

# Nashville SAFE Protecting Lives and Property



Dana Waits & Whitney Fuquay, Amec Foster Wheeler



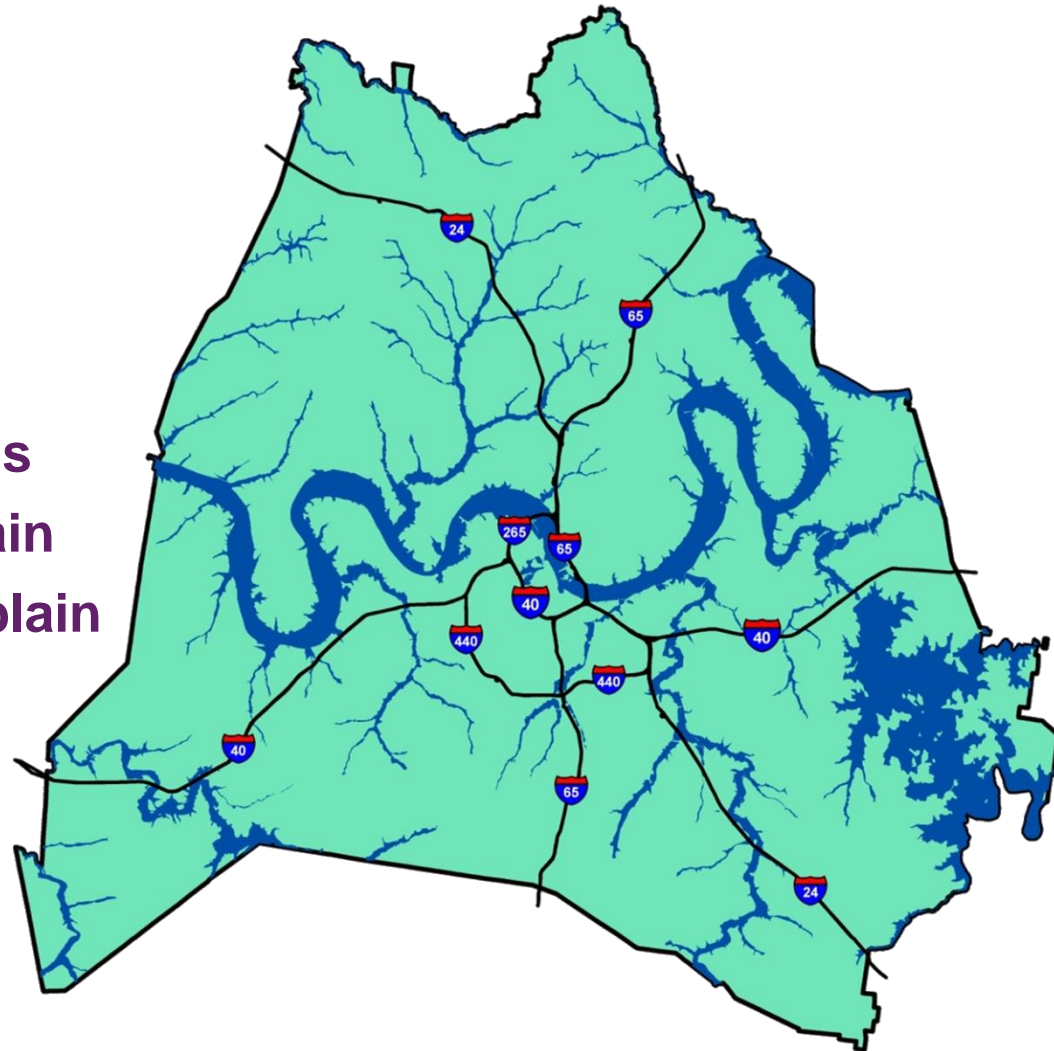
KSA Conference  
July 21, 2017

# Metro Nashville & Davidson County



## May 2010

- 533 Square Miles
- Population 570,000
- NFIP Participant
- CRS Class 8
- 340 Miles of FEMA Streams
- 10,000 Parcels in Floodplain
- 8,000 Structures in Floodplain

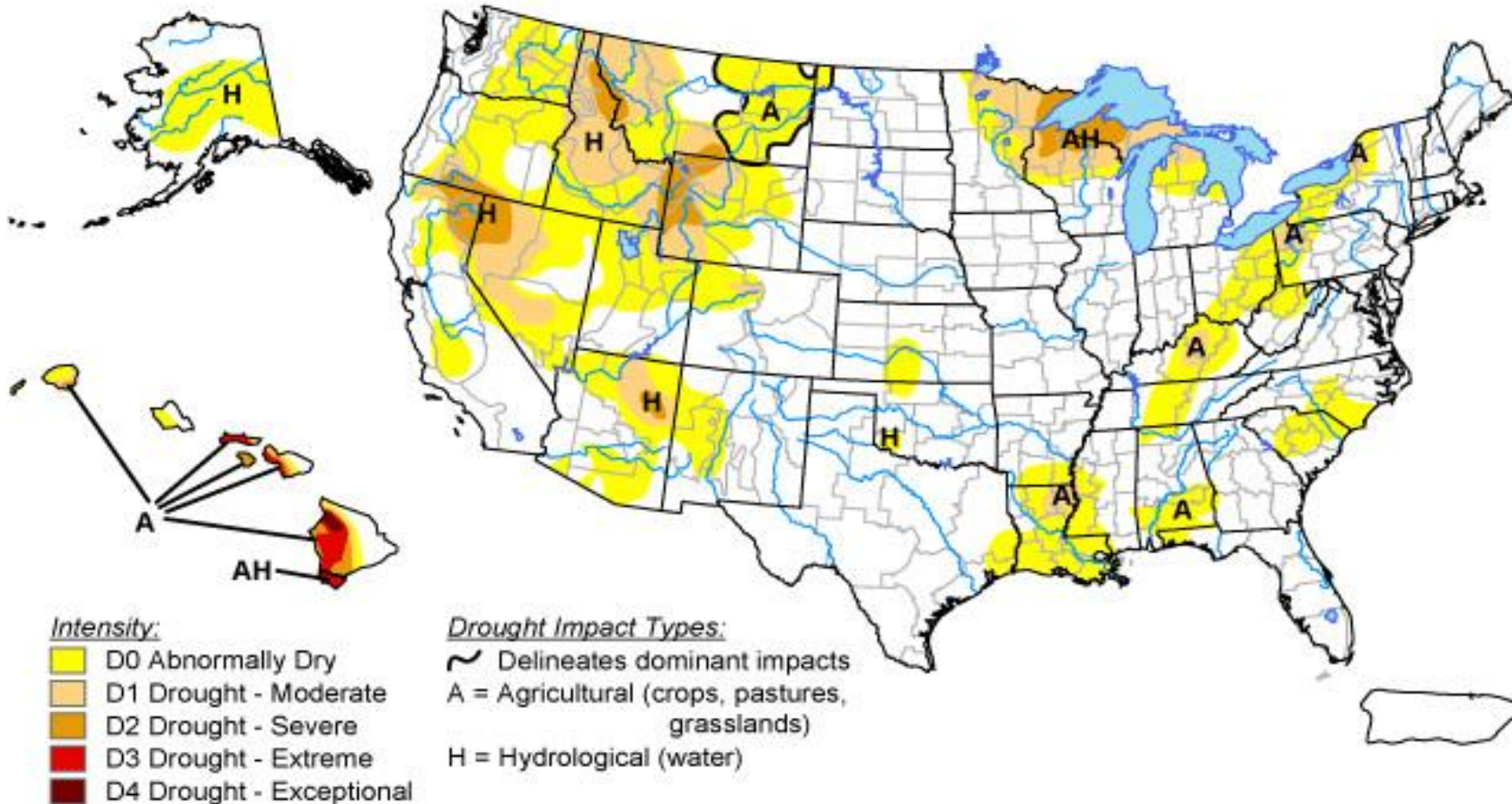


# Pre-Flood Conditions



## U.S. Drought Monitor

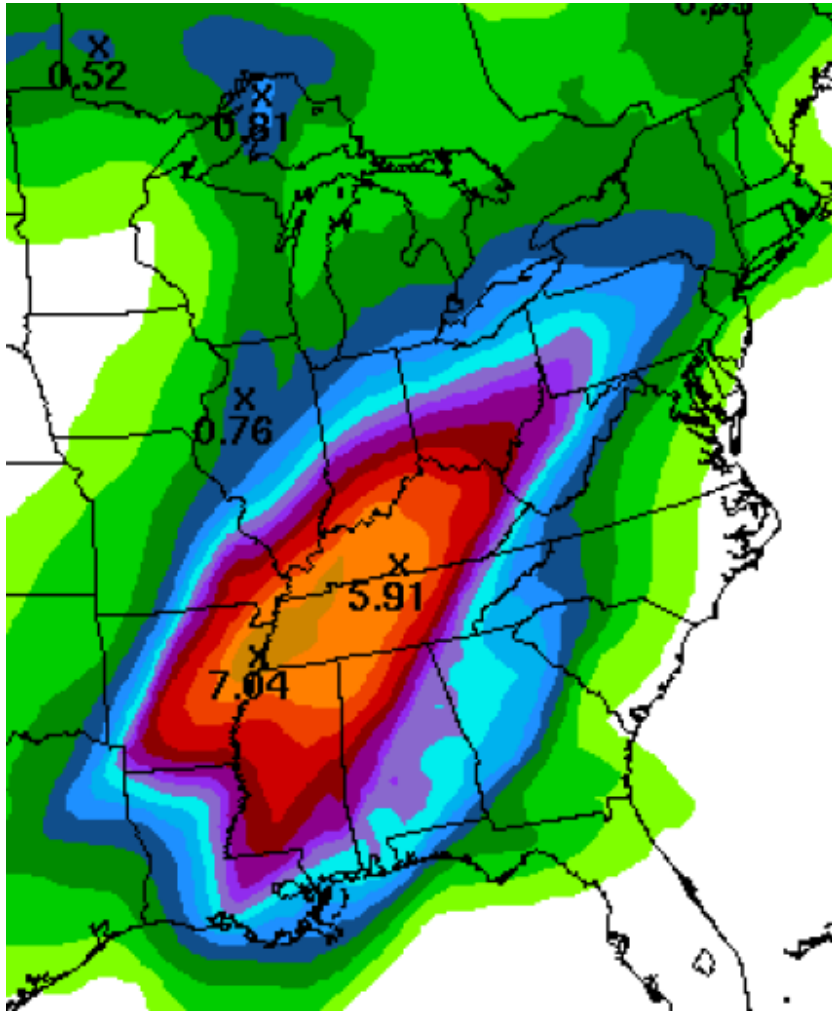
April 27, 2010  
Valid 8 a.m. EDT



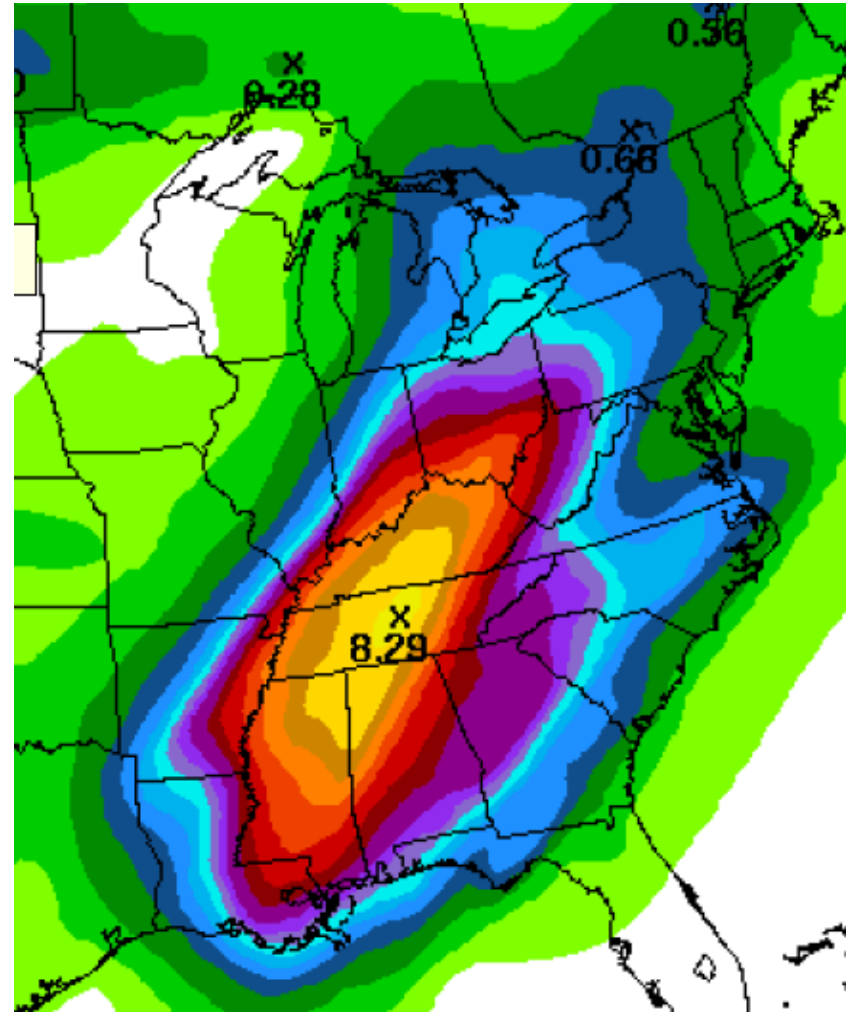
# Rainfall Forecast (3-day total)



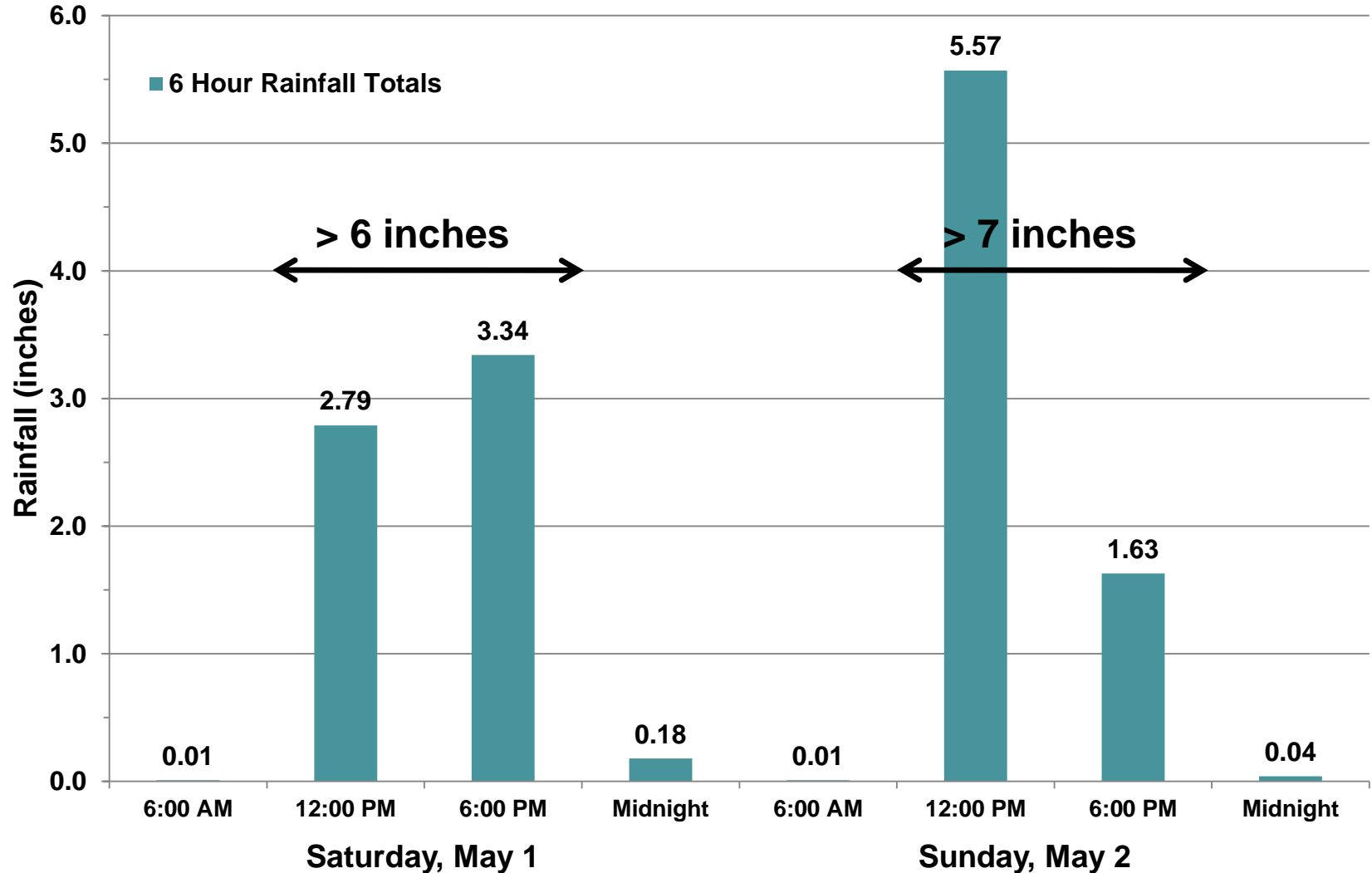
## Friday Night April 30



## Saturday Morning May 1



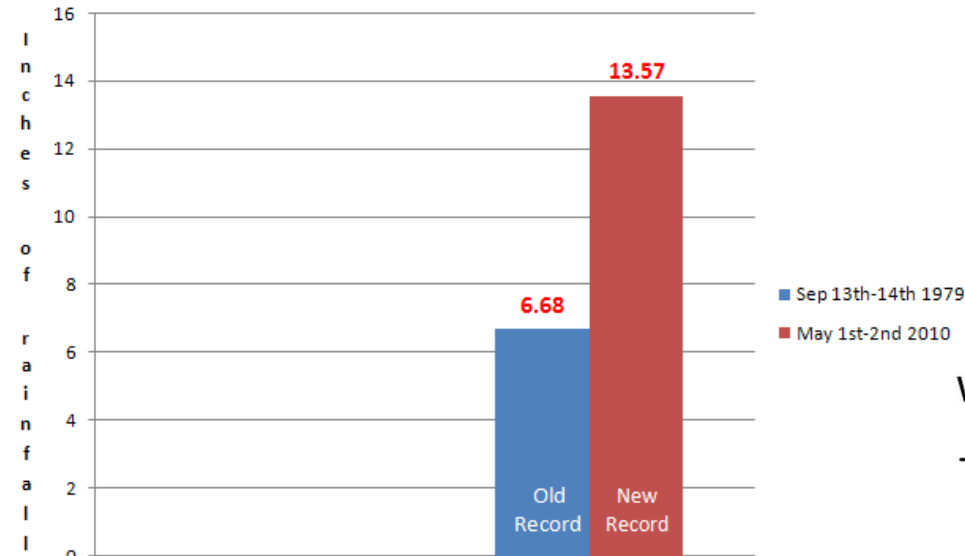
# Two Day Rainfall Pattern



# Rainfall Records Shattered

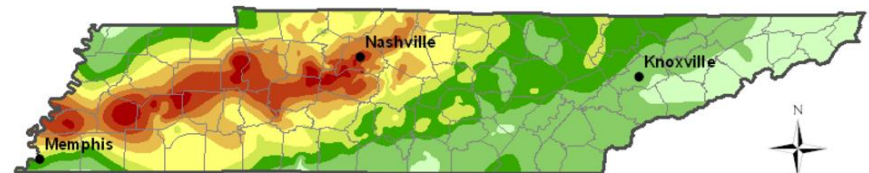


## Epic Nature of May 1st-2nd 2010, 2-day Rainfall Total at Nashville Airport

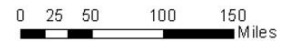


NWS/Nashville, TN  
Bobby Boyd/Darrell Massie

## Weekend Rainfall Totals - May 1st & 2nd, 2010 Tennessee



Source: CoCoRaHS



Precipitation Contours	
In Inches	
0.01" - 2.00"	8.01" - 10.00"
2.01" - 4.00"	10.01" - 12.00"
4.01" - 6.00"	12.01" - 14.00"
6.01" - 8.00"	14.01" - 16.00"
	16.01" - 20.00"



This map is an interpolation of actual reported values, but should be considered an estimation only.

Created by the National Weather Service Forecast Offices Nashville, Tennessee & Louisville, Kentucky

# Interstate Highways Flooded



# Opryland Hotel and Grand Ole Opry House

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# Opry Mills Mall

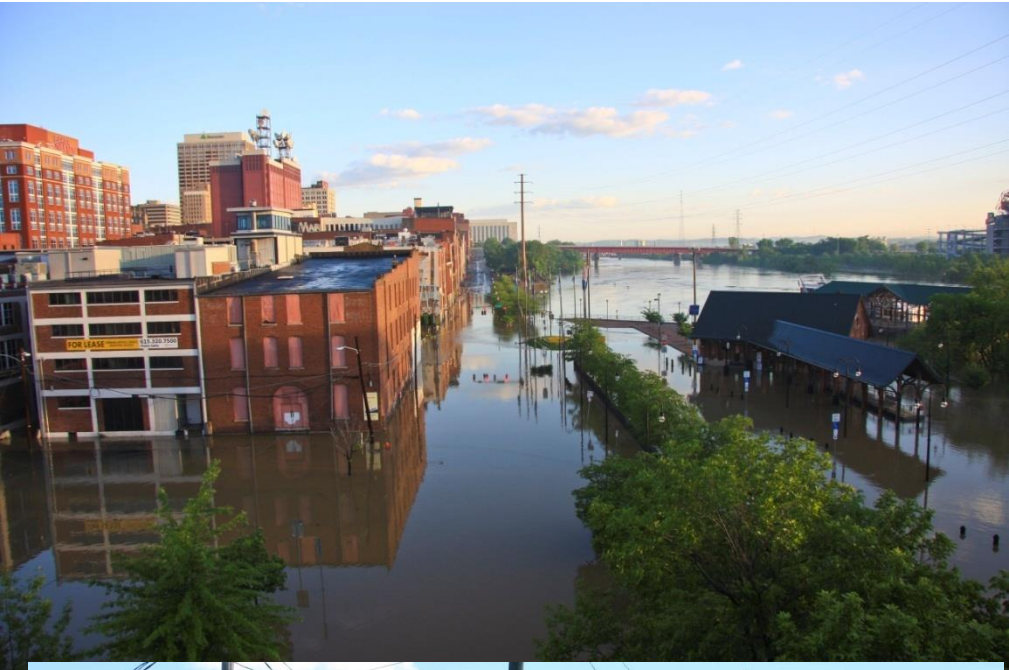
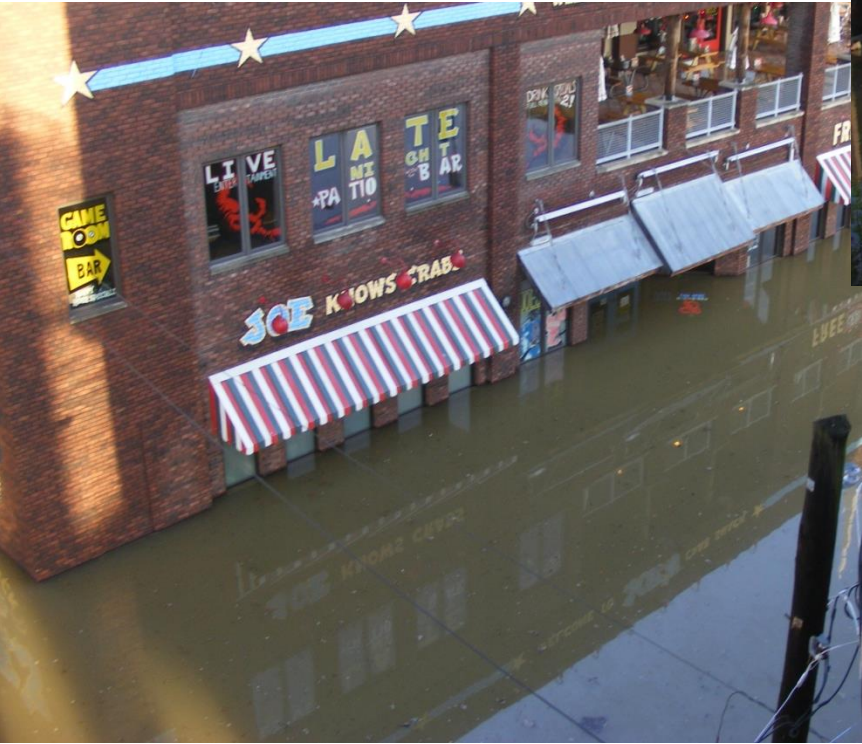


# Nissan Stadium



# Downtown Nashville

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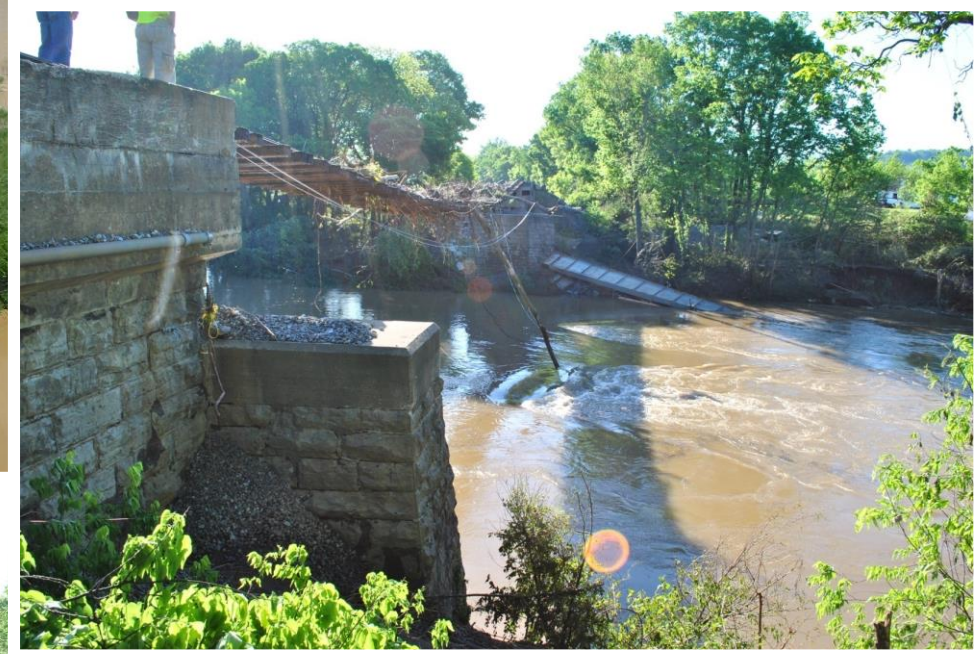


# KR Harrington Water Treatment Plant



# CSXT – Widespread Flood Damage

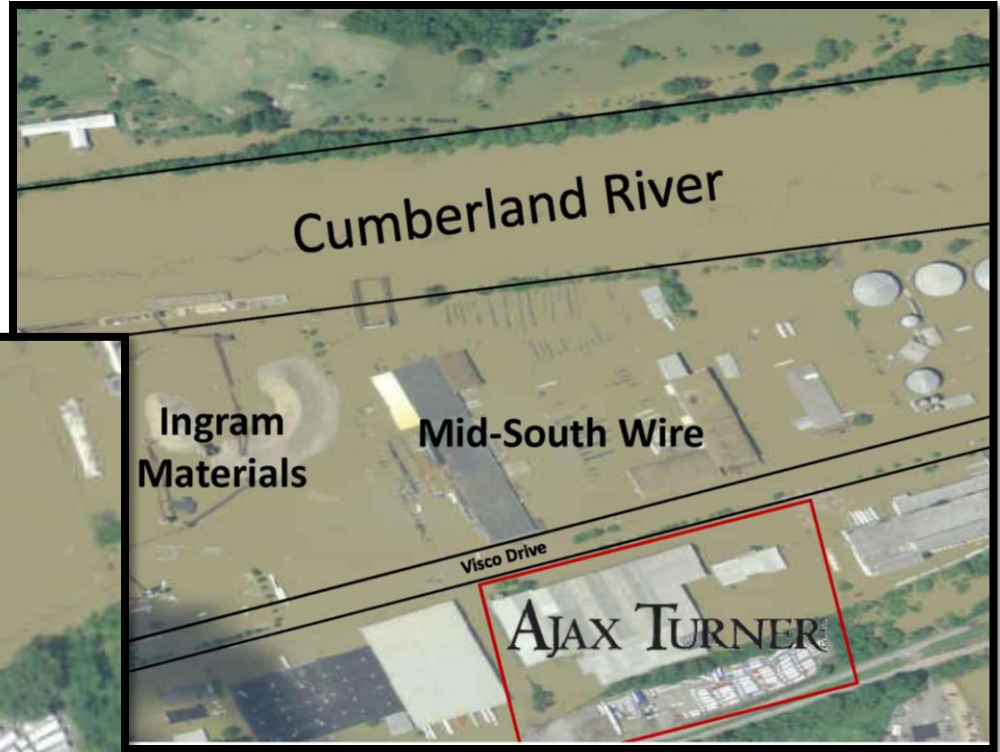
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# REOstone Quarry Along Richland Creek



# Ajax Turner (Anheuser-Busch Distributor)



# Flood Summary



## Nashville & Davidson County

- 11,000 Properties Damaged
- 10,000+ People Displaced
- 3,472 Post-flood Residential Building Permits Issued
- Hundreds of Homes Permanently Abandoned
- 2,800 Businesses Sustained Damage (40% of which was retail)
- 13,000 Jobs Temporarily Lost
- 1,500 Jobs Permanently Lost
- \$3.6 Billion in Business Disruption
- 115 Roads Closed up to a Week
- \$2 billion in total damages
- 11 Lives Lost

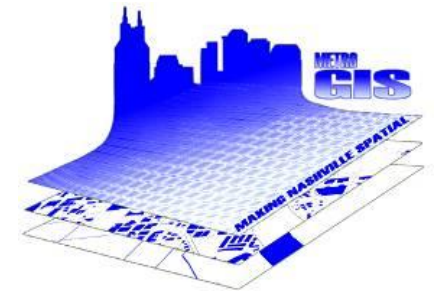




# Building Partnerships



**US Army Corps  
of Engineers®**



amec  
foster  
wheeler





## **SITUATIONAL AWARENESS** *for* **FLOODING EVENTS**

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# Nashville SAFE Mission

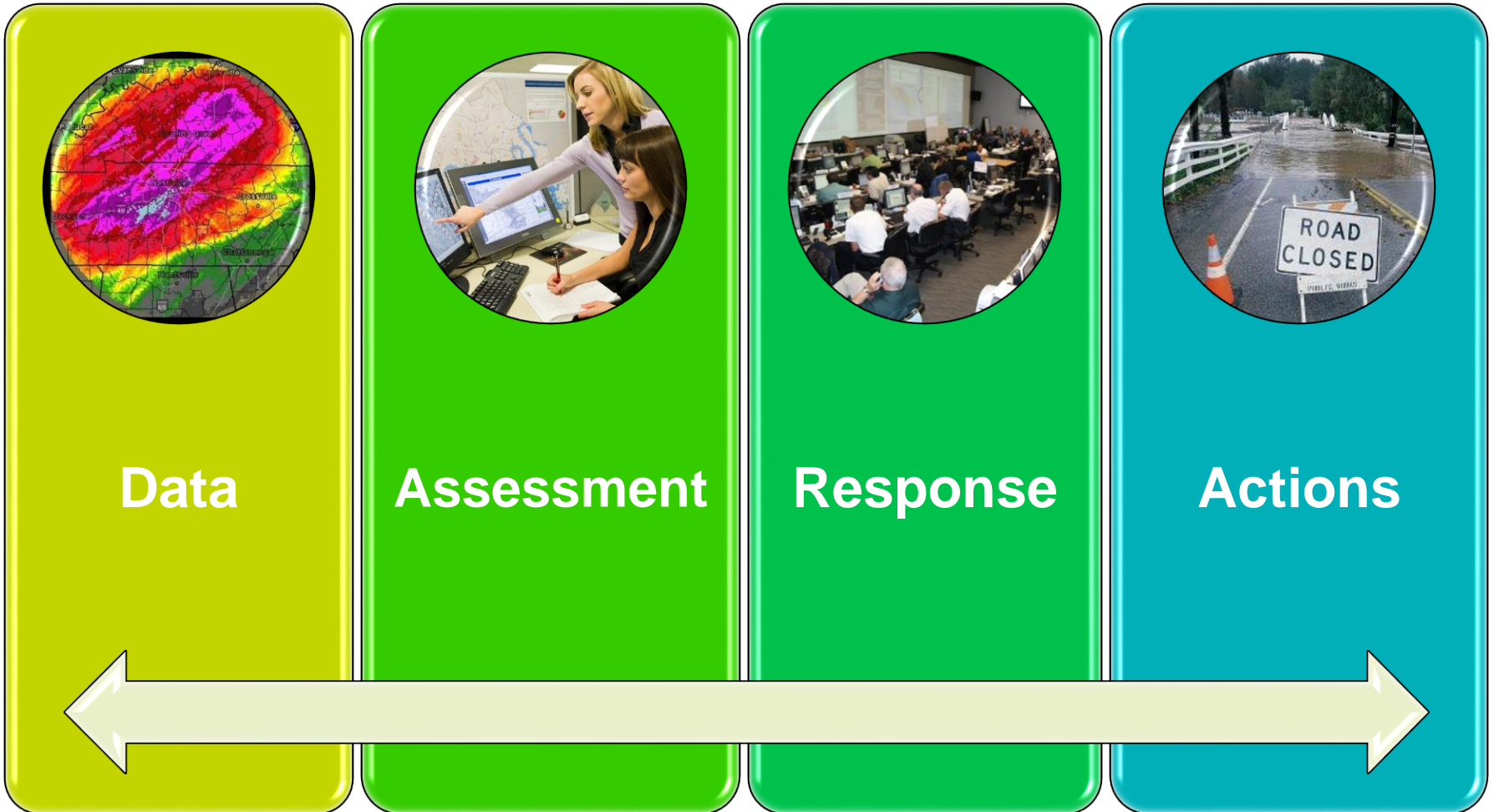
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# Improved Coordination



# Improved Coordination



# Improved Coordination



Nashville SAFE Program

amec collaboration  
Project Web

Site Actions ▾
Browse
Page
Heilwagen, Brad ▾

Nashville SAFE Program ▸ Nashville SAFE Wiki ▸ Senior

**Recently Modified**

- Senior
- Visitor
- Junior
- Home
- How To Use This Library

**Site Content**

- Surveys
- Discussions
  - Discussion Board
- Libraries
  - Virtual Event Log
  - Reference Documents
  - Document Exchange
  - Templates
- Lists
  - Virtual Sign-In Sheet
  - Activation Announcements
  - General Announcements
  - Calendar
  - Tasks
  - SAFE Contact List
  - SAFE Links
  - RFI Center

## Senior Watershed Advisor

**General Responsibilities:**

- Review of watershed assessment provided by Junior Advisors.
- Reporting of data and assessment, including response recommendations, to EOC Information & Planning Section Chief, Situation Management Team, or Crisis Action Team, as directed.

<u>Tasks</u>	<u>Tools</u>
<a href="#">Sign In / Sign Out</a>	<a href="#">Nashville SAFE Chat Room</a>
<a href="#">Announce Activation of Virtual Event Room</a>	<a href="#">Discussion Board</a>
<a href="#">Assign Watershed Tasks</a>	<a href="#">Sandbag Calculator</a>
<a href="#">Review Submitted Situation Reports</a>	<a href="#">Contact List</a>
<a href="#">Download County Level Situation Report</a>	<a href="#">Nashville SAFE Links</a>
<a href="#">Upload County Level Situation Report</a>	<a href="#">Job Action Sheets</a>
	<a href="#">Watershed Advisory Guide</a>

# Improved Coordination



## Heavy Rain/Flooding Potential and Severe Weather Threats

NWS Nashville  
October 13th, 2014

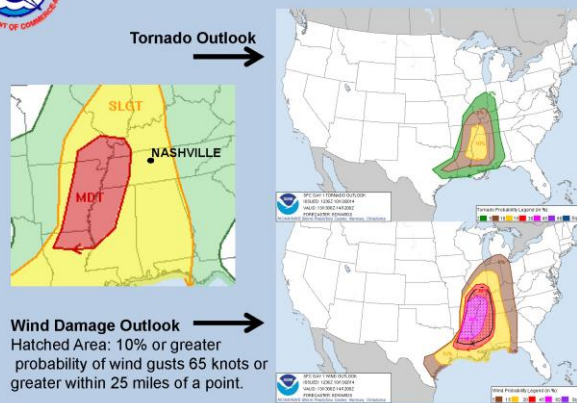


## Severe Weather Potential Today thru Tuesday a.m.

- A very intense system has developed to our west and is expected to move into middle TN this evening, lasting into the morning hours Tuesday.
- Damaging winds, hail and isolated tornadoes are all possible with this system – most likely a squall line.
- Flash Flooding will become a concern tonight.  
**A Flash Flood Watch is in effect from 7 pm tonight through 1 pm Tuesday.**
- Gradient winds will also gust to 40 mph outside of thunderstorms.



## Severe Weather Outlook for Today

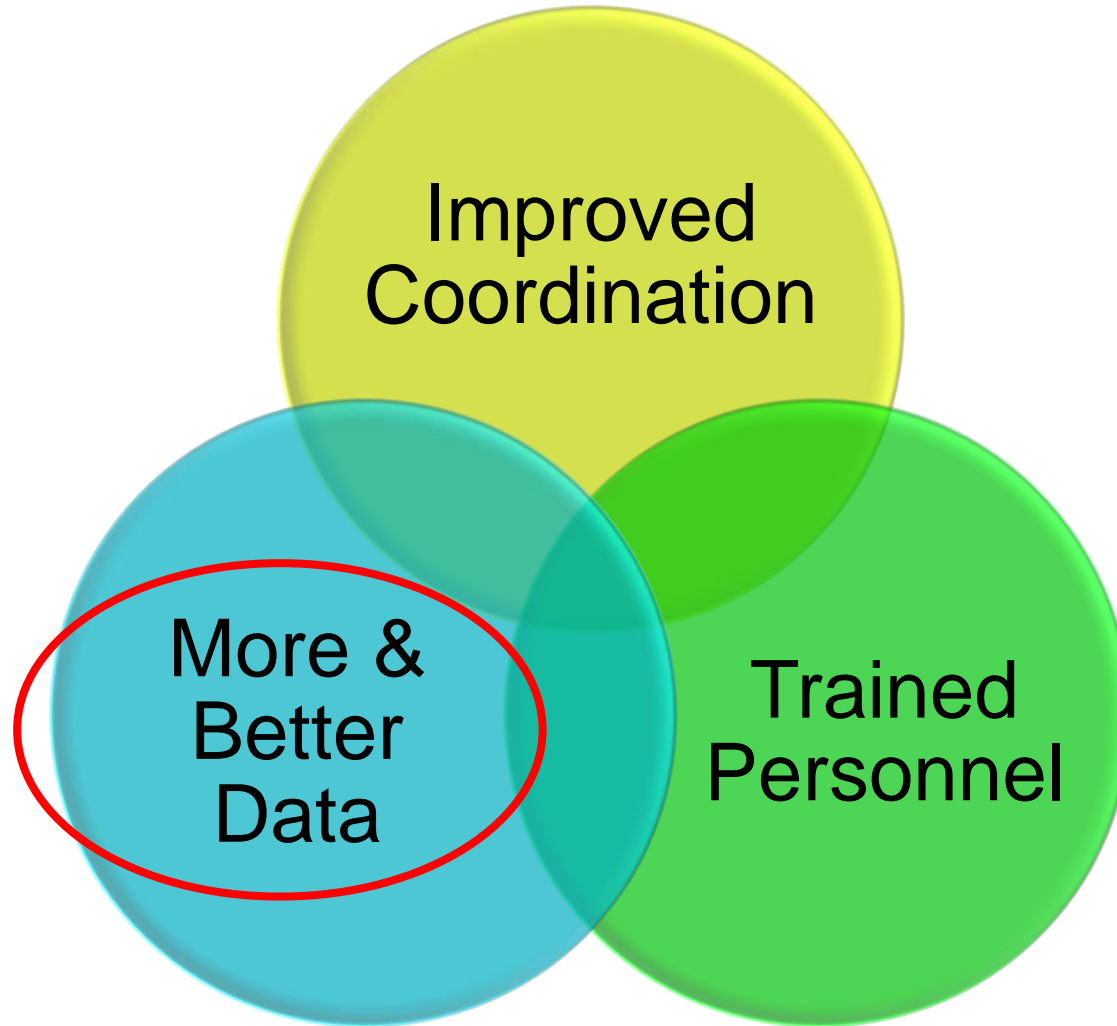


## Approximate Severe Weather Timing



# Nashville SAFE Mission

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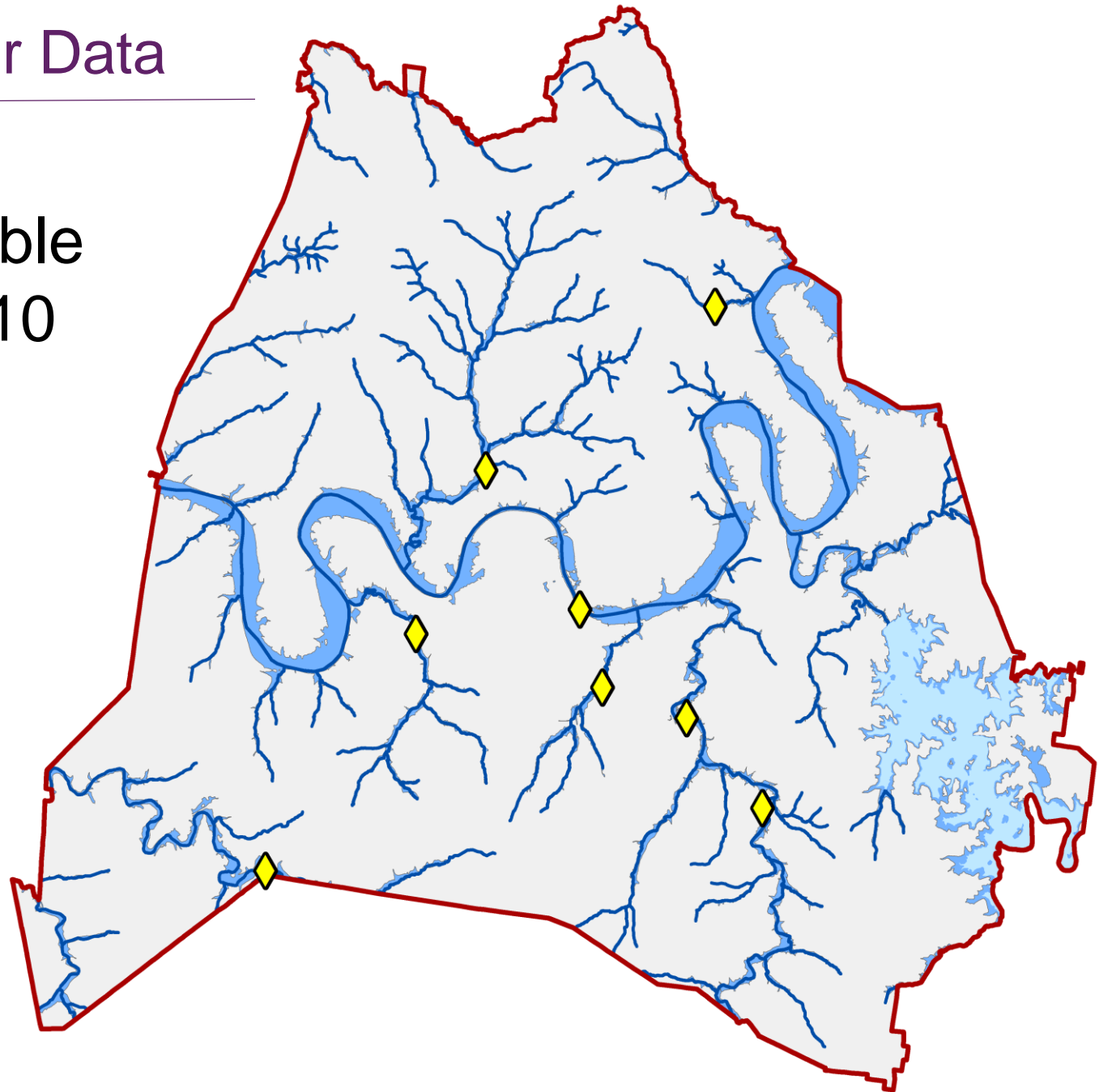




# More & Better Data

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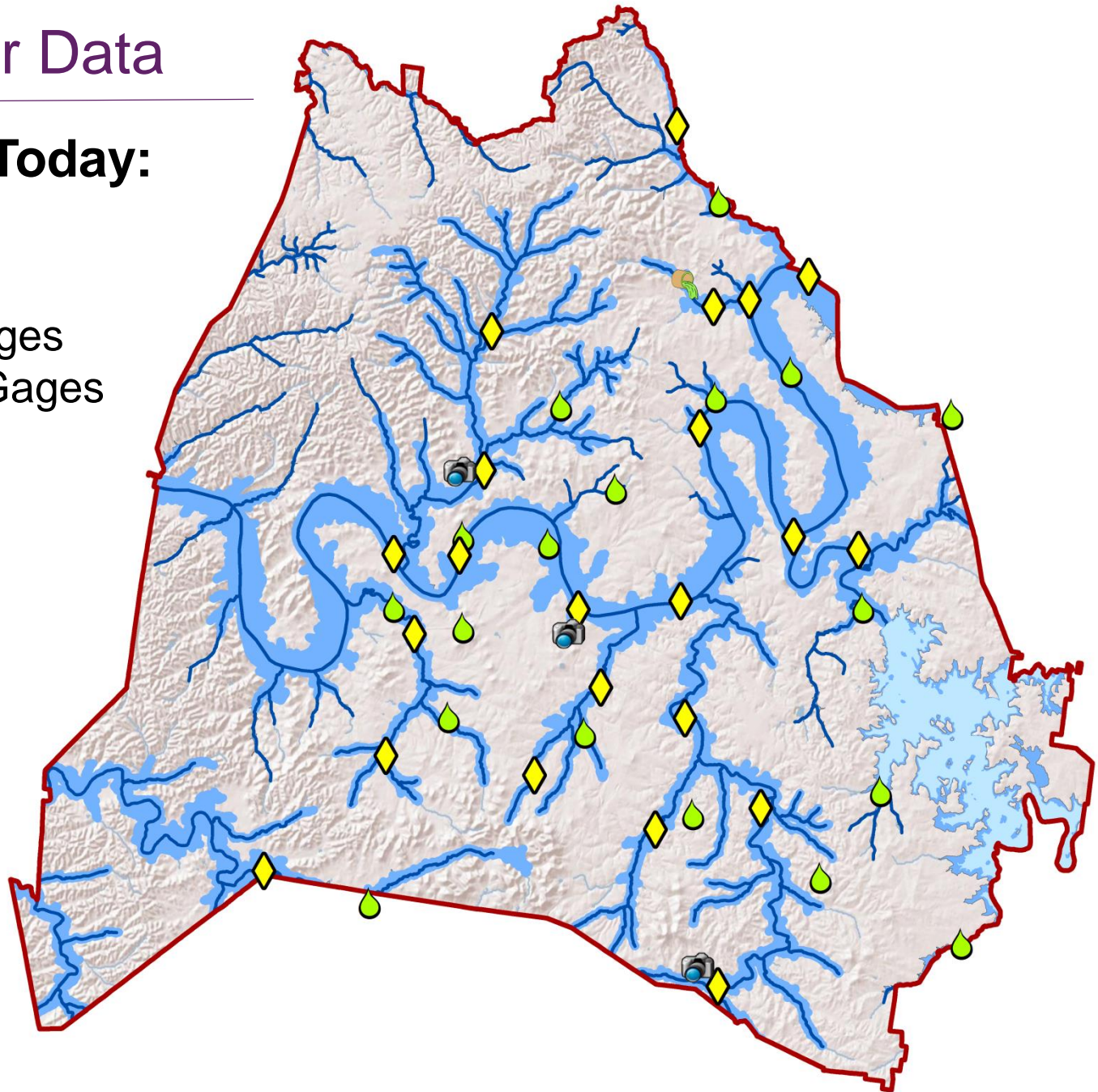
Data Available  
May 1, 2010



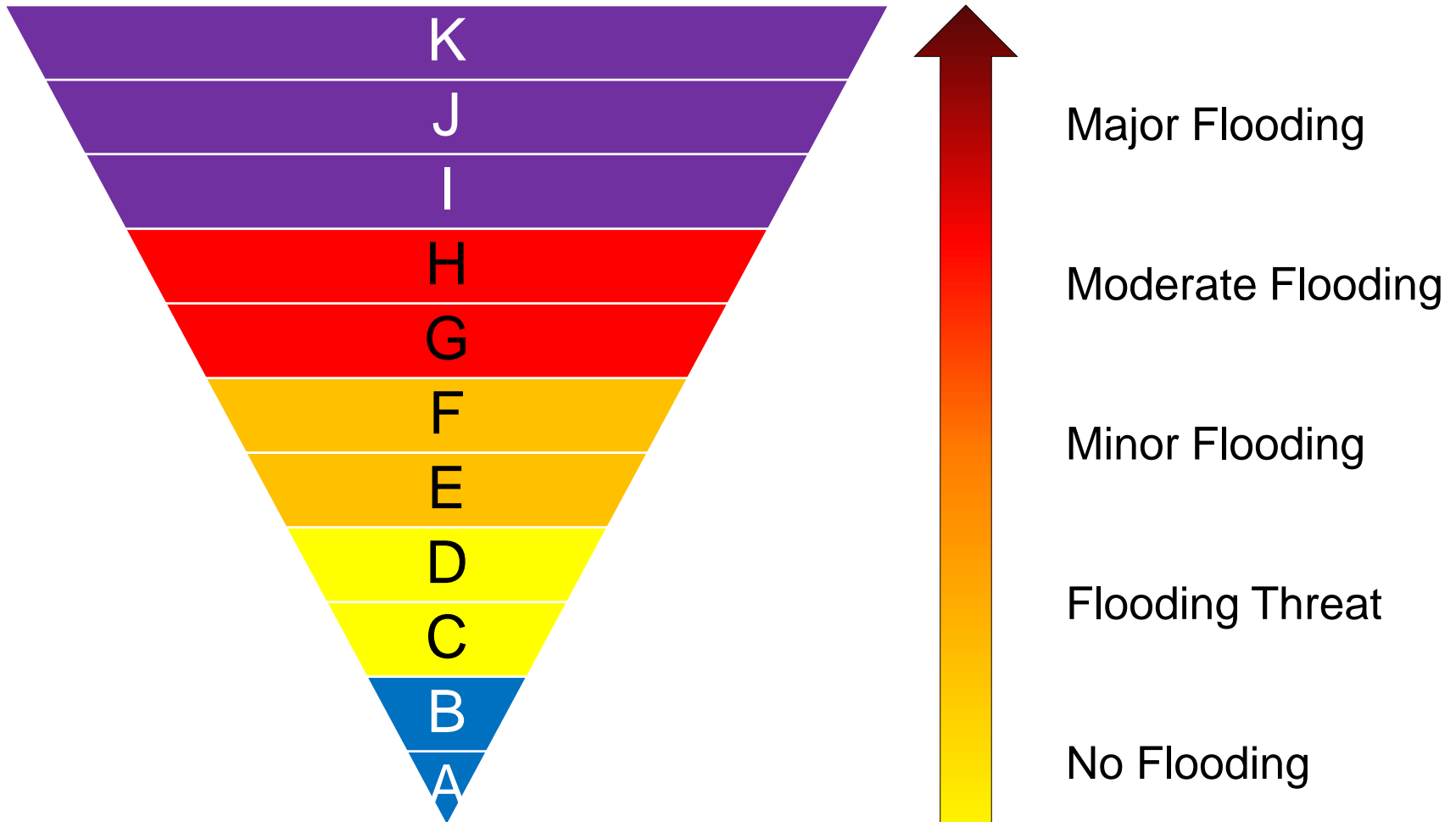
# More & Better Data

## Data Available Today:

- New LiDAR
- New Modeling
- New USGS Gages
- MWS Rainfall Gages
- Webcams



# More & Better Data



# More & Better Data



## Action Levels

### Mill Creek Near Nolensville

River Mile	19.447		SAFE Action Level
Datum El.	527.3	(ft)	
Flow (cfs)	Elev (ft)	Stage (ft)	
	556.7	29.4	K
	555.1	27.8	J
	553.9	26.6	I
	551.7	24.3	H
	550.5	23.2	G
	549.4	22.0	F
	548.2	20.8	E
	546.8	19.5	D
	545.1	17.8	C
	542.9	15.6	B
	539.4	12.0	A

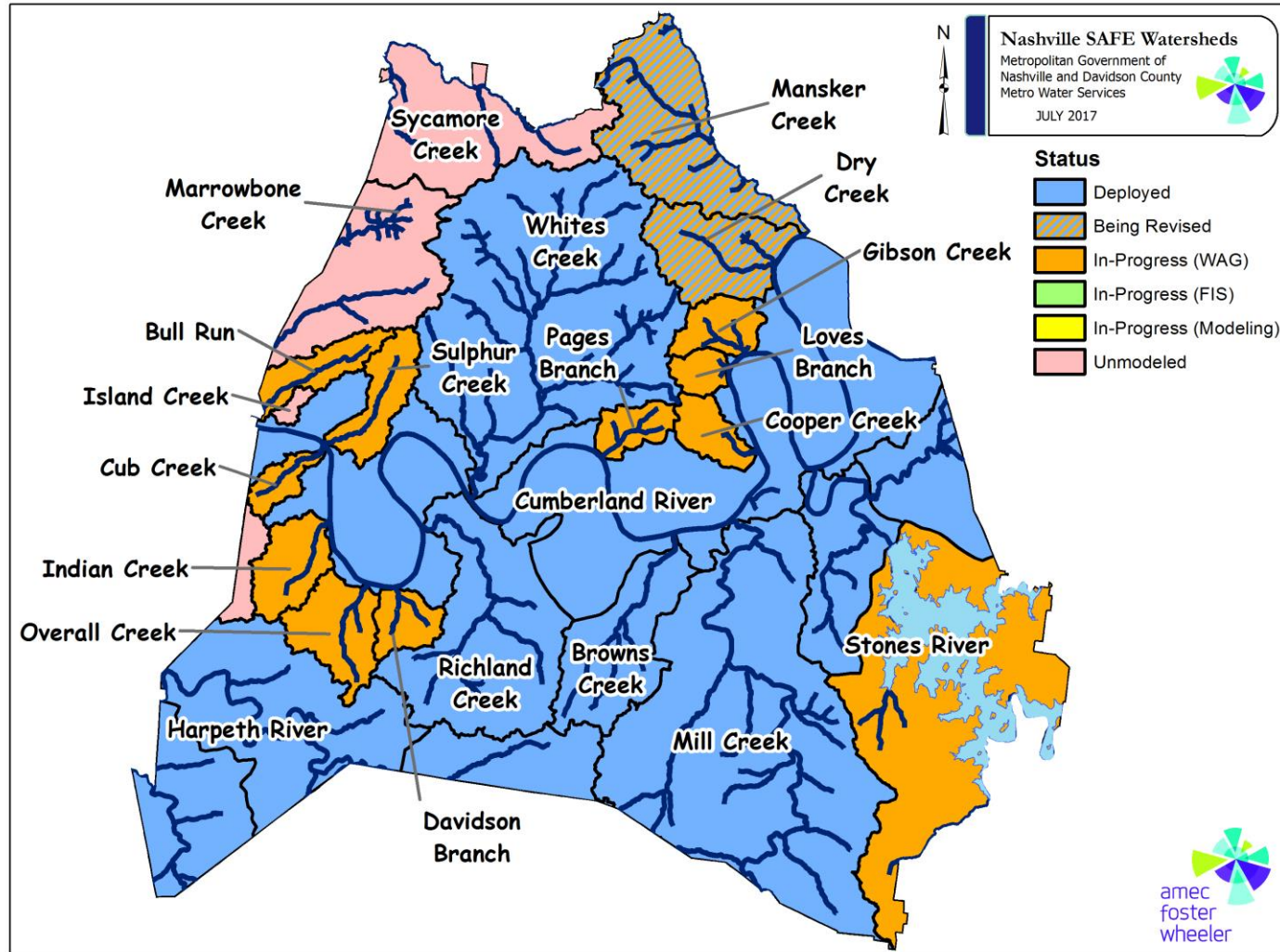
### National Weather Service Flood Categories

Stage (ft)	Elev (ft)	Flood Categories
20.0	547.3	Major Flood Stage
17.0	544.3	Moderate Flood Stage
13.0	540.3	Flood Stage
11.0	538.3	Action Stage

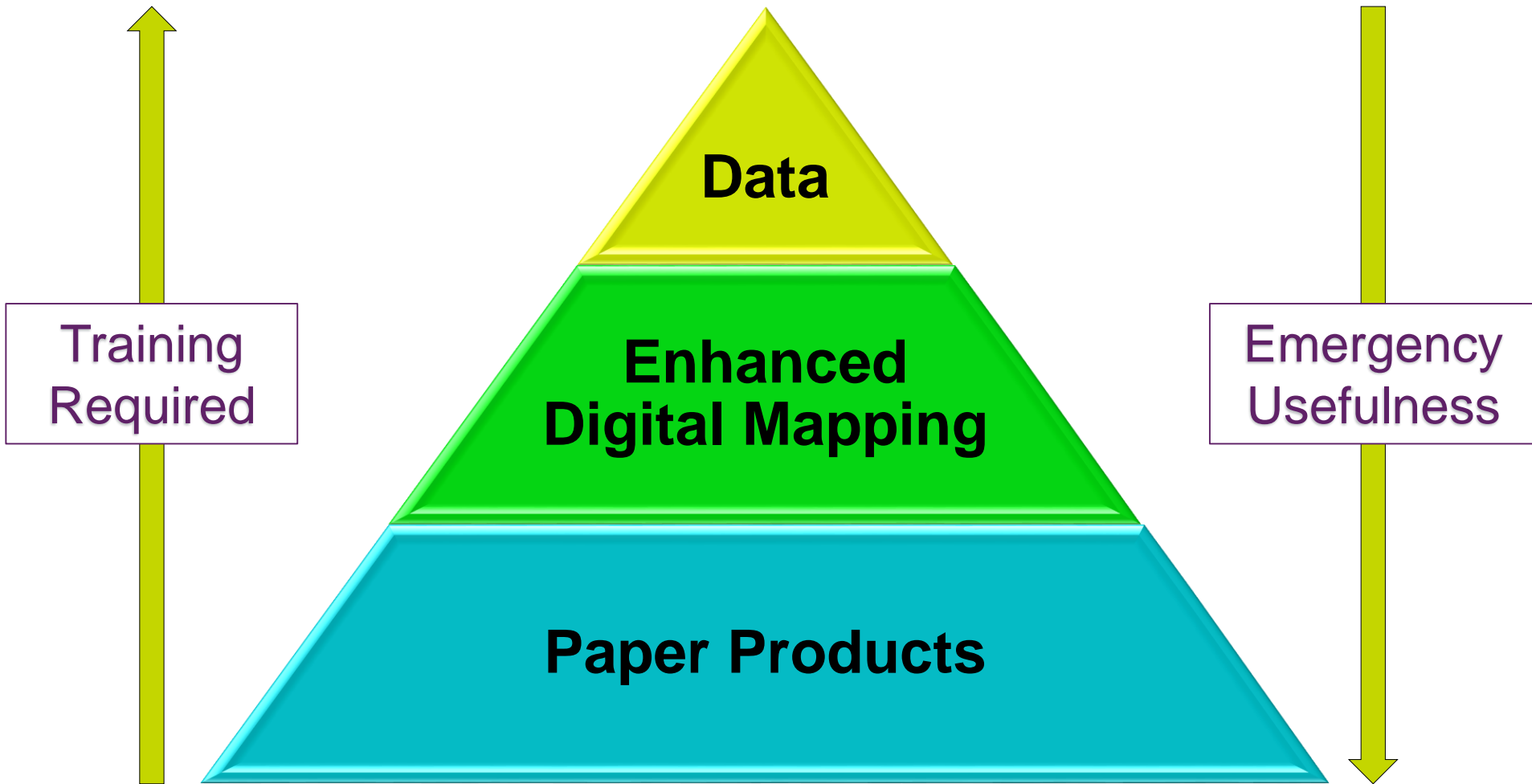
### Historical Crests

17.9	545.2	5/25/2000
17.8	545.2	6/7/2003
17.3	544.6	10/5/1995
17.1	544.4	5/14/1995
16.5	543.9	3/3/1997

# New Modeling



# More & Better Data



# Nashville SAFE Tool



**NASHVILLE SAFE**  
SITUATIONAL AWARENESS FOR FLOODING EVENTS

Current  
 Predicted

Search Address

Additional Layers  
Set Predicted Levels

**WF Browns Creek - Glendale Ln**  
Stage Level  
[Slider] [Dropdown]

**Cumberland River - Woodland**  
Stage Level  
48 [Dropdown]

**Harpeth River - Bellevue**  
Stage Level  
[Slider] [Dropdown]

**Mill Creek - Antioch**  
Stage Level  
[Slider] [Dropdown]

**Mill Creek - Nolensville**  
Stage Level  
[Slider] [Dropdown]

**PREDICTIVE**

Stream Gauge Grid

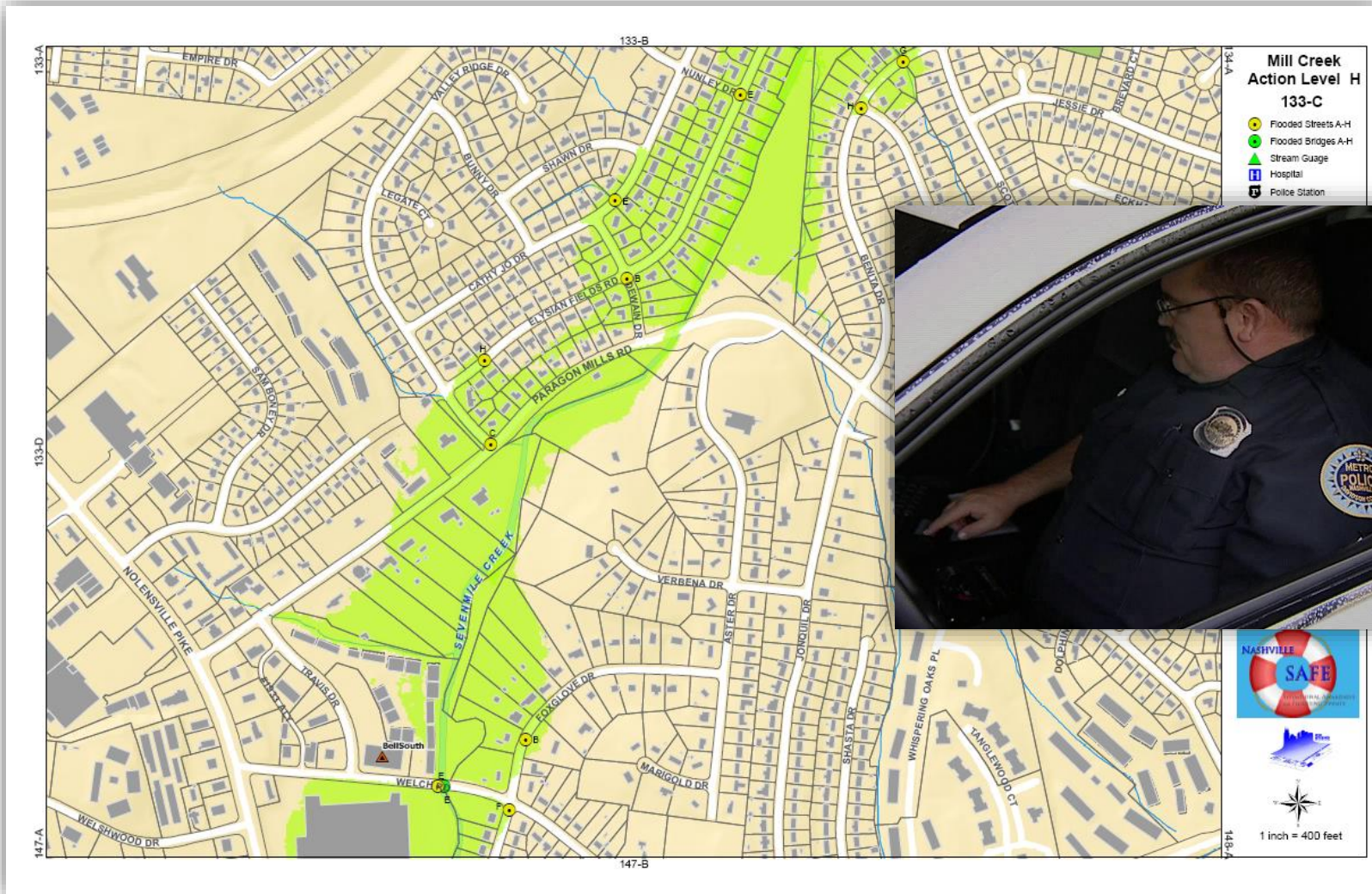
Map features: KERSON PIKE, BERRY ST, WOODLAND ST, INTERSTATE 24, MAN ST, RUSSELL ST, VICTORY AVE, SAND ST, CHURCH ST, 4TH AVENUE, 5TH ST, 6TH AVENUE, 7TH AVENUE, 8TH AVENUE, 9TH AVENUE, 10TH AVENUE, 11TH AVENUE, 12TH AVENUE, 13TH AVENUE, 14TH AVENUE, 15TH AVENUE, 16TH AVENUE, 17TH AVENUE, 18TH AVENUE, 19TH AVENUE, 20TH AVENUE, 21ST AVENUE, 22ND AVENUE, 23RD AVENUE, 24TH AVENUE, 25TH AVENUE, 26TH AVENUE, 27TH AVENUE, 28TH AVENUE, 29TH AVENUE, 30TH AVENUE, 31ST AVENUE, 32ND AVENUE, 33RD AVENUE, 34TH AVENUE, 35TH AVENUE, 36TH AVENUE, 37TH AVENUE, 38TH AVENUE, 39TH AVENUE, 40TH AVENUE, 41ST AVENUE, 42ND AVENUE, 43RD AVENUE, 44TH AVENUE, 45TH AVENUE, 46TH AVENUE, 47TH AVENUE, 48TH AVENUE, 49TH AVENUE, 50TH AVENUE, 51ST AVENUE, 52ND AVENUE, 53RD AVENUE, 54TH AVENUE, 55TH AVENUE, 56TH AVENUE, 57TH AVENUE, 58TH AVENUE, 59TH AVENUE, 60TH AVENUE, 61ST AVENUE, 62ND AVENUE, 63RD AVENUE, 64TH AVENUE, 65TH AVENUE, 66TH AVENUE, 67TH AVENUE, 68TH AVENUE, 69TH AVENUE, 70TH AVENUE, 71ST AVENUE, 72ND AVENUE, 73RD AVENUE, 74TH AVENUE, 75TH AVENUE, 76TH AVENUE, 77TH AVENUE, 78TH AVENUE, 79TH AVENUE, 80TH AVENUE, 81ST AVENUE, 82ND AVENUE, 83RD AVENUE, 84TH AVENUE, 85TH AVENUE, 86TH AVENUE, 87TH AVENUE, 88TH AVENUE, 89TH AVENUE, 90TH AVENUE, 91ST AVENUE, 92ND AVENUE, 93RD AVENUE, 94TH AVENUE, 95TH AVENUE, 96TH AVENUE, 97TH AVENUE, 98TH AVENUE, 99TH AVENUE, 100TH AVENUE.

# Watershed Advisory Guides





# MNPD Action Level Maps



# HEC-RTS Modeling



HEC-RTS - Mill\_Creek

File Edit View Forecast Reports Results Tools Help

Module: Model Interface

Icons Type: Default Values: 1 Selected Layers: 4 Selected

**Model Interface**  
 Forecast: 24 Apr 2012, 12:00  
 Lookback: 22 Apr 2012, 00:00  
 End: 26 Apr 2012, 24:00  
 Time Zone: GMT-06:00  
 Current: 07 Nov 2012, 09:37:16

**Graphical Editor**  
 File Edit View  
 Selected Data Set: //Every/PRECIP-CUM//15 Minutes//

Date/Time	Original (inches)	Estimat... (inches)	Revised (inches)
24Apr2012, 12:15	0.00	0.00	0.00
24Apr2012, 12:30	0.00		0.00
24Apr2012, 12:45	0.00		0.00
24Apr2012, 13:00	2.00		2.00
24Apr2012, 13:15	2.00		2.00
24Apr2012, 13:30	2.00		2.00
24Apr2012, 13:45	2.00		2.00
24Apr2012, 14:00	2.00		2.00
24Apr2012, 14:15	2.00		2.00
24Apr2012, 14:30	2.00		2.00
24Apr2012, 14:45	2.00		2.00
24Apr2012, 15:00	2.00		2.00

Buttons: Estimate, Estimate Missing, Estimate All, Accept, Accept All, Add Data, Delete Data

Coordinates: 1773771 east, 619068 north | Local Workspace Mill\_Creek opened

Show Aerial Background

Webcam (Bradford Hills): 11/7/12, ...  
 11/7/12, 09:43:51 | 9:35:10 AM

Plot: Mill Creek + Inbc, Mill Creek Station Hydrograph 4/24/2012  
 Y-axis: Flow (cfs) 0 to 700  
 X-axis: Time (min) 0 to 7000

# Decision Support Tool



**BLUE WATER OUTLOOK**  
DECISION SUPPORT

Locations

Layout

Alerts

- Show Monitored Areas
- Add Monitored Area

Click Below to Edit Alerts

- A. Warnings
- B. Past Precipitation
- C. Rivers
- D. Forecast Precipitation

Radar

- Local Radar
- Regional Radar
- National Radar
- National Radar Layer

Severe Monitor

Rain Monitor

Right Now

- 1 Hour Rainfall
- Last Hour Precipitation
- Total Precipitation
- Central Tenn Rain Gages
- CoCoRaHS Davidson

Past Precipitation

- NWS Past Precipitation

Tennessee Streamflow

Tuesday, May 26, 2015 00:30ET

USGS

No Alerts Active

Nashville River Review

**CUMBERLAND RIVER NEAR PENNINGTON BEND**

Universal Time (UTC)

12Z	12Z	12Z	12Z	12Z	12Z	12Z	12Z	12Z	12Z
May 23	May 24	May 25	May 26	May 27	May 28	May 29	May 30	May 31	12Z
Latest observed value: 25.00 ft at 6:45 AM CDT 26 May 2015. Flood Stage is 47 ft.									

Site Time (CDT)

Graph Created (2:34 AM May 26, 2015) Observations Courtesy of US Geological Survey

**CUMBERLAND RIVER NEAR HERMITAGE**

Universal Time (UTC)

12Z	12Z	12Z	12Z	12Z	12Z	12Z	12Z	12Z	12Z
May 23	May 24	May 25	May 26	May 27	May 28	May 29	May 30	May 31	12Z
Latest observed value: 15.4 ft at 6:45 AM CDT 26 May 2015. Flood Stage is 48 ft.									

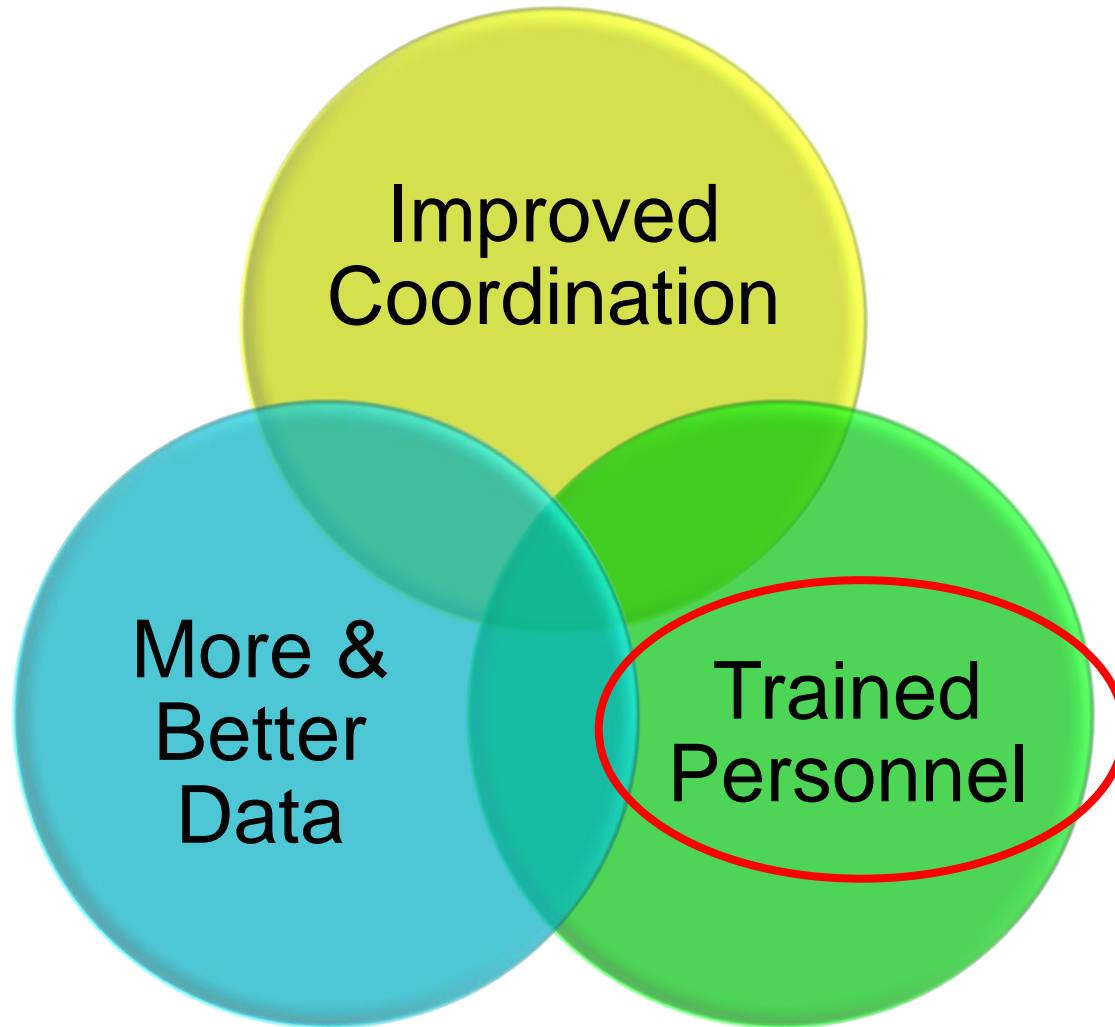
CoCoRaHS Davidson

Daily Precipitation (inches - X.XX) for the 24 hour period ending ~7:00 am Davidson County, Tennessee - 4/23/2015

Data CC-BY-SA by OpenStreetMap

# Nashville SAFE Mission

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# Trained Personnel



## Watershed Advisors



## Does it Work?

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“ We now have the ability to understand and predict what is happening...we can advise the police department on what to do, whether notification or evacuation is necessary...**last night and the night before, we were perfect.** I think it adds a great level of comfort to our citizens... ”

Scott Potter

Director, Metro Water Services

Address to Cumberland River Compact on April 28, 2011

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# Accolades

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- **Nashville Planning Dept. Special Achievement Award**
  - 2011 Esri International User Conference –
- **ACEC Grand Award**
  - 2013 Engineering Excellence Award Studies, Research, & Consulting Category
- **Featured in....**
  - The Tennessean
  - Municipal Sewer & Water Magazine
  - WSMV
  - Numerous Online Publications



# Takeaway





# Takeaway – Team Up!



## Takeaway – End User Focus

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“ I think the most impressive thing AMEC has done is take the science and engineering...**and turn it into a user friendly product** (the Watershed Advisory Guide, for example) that decision makers can use effectively. ”

James LaRosa

Service Hydrologist, National Weather Service



# SITUATIONAL AWARENESS *for* FLOODING EVENTS

# Thank you!

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