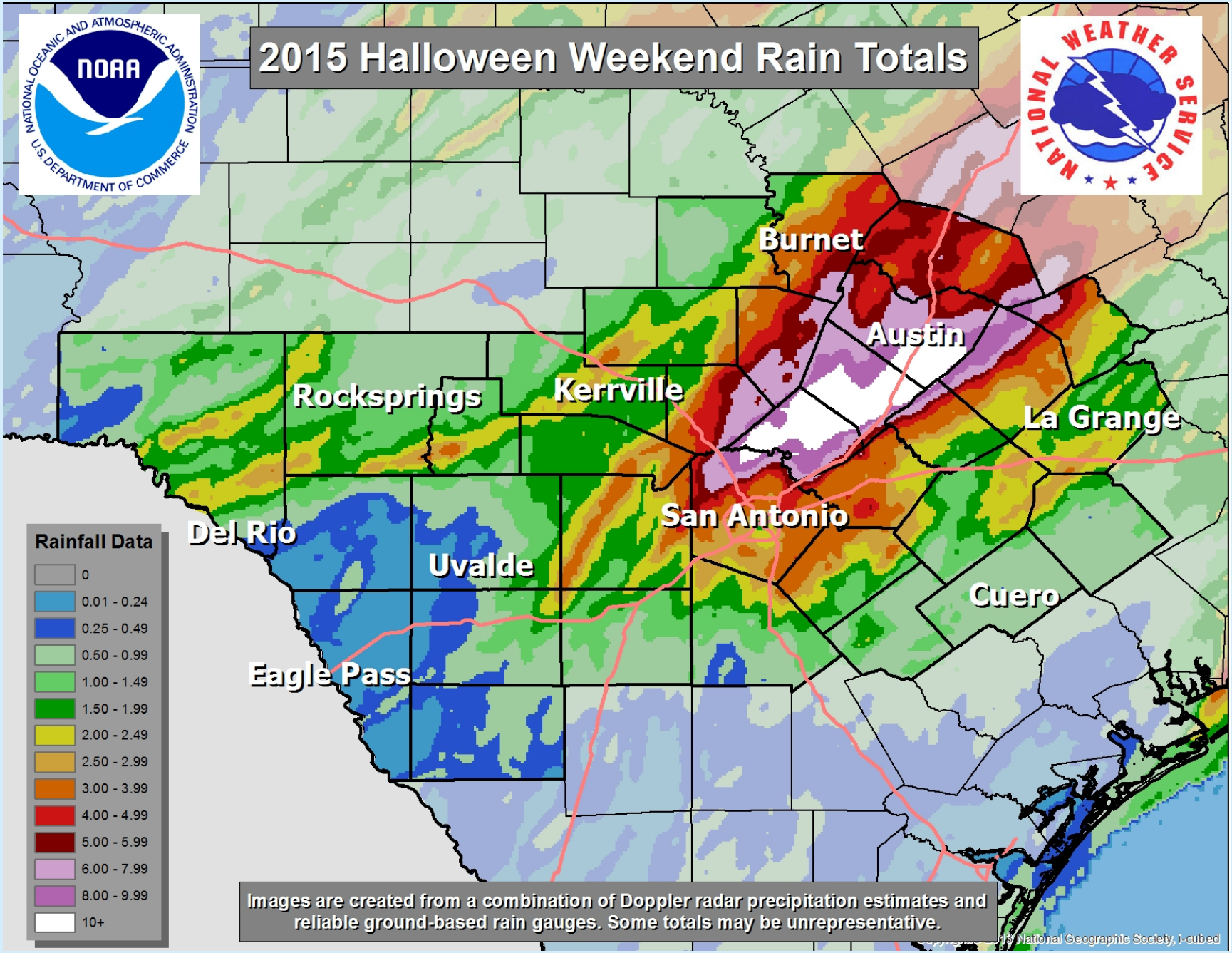
Flood Forecasting for Wimberley, Texas

David R. Maidment
Center for Research in Water Resources
University of Texas at Austin

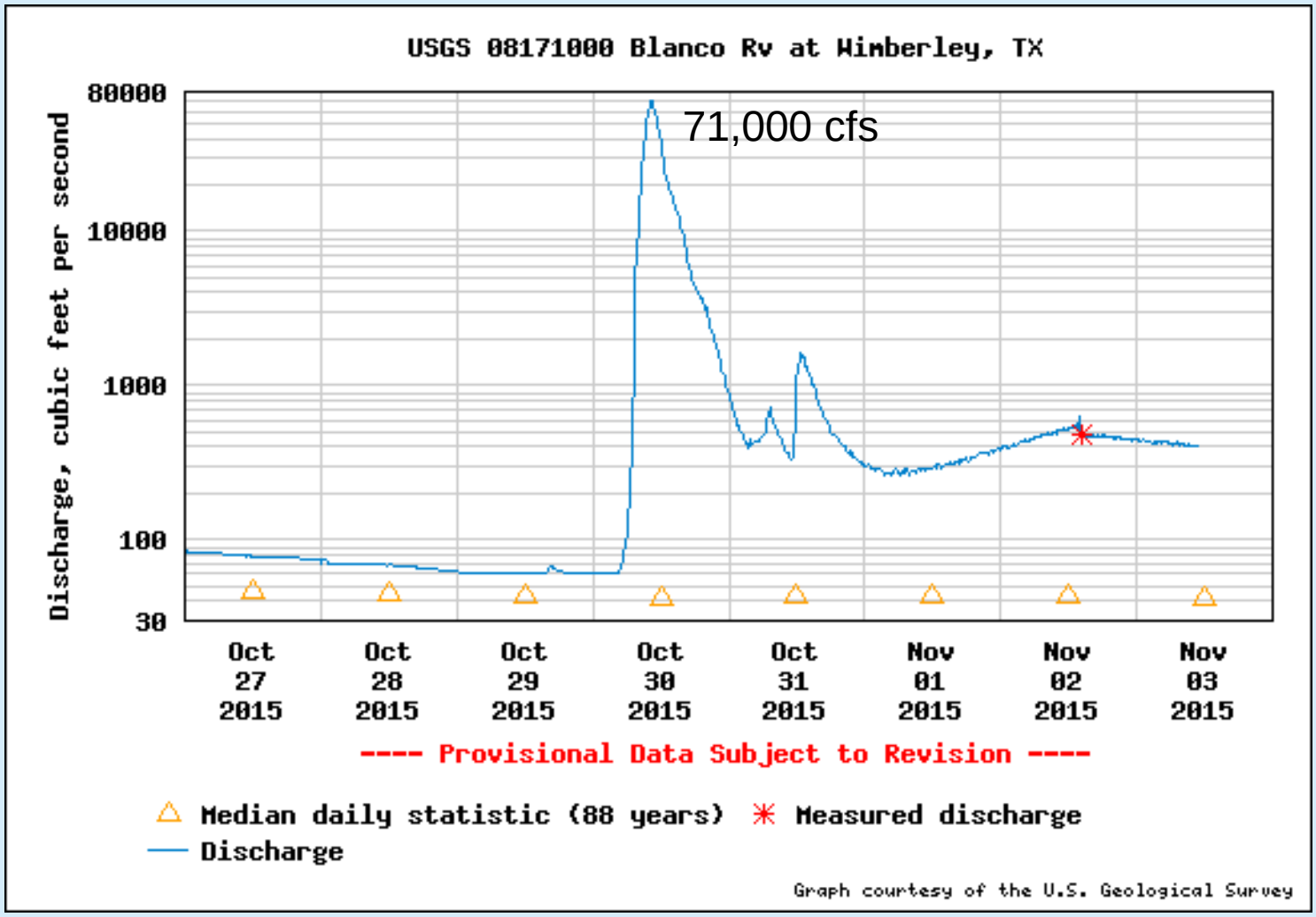
Seminar on Flooding in Wimberley
Austin, TX| 9 November 2015

Acknowledgements: Harry Evans, Cassandra Fagan, ESRI, Kisters, Microsoft Research
This research is supported by the National Science Foundation

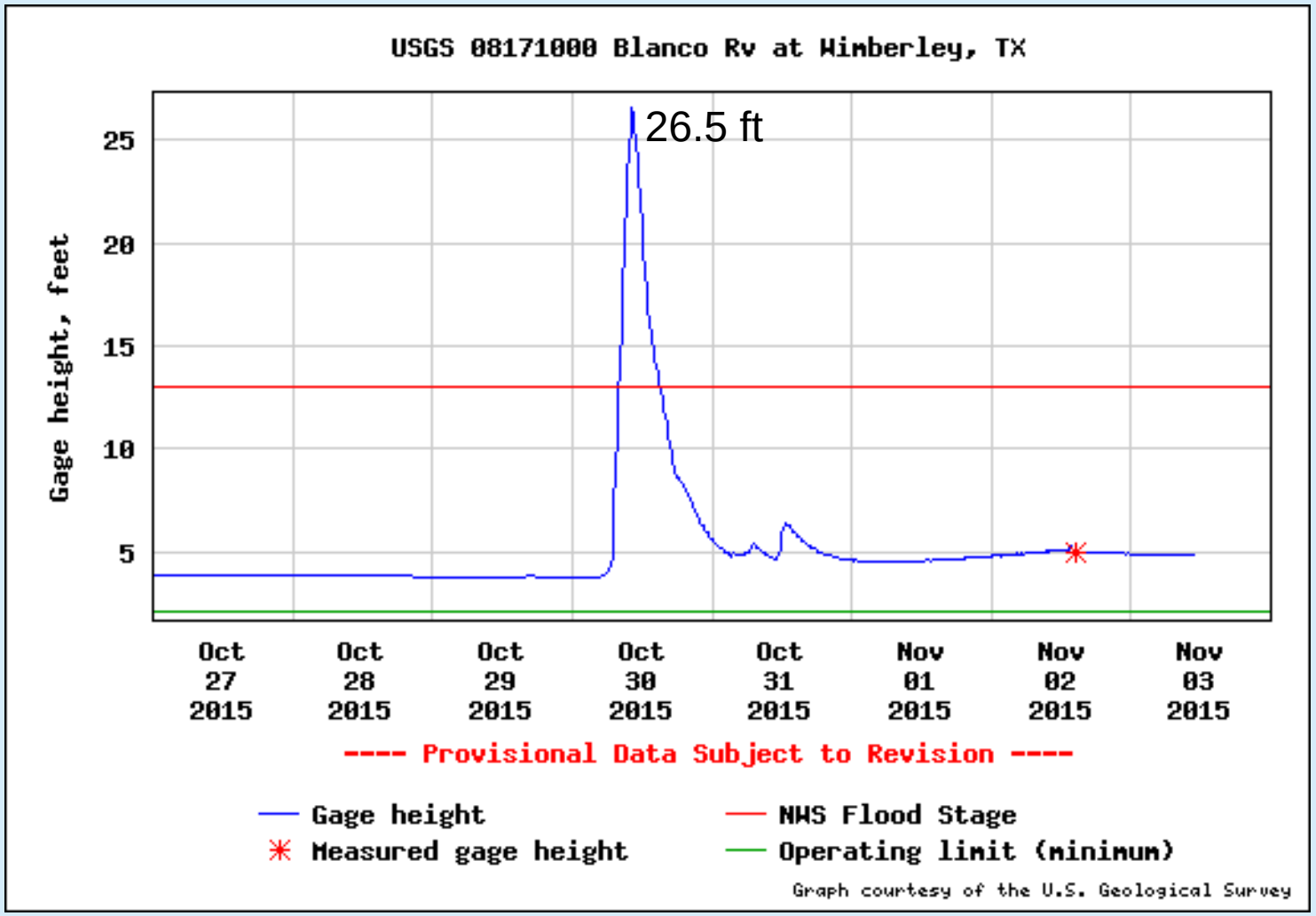


Source: Larry Hopper, NWS

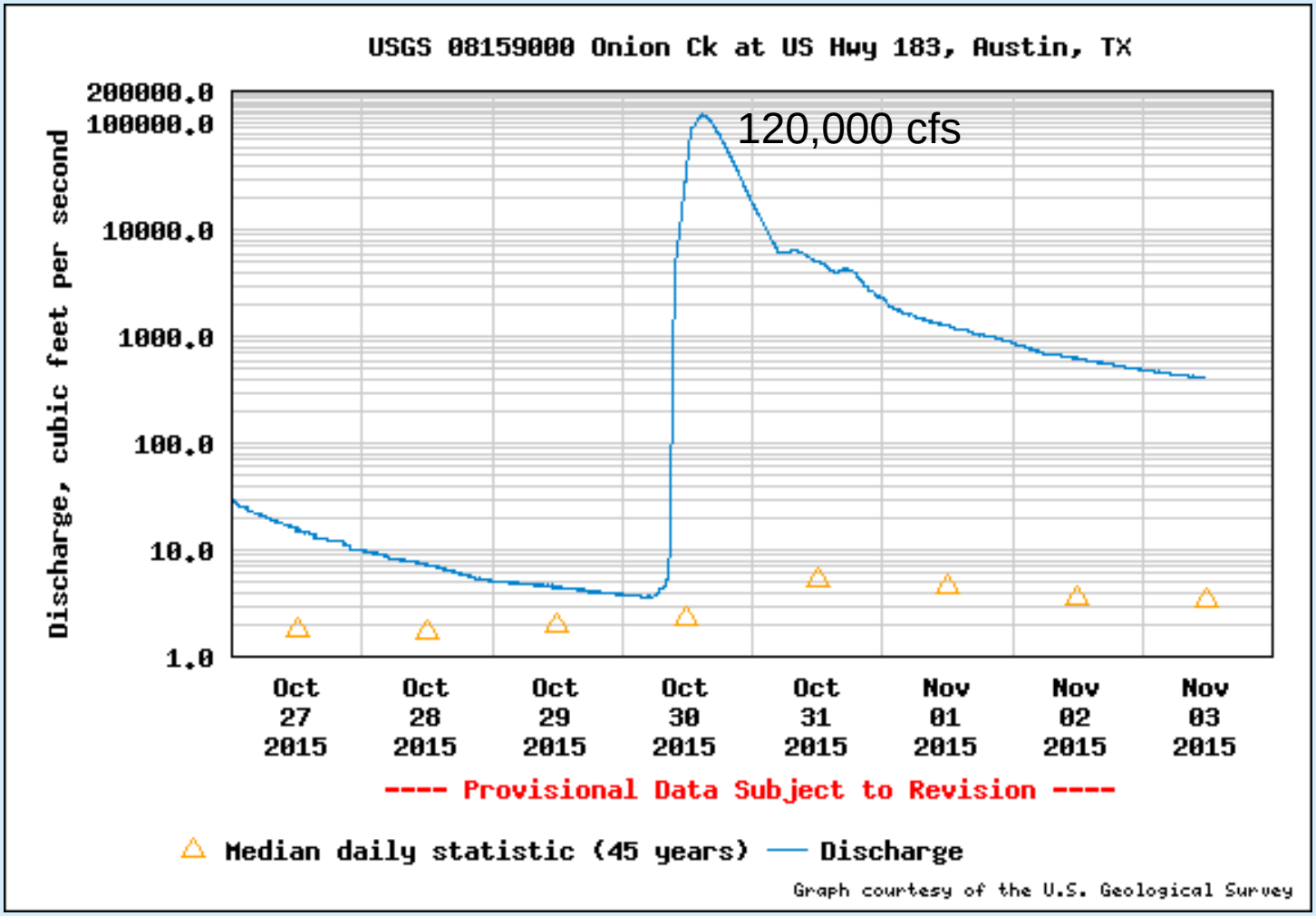
Blanco River at Wimberley (Flow) (Drainage area 355 mile^2) Halloween 2015



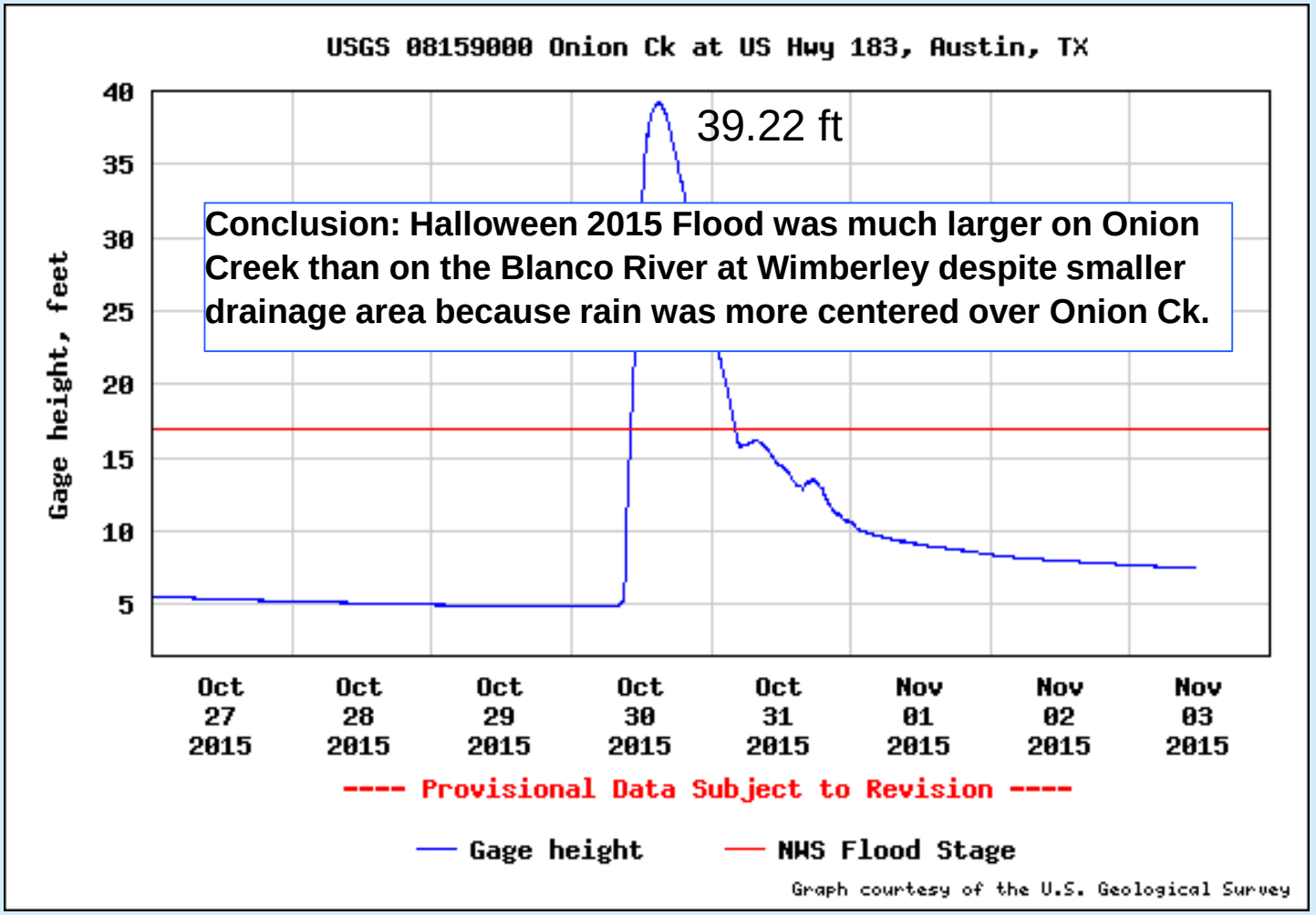
Blanco River at Wimberley (Stage Height) Halloween 2015



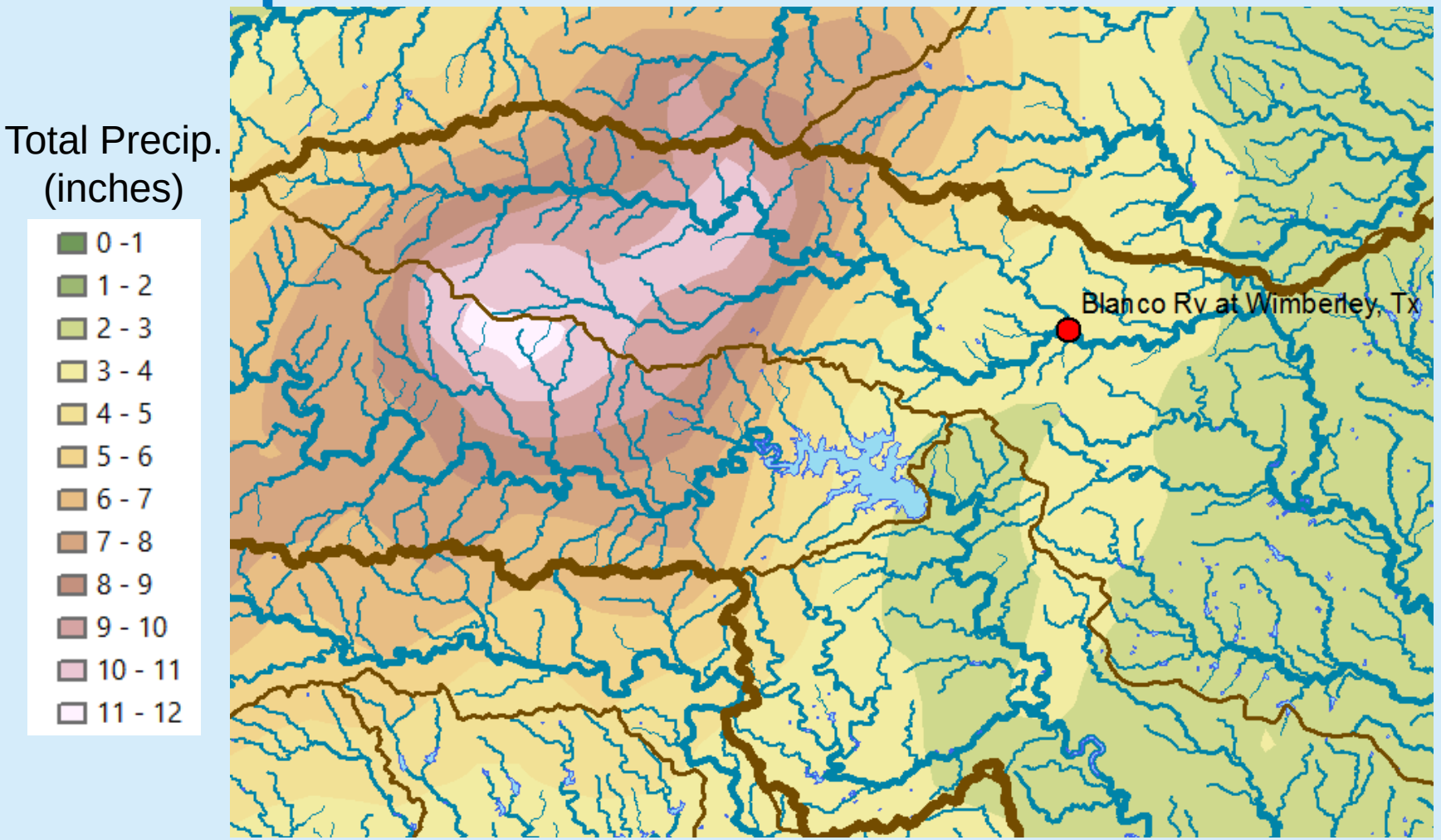
Onion Creek at Highway 183 (Flow) (Drainage area 321 mile^2) Halloween 2015



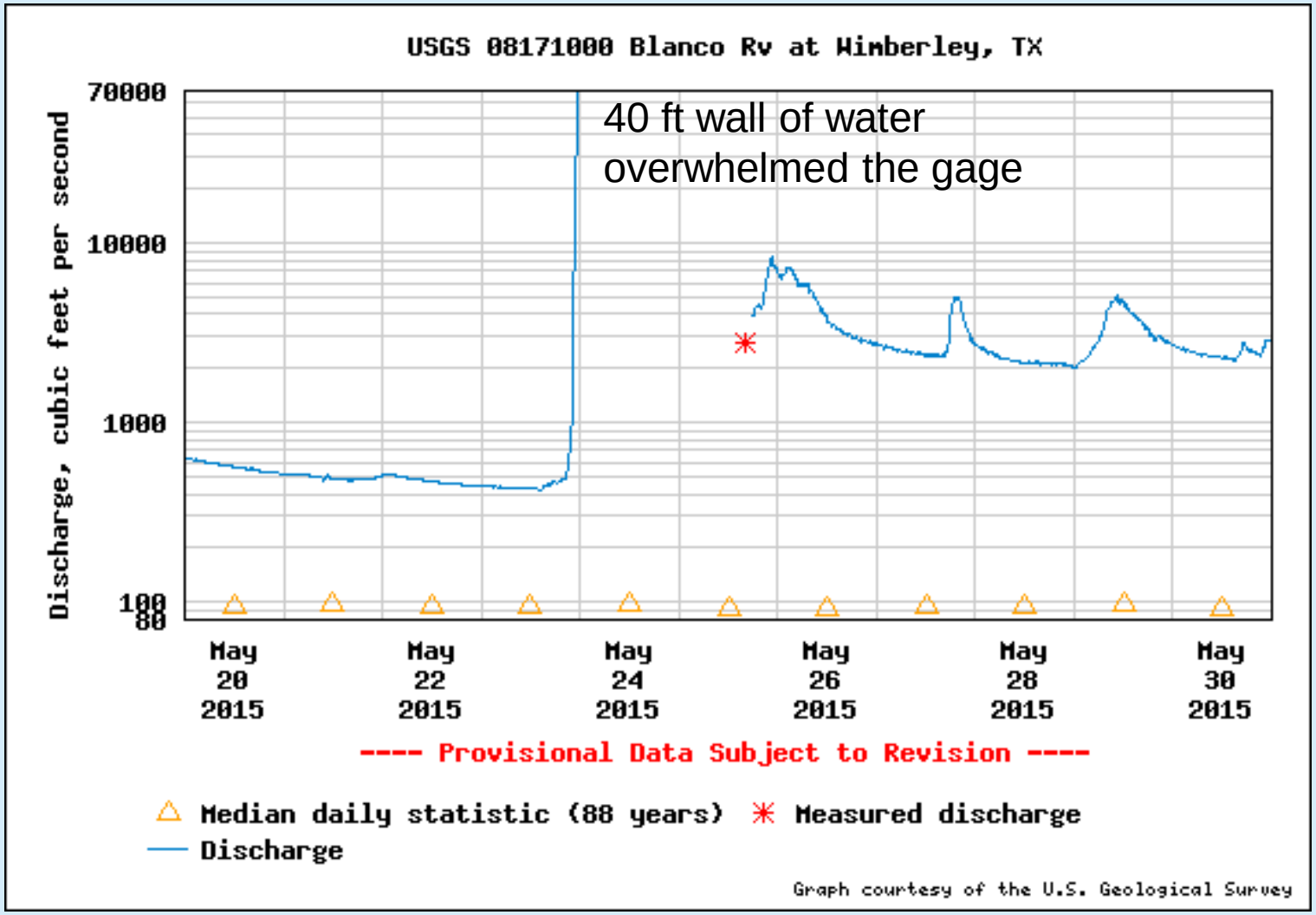
Onion Creek at Highway 183 (Stage Height) Halloween 2015



Memorial Day 2015 Weekend Precipitation on Blanco River

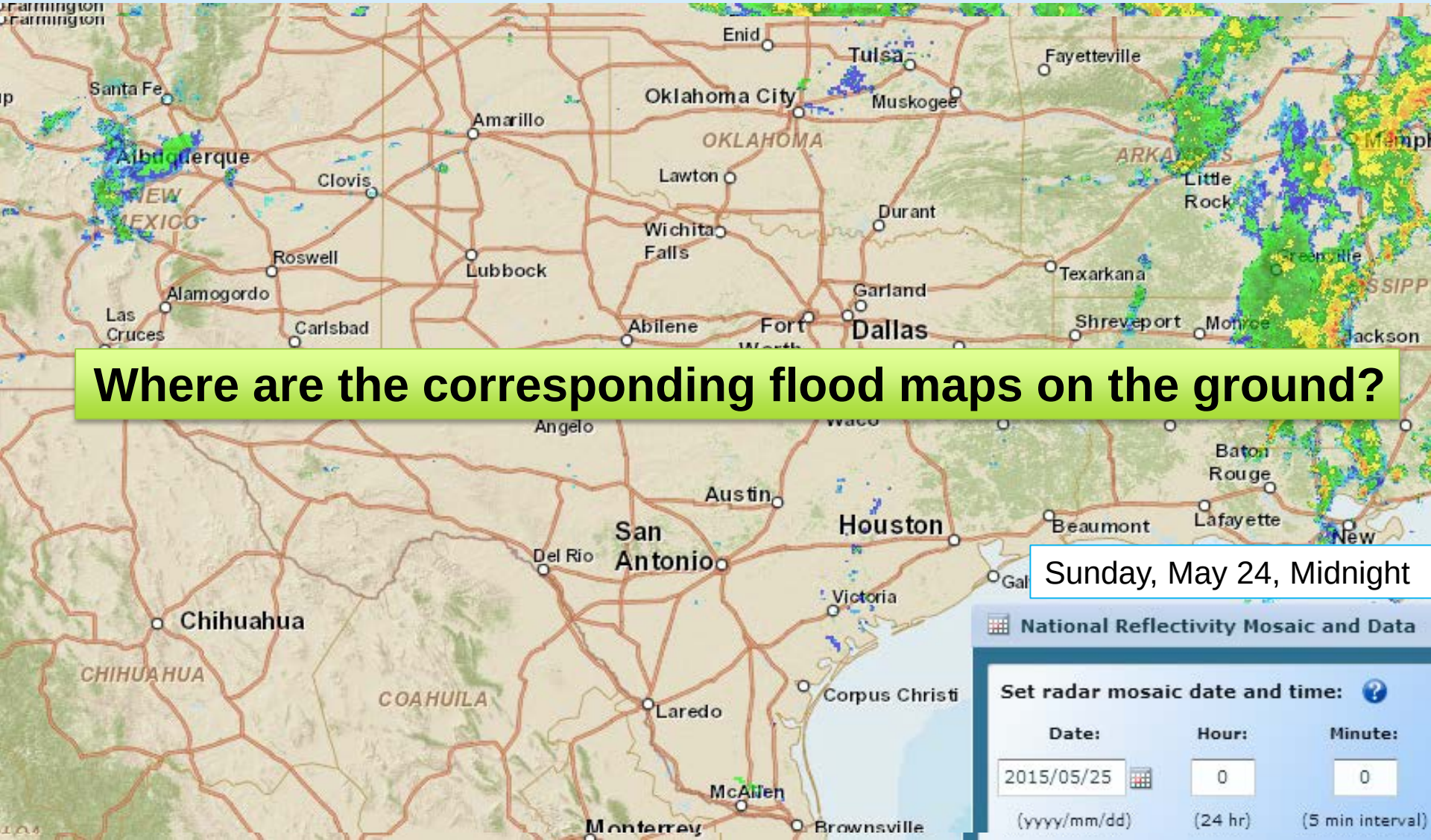


Flow in Blanco River at Wimberley, Memorial Weekend 2015 (much larger than Halloween 2015)



Storm Rainfall during Memorial Day Weekend

http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=radar&theme=radar&display=nexrad

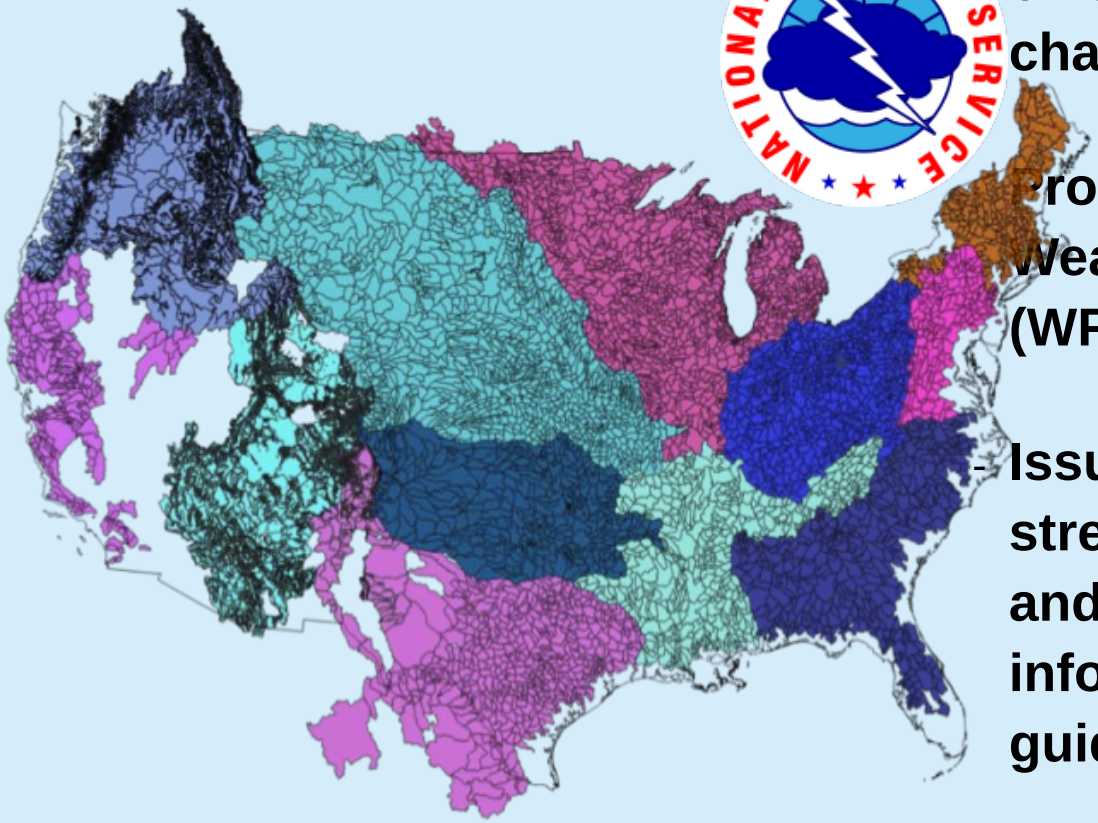


The Opportunity

New National Water Center established on the Tuscaloosa campus of University of Alabama by the National Weather Service and federal agency partners

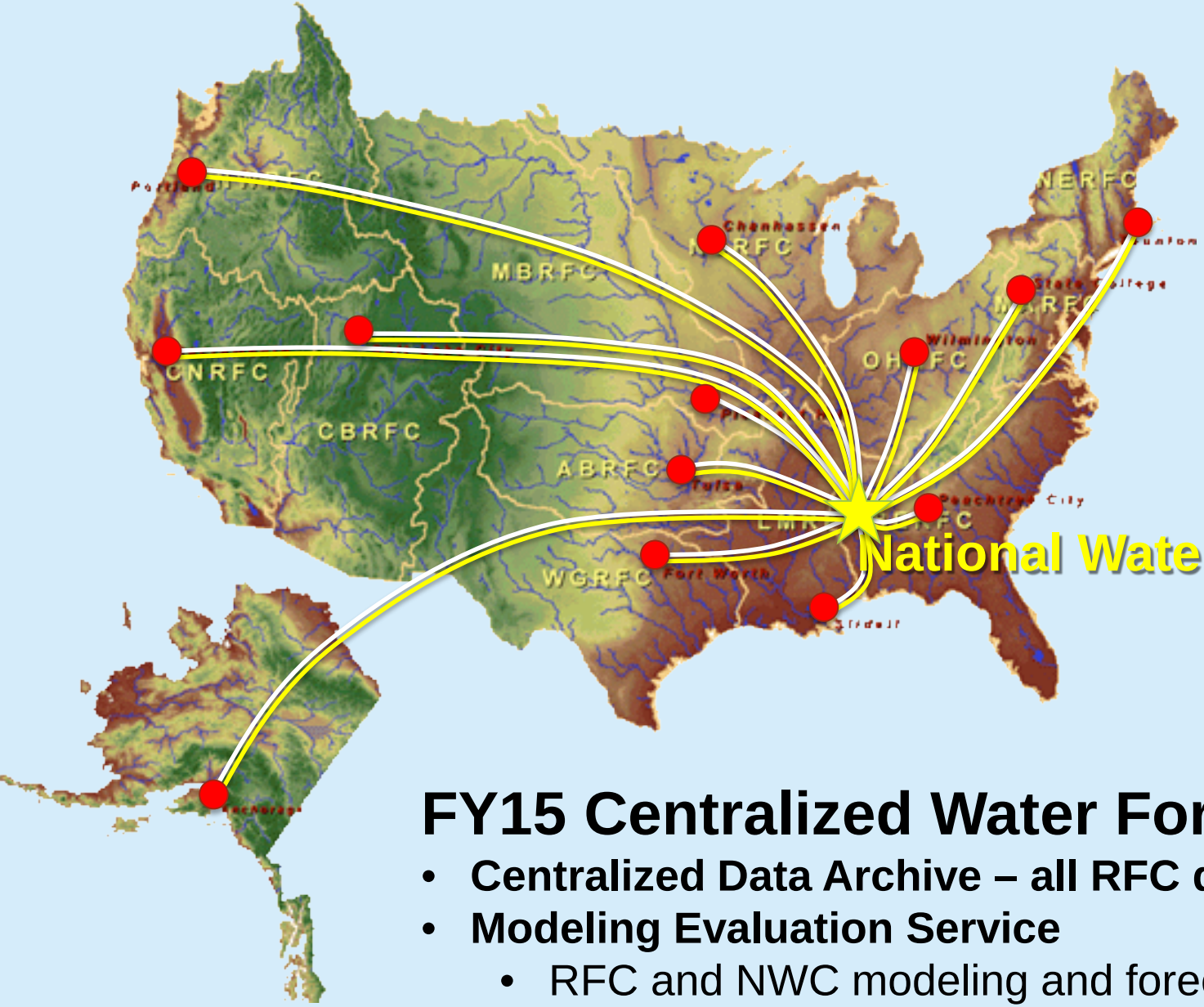
Has a mission to assess hydrology in a new way at the continental scale for the United States

NWS River Forecast Centers (RFCs)



6600 sub-basins in continental US

- **Prepare river and flood forecasts using models based on average basin characteristics**
- **Provide forecast guidance to Weather Forecast Offices (WFOs)**
- **Issue daily stage and streamflow forecasts, rainfall and drought data and information, and flash flood guidance**
- **Work with water managers and other Federal Agencies**



FY15 Centralized Water Forecasting

- **Centralized Data Archive – all RFC data**
- **Modeling Evaluation Service**
  - RFC and NWC modeling and forecasts
- **Modeling Testbed – new NWC capabilities**
- **Centralized Water Forecasting Demonstration**

Inaugural Meeting – May, 2014

Transformative Research (NSF)

Transformative research involves ideas, discoveries, or tools that radically change our understanding of an important existing scientific or engineering concept or educational practice or leads to the creation of a new paradigm or field of science, engineering, or education. Such research challenges current understanding or provides pathways to new frontiers.

http://www.nsf.gov/about/transformative_research/definition.jsp

How to move from evolutionary change to transformative change?

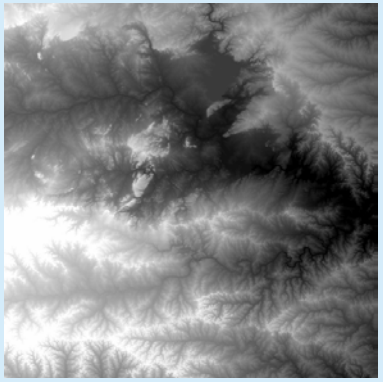
National Flood Interoperability Experiment (NFIE) (Sept 2014 to August 2015)

- Partnership between NWS and the academic community (Interagency Agreement between NSF and NOAA)
- Included a Summer Institute for 44 graduate students from 19 Universities at the National Water Center, June 1 to July 17, 2015

CUAHSI
UNIVERSITIES ALLIED FOR WATER RESEARCH

NHDPlus Version 2.1

Foundation for a Geospatial Hydrologic Framework for the United States



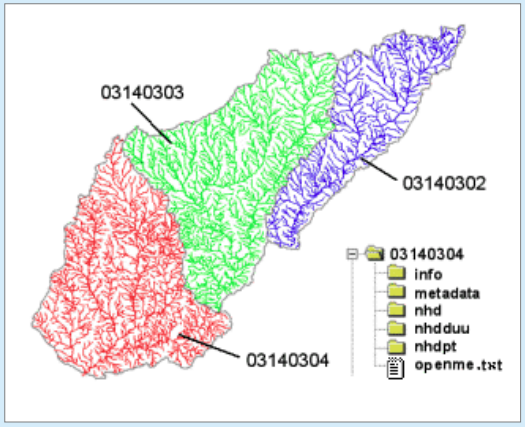
National Elevation Dataset

NHDPlus

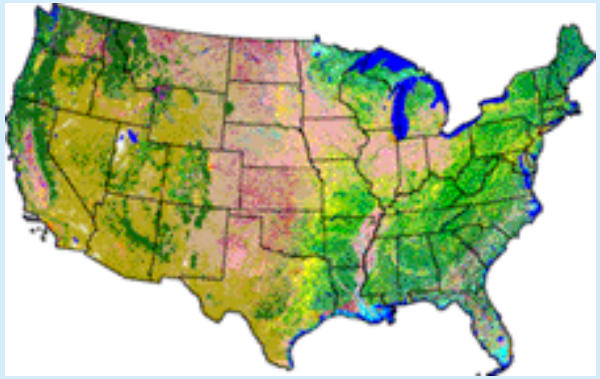
2.7 million reach catchments in US
average area 3 km^2
reach length 2 km
Uniquely labelled

Watershed Boundary Dataset

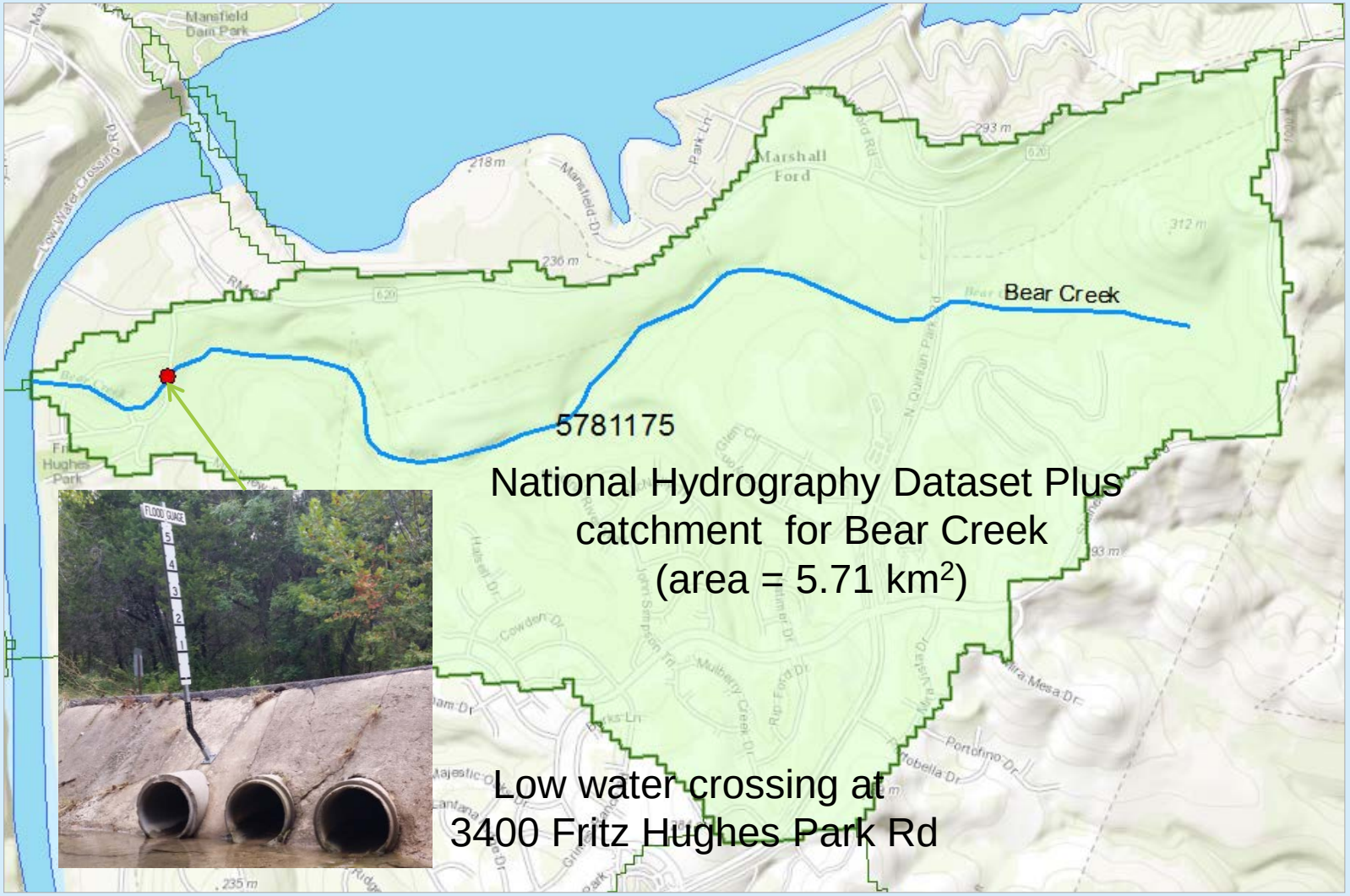
National Hydrography Dataset



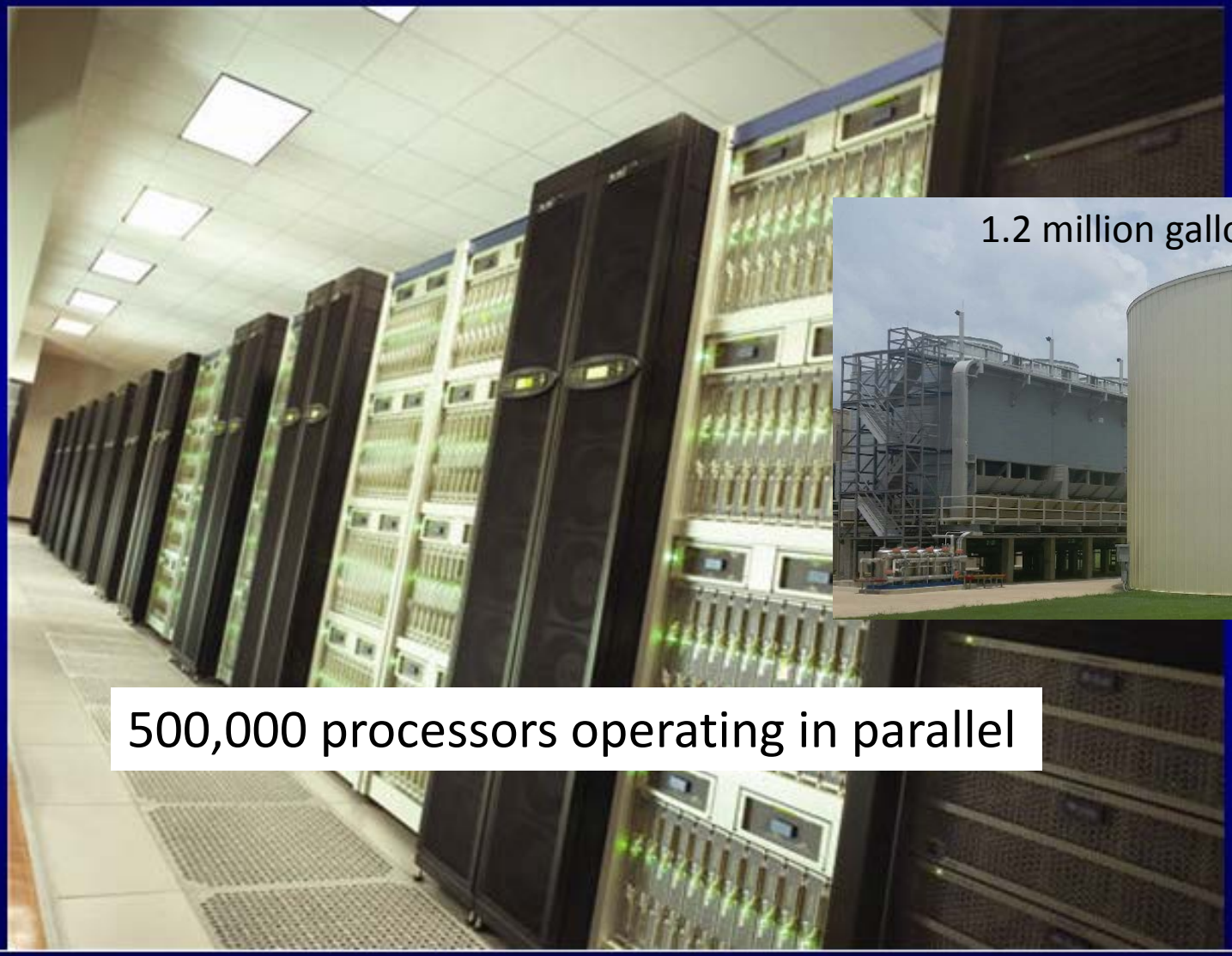
National Land Cover Dataset



Flood Information for Fritz Hughes Park Rd



Stampede

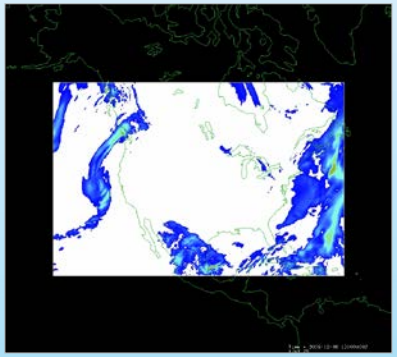


500,000 processors operating in parallel

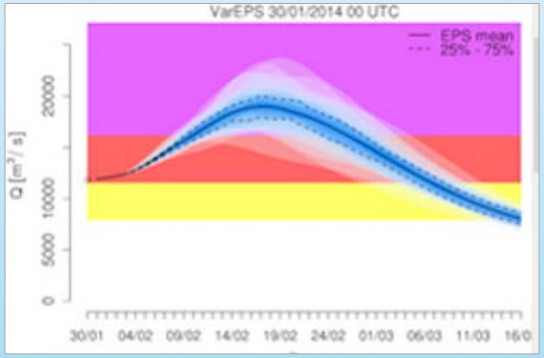
WRF-Hydro Forecasting Model

Computed for the continental US in 10 minutes at Texas Advanced Computing Center

Weather model and forecasts (HRRR)



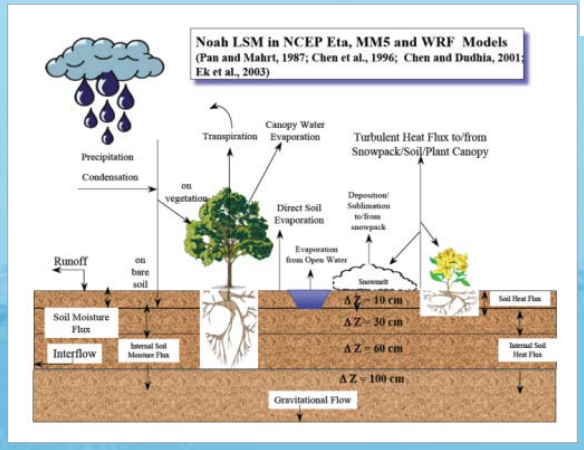
Probabilistic flood forecasts



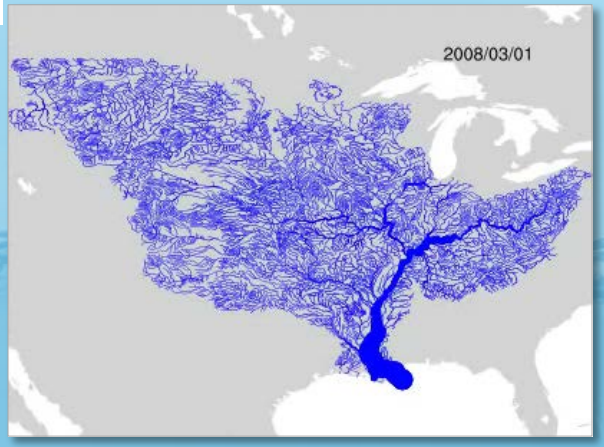
Catchment-level forecasts

Weather → Precipitation

Streamflow



Runoff →



Land-Atmosphere Model (NOAH-MP)

RAPID flow routing (for continental US)

Next Step: National Water Prediction Model Configurations

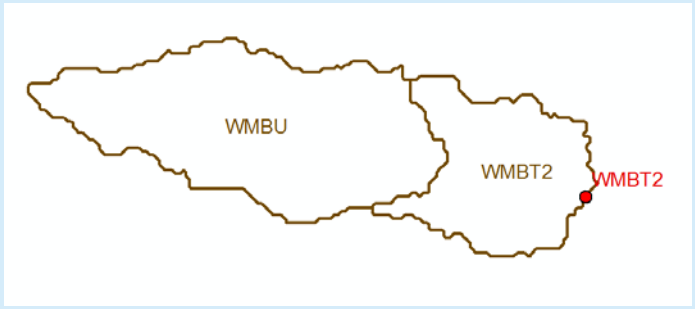
WRF-Hydro IOC Configurations – May 2016

Analysis & Assimilation	Short-Range 'Flood Prediction'	Medium Range 'Flow Prediction'	Long Range 'Water Resources'
Cycling Frequency			
Hourly	3-Hourly	Daily	~Daily (x16)
Forecast Duration			
- 3 hrs	0-2 days	0-10 days	0-30 days
Spatial Discretization & Routing			
1km/250m/NHDPlus Reach	1km/250m/NHDPlus Reach	1km/250m/NHDPlus Reach	1 km/catchment /NHDPlus Reach
Meteorological Forcing			
MRMS blend/ HRRR-NAM bkgnd.	Downscaled HRRR /RAP/NAM blend	Short-range + Downscaled GFS	Downscaled & bias-corrected CFS

Current and New Forecast Systems

Blanco River at Wimberley

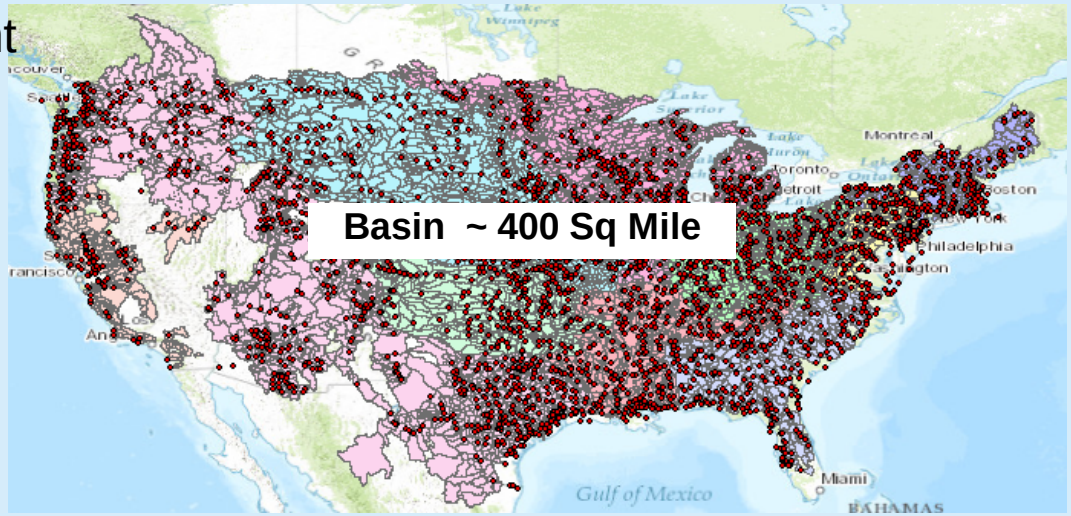
Two basins and one forecast point



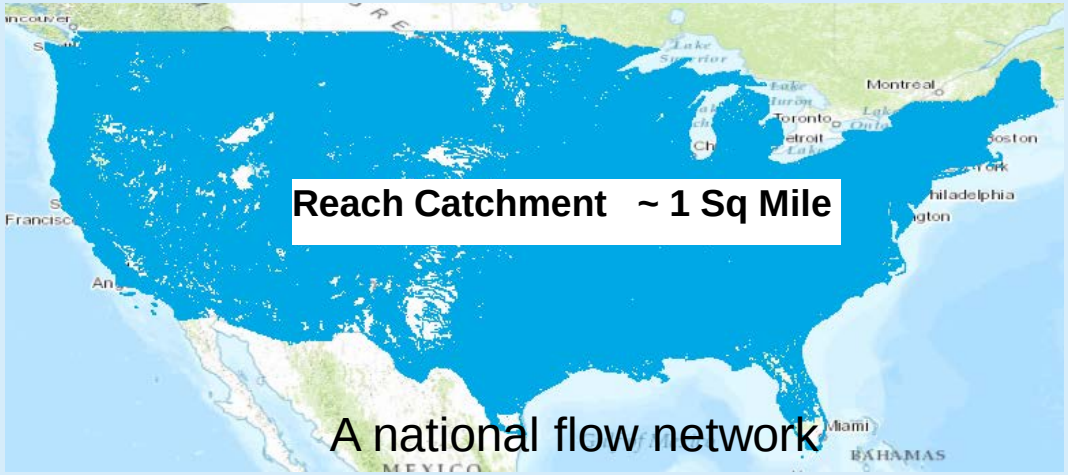
becomes

130 Catchments and Flowlines uniquely labelled

Current: 6600 basins and 3600 forecast points



NFIE: 2.7 million stream reaches and catchments

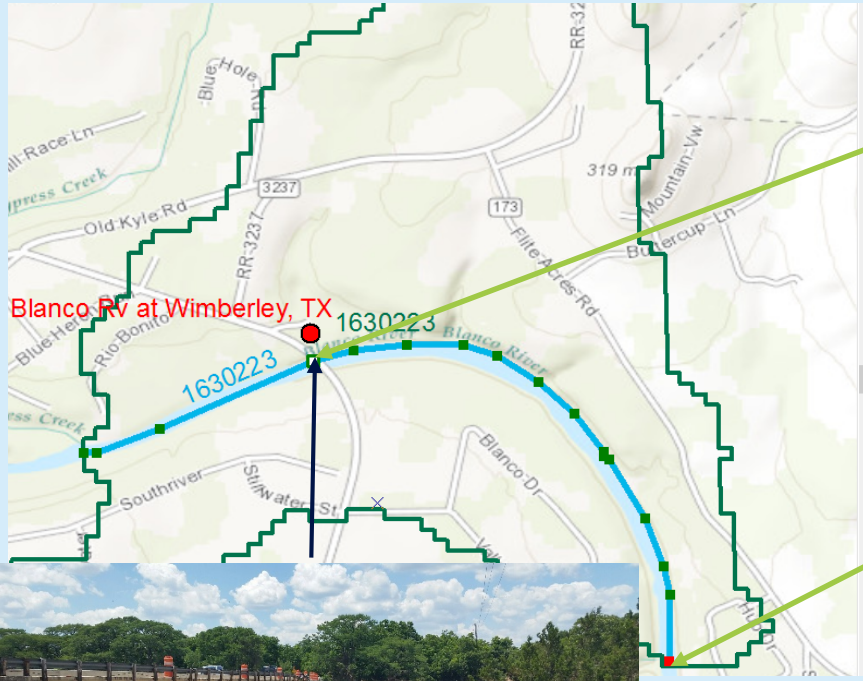


A national flow network

Linear Referencing on Flowlines

Using measures, the flow can be estimated at any point along the line

Bridge and Stream Gage at RR 12 is at Measure 70.246
on Flowline 1630223



#	X	Y	Z	M
0	-98.095	29.991	0.000	100.000
1	-98.094	29.991	0.000	98.393
2	-98.093	29.992	0.000	90.423
3	-98.089	29.994	0.000	70.246
4	-98.088	29.994	0.000	65.321
5	-98.086	29.994	0.000	58.974
6	-98.085	29.994	0.000	52.424
7	-98.084	29.994	0.000	48.200
8	-98.083	29.993	0.000	42.164
9	-98.082	29.992	0.000	36.219
1.	-98.082	29.991	0.000	29.977
1.	-98.082	29.991	0.000	29.482
1.	-98.081	29.991	0.000	28.690
1.	-98.081	29.990	0.000	19.728
1.	-98.080	29.989	0.000	12.962
1.	-98.080	29.988	0.000	9.031
1.	-98.080	29.986	0.000	-0.000

Long. Lat. Measure

Measure is the % distance upstream from most downstream point on line

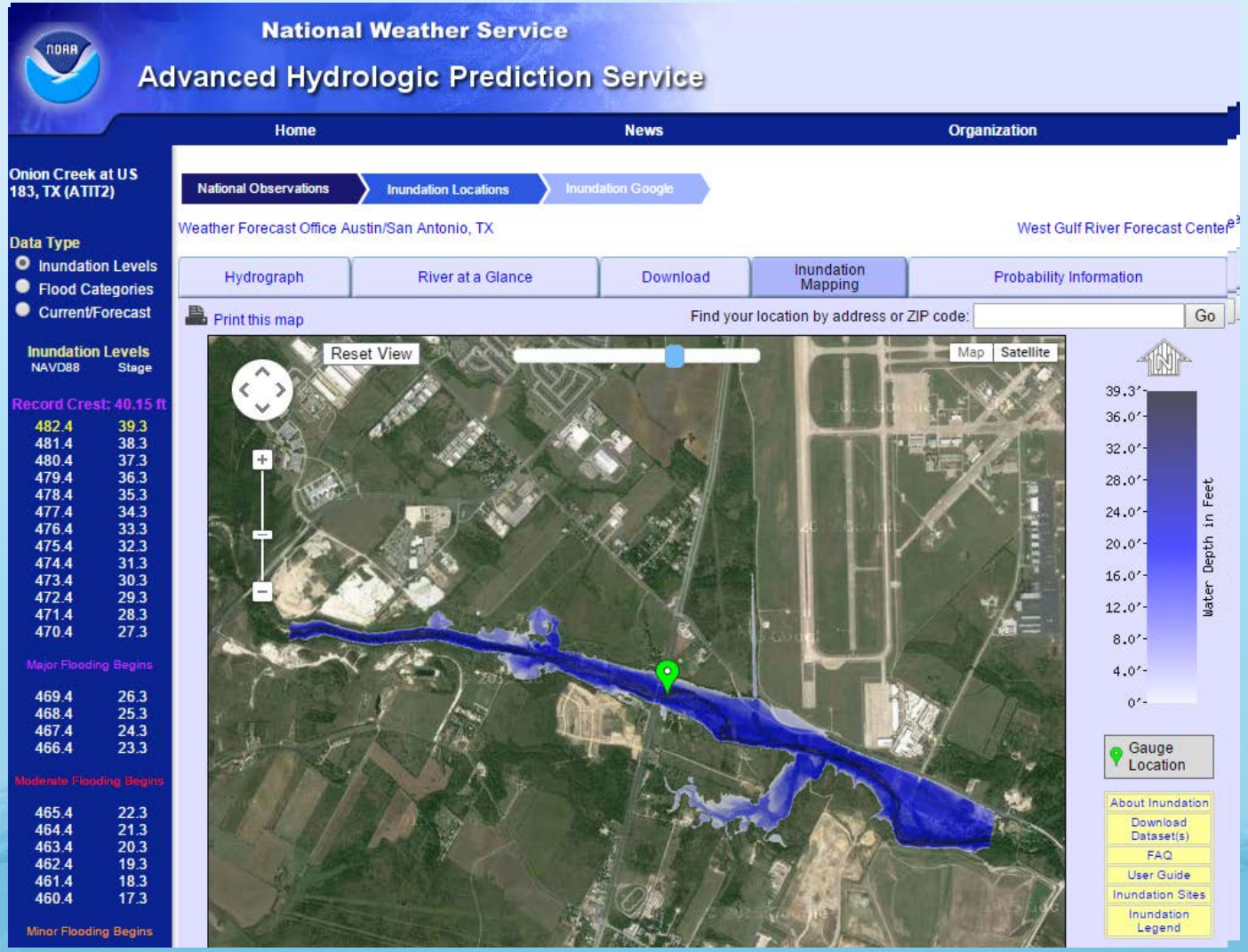
New Radar Measurement Technologies

Measures water level

Measures surface velocity

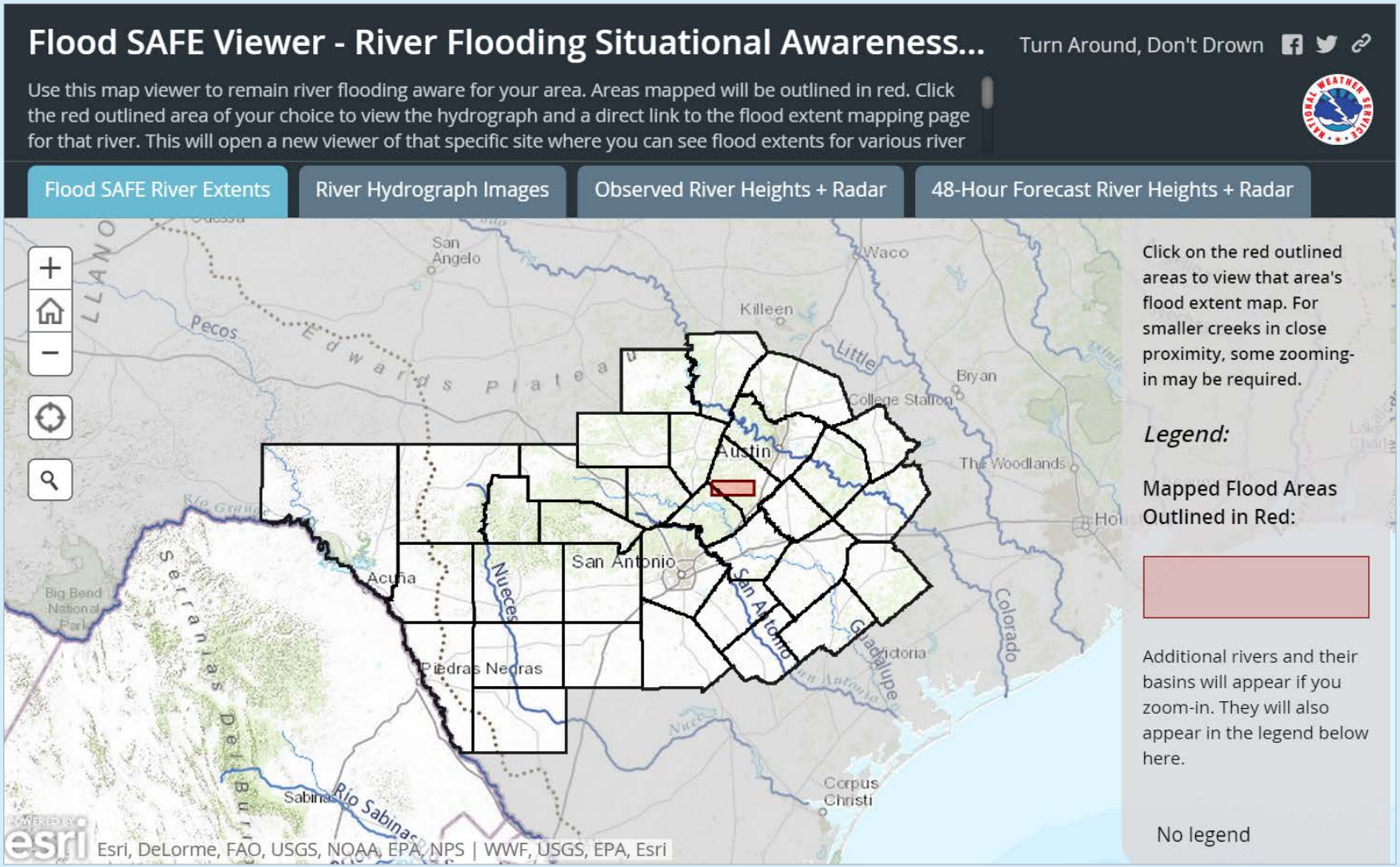
Densified flood forecasting requires densified measurement

Real-Time Flood Inundation Mapping (NWS/AHPS)



http://water.weather.gov/ahps2/inundation/inundation_google.php?gage=atit2

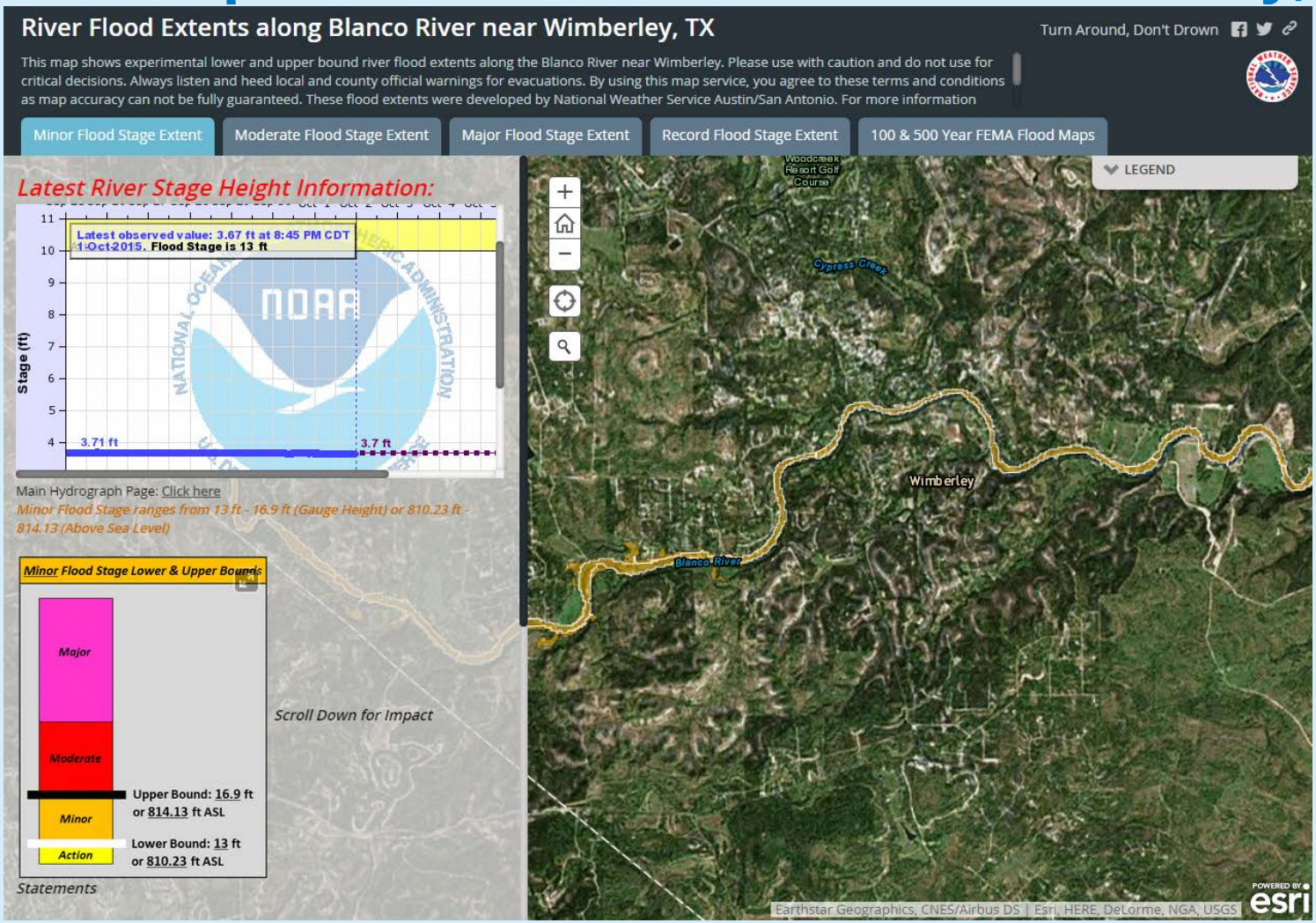
Situational Awareness For Everyone (SAFE)



Source: Jared Allen, NWS Austin-San Antonio Weather Forecast Office

Flood SAFE Viewer: http://arcg.is/1LPOHnE

SAFE Map for Blanco River near Wimberley, Tx



Source: Jared Allen, NWS Austin-San Antonio Weather Forecast Office

Blanco River Proof-of-concept Map: http://arcg.is/1GtObu3

Conclusions

Continental flood simulation works and is being implemented by May 2016 at National Water Center

UT Austin and City of Austin are contributing through the National Flood Interoperability Experiment

New flood forecasting system will be 400 times more spatially dense and will be updated hourly

Instead of one forecast point on Blanco River at Wimberley there will be 130 forecast reaches in the Blanco River watershed above Wimberley

Need a much densified observation network to support this forecasting system

Flood Response and Planning

Harry R. Evans
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Seminar on Flooding in Wimberley
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Acknowledgements: Cassandra Fagan, Austin Fire Dept., COA Watershed Protection, David R. Maidment

Flood Emergency Response

	Emergency Responders	Public
Action	***Incident Response*** • *Current and forecast storm rainfall* • *Creates Flood Response Maps* • *Current and forecast flood conditions* • *Impact on homes, critical infrastructure, and transportation routes*	***Warnings*** • *Public notification and warnings* • *Current and anticipated road closures* • *Real-time and forecast flood maps* • *Evacuation routes*
Planning	***Wide Area Flood Plan*** • *Static flood maps* • *Number of flooded homes, critical infrastructure and transportation routes for different risk conditions* • *Pre-planning of flood response mobilization*	***Public Education*** • *Location based risk* • *Evacuation routes* • *Putting together a “go bag” for evacuation* • *Flood hazard prevention methods*

Flood Emergency Response

- **Real Time Flood Response Maps:** More accurate resource allocation, threat assessment, public impact
- **Public Warning:** Credible and actionable
- **Pre-Planning:** enhances disaster response
- **Public Education:** more public awareness & readiness results in more effective flood response

Community Flood Response Map Book

Austin Fire Department

Flood Handbook

Contents

Source: Tomas Rodriguez, City of Austin

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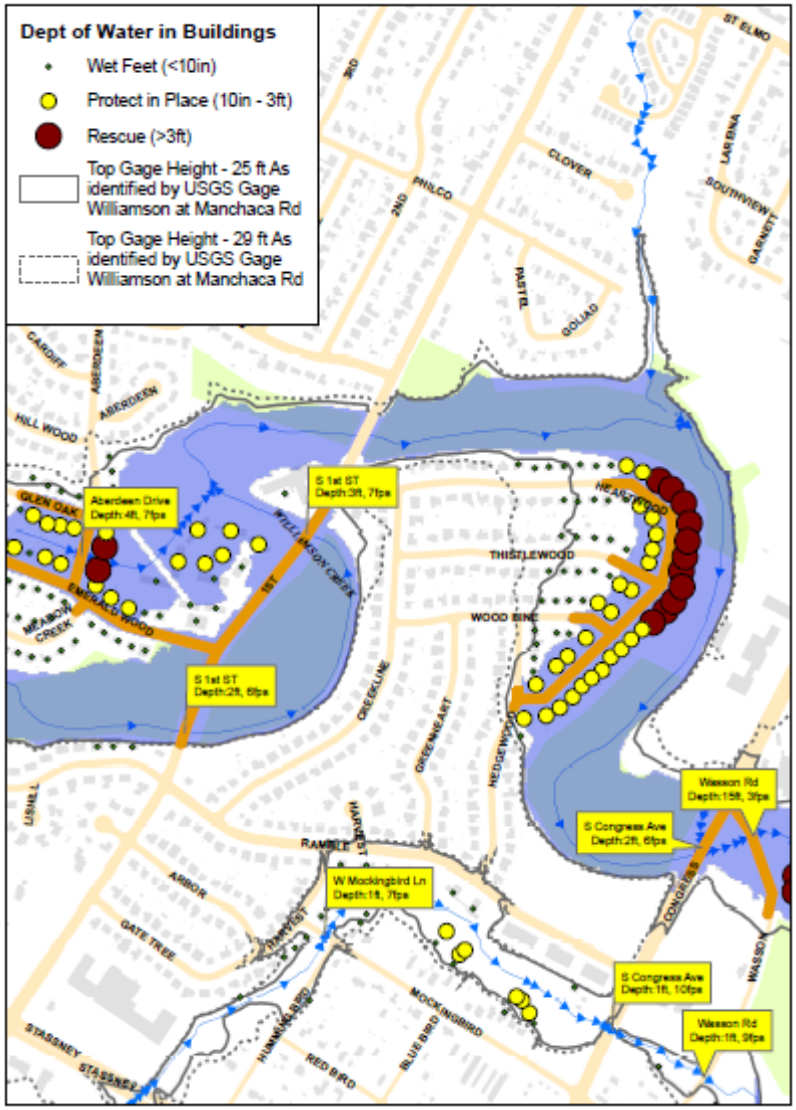

MAJOR FLOOD LEVELS

Middle Williamson Creek - Near Heartwood Road
Forecasts Associated w/ USGS WMS At Manchaca 08158930

ACTIONS

- ☐ Notify City of Austin message that dangerous flooding is occurring in middle Williamson along Heartwood Drive in block ranges 300 to 500 – several feet in homes.
- ☐ Notify residents along Emerald Wood, Glen Oak, and Aberdeen (as indicated in table below) that they should shelter in place until waters have receded.
- ☐ Barricade of Wesson Road LWC should already have occurred.
- ☐ Need barricading resources at 5100 South Congress if that has not already occurred.
- ☐ **BE ADVISED** that travel over 5100 South Congress at Williamson Creek should be avoided because creek has overtopped roadway by several feet.

  In addition, South 1st (4700 -5200 block) at Williamson Creek is overtopped from 4 to 9 feet and should have been barricaded. THIS IS ALL THREE CROSSINGS OF WILLIAMSON CREEK.

  Manchaca Road (5000 block) is overtopped north of Jones Road by 3 feet.

  Therefore, routes to area are restricted from north to south. Travel is possible south from IH 35 to Stassney Drive and from MoPac south to William Cannon eastbound.
- ☐ Rescue of residents from 300 – 500 block of Heartwood on RL side. Advise residents in the 5100 block of Aberdeen, the 800 block of Glen Oak, and the 800 block of Emerald Wood Drive to try to move up and shelter in place. The 5103 and 5105 Aberdeen homes will have just over 3 feet of water.
  APPROXIMATELY ONE HOUR FOR WARNING IN THIS AREA.
  NOTE – Williamson Creek has not witnessed this flooding EVER.

INDICATORS

- NFIE forecasts creek level at USGS Gauge at Manchaca to be at 21 feet and rising.
- Note that on 10/13/13 gauge was estimated at 21 feet.
- 5 inches or more in 3 hours or less with wet soil conditions.

ROAD CLOSURES AND DEPTHS

- Wesson Road – 18 feet (low water crossing)
- 300 – 500 block of Heartwood Drive – 2 to 3 feet
- 5100 South Congress (Williamson Creek crossing) – 5 feet
- 4700 – 5200 block of South 1st (Williamson Creek crossings) 4 – 9 feet
- 5300 block of Emerald Forest Drive (Williamson Creek crossing) – 4 feet
- 5000 block of Manchaca (Williamson Creek crossing) – 3 feet
- 5100 block of Aberdeen – 4 feet
- 800 block of Emerald Wood – 2 feet

Depth of Water in Homes	River Left (RL)	River Right (RR)	*Total*	General Block Ranges
Rescue	26	12	*38*	300 – 500 Heartwood
Rescue	1	0	*1*	5001 S. Congress
Rescue	1	1	*1*	5103; 5105 Aberdeen
Shelter In Place	6	0	*6*	800 Glen Oak
Shelter In Place	0	14	*14*	800 Emerald Wood

0 — 0.25 — 0.5 Miles

Map produced by City of Austin Flood Early Warning System (FEWS)
In conjuction with Austin Fire Department and University of Texas Updated October 2015

Middle Williamson Creek near Heartwood Road -- MAJOR FLOODING

Public Education

READY, SET, GO!

FLOOD PREPARATION

Prepare for Flooding Before it Occurs!

Community Flood Response System

- **Flood Response Map Book**
- **Personal Flood Response Guide**
- **Web Based Flood Emergency Information System**

Disaster Warning Response: Risk Assessment and Action

Calvin L. Streeter
The University of Texas at Austin
School of Social Work

Risk perception to action chain

What Influences Perception of Risk?

Scientific characteristics of the risk

- Likelihood
- Magnitude

Information dissemination

- Confidence/trust in sources
- Timing
- Message content

Personal attributes

- Direct and indirect experience in past
- Trust in authorities

Contextual factors

- Social networks and interpersonal dynamics
- Cultural beliefs

Risk Perception Paradox

1. Individuals understand the risk but choose to accept it because the perceived benefits outweigh the potential negative impacts
2. Individuals understand the risk but do not realize what actions to take
3. Individual understand the risk but lack the resources to act
4. Individuals feel their personal property might be at risk should they evacuate

Implications for Risk Management

Community engagement and risk management

1. Builds trust with authorities and experts
2. Authorities gain knowledge from the “lay experts”
3. Public gains knowledge of what they can expect from authorities and what they need to do to improve their own protection

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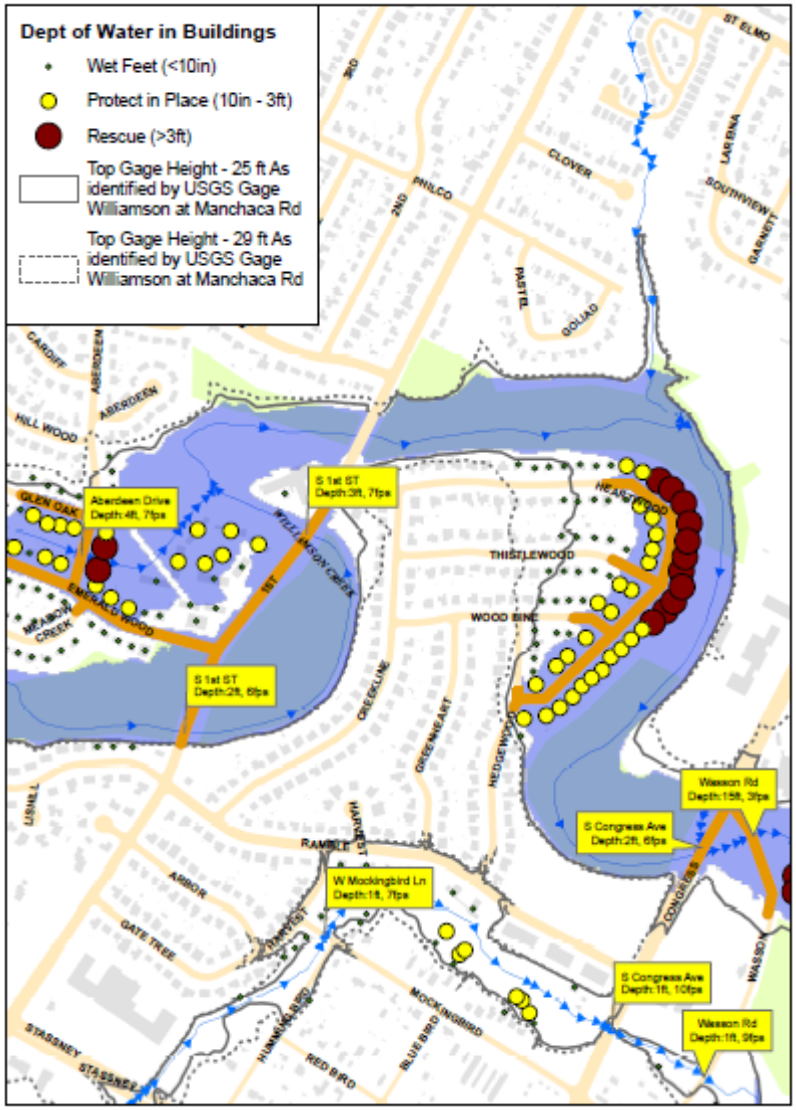

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0 — 0.25 — 0.5 Miles

Map produced by City of Austin Flood Early Warning System (FEWS)
In conjuction with Austin Fire Department and University of Texas Updated October 2015

Middle Williamson Creek near Heartwood Road -- MAJOR FLOODING

Public Education

READY, SET, GO!

FLOOD PREPARATION

Prepare for Flooding Before it Occurs!

Community Flood Response System

- **Flood Response Map Book**
- **Personal Flood Response Guide**
- **Web Based Flood Emergency Information System**

Disaster Warning Response: Risk Assessment and Action

Calvin L. Streeter
The University of Texas at Austin
School of Social Work

Seminar on Flooding in Wimberley
Austin TX, 9 November 2015

Risk Perception to Action Chain

What Influences Perception of Risk?

Scientific characteristics of the risk

- Likelihood
- Magnitude

Information dissemination

- Credibility and confidence in sources
- Timing
- Message content

Personal attributes

- Direct and indirect experience in past
- Trust in authorities

Contextual factors

- Social networks and interpersonal dynamics
- Cultural beliefs

Risk Perception Paradox

1. Individuals understand risk but choose to accept it because the perceived benefits outweigh the potential negative impacts
2. Individuals understand the risk but do not know what actions to take
3. Individual understand the risk but lack the resources to act

Implications for Risk Management

Community engagement and risk management

1. Public forums and community meetings
2. Canvas areas at greatest risk
3. Citizen advisory groups
   - Builds trust with authorities and experts
   - Public safety officials gain knowledge from "lay experts"
   - Public gains knowledge of what they can expect from authorities and what they need to do to improve their own protection