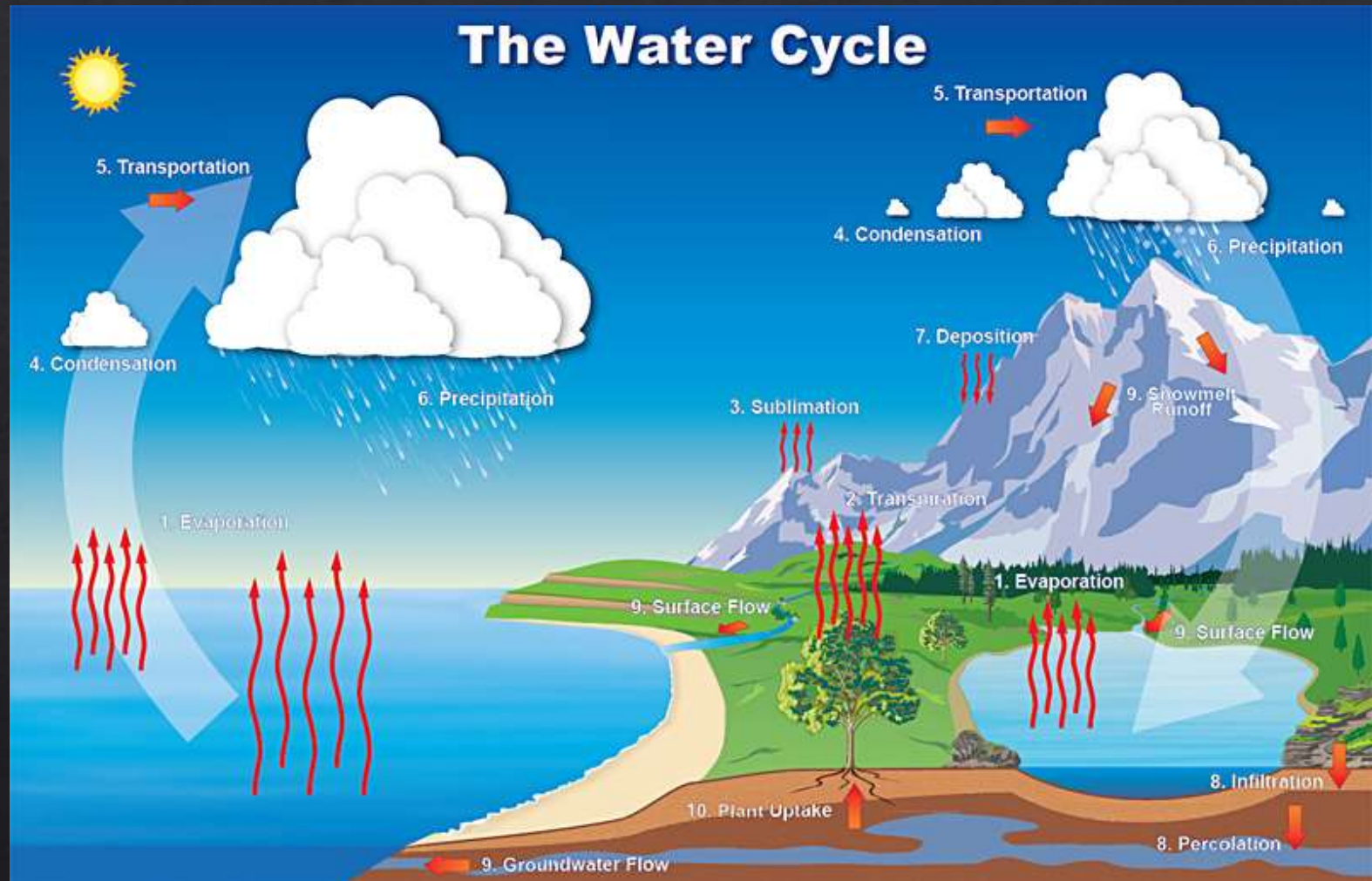


# How do we forecast flood potential?

- ◆ Pre-event assessment *"antecedent conditions"*
- ◆ Consider areas more prone to flooding
- ◆ Look for favorable weather patterns
- ◆ Forecast expected rainfall
- ◆ Put it all together!



# Basic Hydrology

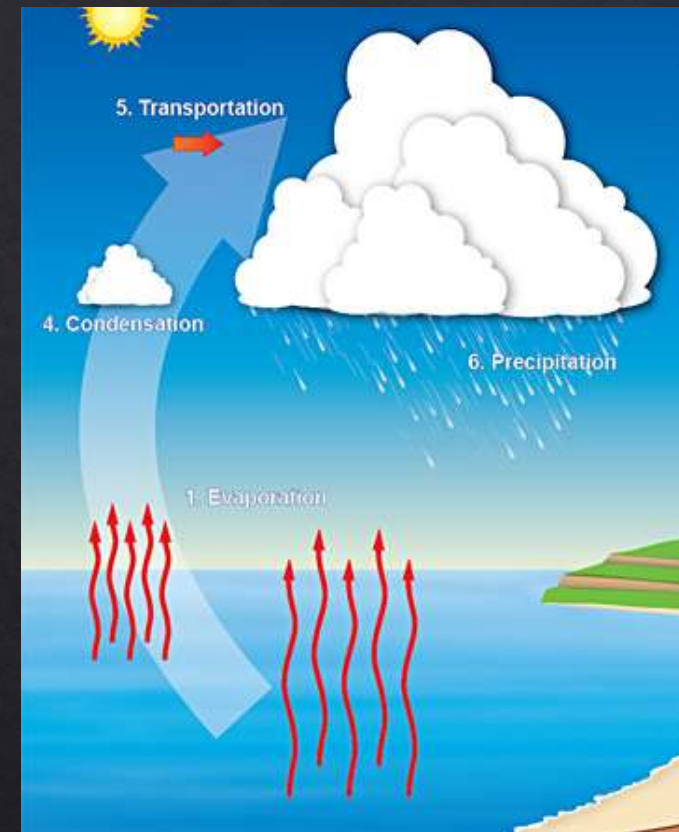


<http://polaris.umuc.edu/cvu/envm/hydro/hydrologic.swf>



# Precipitation in the Water Cycle

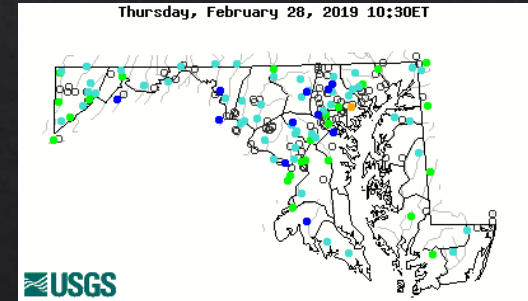
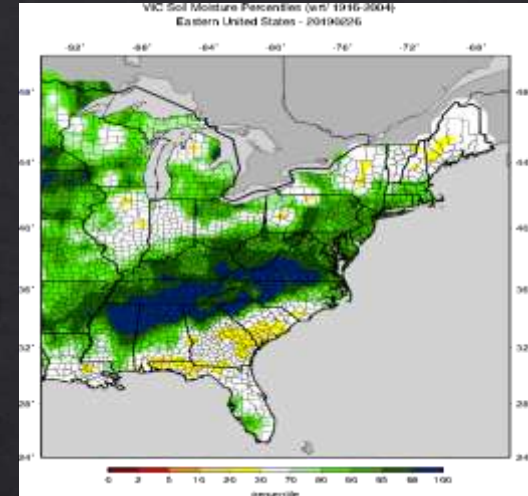
- ❖ The air must be nearly saturated. (100% Relative Humidity)
- ❖ Cloud droplets or ice crystals form through condensation on small particles (often minerals in the air)
- ❖ These droplets/crystals then grow in size
- ❖ For precipitation to occur, cloud elements must get so large that their falling speeds exceed the upward motion in the air
- ❖ Also, the precipitation must be able to fall through any drier air that exists between the cloud and the ground.



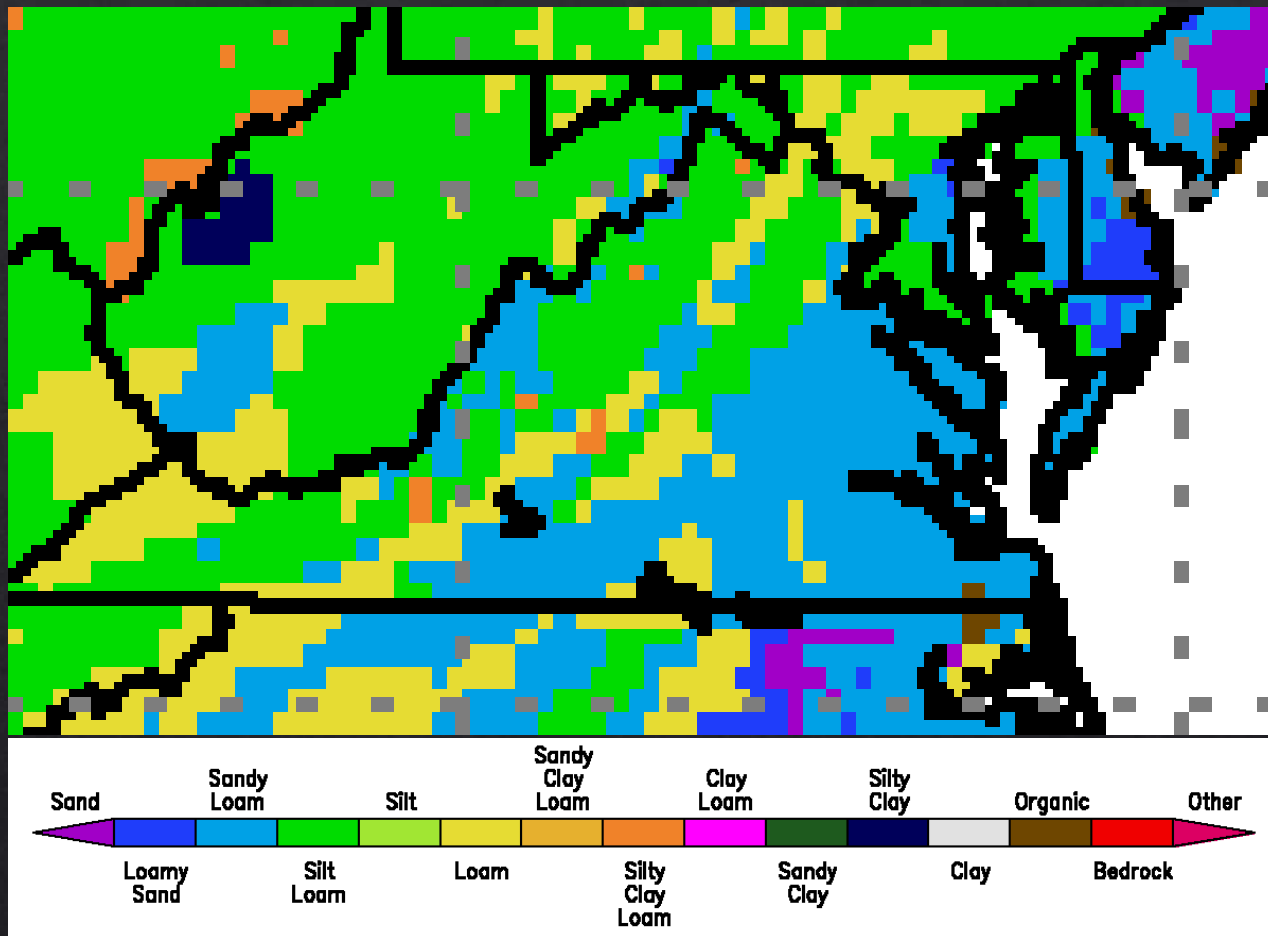
# Pre-event assessment

## Questions to ask / items to check:

- ◇ Is the ground/soil wet or dry?
- ◇ What type of soil exists? (sandy, clay, frozen)
- ◇ Are streams at baseflow or elevated?
- ◇ What is the topography of the area?
- ◇ **More questions based on time of year**
  - ◇ Have the trees leafed out yet?
  - ◇ Is there snow on the ground? Will the snow melt?
  - ◇ Could plowed snow or fallen leaves clog drainage systems?



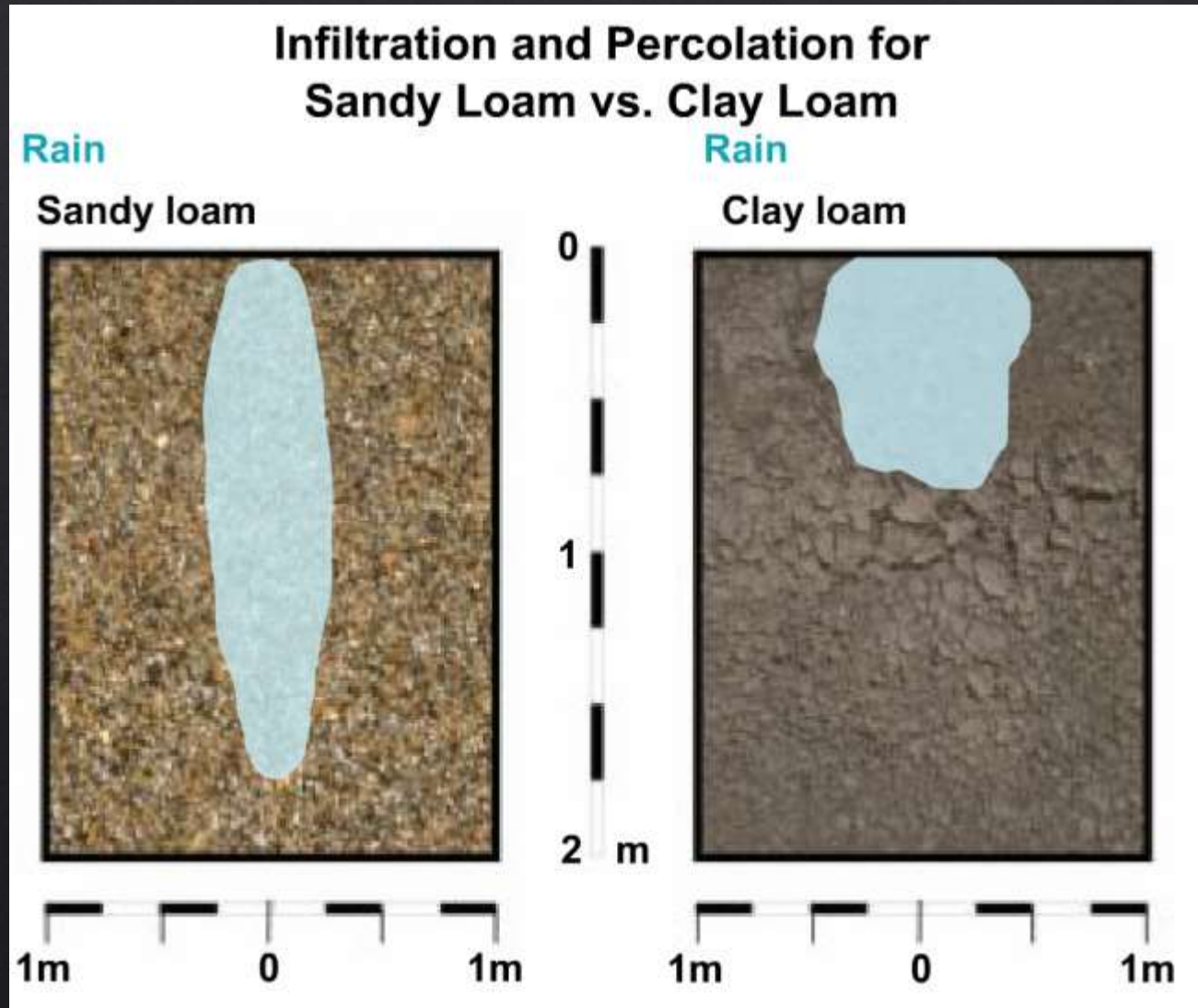
# Soil Types





# Soil Type Effects

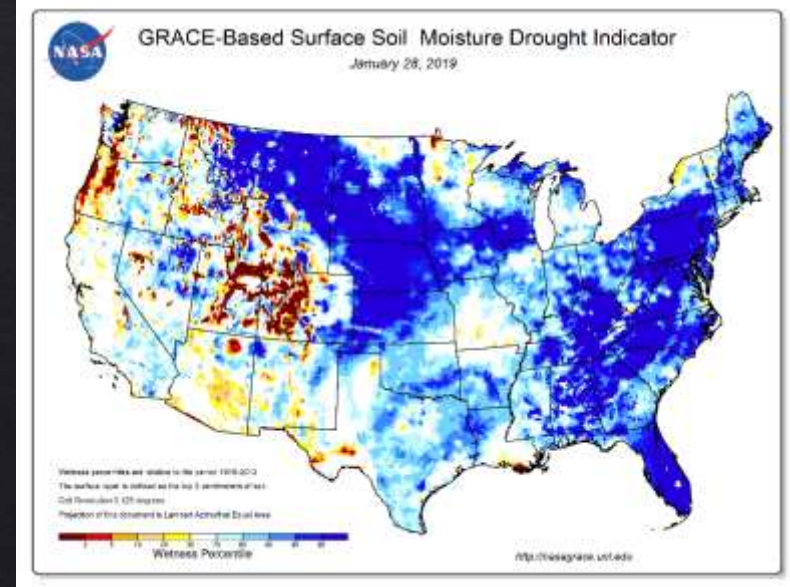
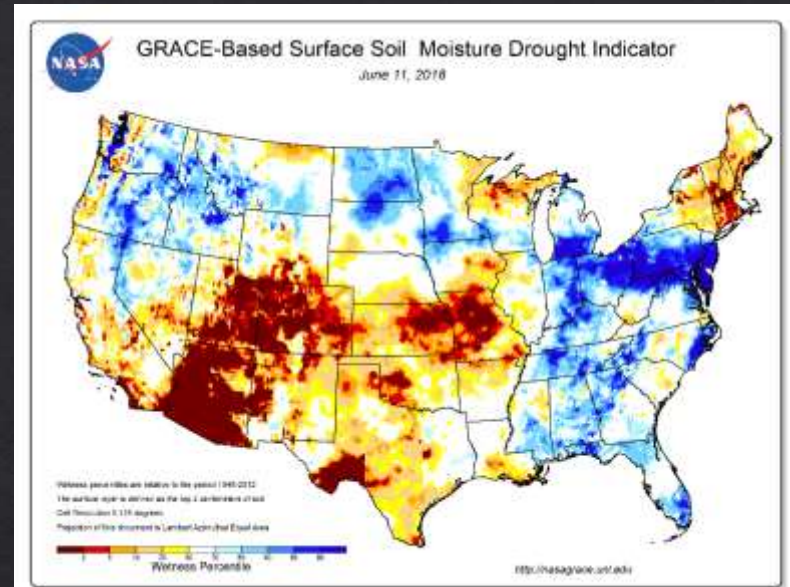
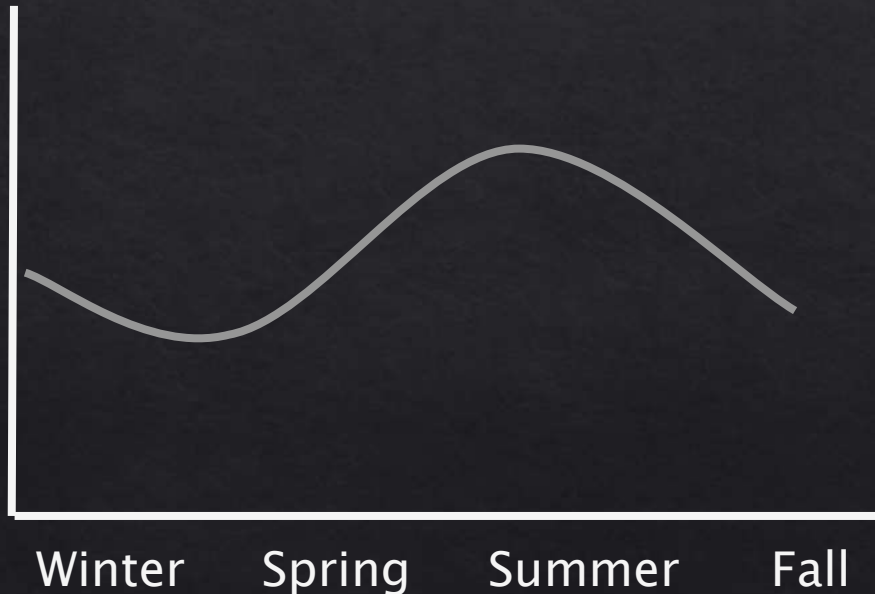
- ◇ Sandy soils accept rainwater deeper into the ground faster, thus taking longer to approach saturation and leading to less flood susceptibility.



# Soils

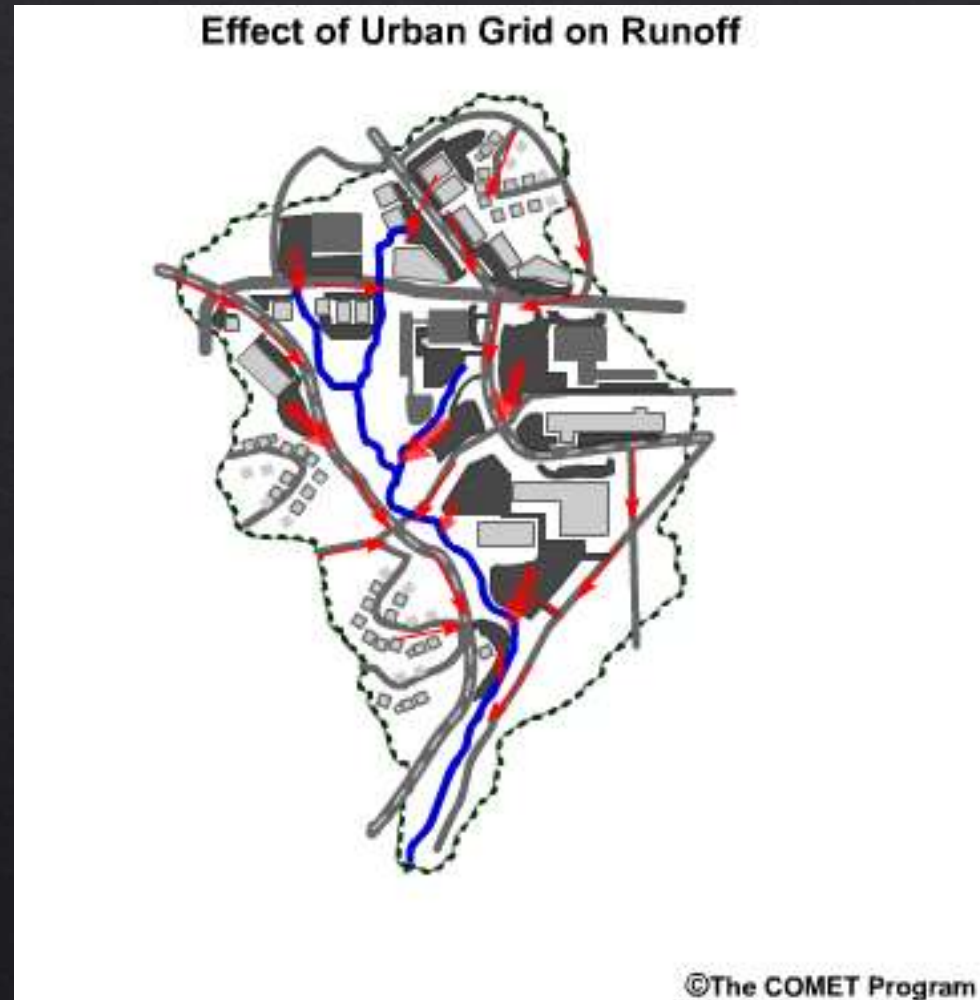
- ◇ But also: Soil infiltration rate changes with the season. This impacts flood potential!

Mean Infiltration rate



# How Urbanization Effects Flooding

- Anything that cannot be absorbed into the soil becomes *runoff*.
- In an urban area, where surfaces like concrete and asphalt are impermeable, everything becomes runoff!





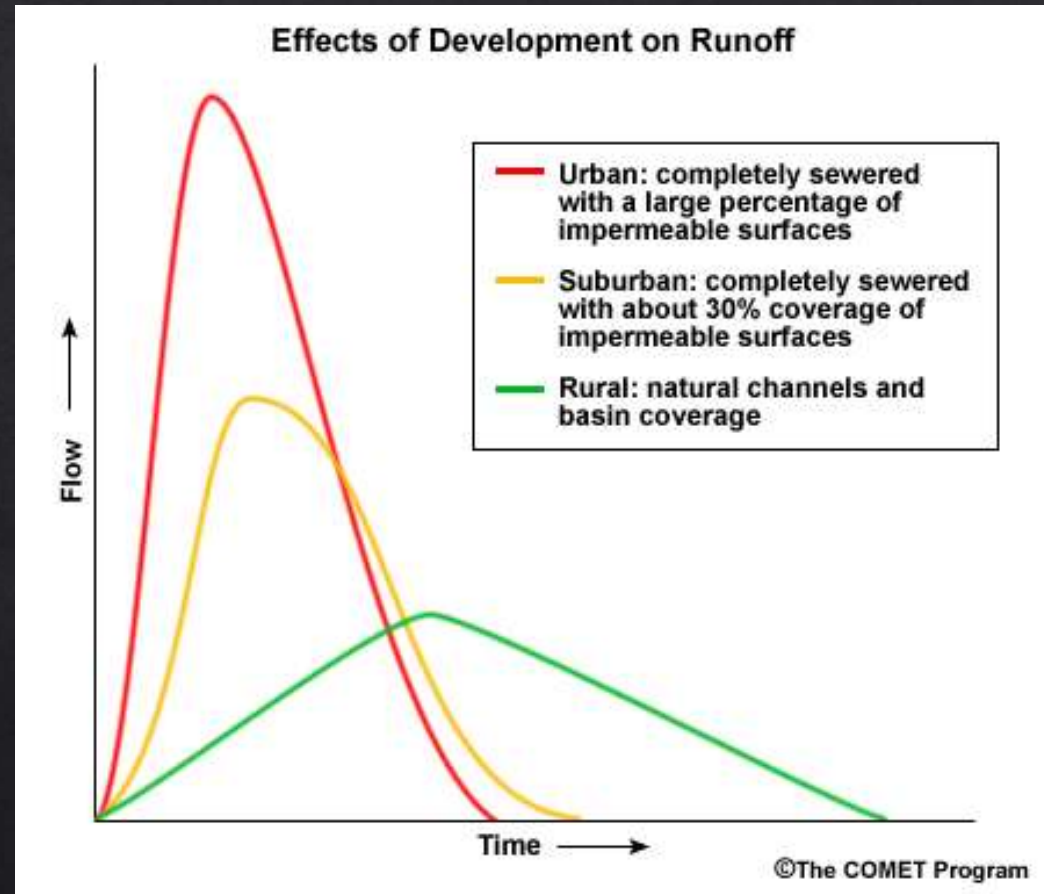
# Bigger, Faster, Better?

## ◇ The good:

- ◇ The stream reacts faster, and thus may be less susceptible to a prolonged event.

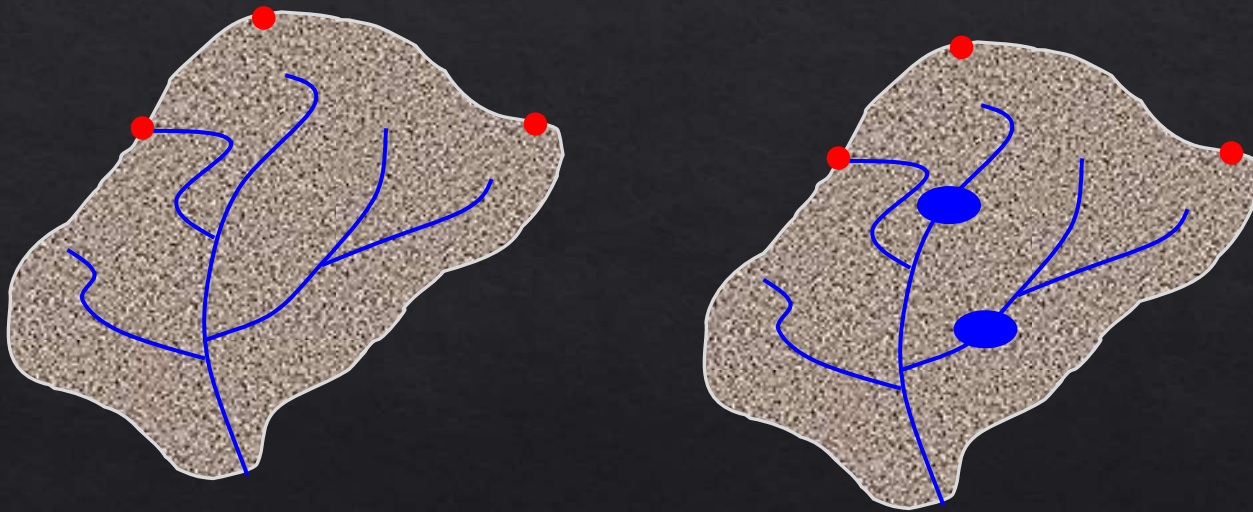
## ◇ The bad:

- ◇ The stream rises higher due to runoff, and thus may be more susceptible to a high intensity (but relatively short duration) event.



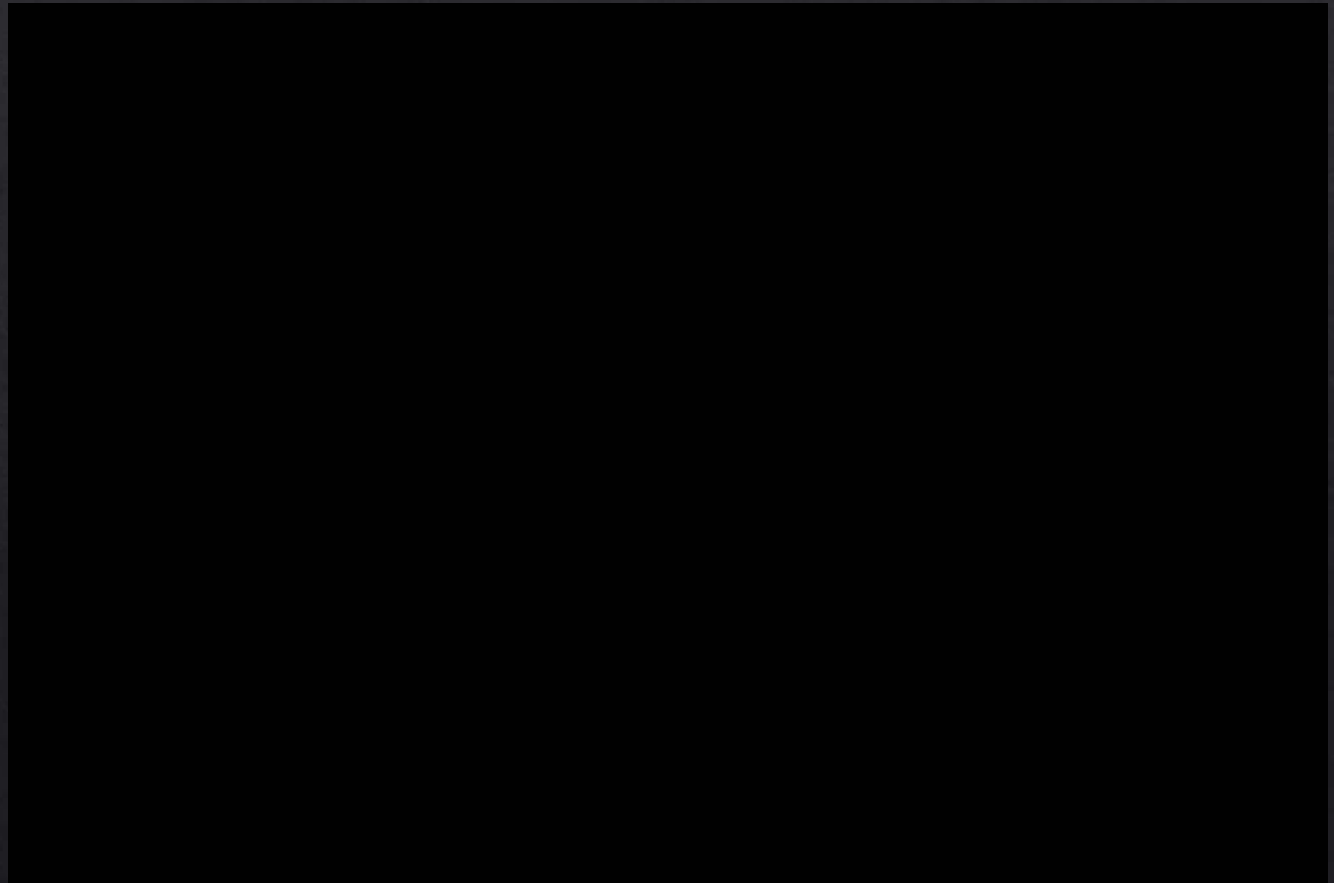
# Why Dams Can Be Helpful

Key point: Lakes and flood control basins are important to locate



# Why Dams Can Be Harmful

- ◇ Although it's rare, sometimes (due to a variety of factors) a dam could fail. If it does, downstream flooding can be catastrophic.



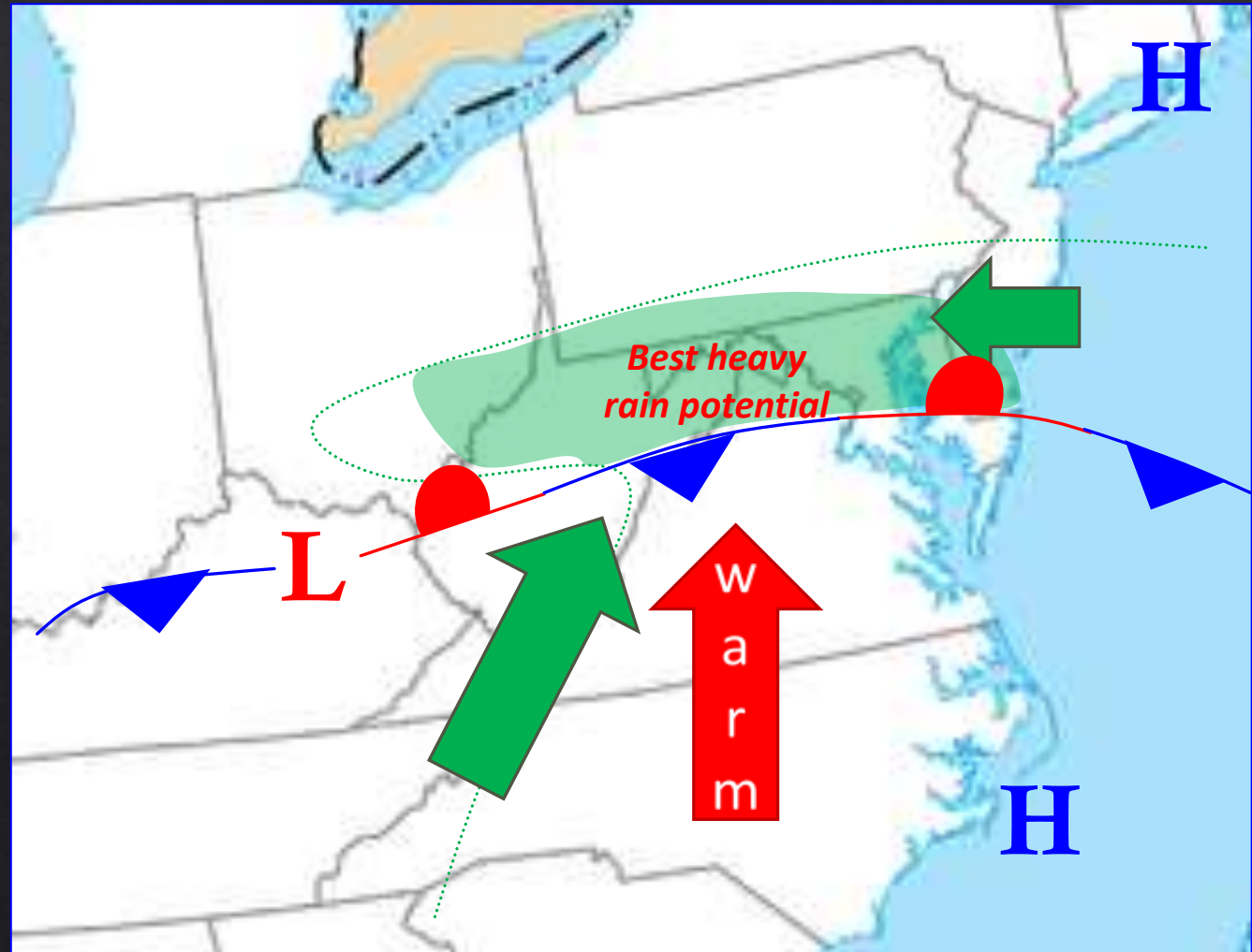


# What Causes Floods Here?

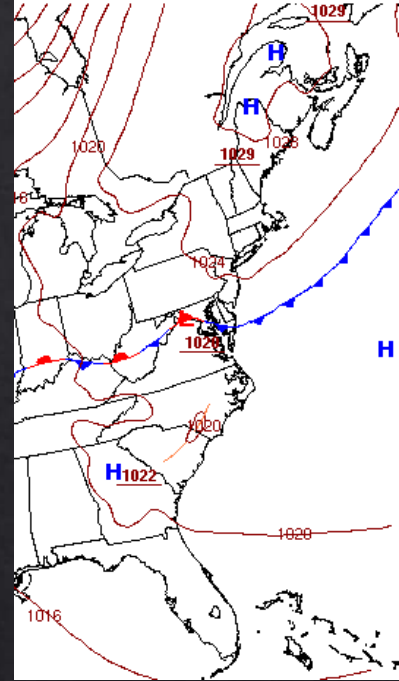
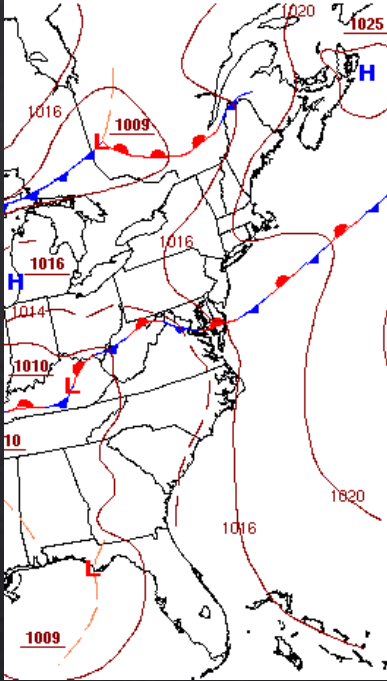
- ◇ Stalled fronts  
(with more extreme floods near them in the summer)
- ◇ Coastal Lows
- ◇ Tropical storms / hurricanes
- ◇ Snowmelt
- ◇ Unusually high tides (sometimes not from hurricanes)

# Stalled Fronts

*The heaviest rain may not be where you would have expected!*



## How common is it?

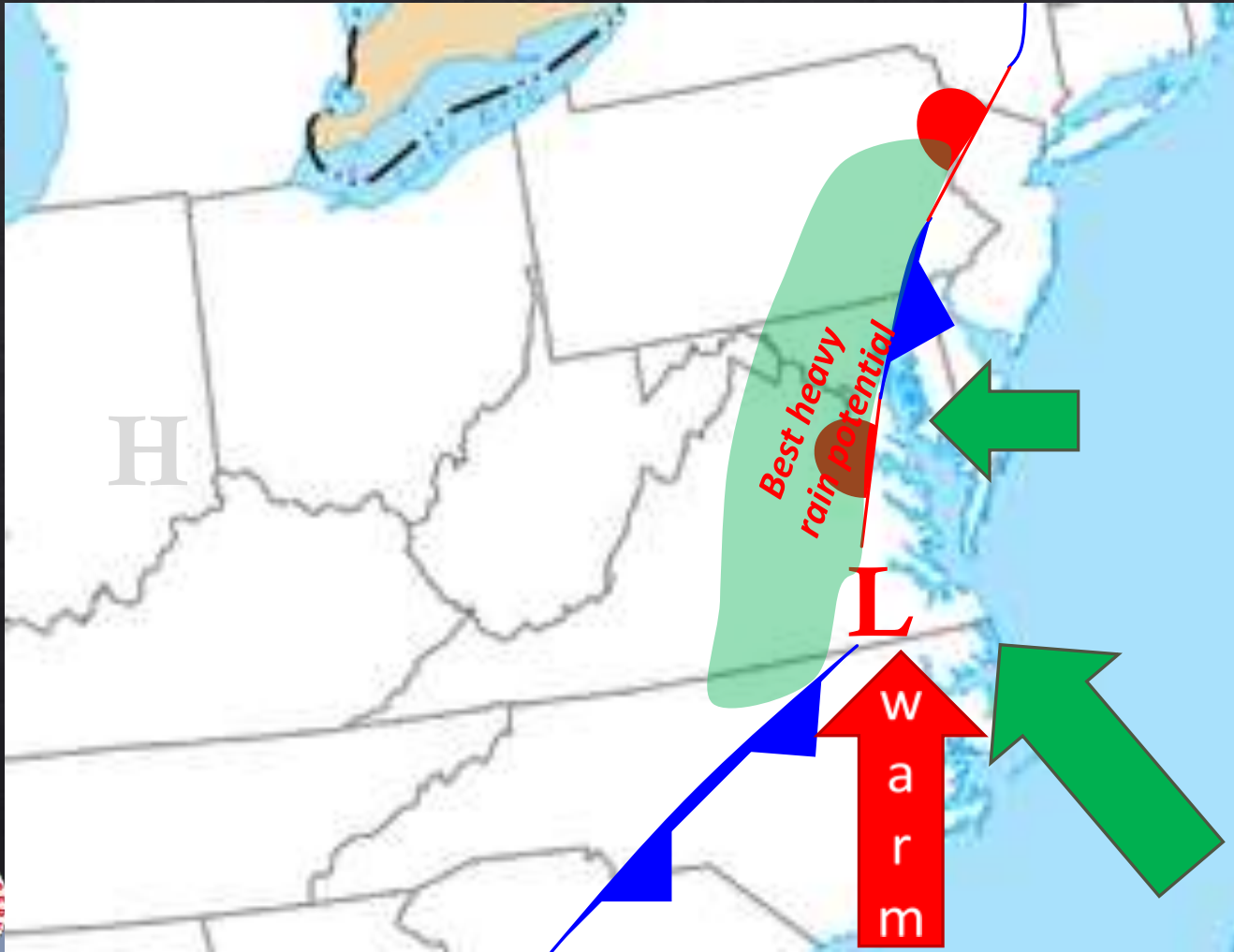


- ❖ These four events (among many others) caused flooding locally in 2018. (April 15-16, Frederick MD, Ellicott City, Harford County)



# Can it look differently?

- ◇ Orientation does not matter  
*(this one is potentially even worse due to mountains)*



# Madison County (VA) - June 27, 1995

- ◆ Affected foothills of central Virginia
- ◆ 24" rain within 24 hours
- ◆ 3 fatalities
- ◆ Mud/Debris slides
- ◆ All bridges in and out of Madison County were washed out or damaged except for U.S. Route 29 South.



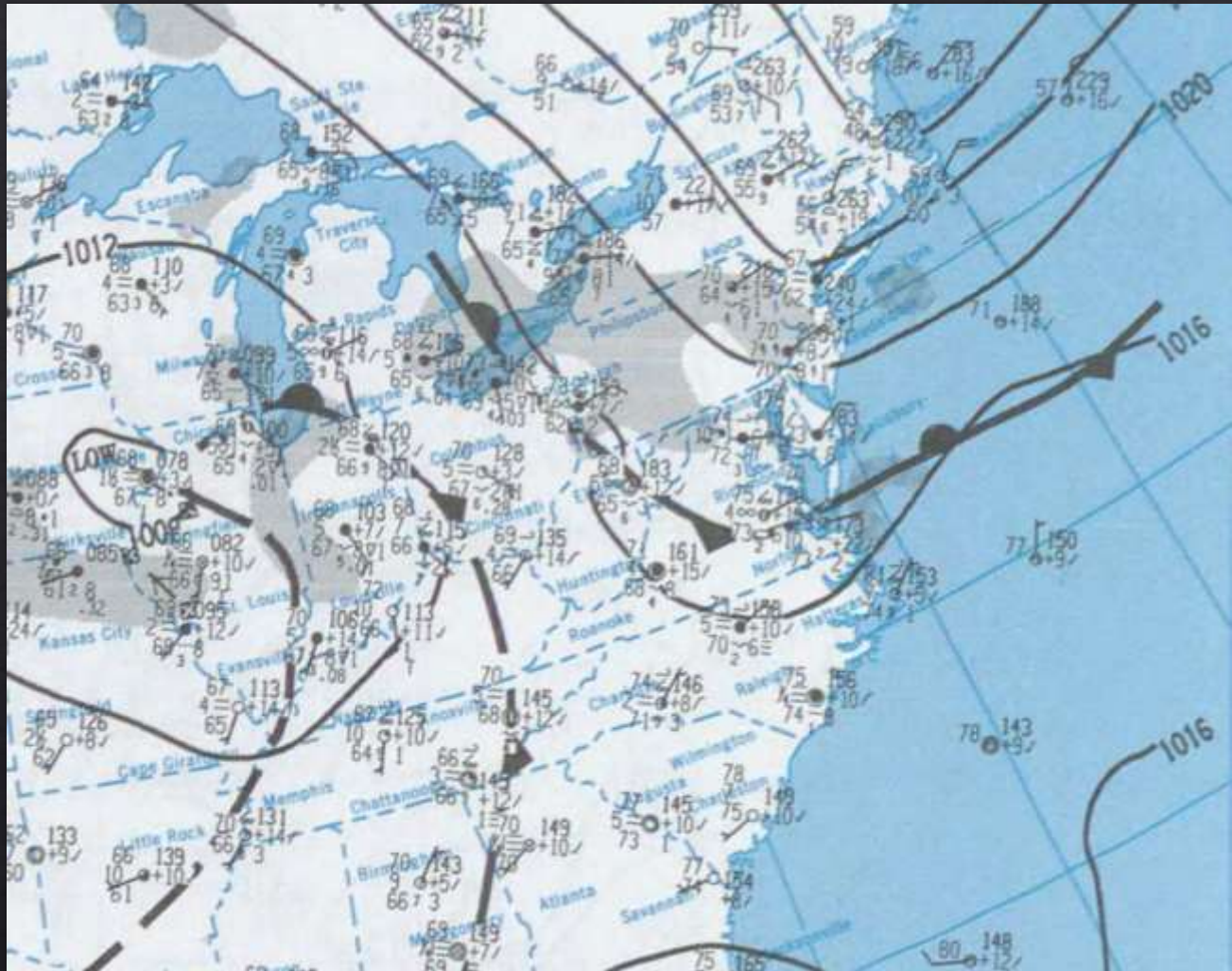
**Rt. 29 @ Madison/Greene County Line**



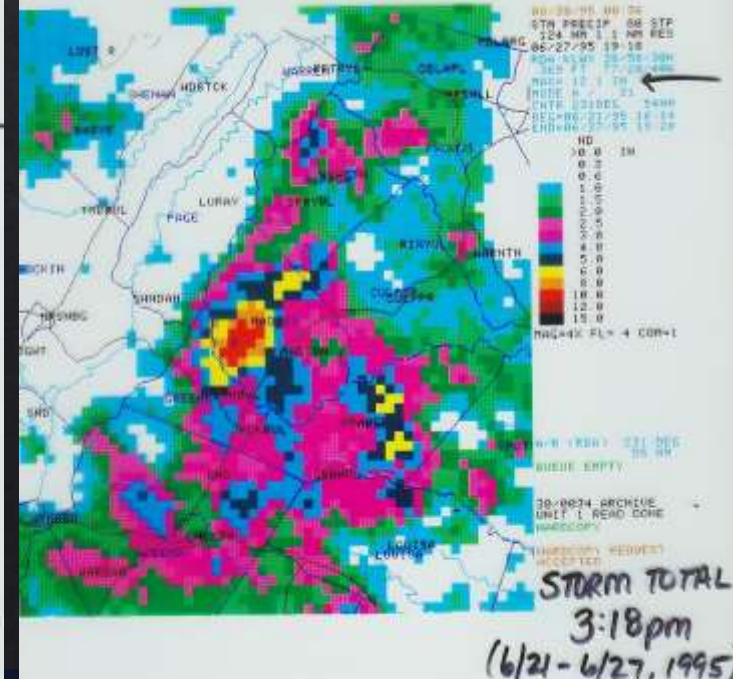
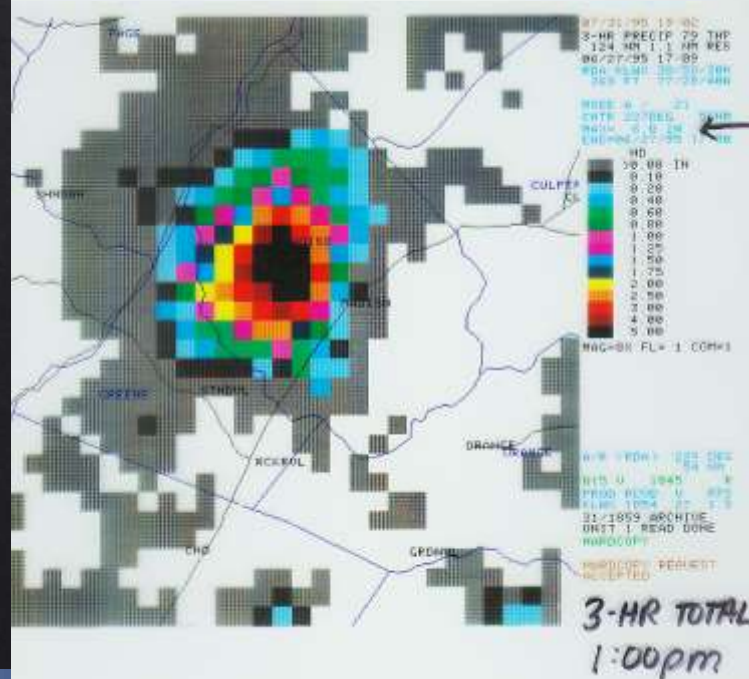
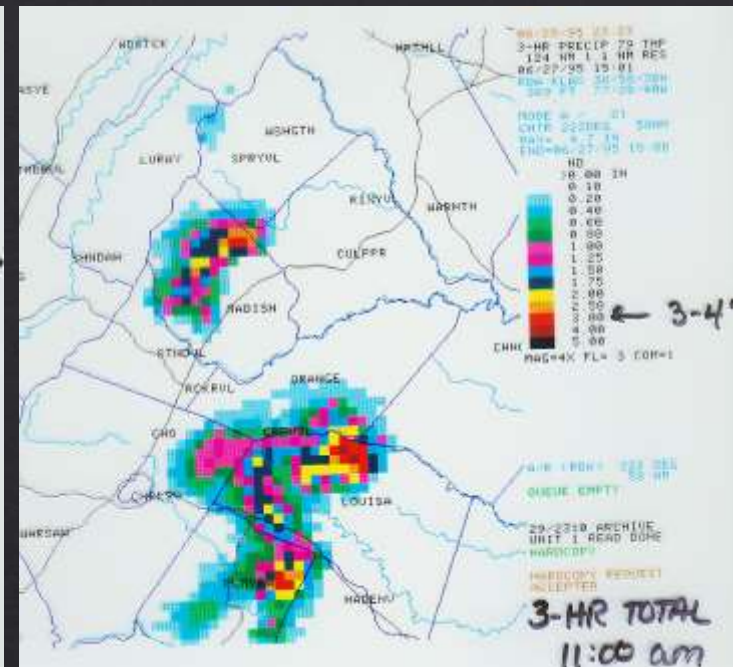
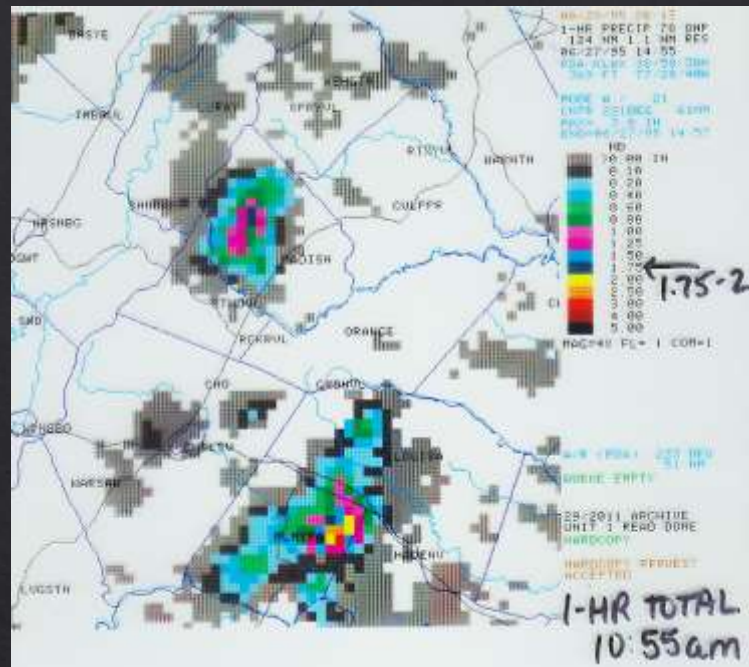
**Rapidan River poured over U.S. Rt 29 at the border of Madison & Greene counties**



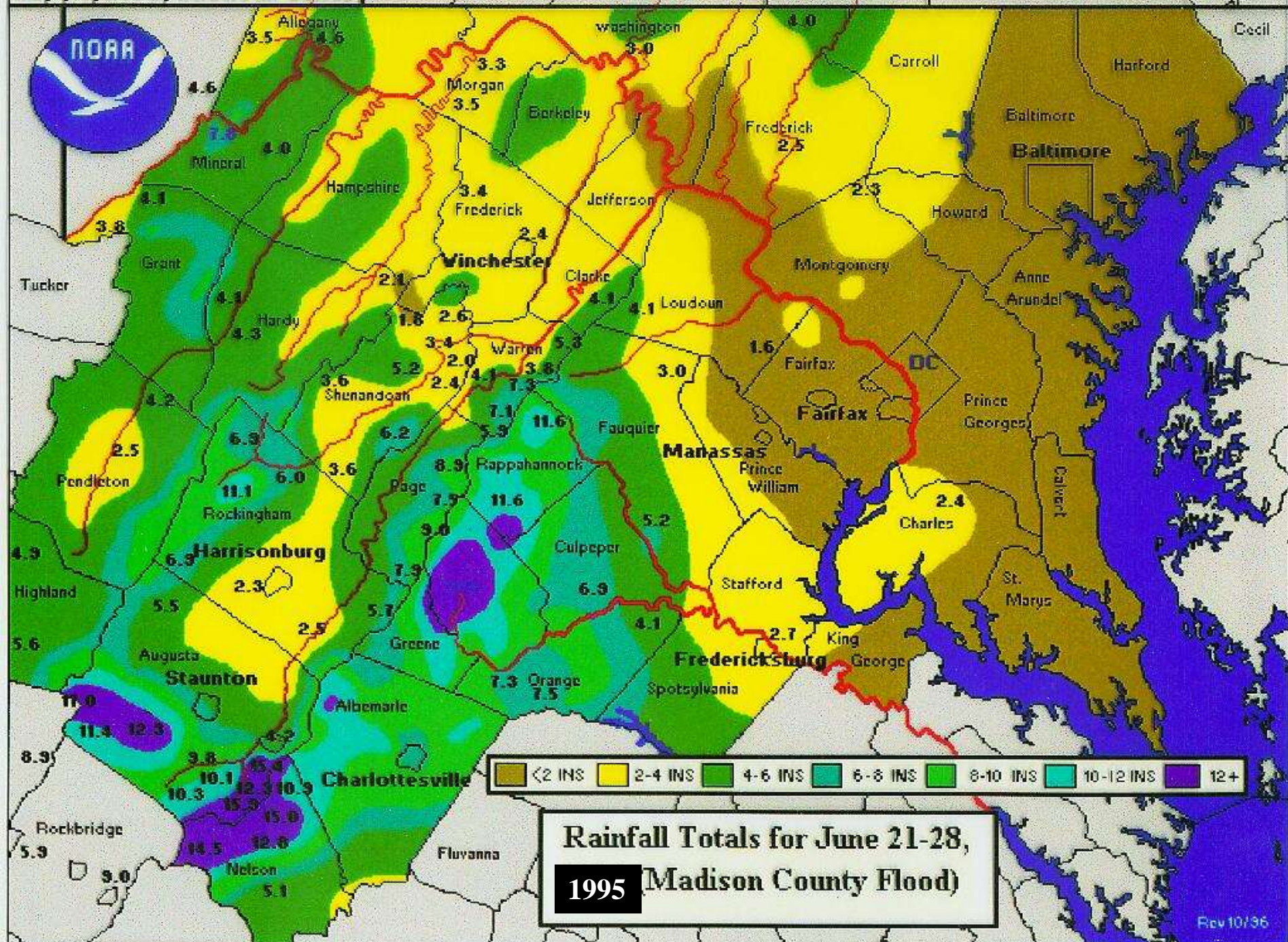
# How it Happened









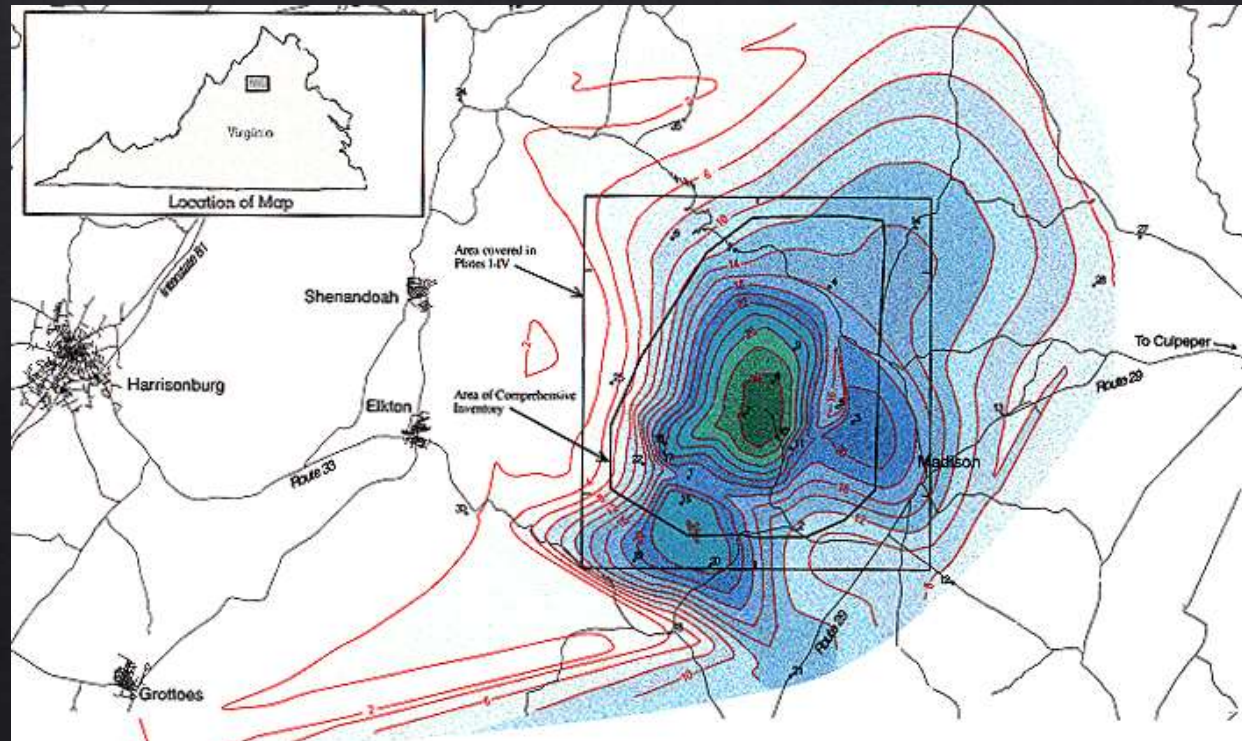


Rainfall Totals for June 21-28,  
**1995** (Madison County Flood)



# Madison County (VA) Flash Flood

- ❖ Precipitable water before the event from the Dulles sounding was 1.97", near record high for the date.
- ❖ At peak, the Rapidan River was flowing at 125 times its normal rate – 37 *billion* gallons per hour!
- ❖ Rainfall of 20 to 30 inches over quite a large area





# Madison County (VA) Flash Flood

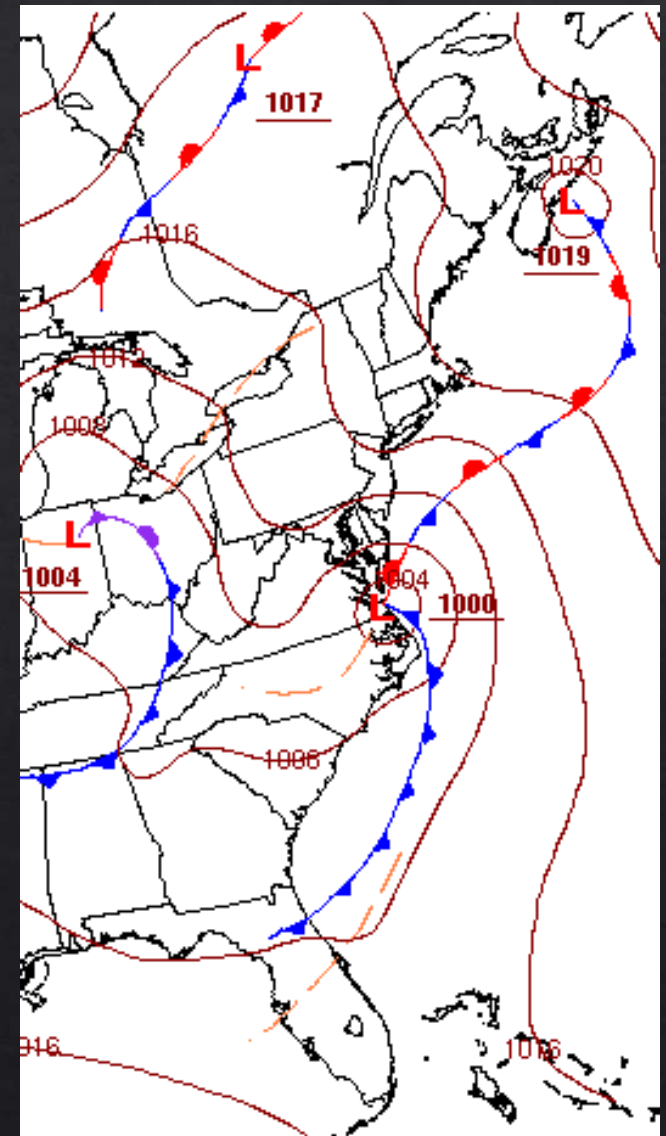
- ❖ Radar was underestimating rainfall - ratio of ground truth to radar estimates was 1.8 : 1.
- ❖ As flooding became more severe, communications were lost.
- ❖ Skywarn amateur radio spotters provided the first ground-truth report from Madison County.
- ❖ At 2PM, Etlan reported 10", with 5" falling between 10AM & 2PM.
- ❖ Record Flooding along the Rapidan River near Ruckersville and Culpeper

Debris Flow from Madison County flood



# Coastal Lows – July 21<sup>st</sup>, 2018

- ◆ Coastal Low near Virginia Beach, VA
  - ◆ This is a favored spot for heavy snow in the winter too
- ◆ It was already wet from all the previous events, although the early part of July had been dry



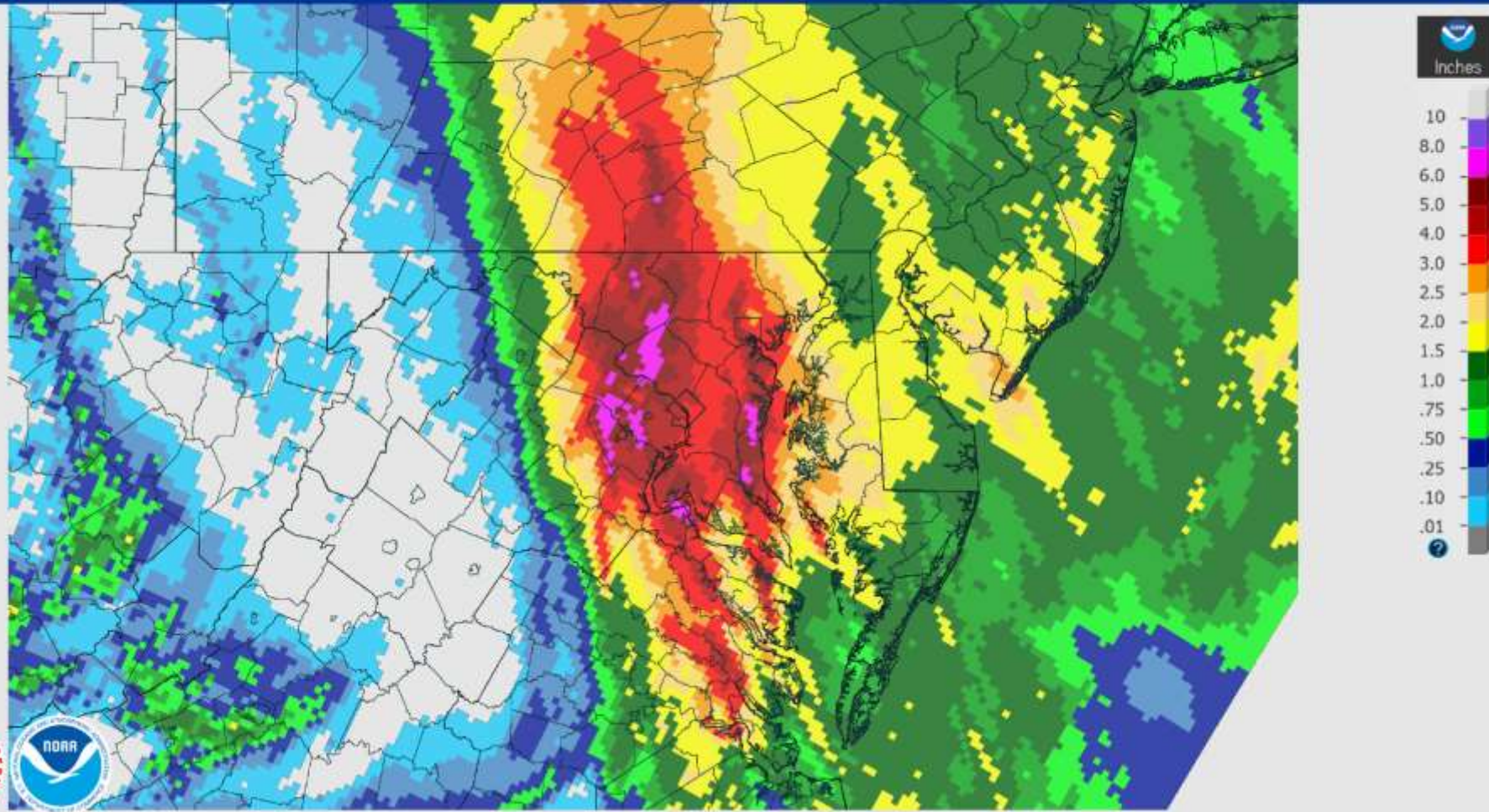


# July 21<sup>st</sup>, 2018

## July 22, 2018 1-Day Observed Precipitation

Created on: March 19, 2019 - 13:29 UTC

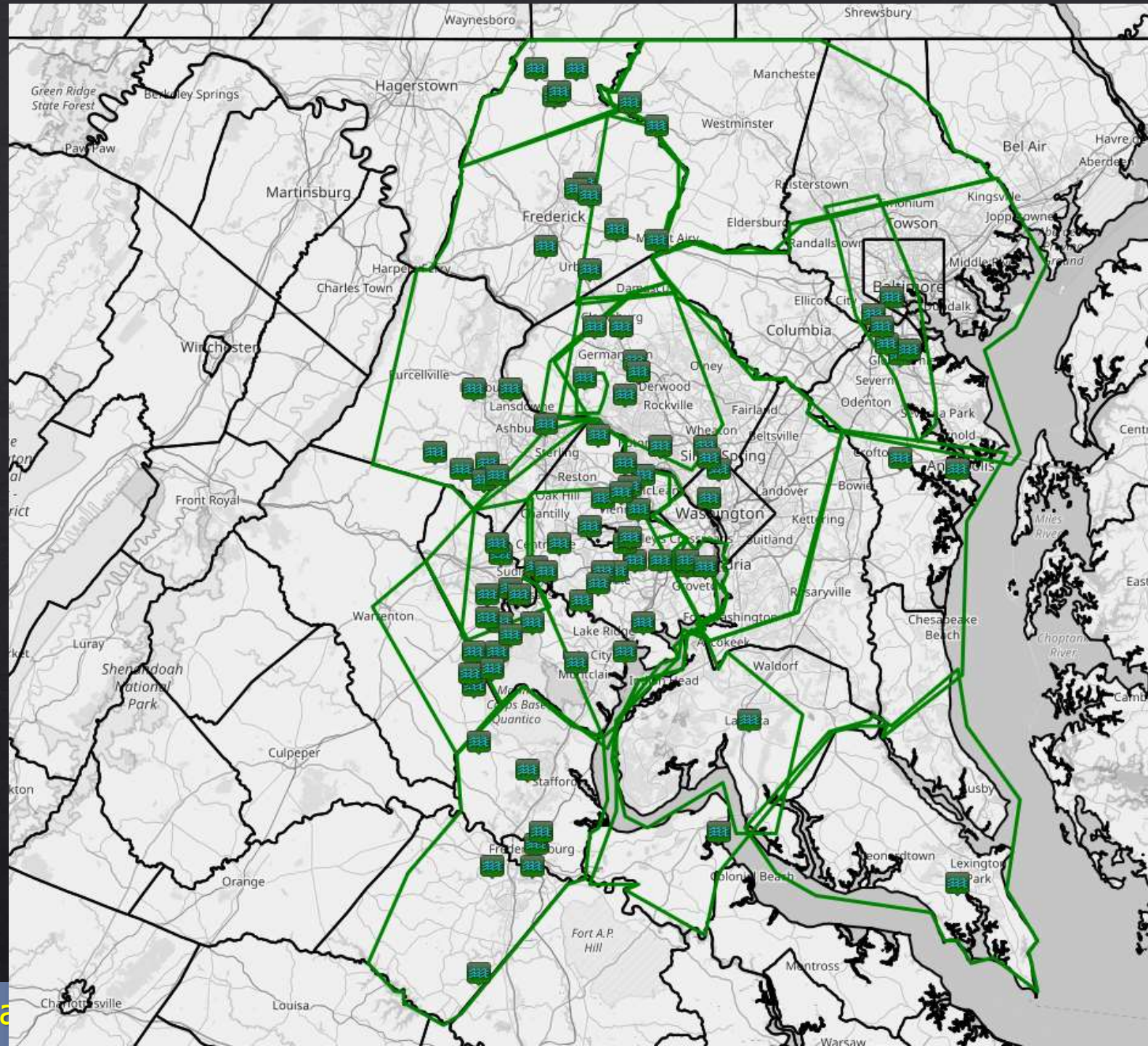
Valid on: July 22, 2018 12:00 UTC



National Weather Service Baltimore/Washington

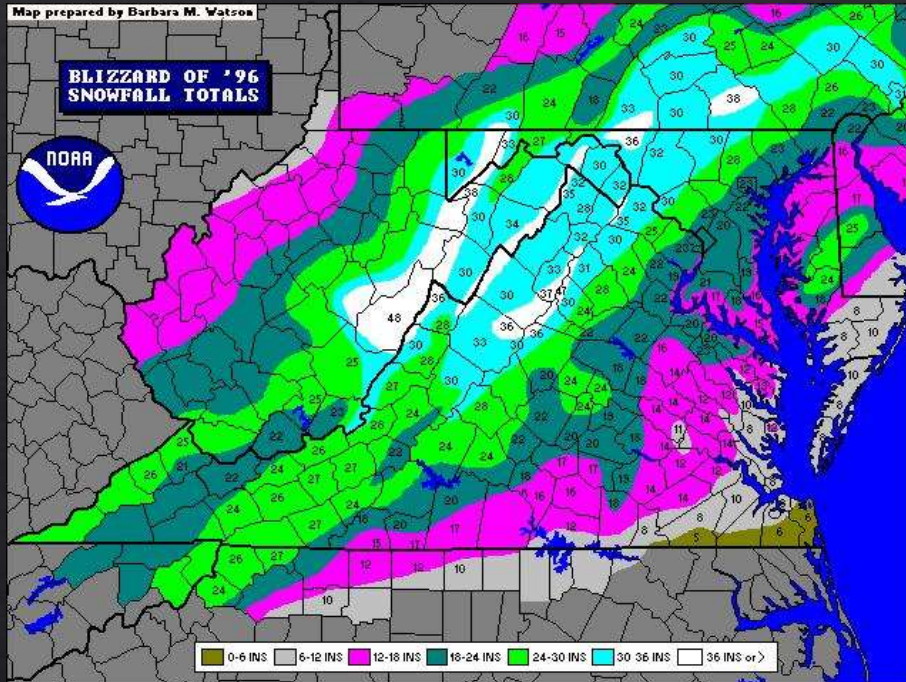






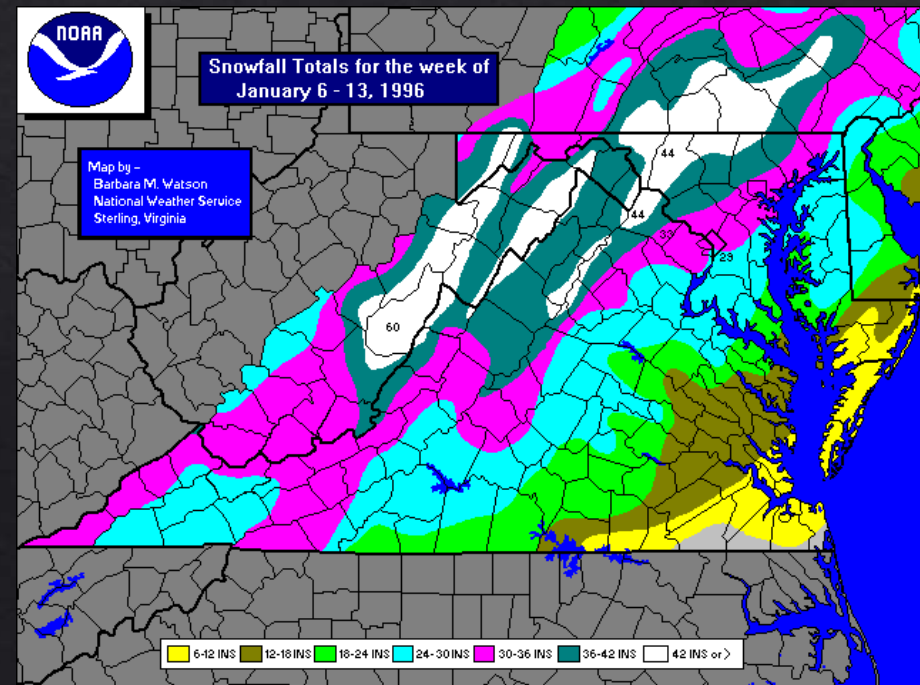


# Snowmelt Case - January 6-13, 1996



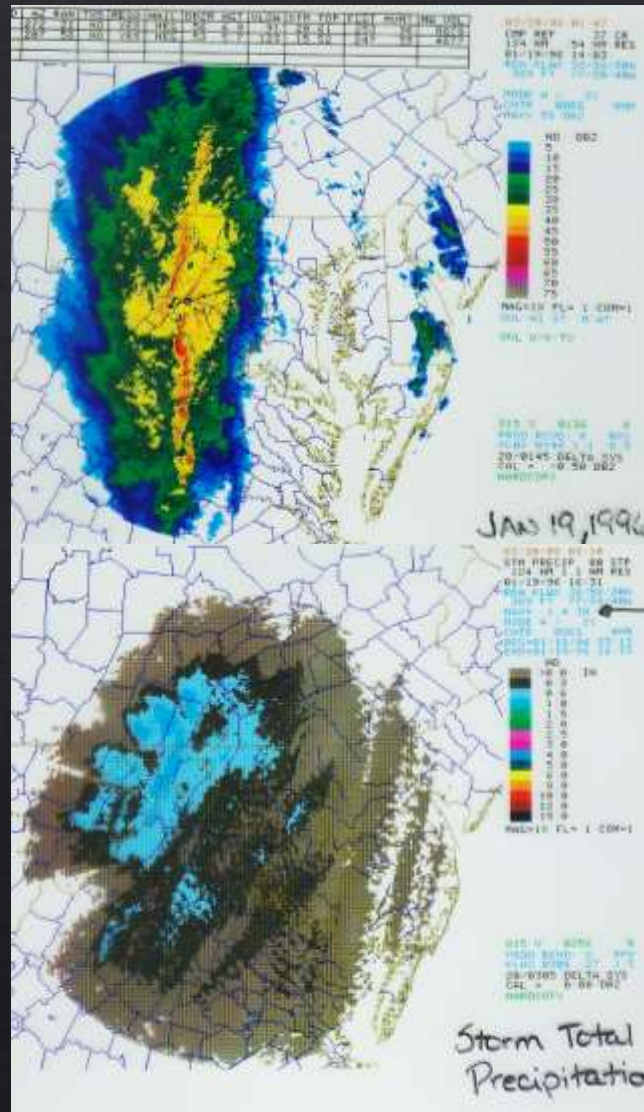
Snowfall from January 6-8, 1996  
Blizzard

Additional snow fell January  
12<sup>th</sup>. Snowfall totals for the week  
January 6-13, 1996



# January 19, 1996

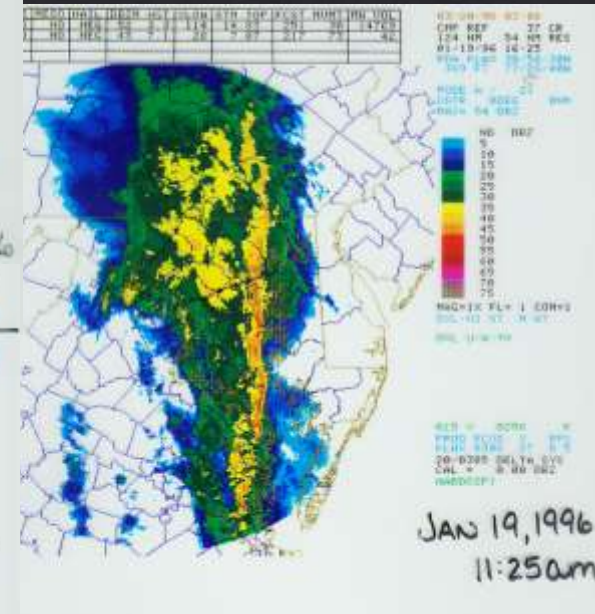
Snowfall at Dulles Int'l Airport (IAD)		
Date	New Snow	Snow on ground (7 am)
6	1.4	0
7	19.8	7
8	3.4	24
9	0.2	24
10	T	21
11	0	18
12	6.1	19
13	0	23
14	0	20
15	0	14
16	0	12
17	0	11
18	0	9
19	0	T
20	0	T
21	T	T



Radar images on Jan 19<sup>th</sup>...

-9:03 am (left)

-11:25 am (below)



Radar estimated total rainfall – max 1.4 inches



# January 1996 event

- ◇ 2 – 3 feet snowfall early
- ◇ Additional snow a week later (less than 1' East & 3' West)
- ◇ Water equivalent of snow pack 2-3" (17<sup>th</sup> & 18<sup>th</sup>)
- ◇ Additional 1 – 3" rain, locally up to 5"



**Above: Shenandoah Street in Harpers Ferry flooded in January 1996**

**Left: Flood Markers on Whites Ferry General Store include the January 1996 flood**

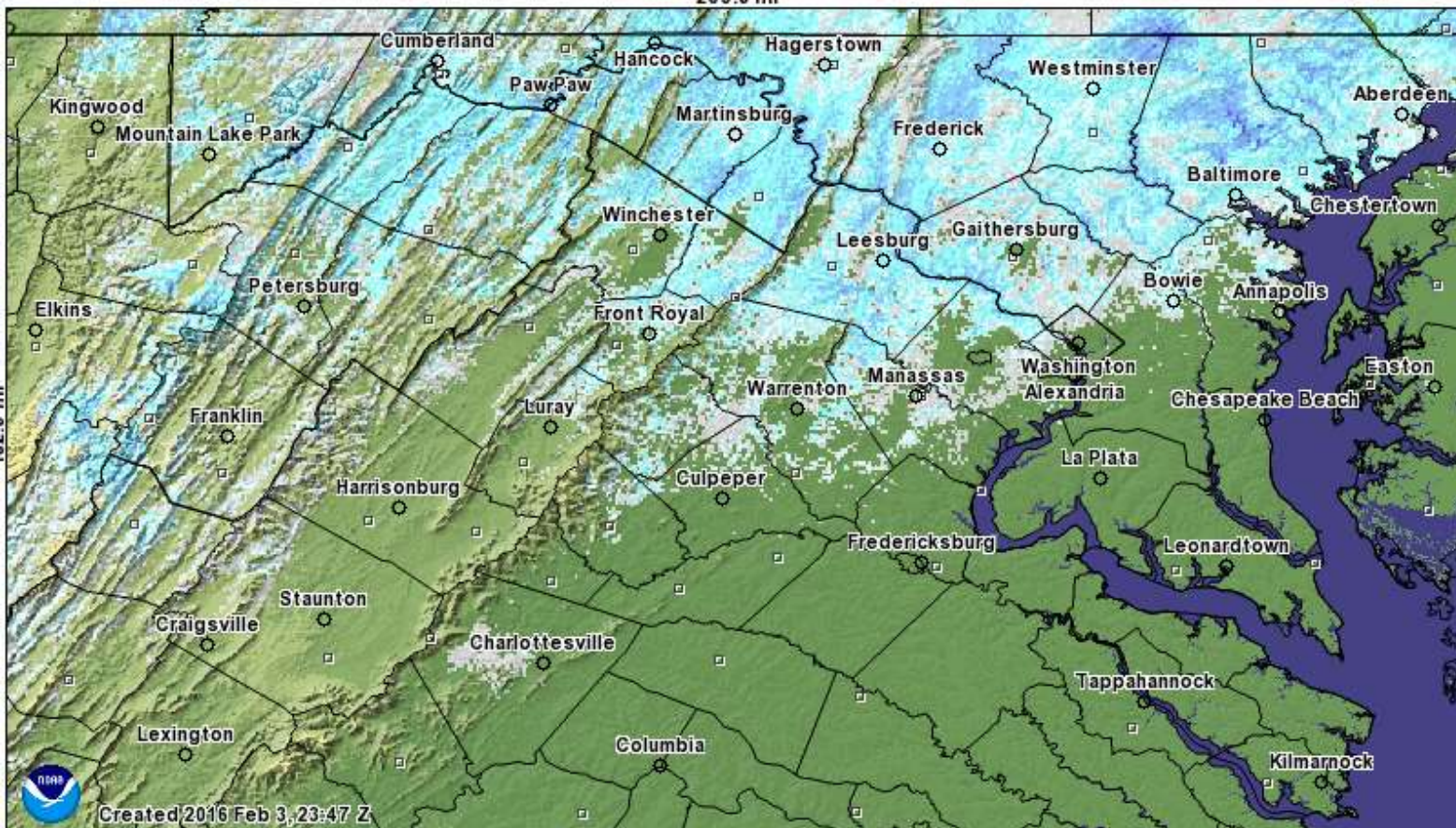


# 1996 Blizzard vs. 2016 Blizzard

## *Why no flood in 2016??*

Modeled Snow Depth for 2016 February 3, 12:00 UTC

209.8 mi

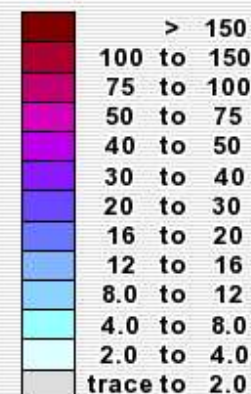


Created 2016 Feb 3, 23:47 Z

216.3 mi

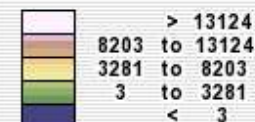


Inches of depth



Not Estimated

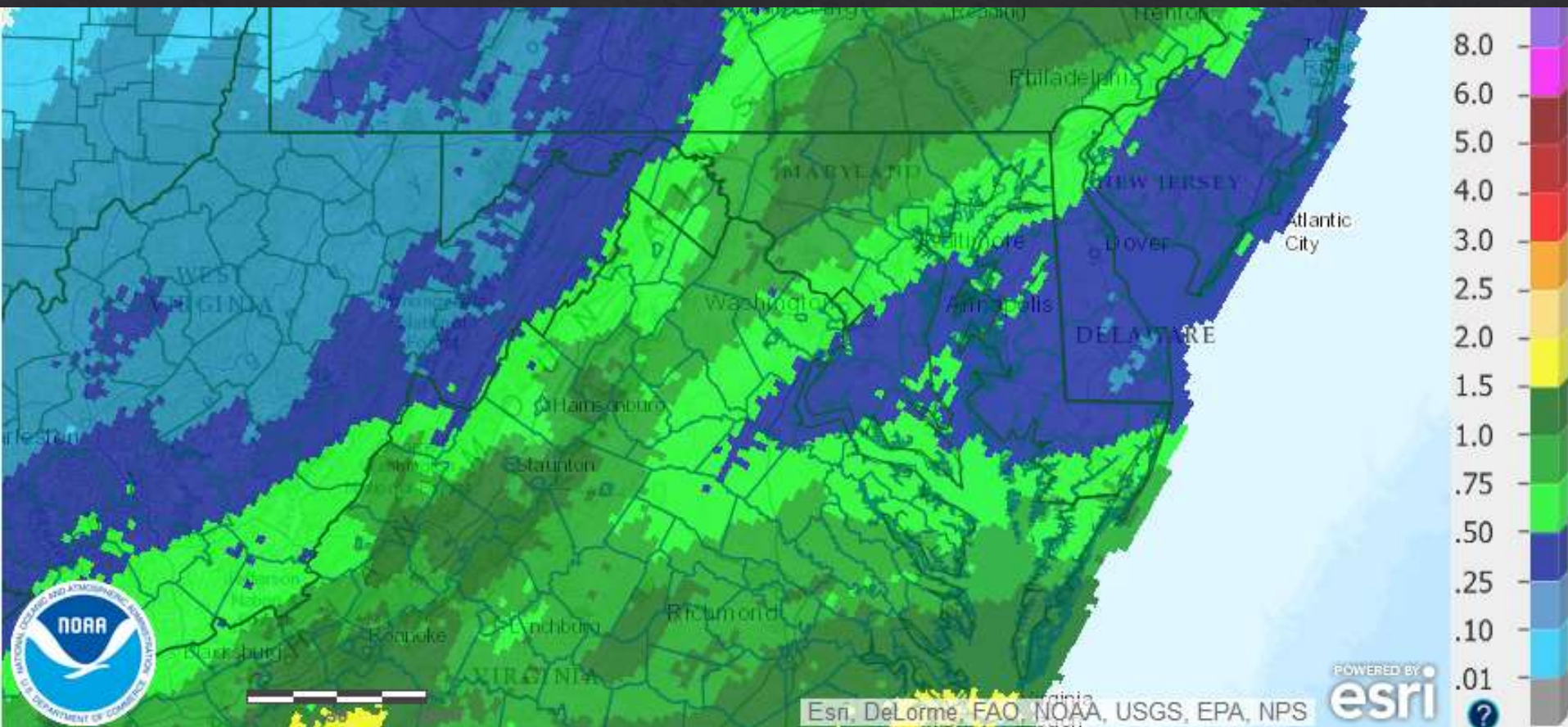
Elevation in feet





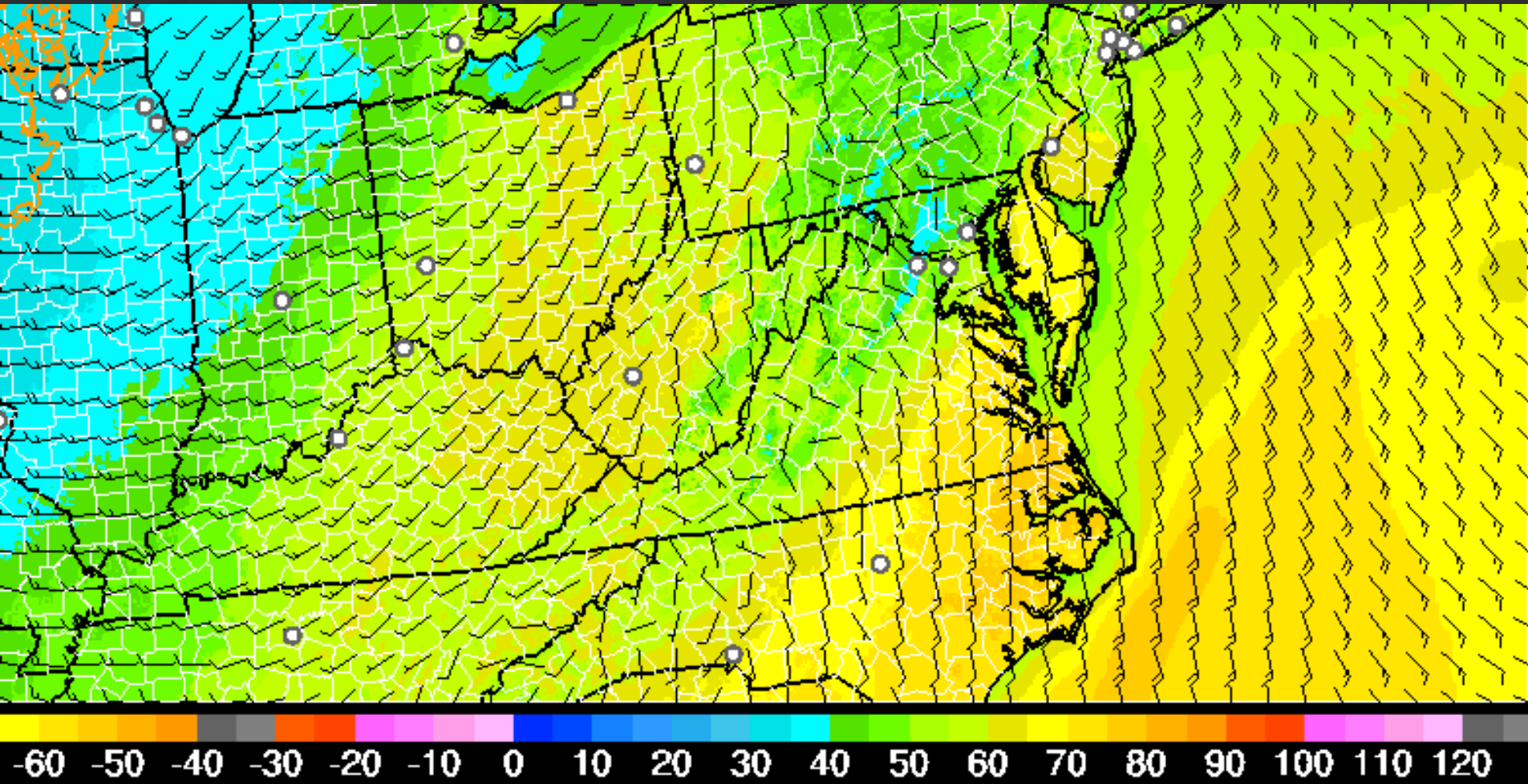
# 1996 Blizzard vs. 2016 Blizzard

*Why no flood in 2016??*



# 1996 Blizzard vs. 2016 Blizzard

*Why no flood in 2016??*



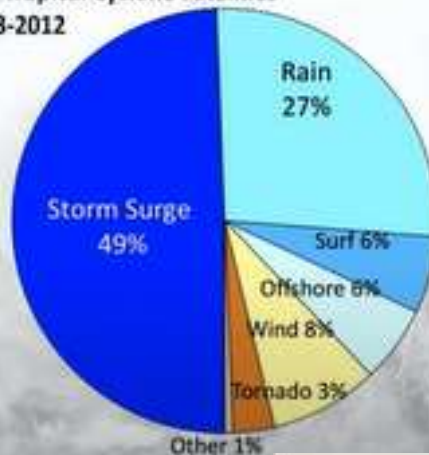


# Tropical Rains

## Lesson 7. Water is What KILLS!!!



U.S. Tropical Cyclone Fatalities  
1963-2012



Water  
accounts  
for about  
90% of  
the direct  
deaths

## Water is What KILLS!!!

2016-18 Fatalities\*

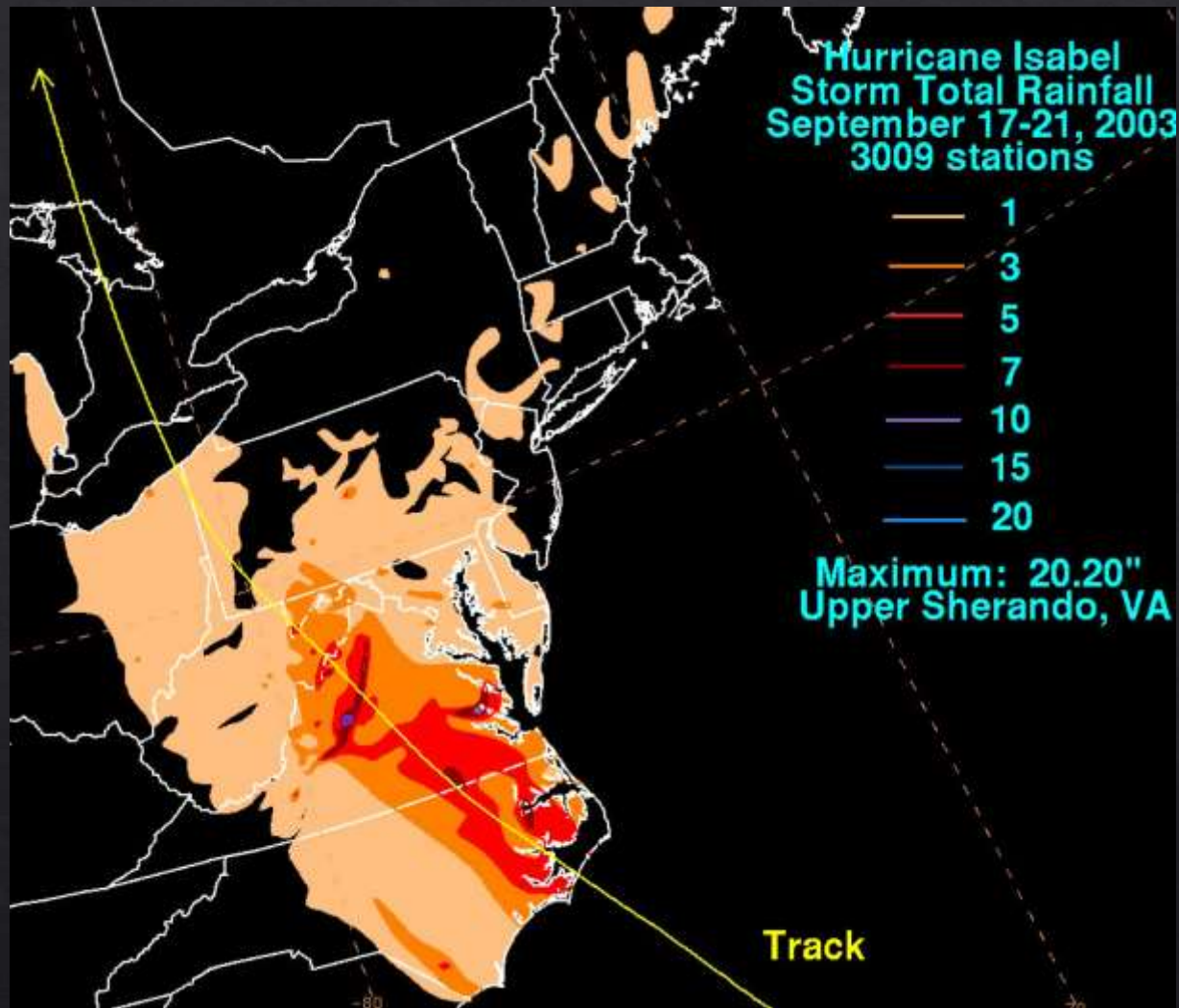


83% Water Related

Most Inland Flooding – Only 4% Storm Surge Related

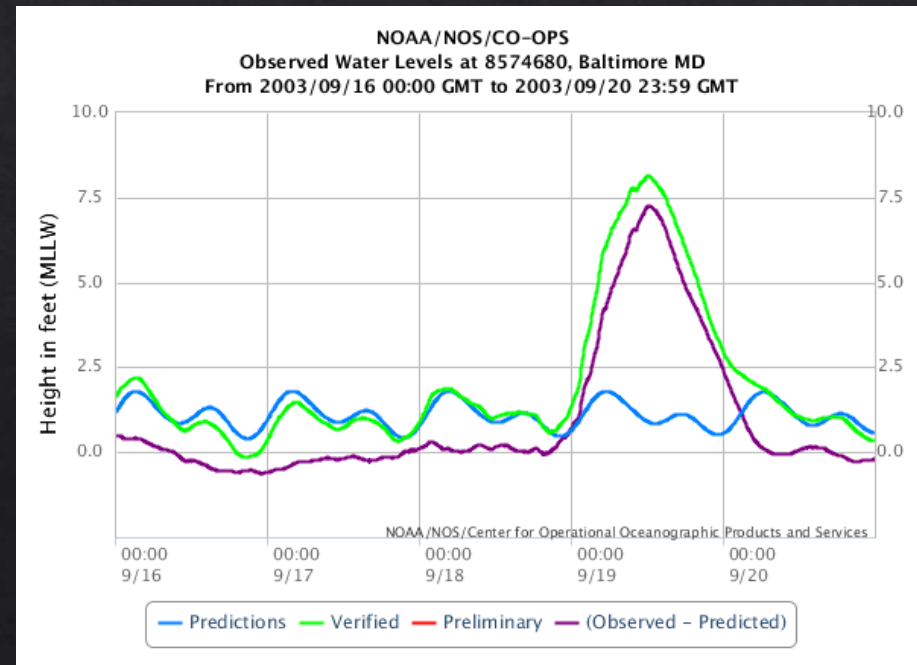
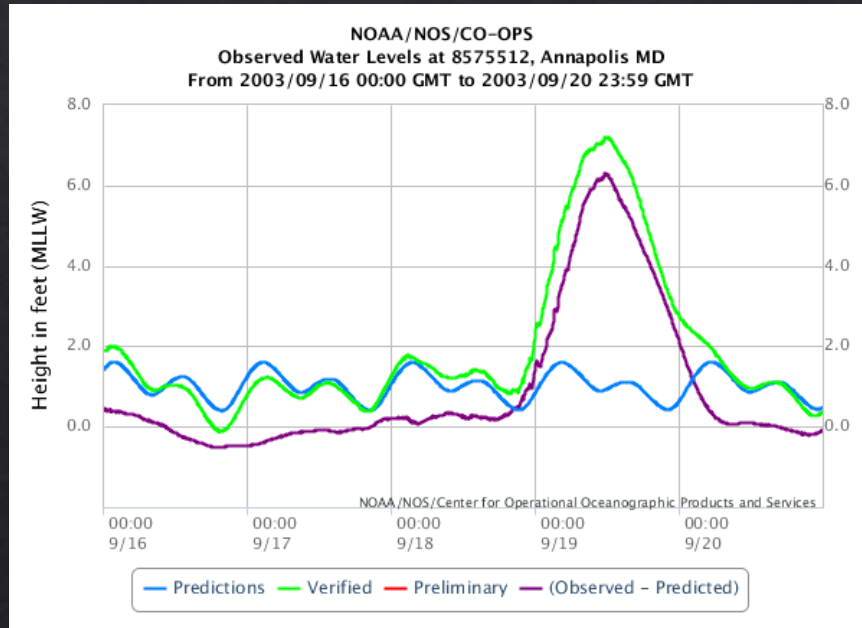
\*excludes Maria due to uncertainty related to causes of direct deaths

# Tropical Case: Isabel (2003)





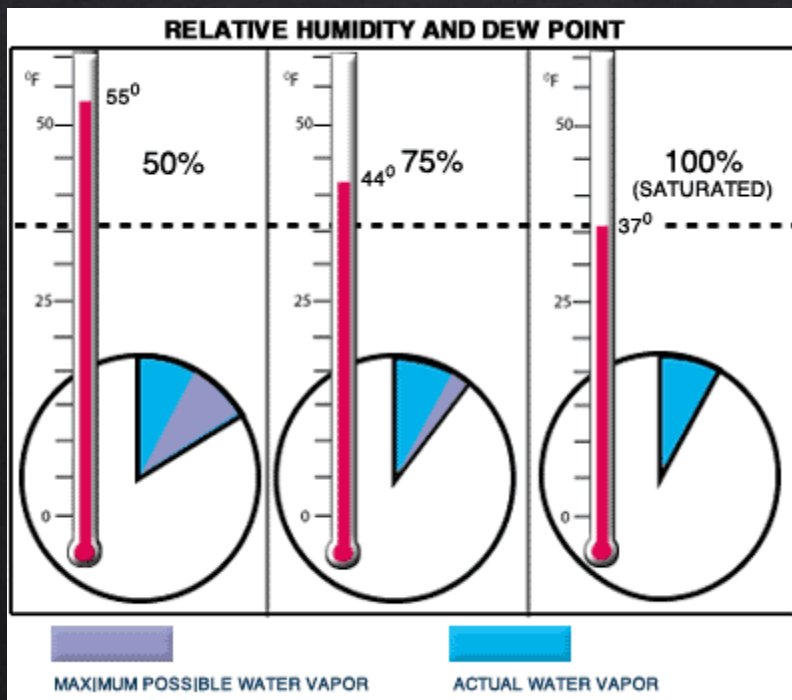
# Isabel (2003) – Record Tides



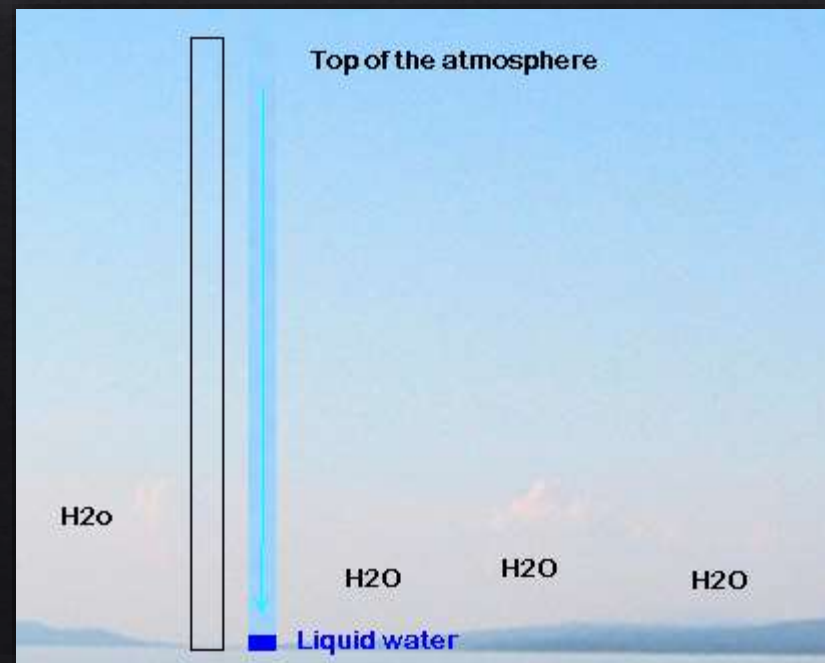
# Other “Ingredients” We Need

◆ High Moisture Content – measured two ways

## Dewpoint



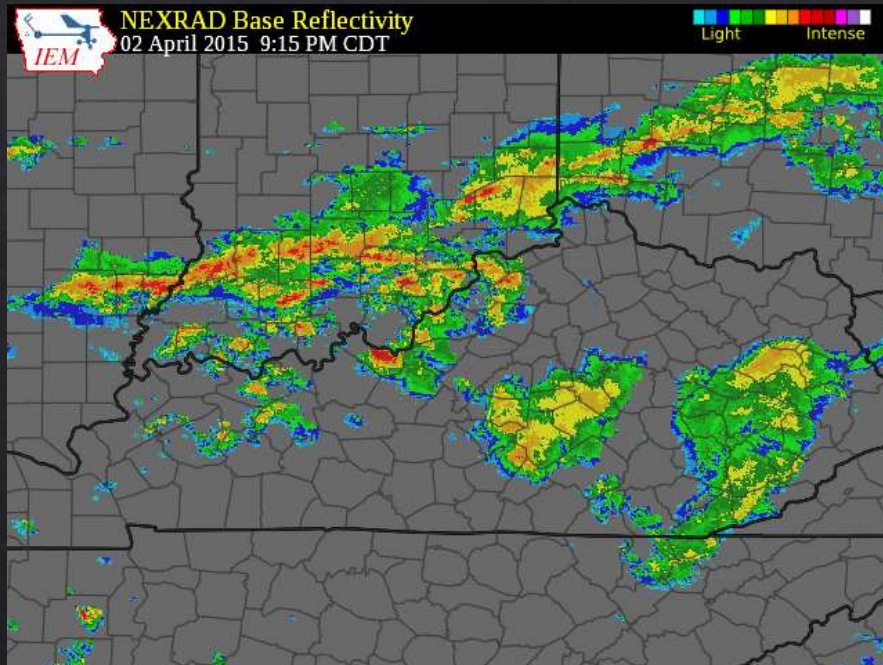
## Precipitable Water



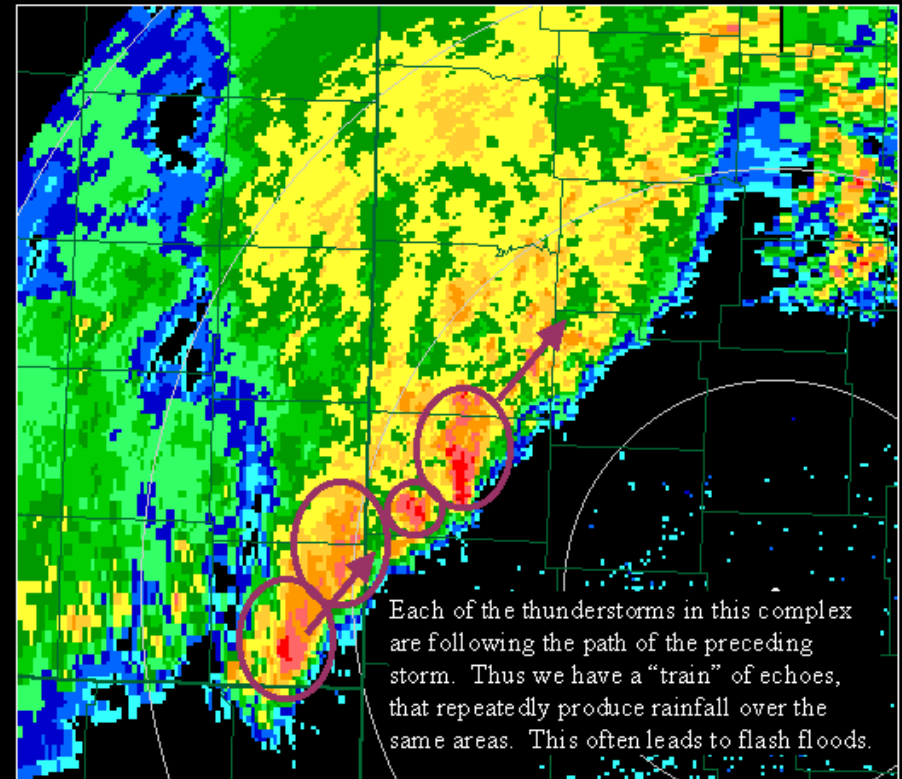


# Other “Ingredients” We Need

## ◇ Slow-moving or Training (Repeating) Thunderstorms

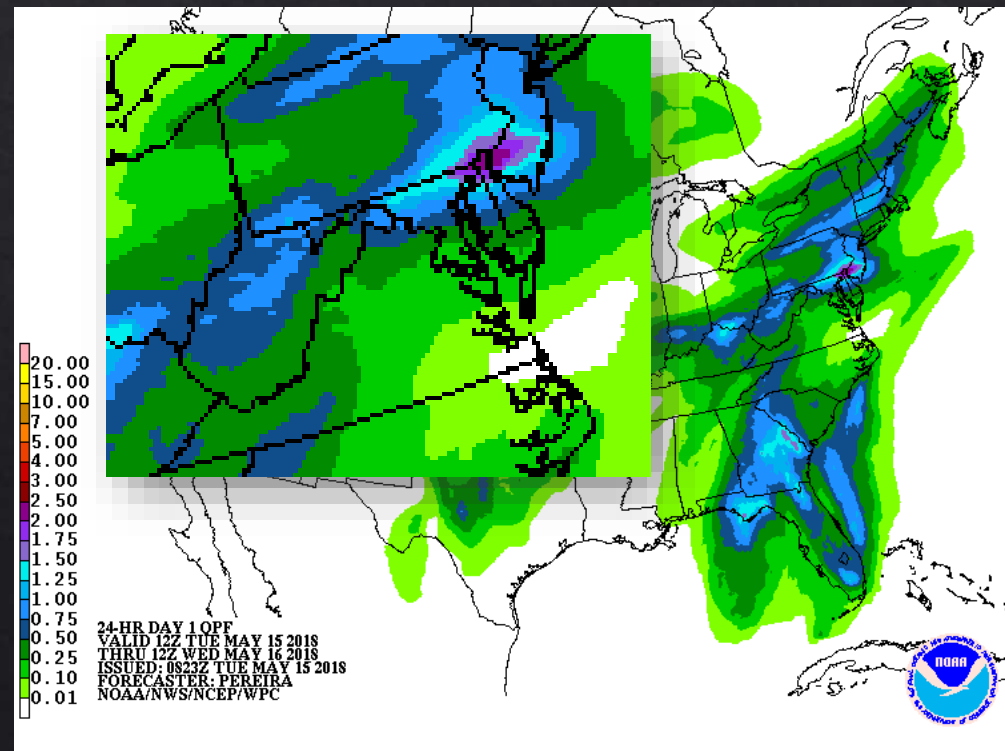
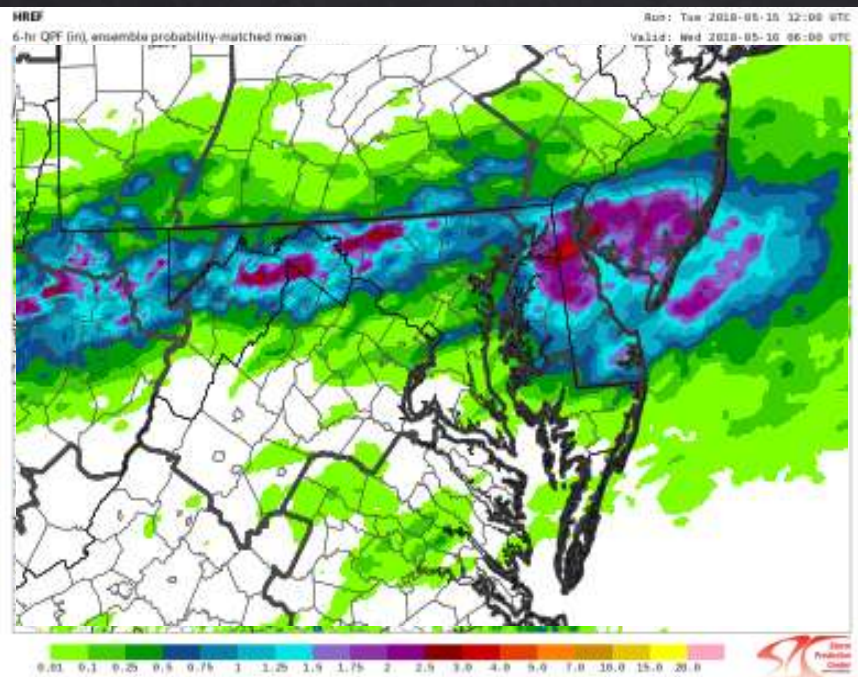


### Training Echoes Example



# Making a Rainfall Forecast

- ◇ We begin with national precipitation forecasts from the NWS Weather Prediction Center (WPC).
- ◇ We then localize this – especially in the first 6-12 hours as we get the best idea of where the heaviest rain will occur.

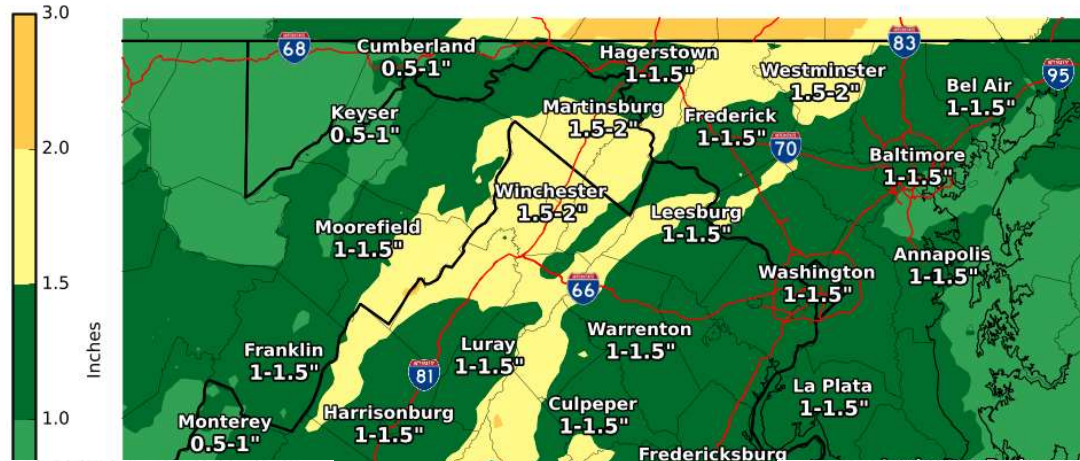




# It's Not Just One Number!

## Expected Liquid Precip - Official NWS Forecast

Valid: 05/03/2019 10:00 PM - 05/06/2019 08:00 PM



## Low End Amount - 9 in 10 Chance (90%) of Higher Liquid Precipitation

Valid: 05/03/2019 10:00 PM - 05/06/2019 08:00 PM

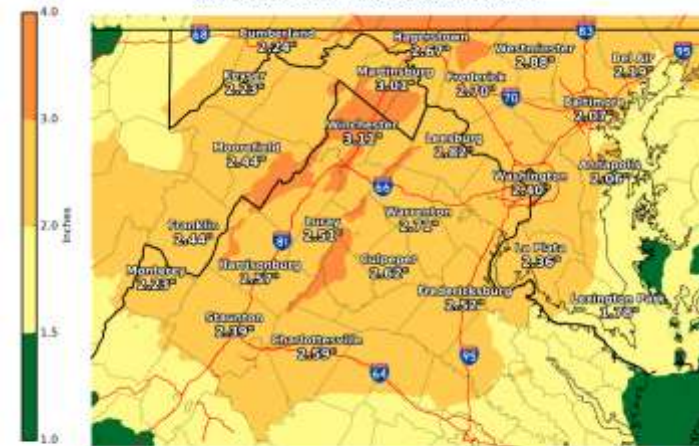


National Weather Service  
Baltimore/Washington  
05/03/2019 10:53 PM EDT

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weather.gov/washington

## High End Amount - 1 in 10 Chance (10%) of Higher Liquid Precipitation

Valid: 05/03/2019 10:00 PM - 05/06/2019 08:00 PM



National Weather Service  
Baltimore/Washington  
05/03/2019 10:55 PM EDT

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weather.gov/washington

National Weather Service  
Baltimore/Washington  
2019 10:51 PM EDT



National Weather Service Baltimore/Washington





### High End Amount - 1 in 10 Chance (10%) of Higher Liquid Precipitation



Valid: 07/07/2019 08:00 PM - 07/10/2019 08:00 PM

Inches




4.0  
3.0  
2.0  
1.5  
1.0  
0.5  
0.25  
0.1

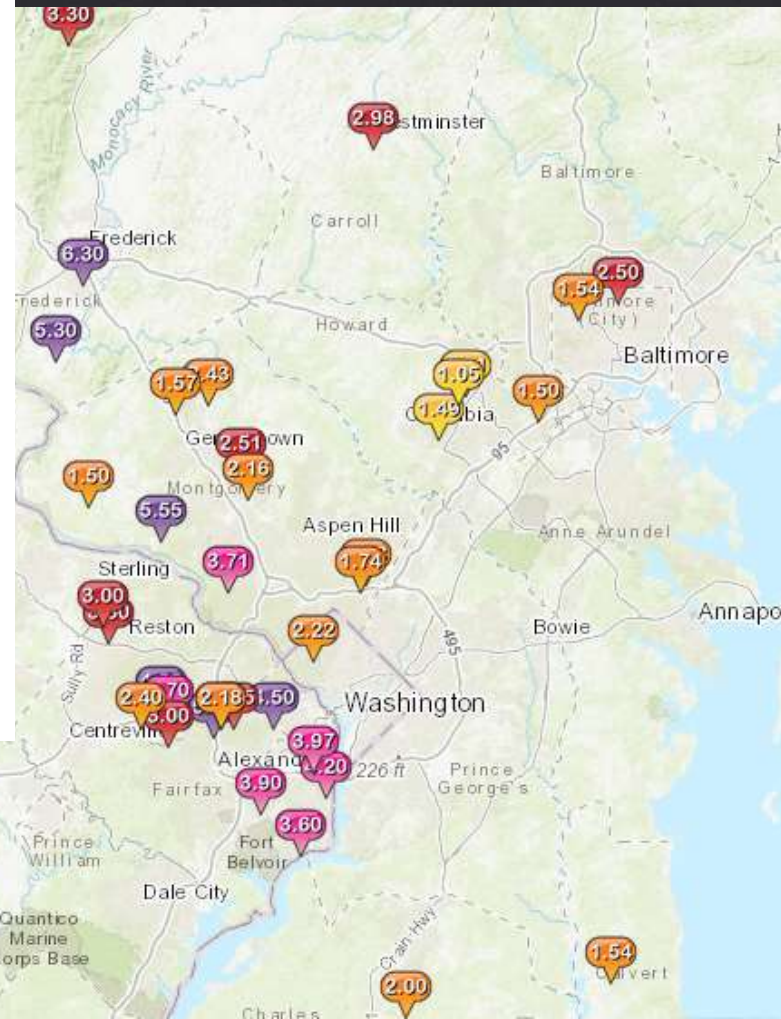
Cumberland 1.57"  
Hagerstown 2.03"  
Westminster 1.49"  
Bel Air 0.75"  
Keyser 1.07"  
Martinsburg 1.88"  
Frederick 1.77"  
Baltimore 1.18"  
Winchester 2.04"  
Leesburg 1.87"  
Annapolis 1.54"  
Washington 1.70"  
Moorefield 0.97"  
Luray 1.19"  
Warrenton 1.79"  
La Plata 1.86"  
Lexington Park 1.91"  
Franklin 0.93"  
Harrisonburg 1.15"  
Culpeper 1.49"  
Fredericksburg 1.61"  
Monterey 0.96"  
Staunton 1.11"  
Charlottesville 1.17"

I-68 I-83 I-95 I-70 I-66 I-81 I-64 I-95

**National Weather Service**  
Baltimore/Washington  
07/07/2019 08:00 PM EDT

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[weather.gov/washington](https://weather.gov/washington)





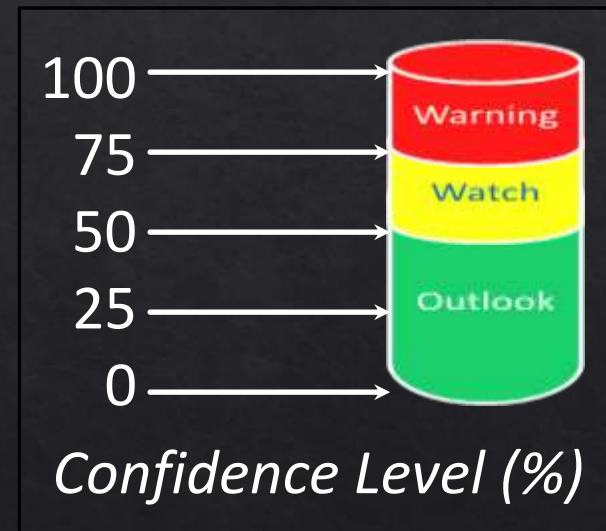
# Putting It All Together

- ◆ Once we have forecast an expected amount and range of rainfall expected...we have to combine this forecast with the antecedent conditions, as well as how quickly the rain is expected to fall.



# Watch vs. Warning

- ◇ **WATCH:** Conditions are favorable for flooding to occur (>50% chance). Be alert for possible flooding during the watch period.
- ◇ **WARNING:** Flooding is occurring or is extremely likely to occur (>75% chance). Stay out of low areas and seek higher ground if necessary!
- ◇ Note: A watch does not necessarily precede a warning, especially for river flooding.



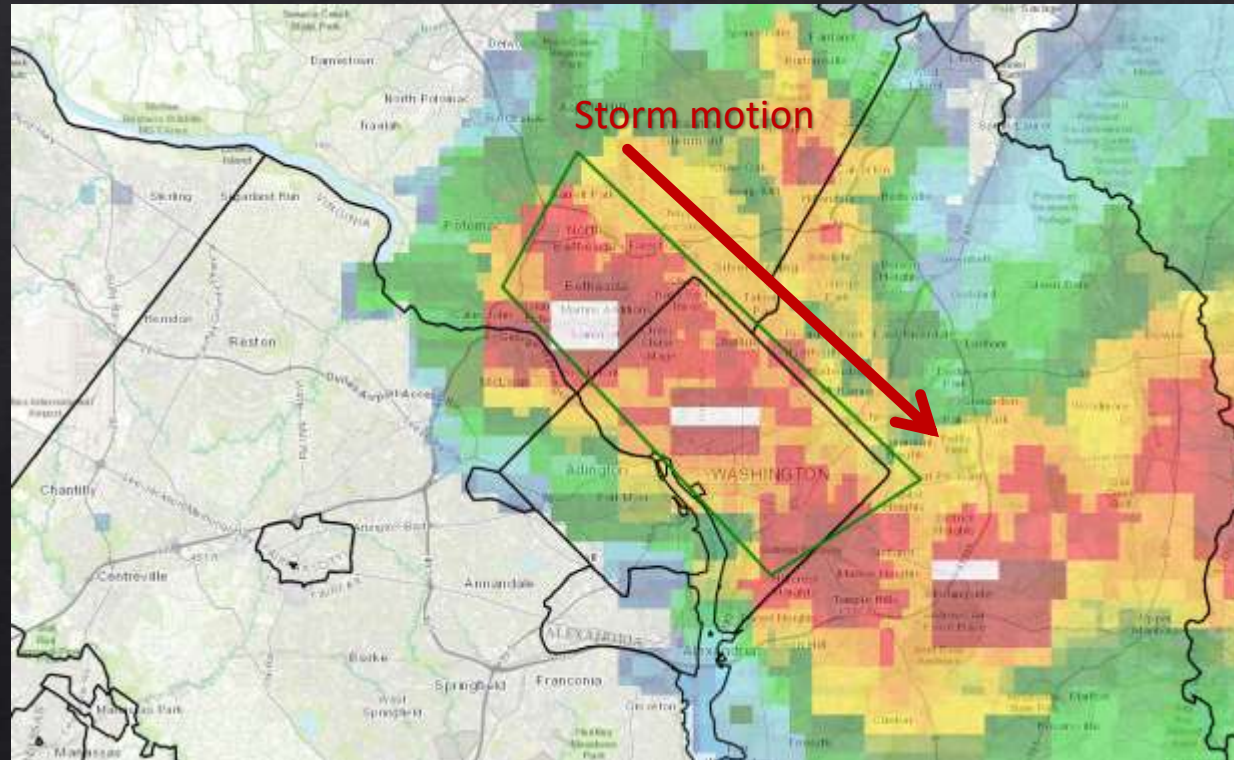


# Flood Warning vs. Flash Flood Warning

- ❖ **FLOOD WARNING:** Flooding is expected during the period of the warning. This flooding will generally be slower to develop (water might not be moving as quickly) but could ultimately become just as significant/severe as a flash flood.
- ❖ **FLASH FLOOD WARNING:** Rapid and extreme flooding is expected during the warning period. You will have little, if any, time to react, and swift moving water will occur in some spots. Other locations may experience less impactful flooding.
- ❖ **FLASH FLOOD EMERGENCY:** Rapid and extreme flooding is occurring and is causing significant damage or threat to life RIGHT NOW. There is no time to wait; action must be taken immediately and a certain spot (or spots) within the warning area are in grave danger. Other locations may experience less impactful flooding.

# Basin-Based Warnings

- ◇ Our goal is to warn for:
  - ◇ Where the rain is going to go
  - ◇ Where the water is going to flow
- ◇ This means we may warn for places where it will not even rain!





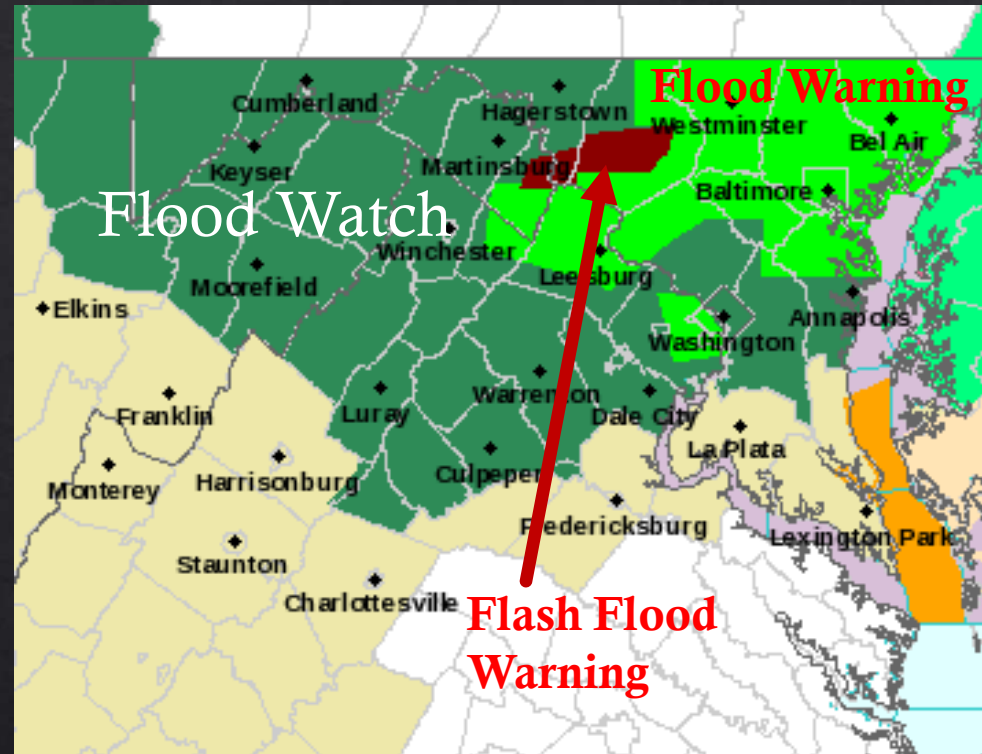
# Respect the Polygon!

- ◇ All flood warnings (except coastal flood) are issued as polygons.

- ◇ Limits the area covered by a watch or warning
- ◇ If you're not in a box, we believe your threat is low!

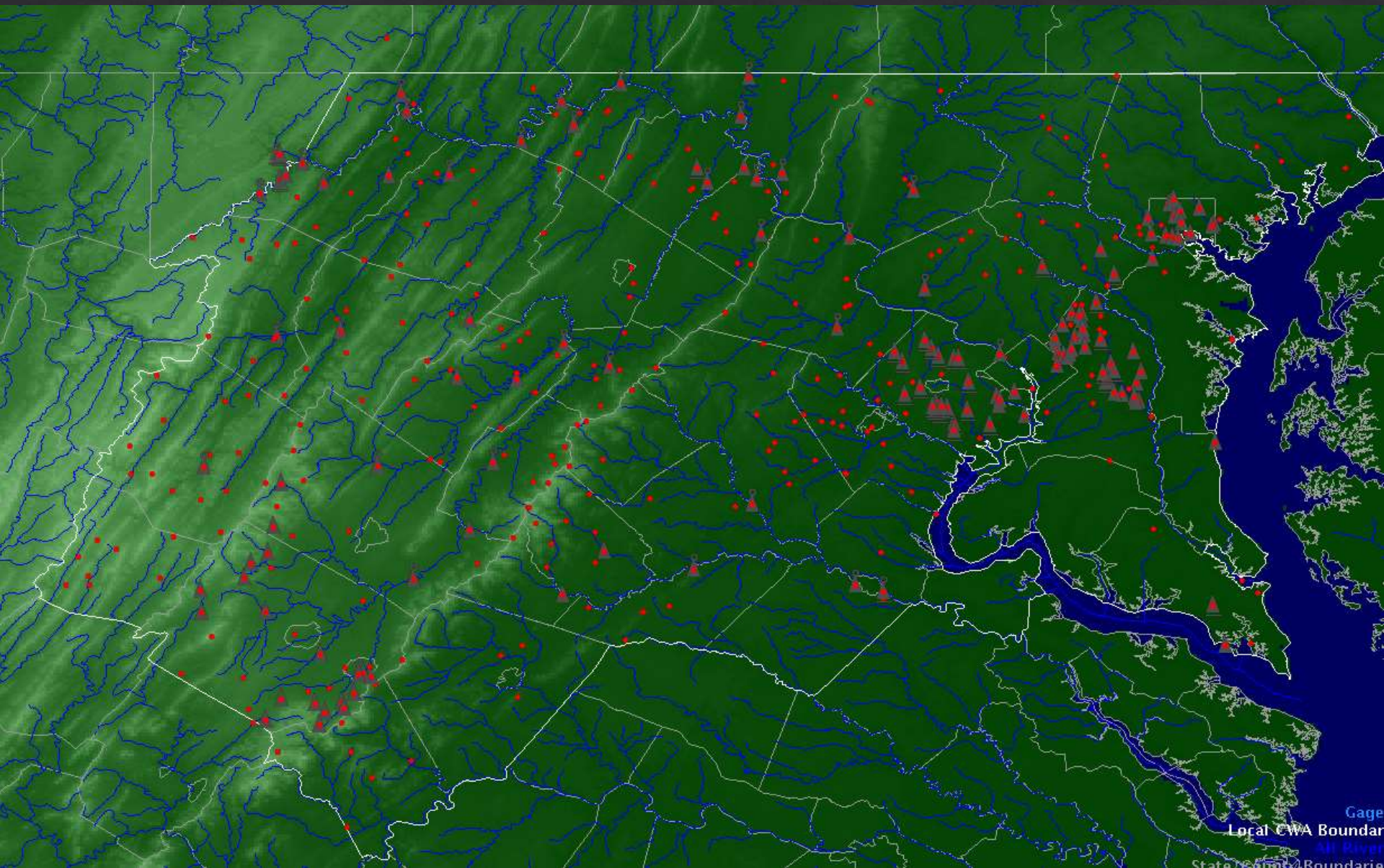
- ◇ For watches, only river flood watches are issued as polygons.

- ◇ Reminder: While all areas in the polygon are perceived to have an imminent flood threat, in many cases only a few small areas will actually experience flooding.





# Precipitation Monitoring





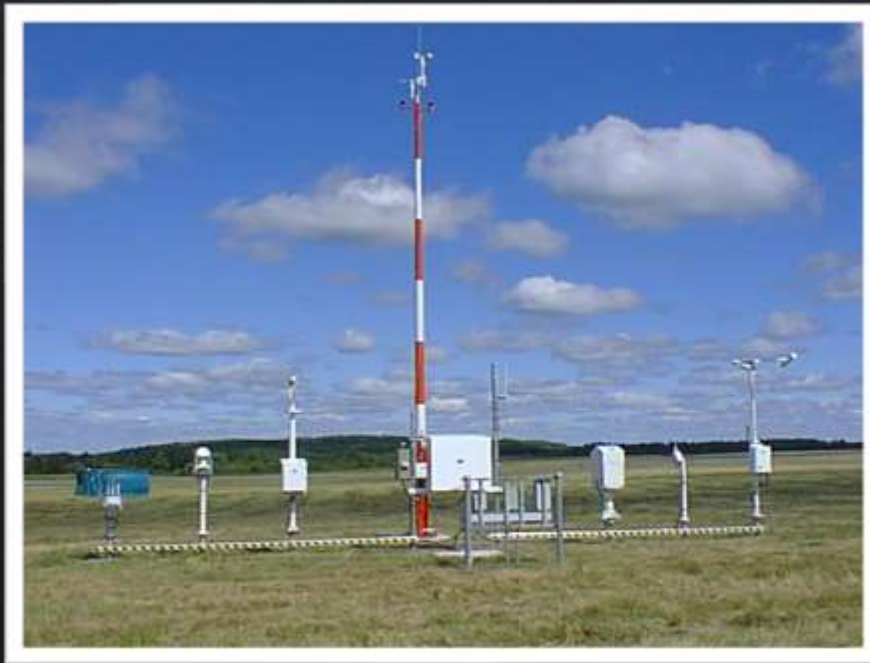
# Observations during heavy rain

- ◆ Automated observations

- ◆ Near-real time, but...

- ◆ Subject to error/clogging/freezing

- ◆ No measurement of how much of the fallen rain is being soaked into the ground, and how much is running into streams



# Observations during heavy rain

- ◇ Ground truth
  - ◇ Nothing ever beats an eye in the field!
  - ◇ Rainfall measurement / flood report / stream measurement
  - ◇ Safety is always key!



**US 301 / MD 4**  
**Prince George's Co., MD**

*Photo courtesy Prince George's County EMS*



# Additional Reports

If you have a rain gauge or automated weather station:

- ❖ We would love to have your reports routinely!
- ❖ Rain gauge or automated weather station must be well-sited (not attached to side of house, not under trees, etc.)



National Weather Service Baltimore/Washington



# Ways to report rain or snow

**Please choose only one method;** sending it more than one way will cause us to receive duplicate information for the same location!

- ◇ NWS Spotter Form
  - ◇ Link is near the top of <https://www.weather.gov/lwx/skywarn>
- ◇ CoCoRaHS 
  - ◇ <http://www.cocorahs.org>
  - ◇ Requires a standard rain gauge
- ◇ Citizen Weather Observer Program
  - ◇ <http://www.wxqa.com>

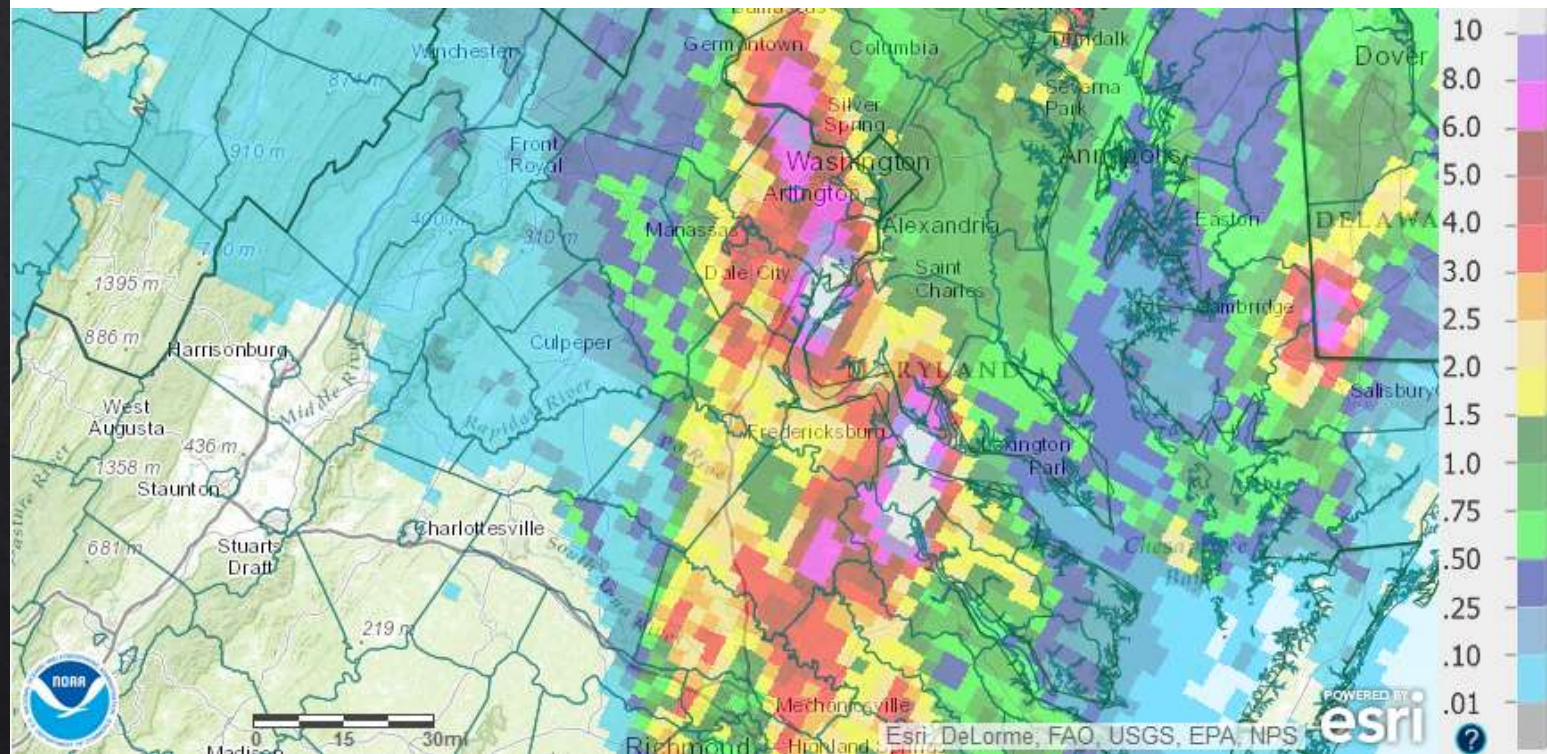




# Precipitation Estimates

- ◇ Remote Sensing
  - ◇ Radar
  - ◇ Satellite

Baltimore/Washington, VA (LWX): 9/9/2011 1-Day Observed Precipitation  
Valid at 9/9/2011 1200 UTC- Created 9/11/11 23:31 UTC



# The “Ultimate Combo”

- ◆ Ground truth observations
- ◆ Radar & satellite estimates skewed by ground truth
- ◆ Gaps filled in by radar & satellite
- ◆ Spotter reports are vital!
  - ◆ Rain amounts
  - ◆ River level status
  - ◆ Is there water over the road?



Ellicott City, MD

Photos by Craig Coyne



# Why Do We Need Spotters?

- ◇ All one team!
  - ◇ Emergency Managers
  - ◇ Other Government Agencies
  - ◇ Broadcast and Print Media
  - ◇ SKYWARN Spotters
  - ◇ Amateur Radio Operators
  - ◇ Cooperative Observers



# Spotter Reports

## ◆ Answer the 4 Ws:

- ◆ Who are you?
- ◆ What is your report?
- ◆ When did this happen?
- ◆ Where did this happen?



Tips:

*Give us your spotter number & name*

*Be descriptive about what you see  
(pictures are great, but be safe!)*

*Be as specific about location as possible*





# Why Specificity Matters

◆ Floods are not created equal!



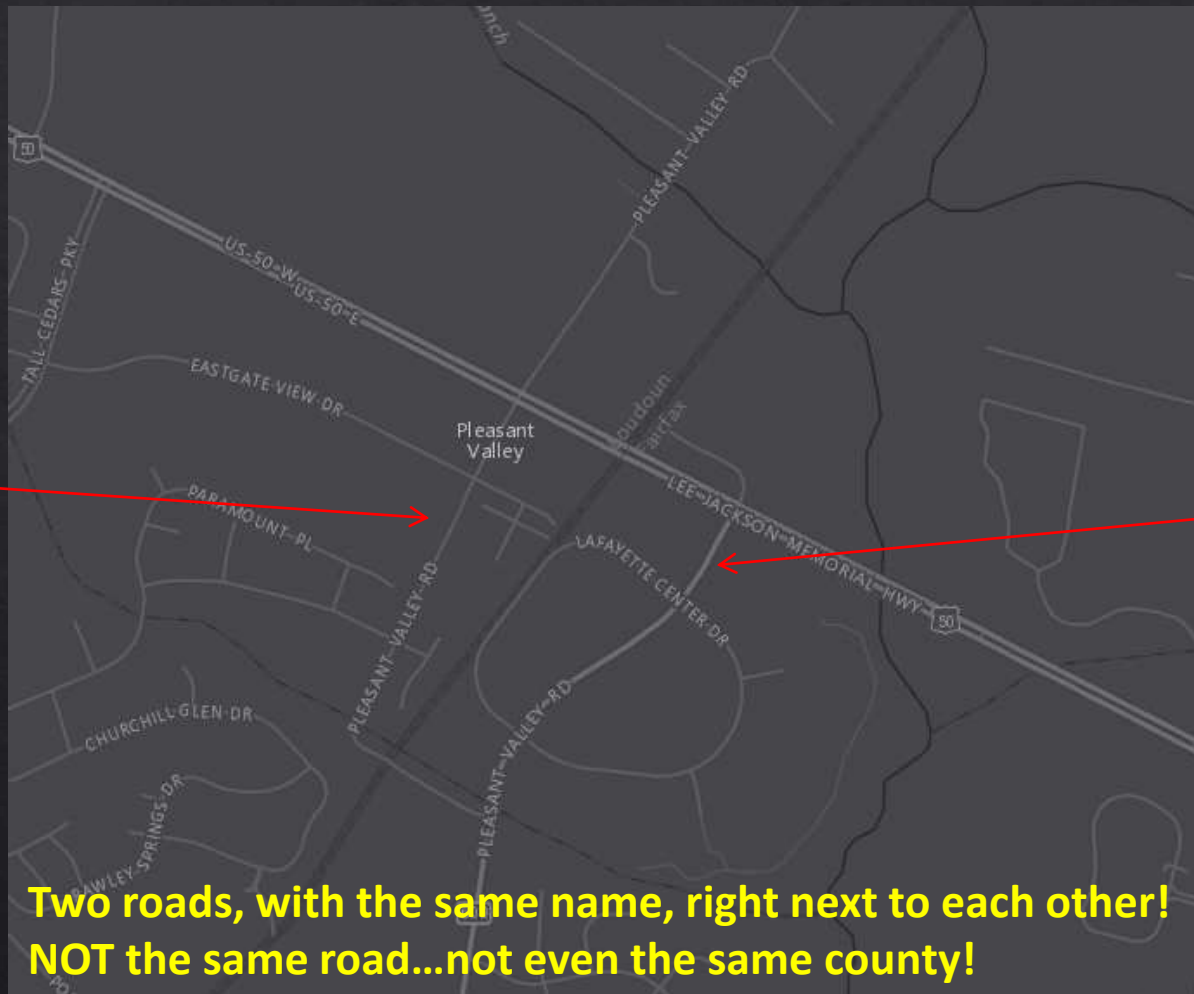
VS.



# Why Specificity Matters

## ◆ Location...location...location!

Pleasant  
Valley Rd  
(Loudoun Co.)



Pleasant  
Valley Rd  
(Fairfax Co.)

Two roads, with the same name, right next to each other!  
NOT the same road...not even the same county!



# Floods – What to Report

- ◇ River or stream flows out of banks and is a threat to life or property.
- ◇ Person or vehicle swept away by flowing water **from runoff that inundates** adjacent grounds.
- ◇ A maintained county or state road closed by high water.
- ◇ Approximately **six inches or more of flowing water** over a road or bridge.
  - ◇ This includes low water crossings in a heavy rain event that is more than localized (i.e., radar and observer reports indicate flooding in nearby locations) and poses a threat to life or property.



*See water where it doesn't belong, but it doesn't meet these criteria? Report it anyway, but be as descriptive as you can! We don't want to issue warnings when they aren't really needed!*

# Floods – What to Report

- ❖ Dam break or ice jam release causes dangerous out of bank stream flows or inundates normally dry areas creating a hazard to life or property.
- ❖ Any amount of water in contact, flowing into or causing damage of an **above ground** residence or public building and is **runoff from adjacent grounds**.
- ❖ **Three feet or more of ponded water** that poses a threat to life or property.
- ❖ Mud or rock slide caused by rainfall (could possibly occur in a burned area with only light-moderate rainfall).

*See water where it doesn't belong, but it doesn't meet these criteria? Report it anyway, but be as descriptive as you can! We don't want to issue warnings when they aren't really needed!*





# What to Report

- ◆ **Flooding & Flash Flooding** –  
Streams, creeks or rivers out of banks or flooding of roads

## Things to look for:

- ◆ Is the water still or flowing?
- ◆ How deep is the water?
- ◆ What is the source of the water?  
(stream? drainage ditch? poor drainage?)
- ◆ If a road is impacted, lat/lon or block #
- ◆ Are any structures impacted (including outbuildings)?
- ◆ Can you safely get any pictures?



# Terminology Reminders

## ◆ **By NWS Definition** –

A flood/flash flood must impact life or property!

- ◆ Water over the banks of a stream but not affecting anything is technically not a flood...but we'd still like to know! Let us know that "(name of stream) is bankfull" or "just over bankfull".

## ◆ **Low Water Crossings** –

We have many of these in this area. They are designed to be covered by water while the stream is entirely within its banks. (Not a flood!) If the "flood" is of a low water bridge, please say so!





# Flood Spotter Safety Reminder

## ◆ **Don't become a statistic!**

Practice what we preach!

If you come across a flooded road,  
that is a report! Don't drive through  
it looking for more flooded roads!



# Reporting Rain

- ◆ **Heavy Rain** – measured 1" or more (we prefer to get storm total at end, unless very heavy)
- ◆ **Rainfall Rate** –  
Rainfall in inches per hour  
(**Warning:** automated weather stations often provide an “instantaneous rain rate” which can sometimes be 10+ in/hr... this is not what we are looking for!)





# Winter Reports

- ◆ **Ice Accretion** – Any glaze on surfaces (or more) →
- ◆ **Snow Accumulation** – Every 2" and a storm total, or any accumulation not reflected in the forecast



**Average Ice Accretion**  
**5/16" = 0.3"**

Bonus points ☺:

**Snow Water Equivalent** –  
melt your snow down to see  
how much water is within it



**Snow Measurement Guidelines:**

[https://madis-data.noaa.gov/snow\\_measurements.html](https://madis-data.noaa.gov/snow_measurements.html)

# Setting Up for Snow Reports



Ideally, a snowboard is the best measuring surface.

- Can be as simple as a 2 ft square piece of plywood painted white
- May want to place flags/markers near the board to help locate during snowy weather
- You can measure snow on a table if you don't have a board
- Do NOT clean off the snowboard more frequently than every **six hours**.



# Non-Flood spotter reports

- ◇ Although we don't go into severe reports here, if you're already a spotter by having taken our Basic course, you certainly can report that too!
- ◇ If you want to provide tornado/funnel cloud reports, you should attend Basic first!



# How to Report Hail



Hail reports are the most difficult to gather. The hail shaft can be very narrow and short lived.

**“Marble Size” hail is ambiguous. Do not report hail as marble sized.**





# How to Report Hail



Please  
sports

ns or  
ruler.

Hail should be measured along the longest dimension. It is best to use a ruler or tape measure.

# Best way to report

## VERY IMPORTANT INFORMATION:

- ❖ Please DO NOT send flooding reports by email, unless you see it after the fact, have a picture, or can't get to a phone!
- ❖ This is very time critical information that needs to be relayed to forecasters immediately.
- ❖ Best means to get information to the NWS quickly is via the telephone or Amateur Radio.
- ❖ Rainfall/snowfall observations via email/web form are fine unless you think we need to know more urgently.

**PLEASE DON'T WAIT FOR US TO CALL YOU! (we will...)**





# Quick Quiz!

Let's take a minute to think about some scenarios and what we would report in to the NWS.

I'll show you some pictures and give you basic information – then you take it from there.

**There isn't necessarily just one right answer, so don't be afraid to speak up!**



# Quick Quiz!

## Question 1

**You're looking where Sandy Creek crosses Route 142, and this is your view. You decide to call this in to the NWS.**

**What description would you provide?**



National Weather Service Baltimore/Washington



# Quick Quiz!

## Question 2

You're standing at the corner of Main Street and First Avenue, and this is your view. You decide to call this in to the NWS.

**What description would you provide?**

**Is this a flash flood?**



Flickr / air babble



BY-SA 2.0



National Weather Service Baltimore/Washington

# Quick Quiz!

## Question 3

This is the view in front of your home on Happy Lane.  
You decide to call this in to the NWS.

**What description would  
you provide?**



Geograph / jobomobo



BY-SA 2.0



National Weather Service Baltimore/Washington



# Quick Quiz!

## Question 4

**You're next to the Chesapeake Bay at the parking lot of Bay Breeze Baptist Church. As you can see, it's a sunny day.**

**What description would you provide?**



Geograph / Marathon



BY-SA 2.0



National Weather Service Baltimore/Washington

# The Last Word

- ◇ At least one major flash flood happens here almost every year:

2019 – Grant County, Arlington/DC

2018 – Ellicott City, MD (again); Frederick, MD; Charlottesville, VA; Greene & Madison Counties, VA; Harford County, MD; Fulks Run, VA; Berkeley Springs, WV (again); and more!!!

*2017 – we got lucky!*

2016 – Ellicott City, MD

2015 – Woodstock, VA

2014 – Clear Spring, MD & BWI Airport

2013 – Laurel, MD

2012 – Berkeley Springs, WV

2011 – (widespread flooding from Lee)

- ◇ But...

- ◇ Last Major Tidal Flood: 2003

- ◇ Last Major Potomac Freshwater: 1996

- ◇ The Potomac floods, on average, every 6-7 years.  
**We are overdue!!**



# Review

- ◇ Stay informed via the NWS website.

weather.gov/washington

or

weather.gov/baltimore

Or use...

mobile.weather.gov  
for cell phone display

