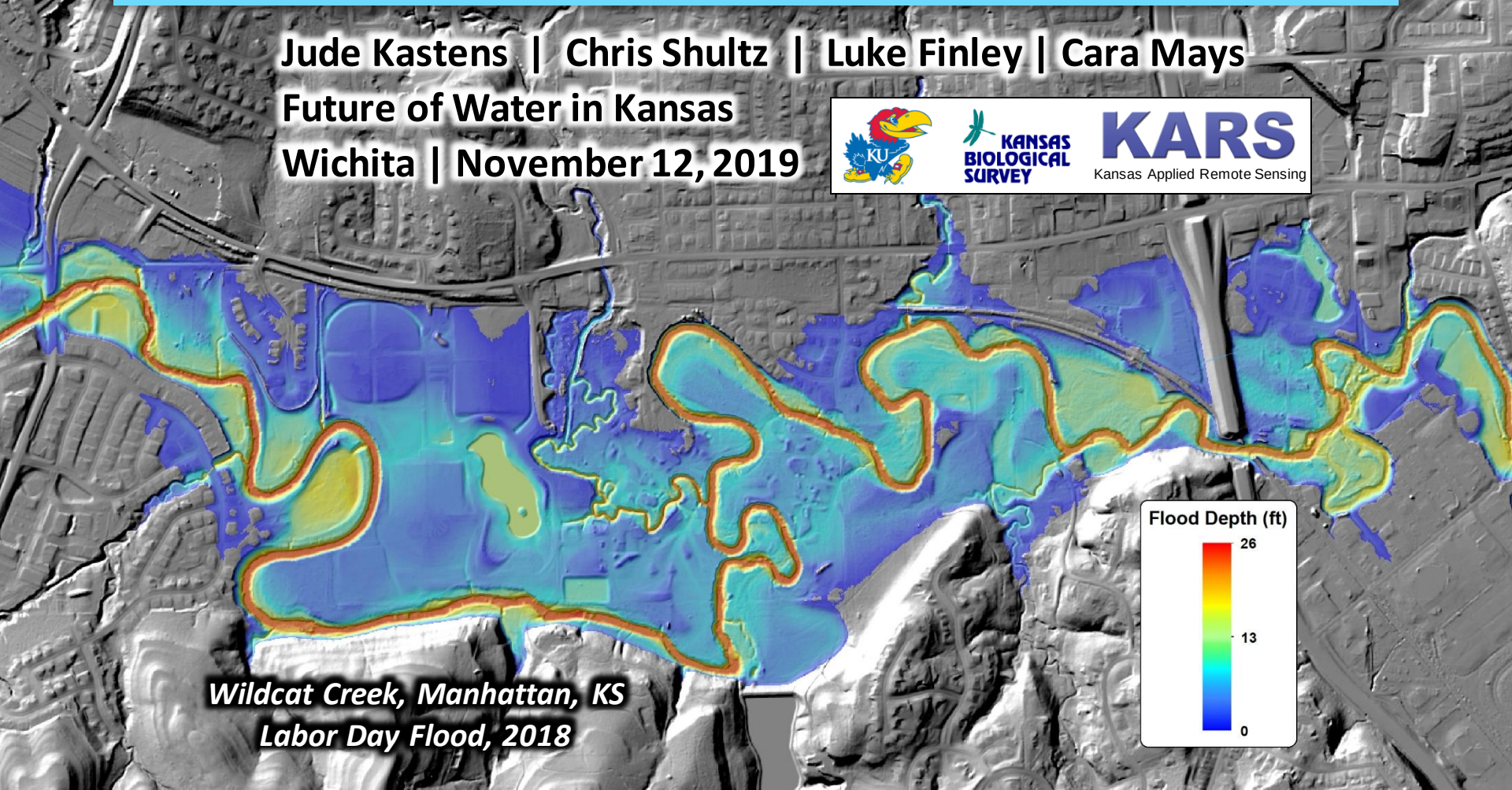
Improving Situational Awareness with Real-time Flood Mapping in Kansas: Live Action from Spring 2019

Jude Kastens | Chris Shultz | Luke Finley | Cara Mays

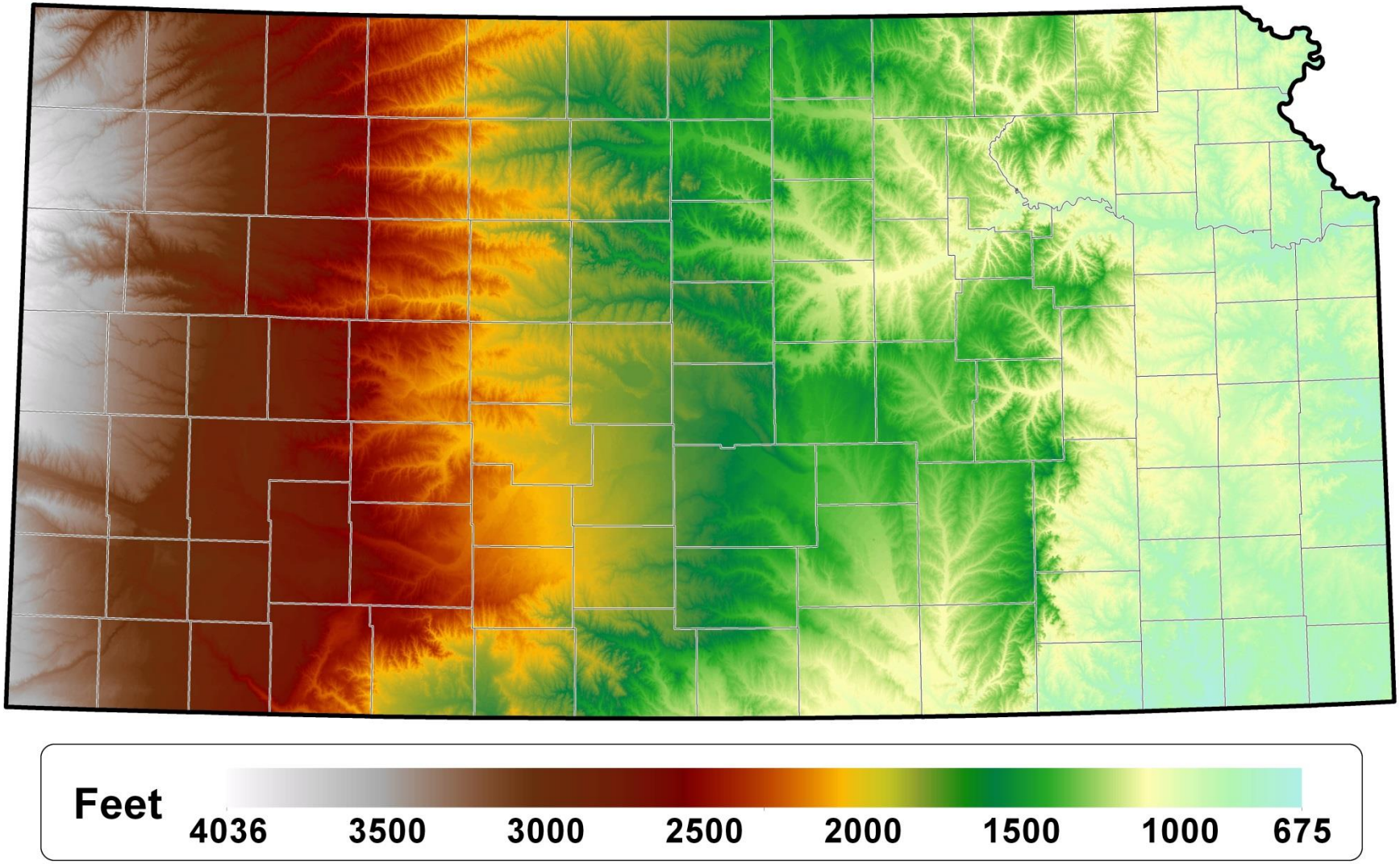
Future of Water in Kansas

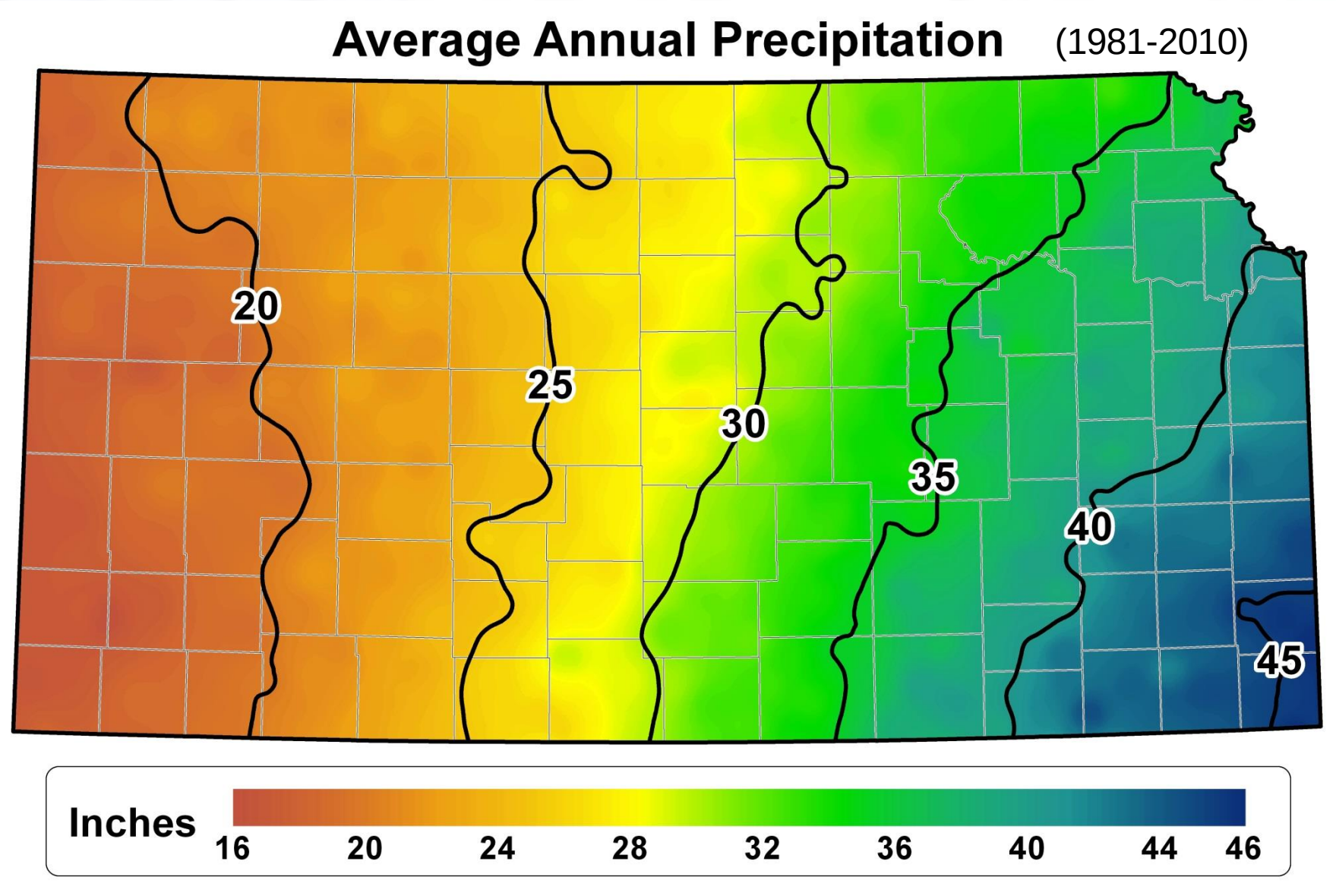
Wichita | November 12, 2019



Wildcat Creek, Manhattan, KS
Labor Day Flood, 2018

Elevation

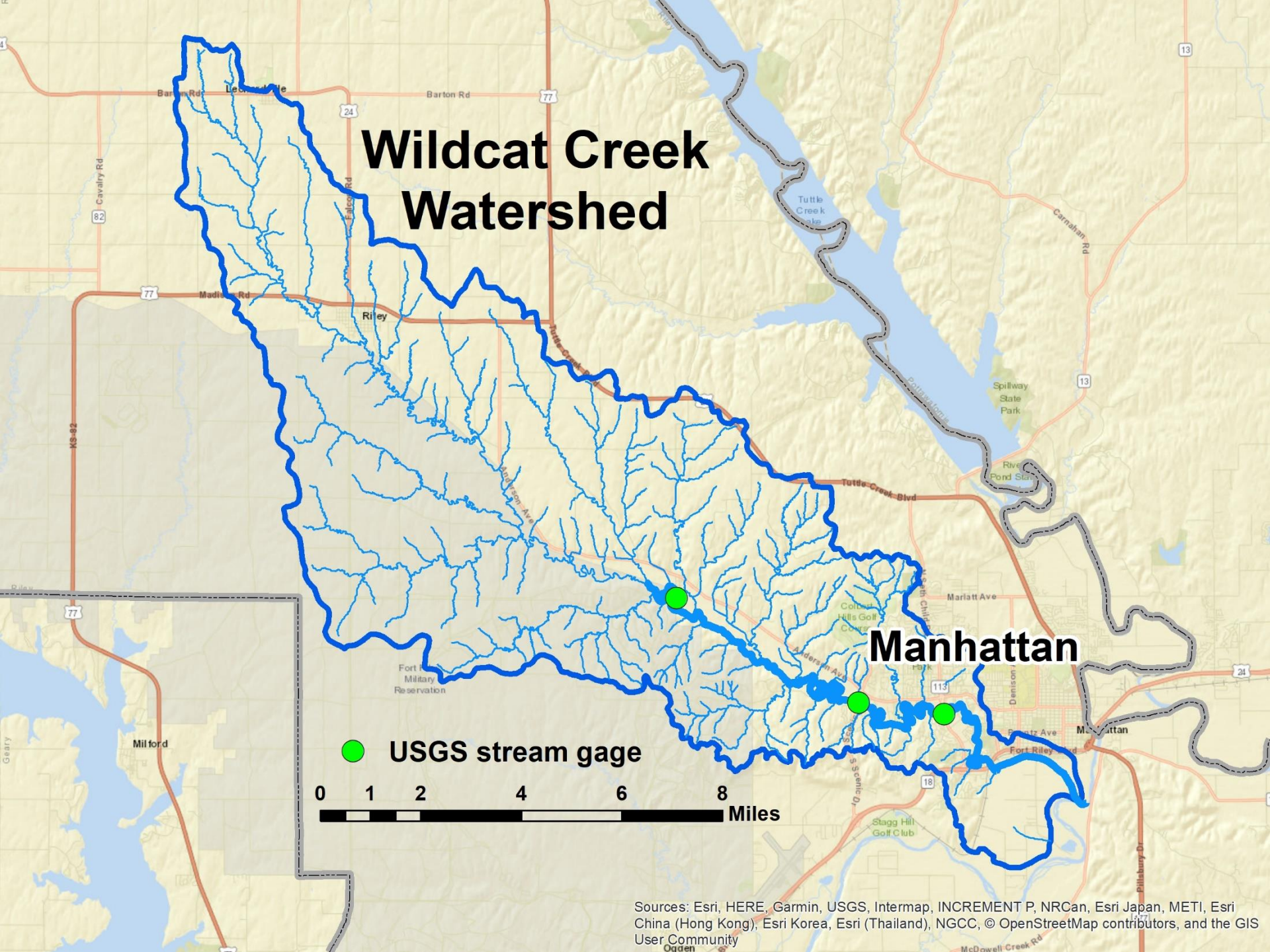



Average Annual Precipitation (1981-2010)
20
25
30
35
40
45
Inches
16
20
24
28
32
36
40
44
46

FLASHBACK

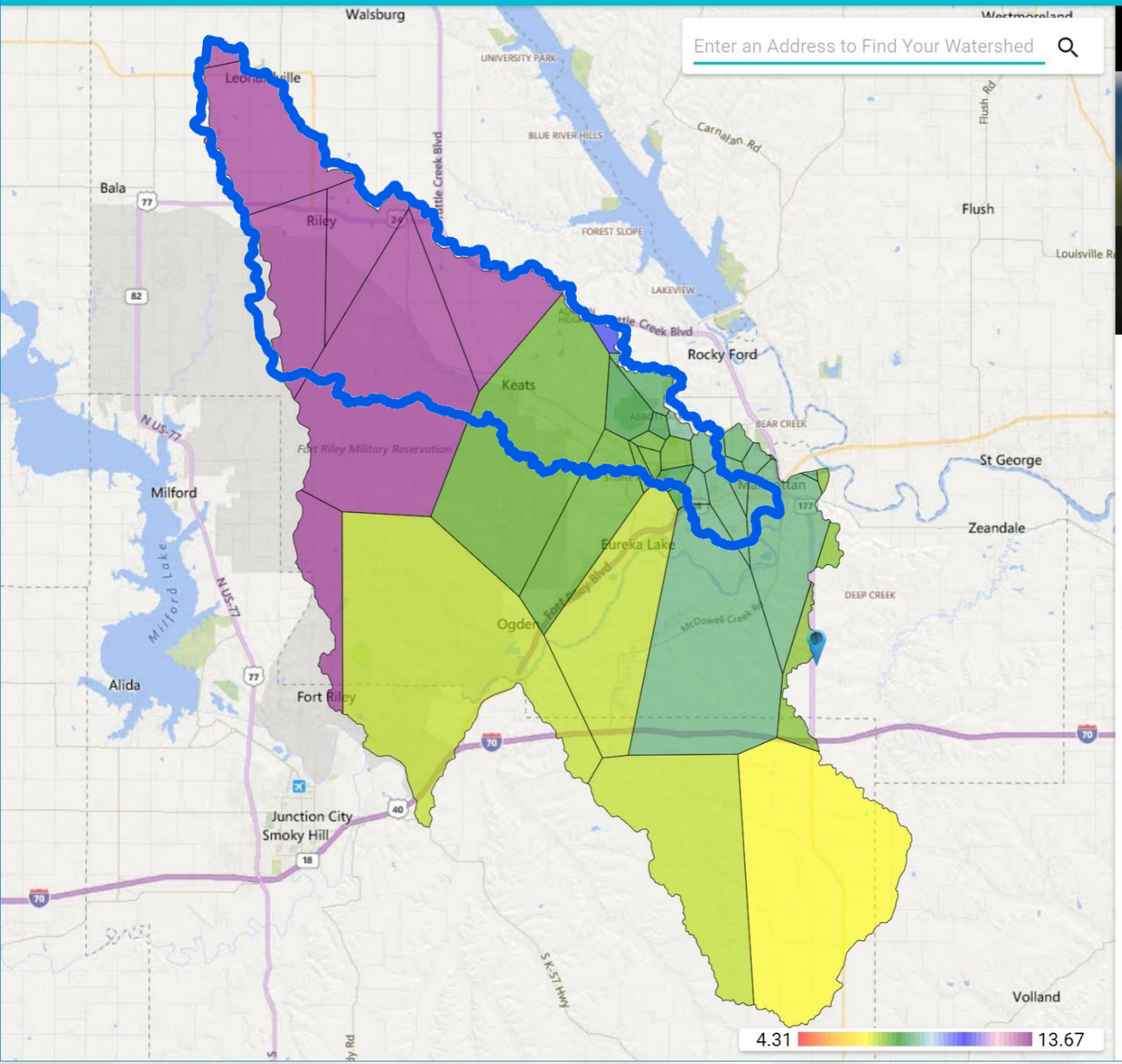
Wildcat Creek Flood, September 3, 2018

Manhattan, KS


Wildcat Creek Watershed
Manhattan
USGS stream gage
0 1 2 4 6 8
Miles
Barton Rd
Cavalry Rd
Madison Rd
Riley
Tuttle Creek Blvd
Anderson Ave
Marlatt Ave
Carnahan Rd
Tuttle Creek Lake
Spillway State Park
Fort Riley Military Reservation
Milford
Stagg Hill Golf Club
Fort Riley Blvd
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

CoCoRaHS Watershed Mapping

ABOUT



Watershed Details

Wildcat Creek-Kansas River

1027010102

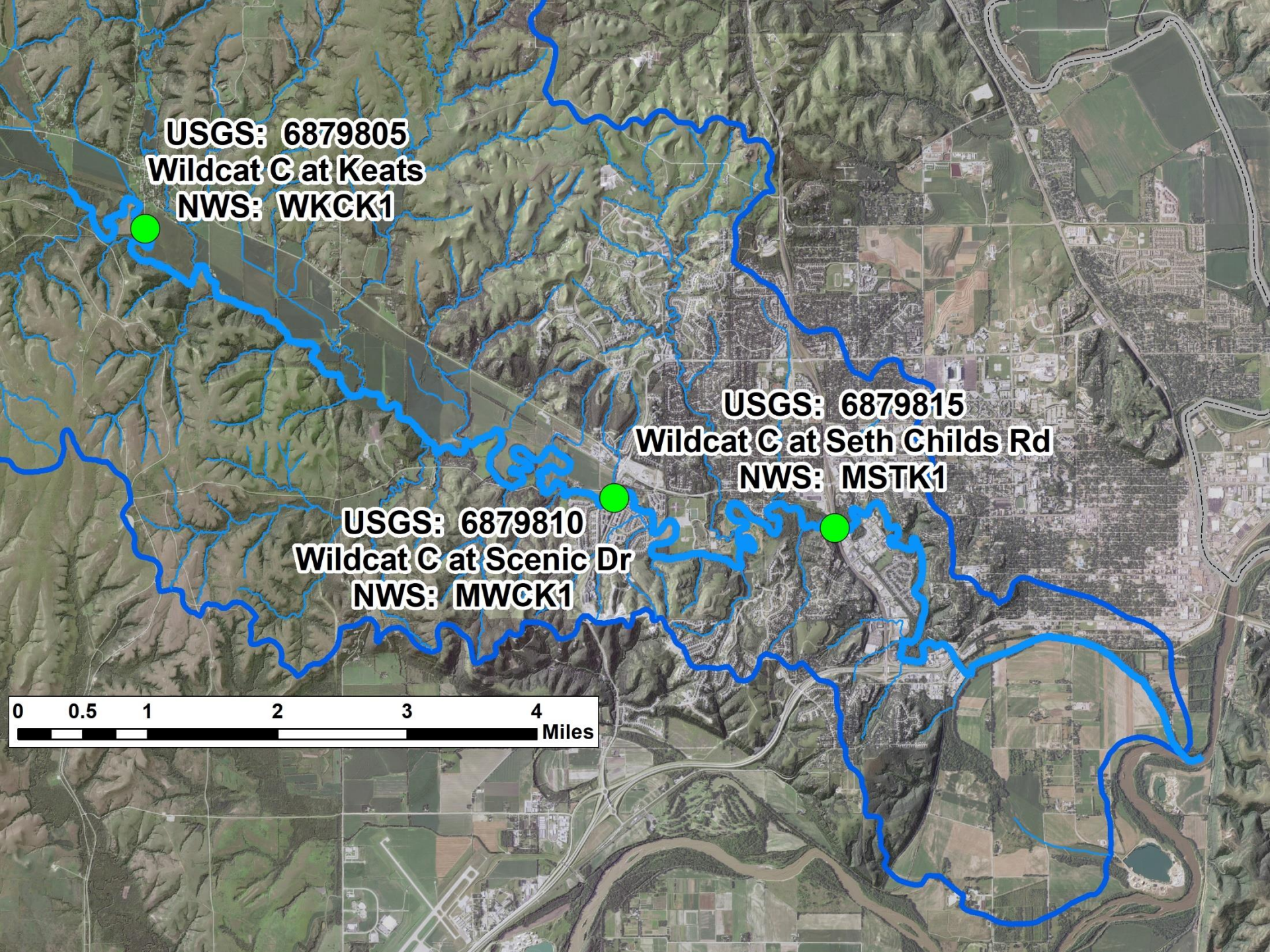
The Wildcat Creek-Kansas River watershed spans parts of Kansas. It has a total area of 183,663 acres or 287 square miles.

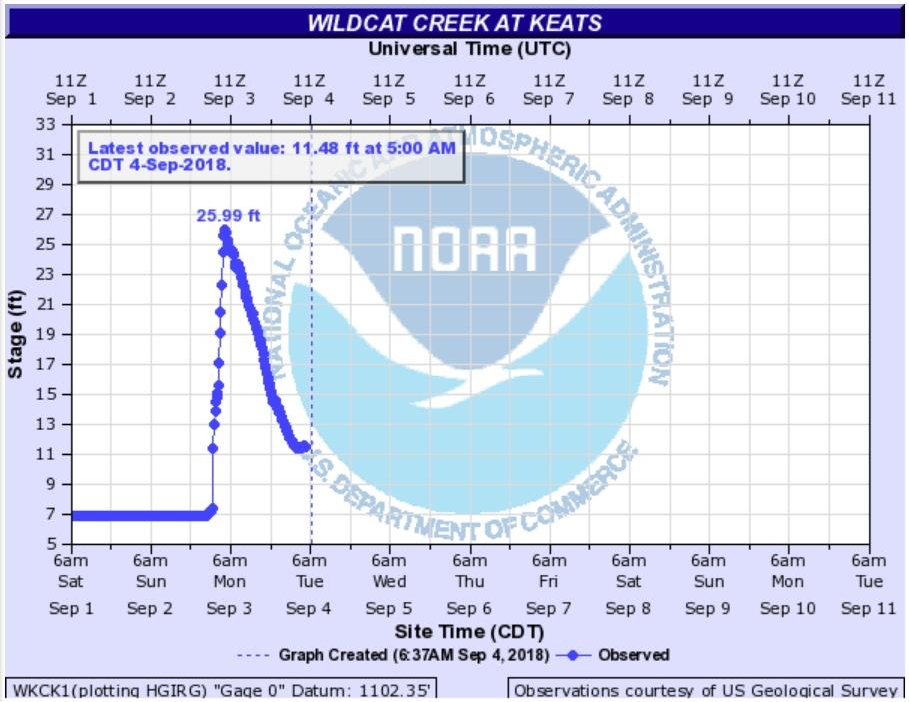
Accumulated Precipitation for September 2018: **7.68 in.**

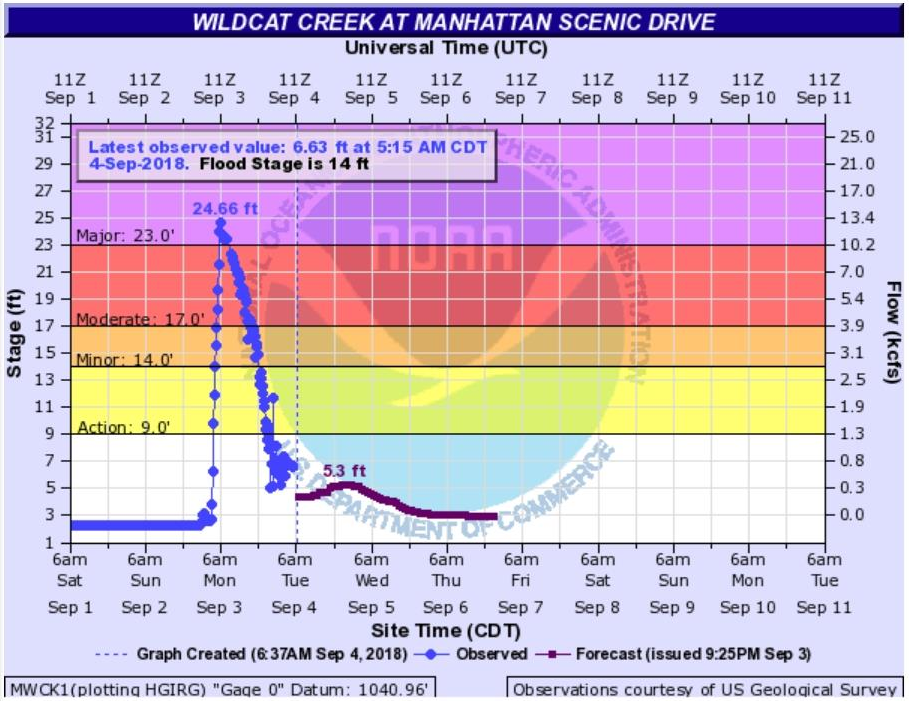
There are 36 CoCoRaHS stations in this watershed.

Search for CoCoRaHS Station

PRECIPITATION REPORTS


USGS: 6879805
Wildcat C at Keats
NWS: WKCK1
USGS: 6879815
Wildcat C at Seth Childs Rd
NWS: MSTK1
USGS: 6879810
Wildcat C at Scenic Dr
NWS: MWCK1
0 0.5 1 2 3 4
Miles

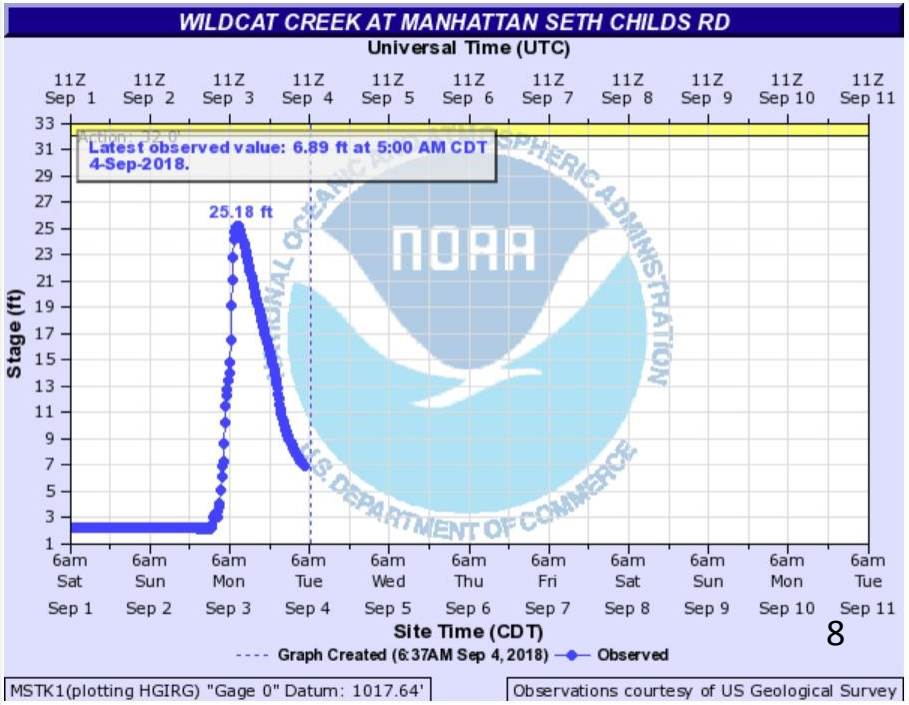




Hydrographs, the day after the flood

7 ft, 8 ft, & 9 ft above records

(These gages don't have long histories, however)



Advanced Hydrologic Pre

Secure | https://water.weather.gov/ahps2/inundation/index.php?gage=mwck1

weather.gov

National Weather Service
Advanced Hydrologic Prediction Service

Home | News | Organization | Search for: | NWS | All NOAA | Go

Wildcat Creek at Manhattan Scenic Drive, KS (MWCK1)

Data Type
- Inundation Levels
- Flood Categories
- Current/Forecast

Inundation Levels

NAVD88	Stage
1,072.0*	31.0*
1,071.0*	30.0*
1,070.0*	29.0*
1,069.0*	28.0*
1,068.0*	27.0*
1,067.0*	26.0*
1,066.0*	25.0*
1,065.0*	24.0*
1,064.0*	23.0*
Major Flooding Begins	
1,063.0*	22.0*
1,062.0*	21.0*
1,061.0*	20.0*
1,060.0*	19.0*
1,059.0*	18.0*
Record Crest: 17.53 ft	
1,058.0*	17.0*
Moderate Flooding Begins	
1,057.0*	16.0*
1,056.0*	15.0*
1,055.0*	14.0*
Minor Flooding Begins	
1,054.0*	13.0*
1,053.0*	12.0*
Near Flooding Begins	

* = Extended rating

Inundation Feedback

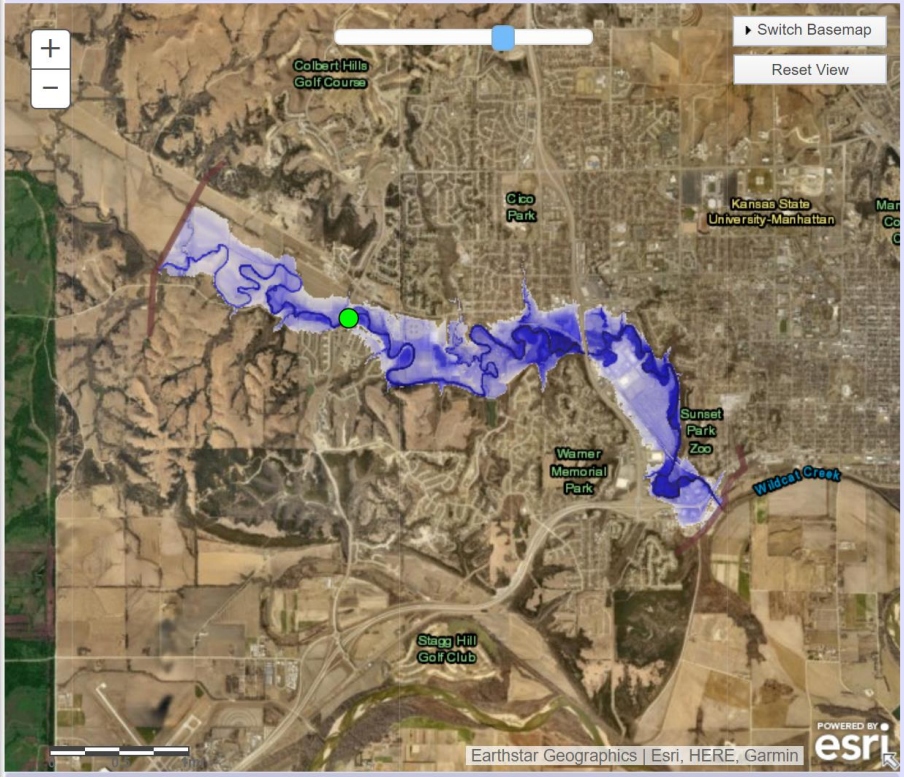
Provided in Partnership with

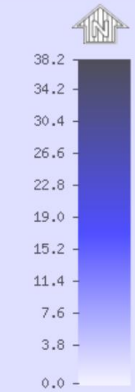
National Observations | Inundation Locations | View Inundation Site

Weather Forecast Office Topeka, KS | Missouri Basin River Forecast Center

Hydrograph | River at a Glance | Download | Inundation Mapping

Print this map | Find address or location





Gauge Location

About Inundation | Download Dataset(s) | FAQ | User Guide | Inundation Sites | Inundation Legend

User guide video on YouTube

What is UTC time? | Map Help

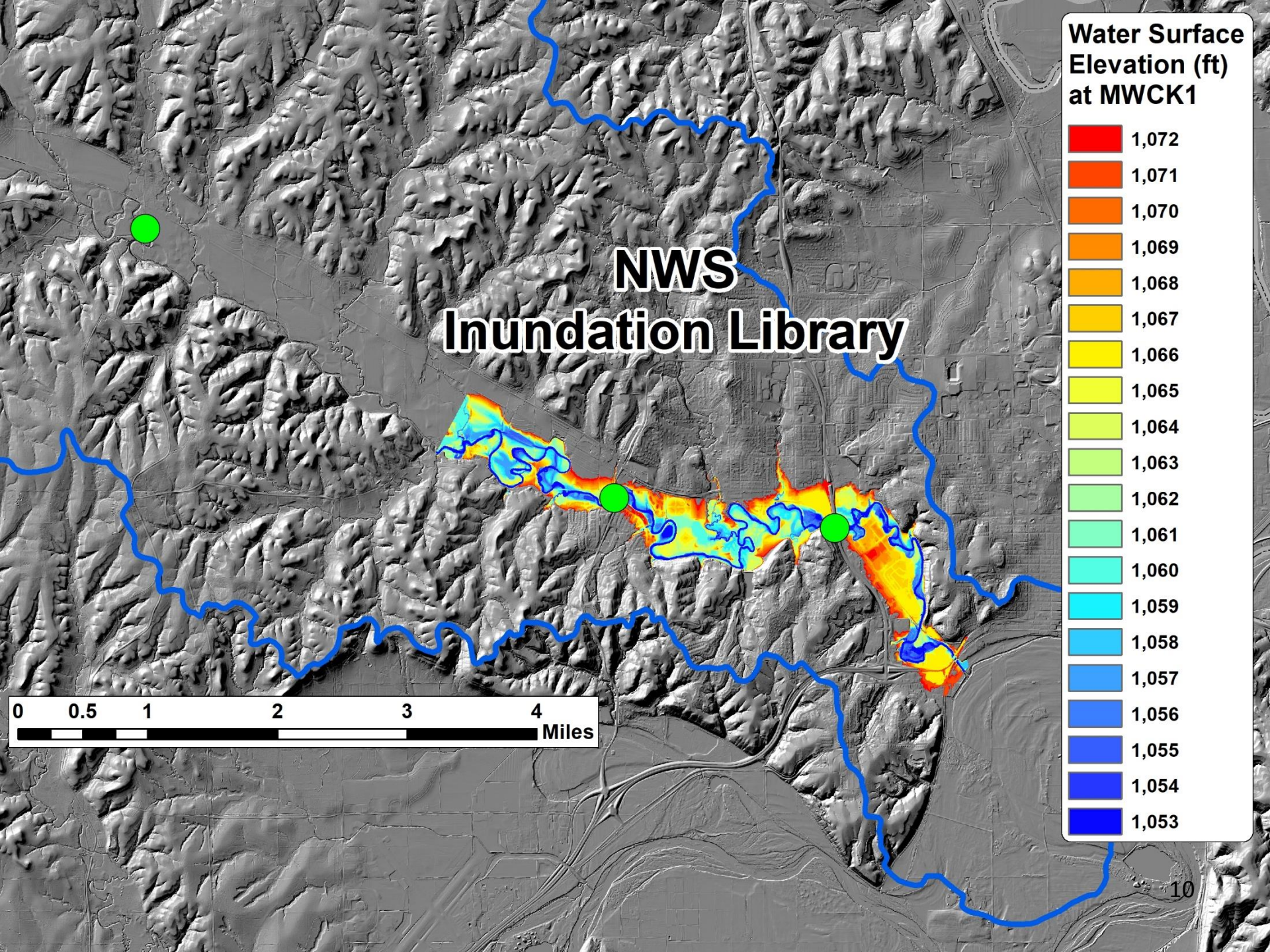
Disclaimer

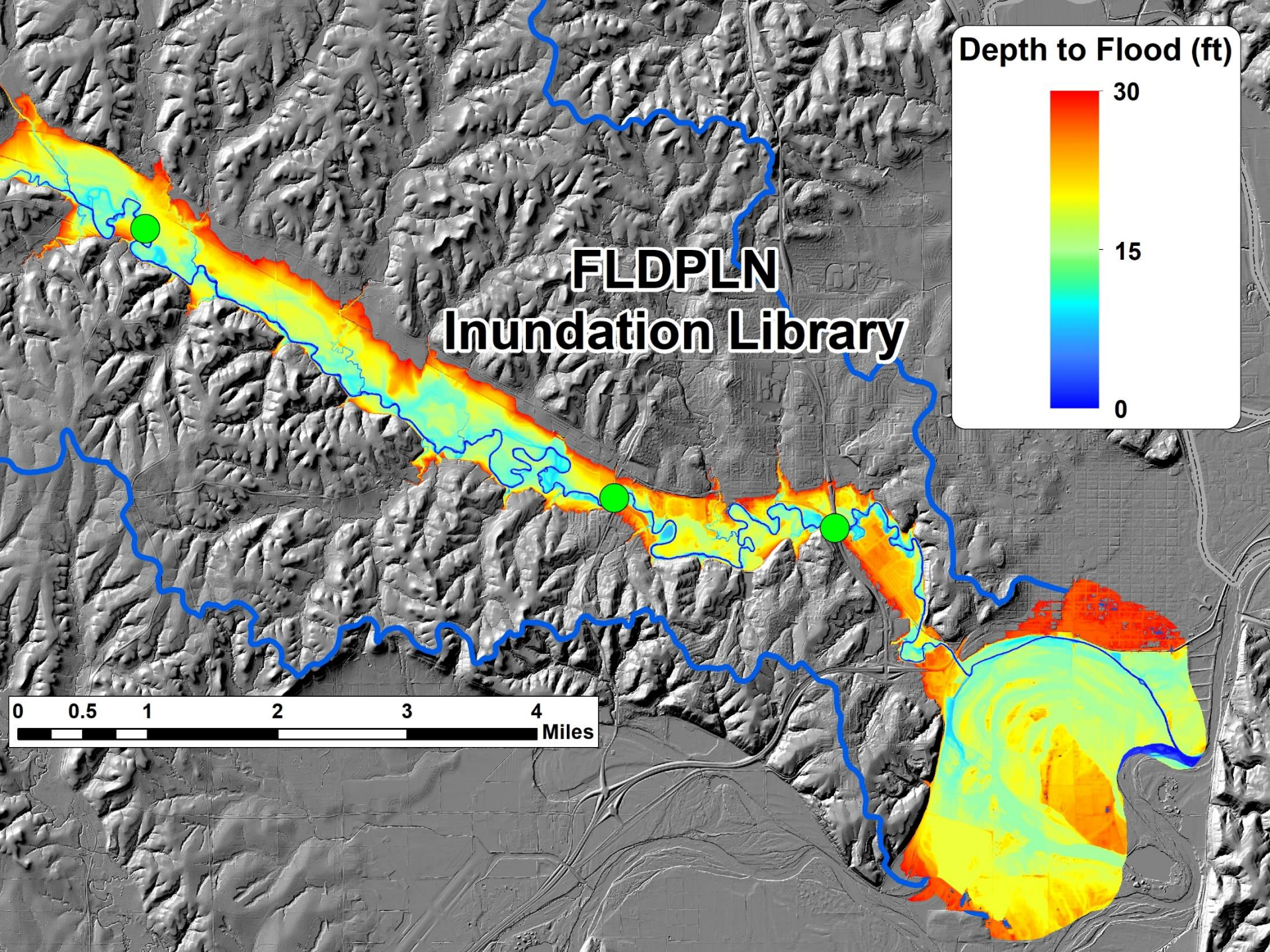
Click on mapped inundation to see water depth values for that location, or hold shift and drag to zoom to area.

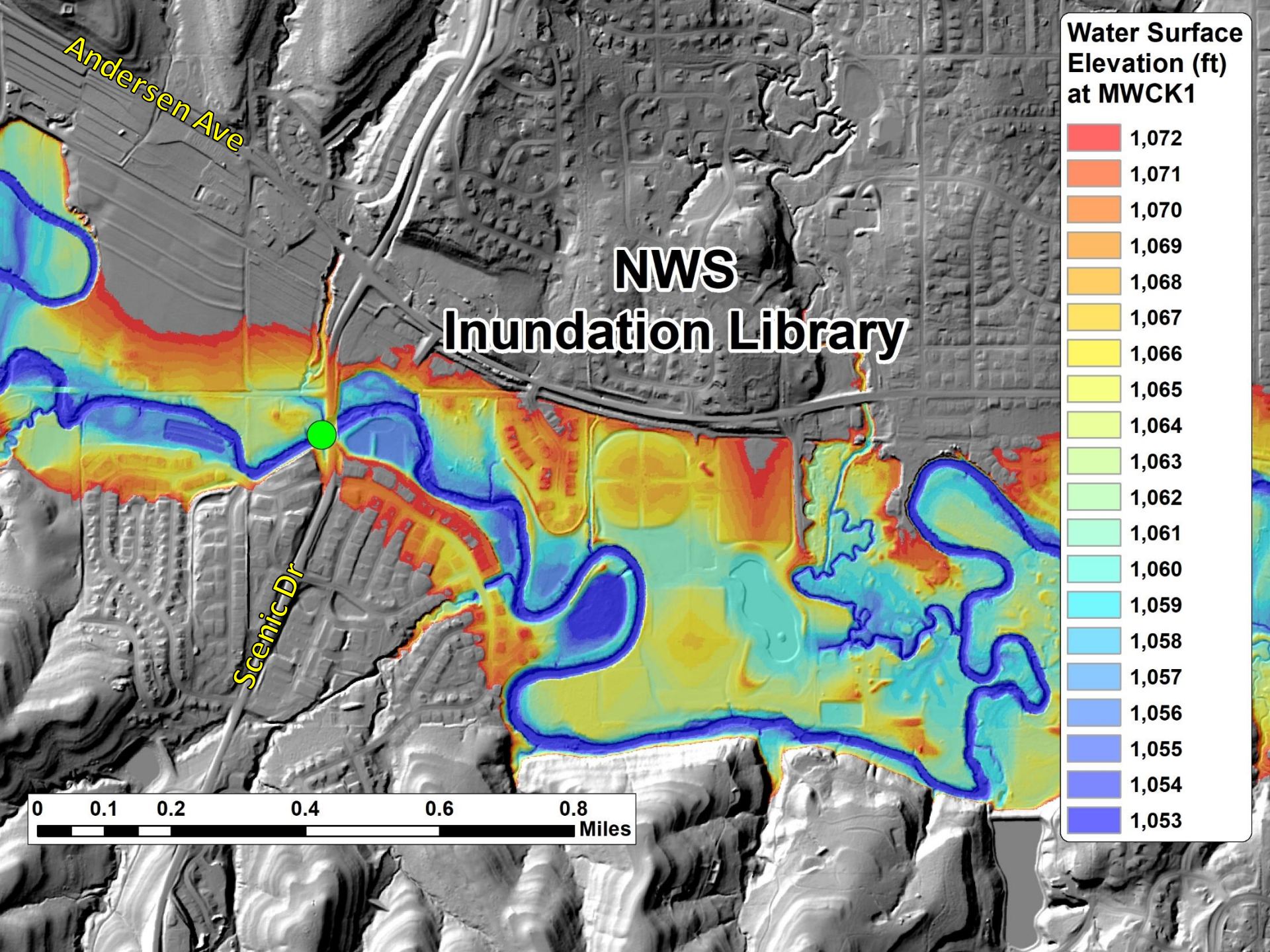
Current Stage:	Selected Inundation	Mouse Location	
4.1 ft at 09/12/2018 16:15:00 UTC	NAVD88: 1,072.0* ft stage: 31.0* ft	Depth: No Data	Lat: 39.219 Lon: -96.592

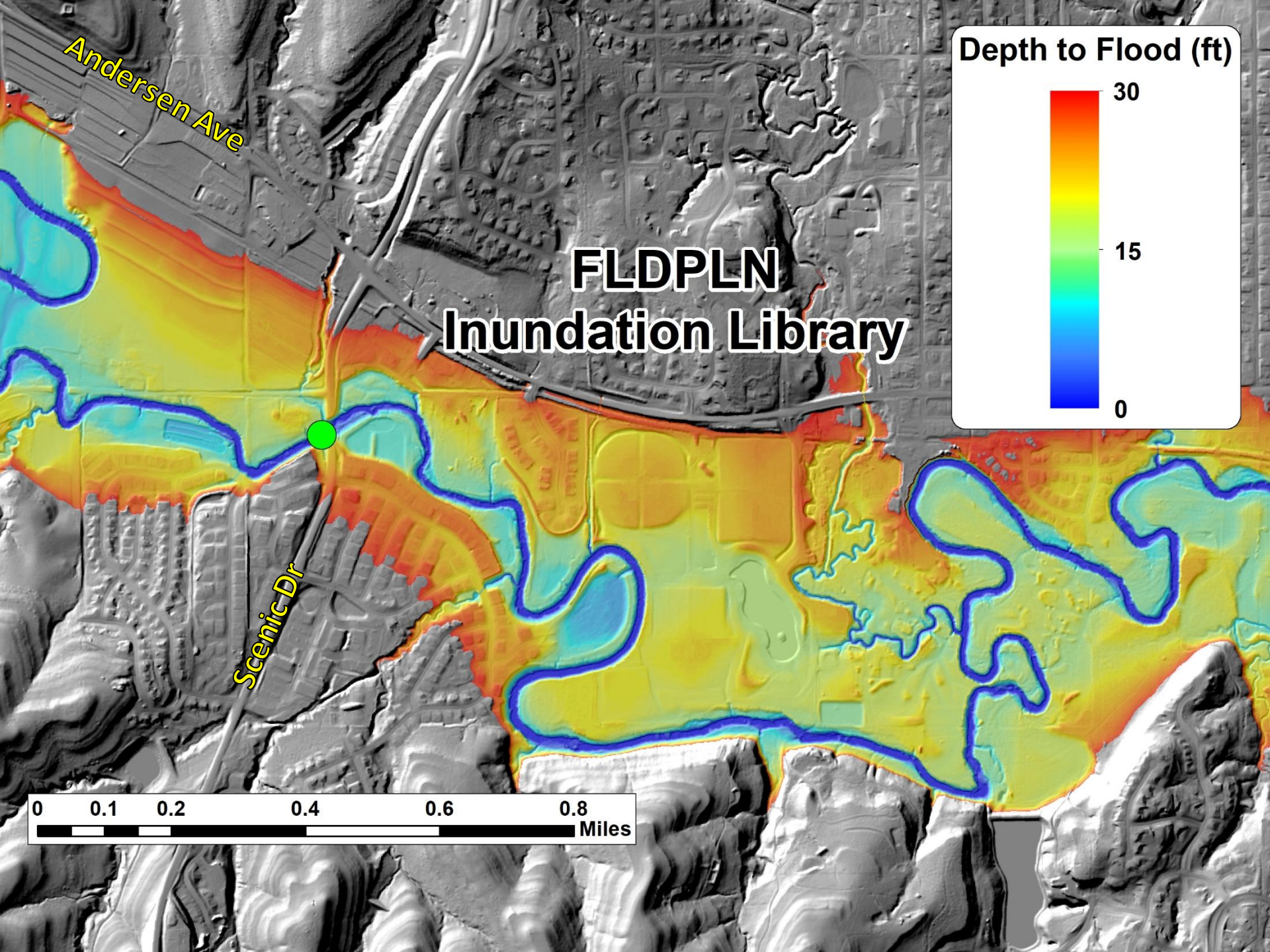
Latitude/Longitude Disclaimer: The gauge location shown in the above map is the approximate location based on the latitude/longitude coordinates provided to the NWS by the gauge owner.

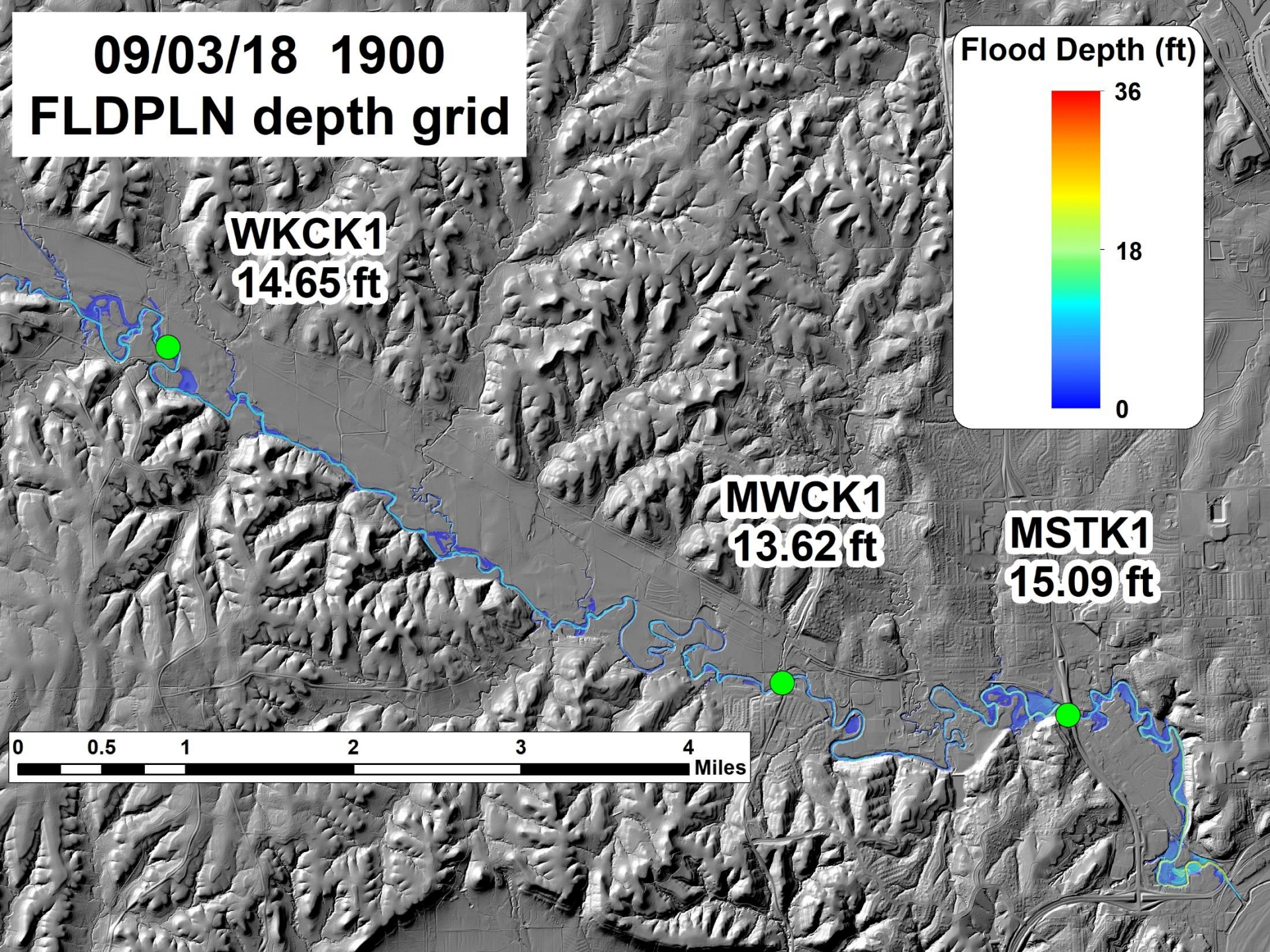
Gauge Information | Collapse

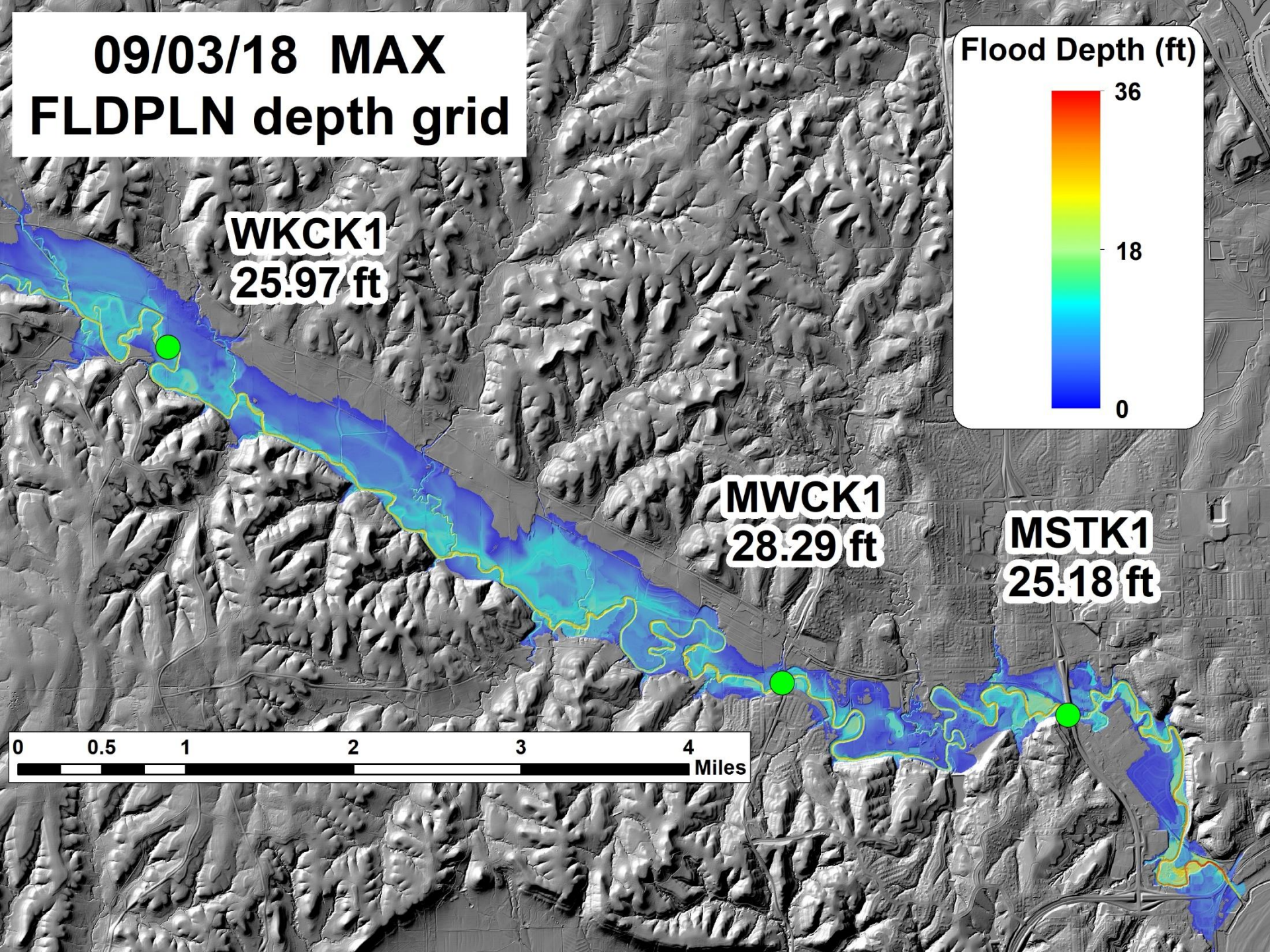

NWS
Inundation Library
Water Surface Elevation (ft) at MWCK1
1,072
1,071
1,070
1,069
1,068
1,067
1,066
1,065
1,064
1,063
1,062
1,061
1,060
1,059
1,058
1,057
1,056
1,055
1,054
1,053
0
0.5
1
2
3
4
Miles

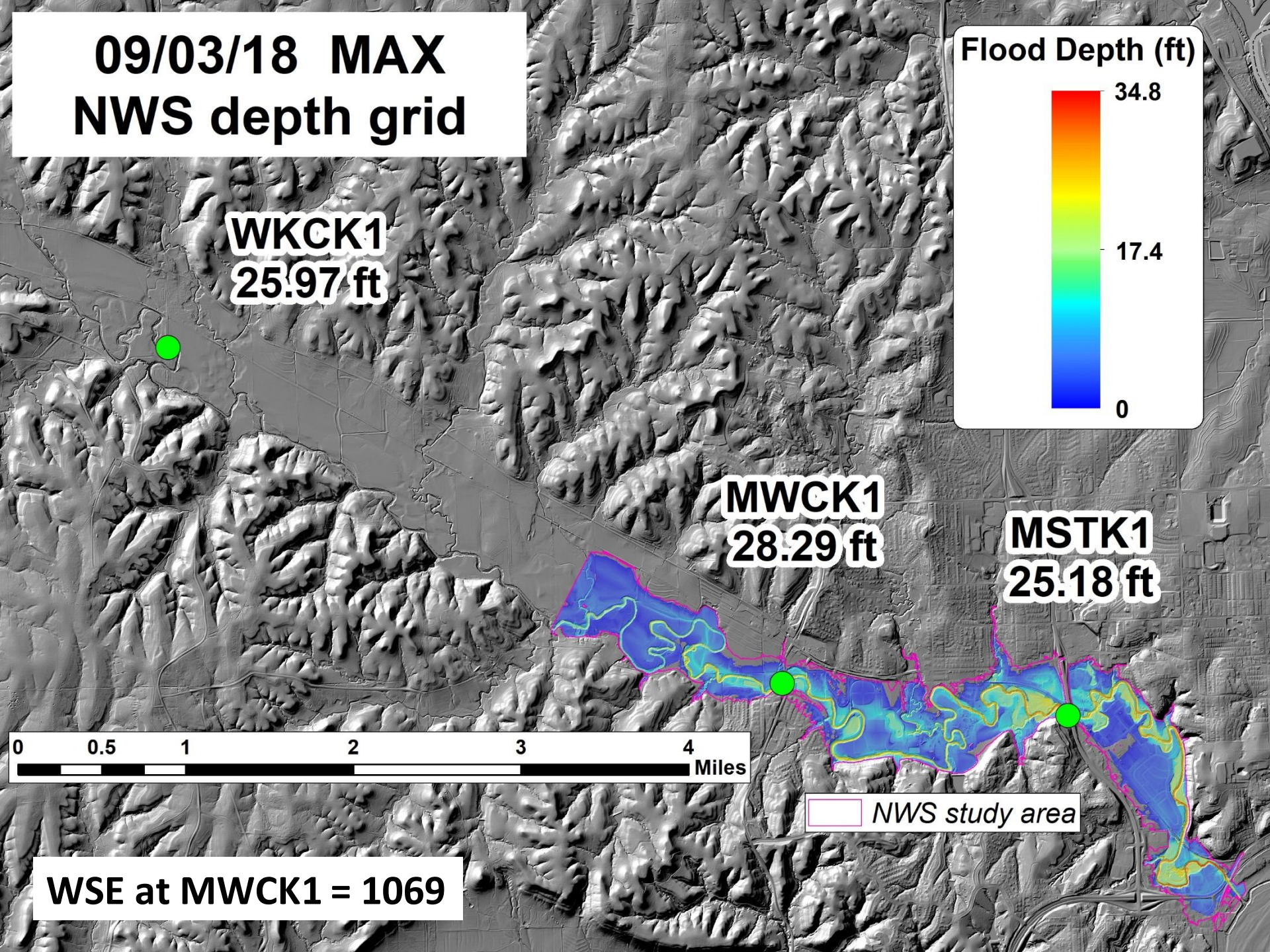

FLDPLN
Inundation Library
Depth to Flood (ft)
30
15
0
0
0.5
1
2
3
4
Miles


Andersen Ave
NWS
Inundation Library
Scenic Dr
Water Surface Elevation (ft) at MWCK1
1,072
1,071
1,070
1,069
1,068
1,067
1,066
1,065
1,064
1,063
1,062
1,061
1,060
1,059
1,058
1,057
1,056
1,055
1,054
1,053
0
0.1
0.2
0.4
0.6
0.8
Miles


Andersen Ave
FLDPLN
Inundation Library
Depth to Flood (ft)
30
15
0
Scenic Dr
0
0.1
0.2
0.4
0.6
0.8
Miles


09/03/18 1900
FLDPLN depth grid
Flood Depth (ft)
36
18
0
WKCK1
14.65 ft
MWCK1
13.62 ft
MSTK1
15.09 ft
0
0.5
1
2
3
4
Miles


09/03/18 MAX
FLDPLN depth grid
Flood Depth (ft)
36
18
0
WKCK1
25.97 ft
MWCK1
28.29 ft
MSTK1
25.18 ft
0
0.5
1
2
3
4
Miles

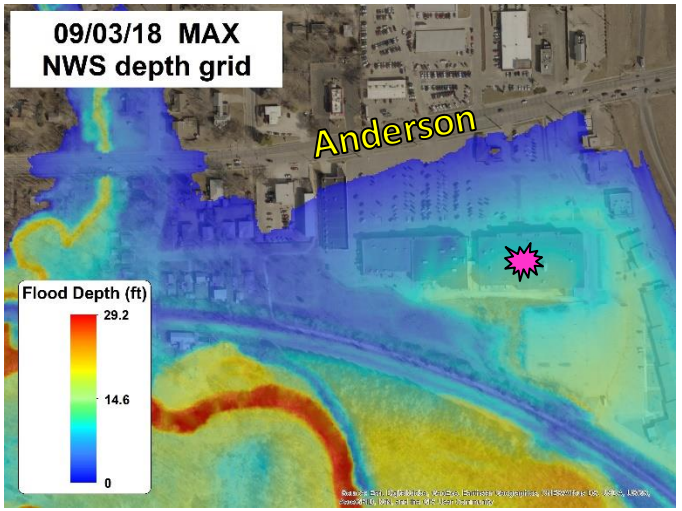

09/03/18 MAX
NWS depth grid
Flood Depth (ft)
34.8
17.4
0
WKCK1
25.97 ft
MWCK1
28.29 ft
MSTK1
25.18 ft
0
0.5
1
2
3
4
Miles
NWS study area
WSE at MWCK1 = 1069

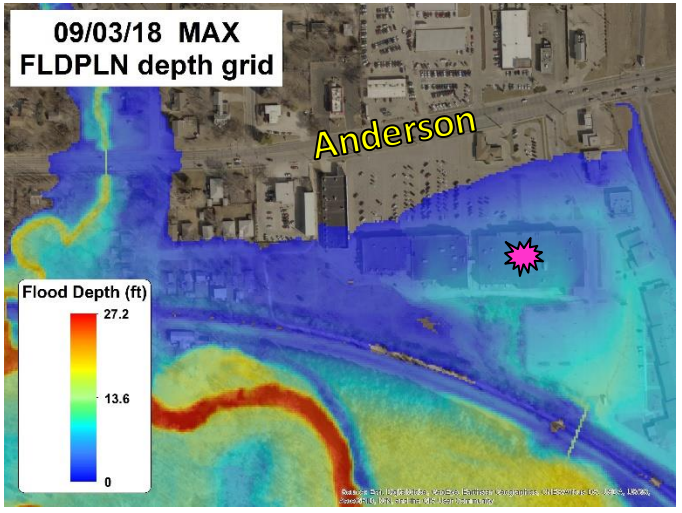
Agreement

85%

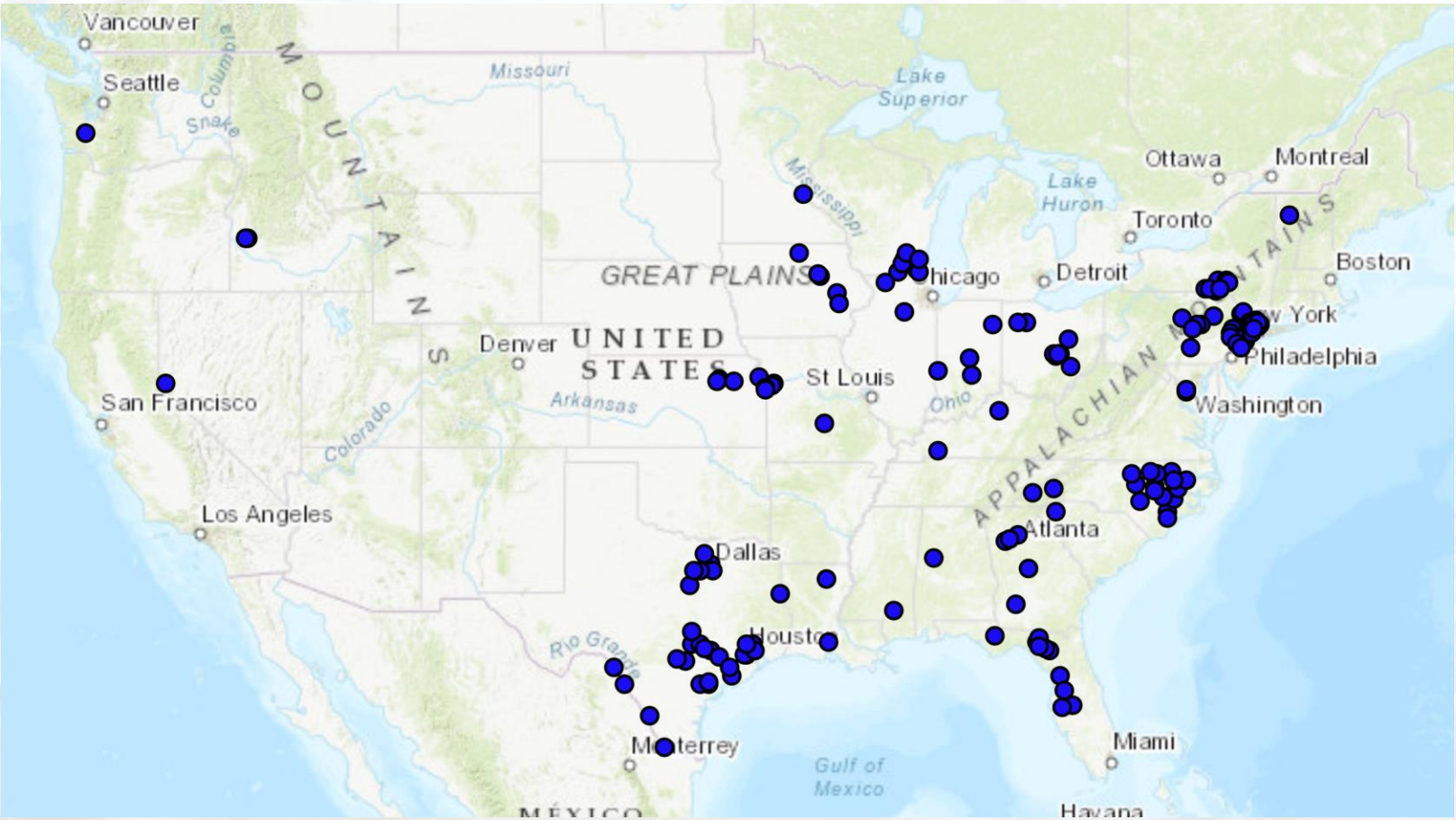
between FLDPLN and NWS max extent estimates along Wildcat Creek

Anderson Ave & Meadowbrook Ln (looking east)





Why not use NWS inundation mapping everywhere?



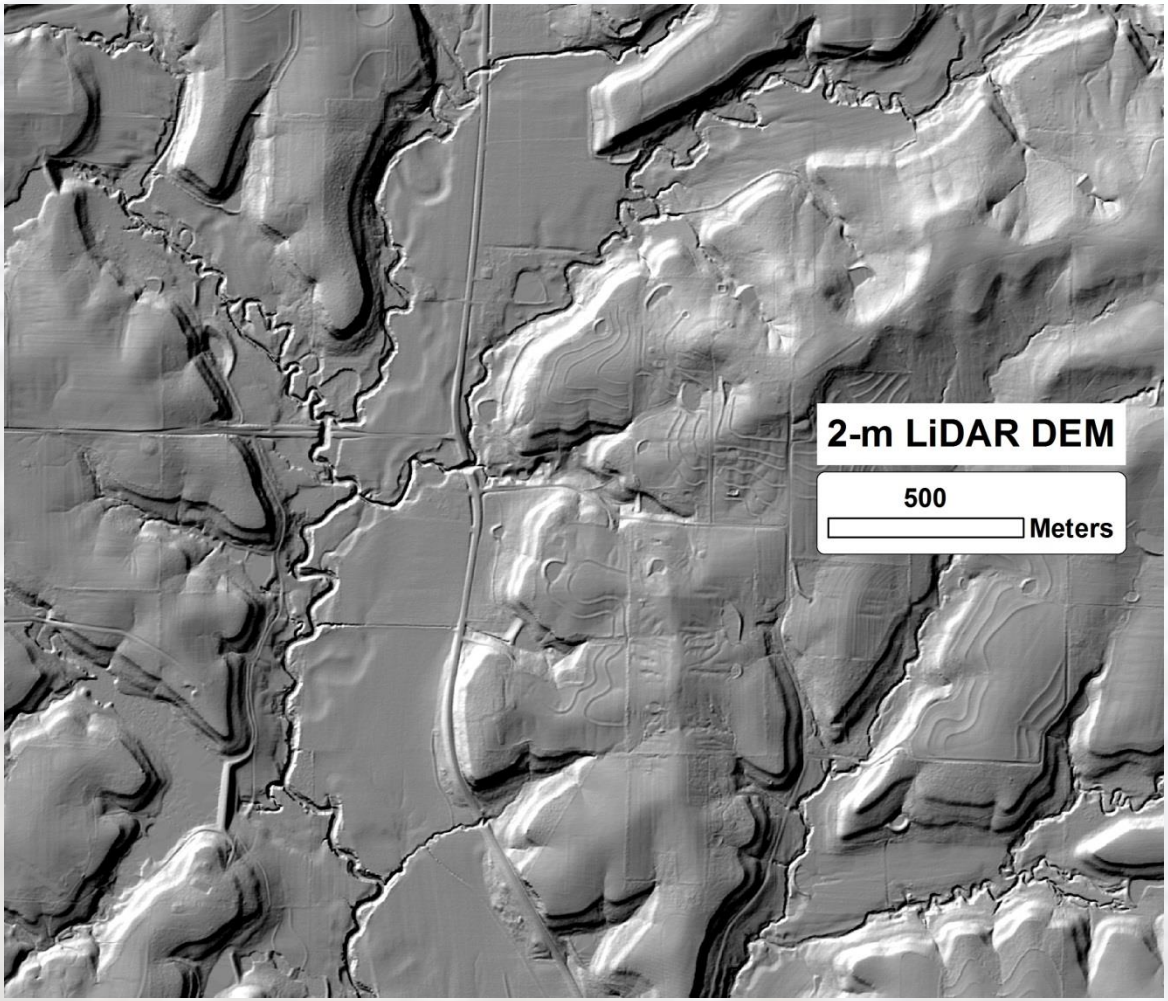
Just 172 gage sites have been mapped across the country (~3000 total km of stream reach)

- No certain plans to add more sites in Kansas

FLDPLN
(“Floodplain”)

The Model Behind The Libraries

Terrain Processing: ***DEM (Digital Elevation Model)***

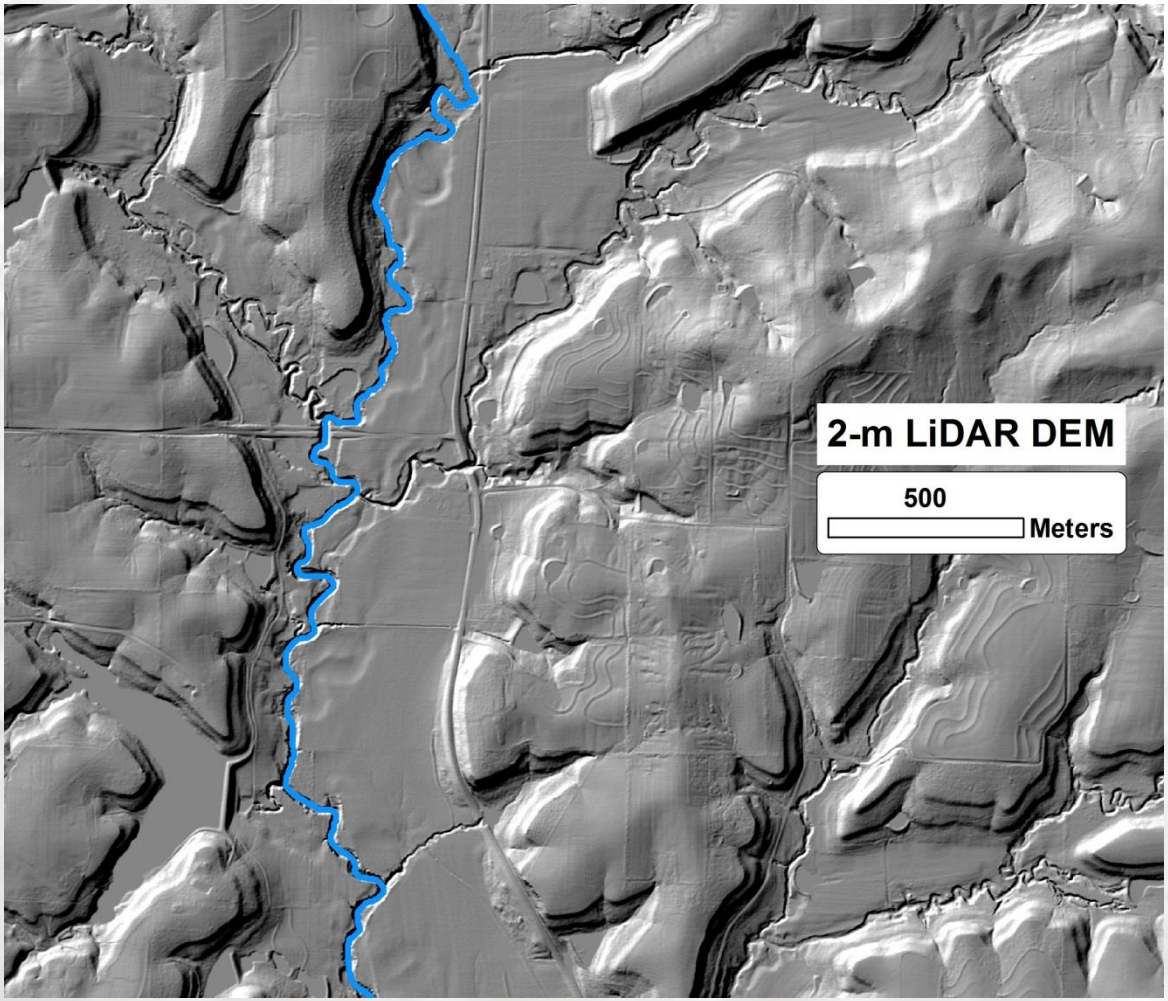


DEM (shown in shaded relief)

This DEM was created using LiDAR data.

Shown is a portion of the river valley for **Mud Creek** in **Jefferson County, Kansas.**

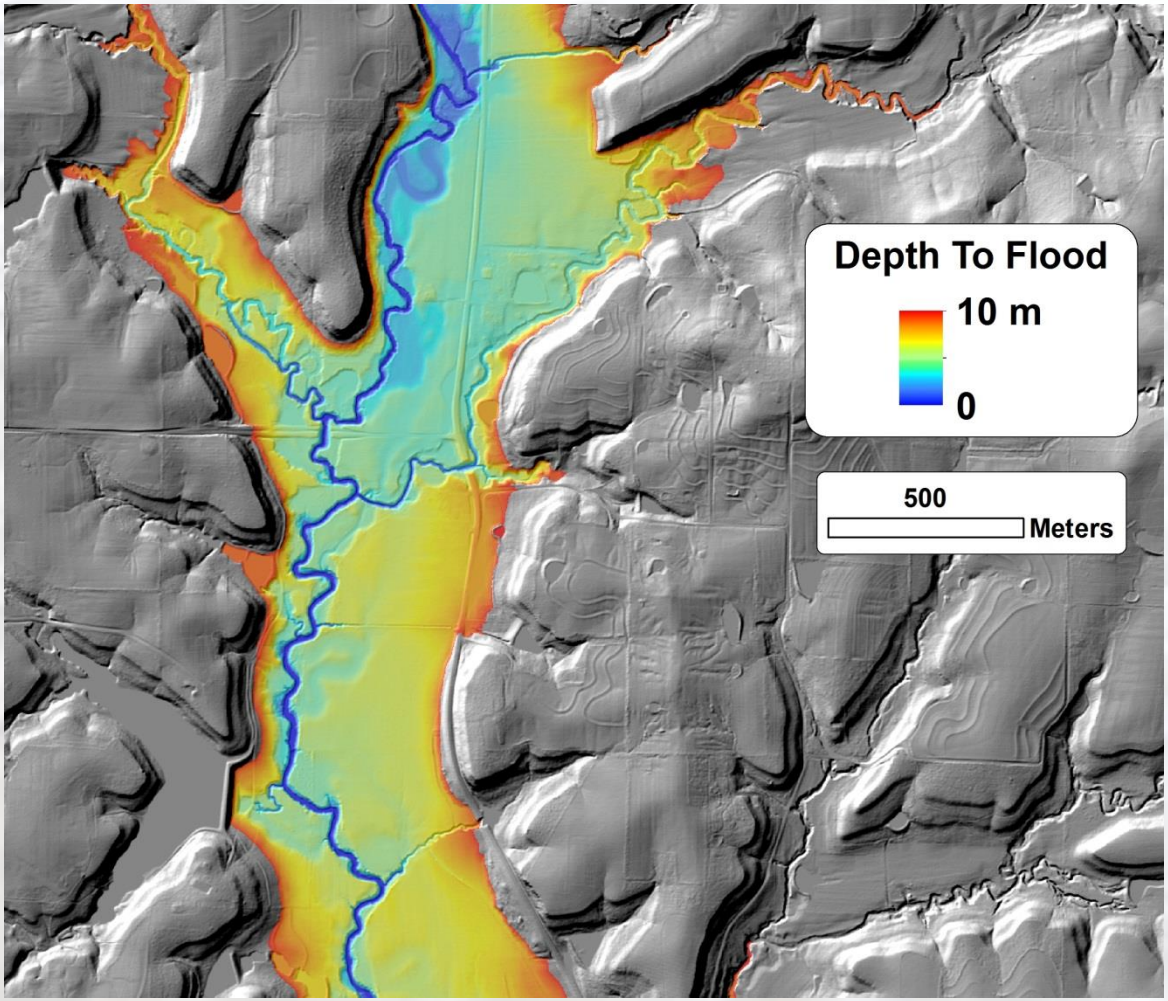
Terrain Processing: ***Stream Delineation***



The **<u>Mud Creek</u>** streamline is identified (shown in blue) using an appropriate flow accumulation threshold.

"Synthetic Stream Network"

Terrain Processing: ***Floodplain Mapping***



10-m Floodplain (DTF Map)

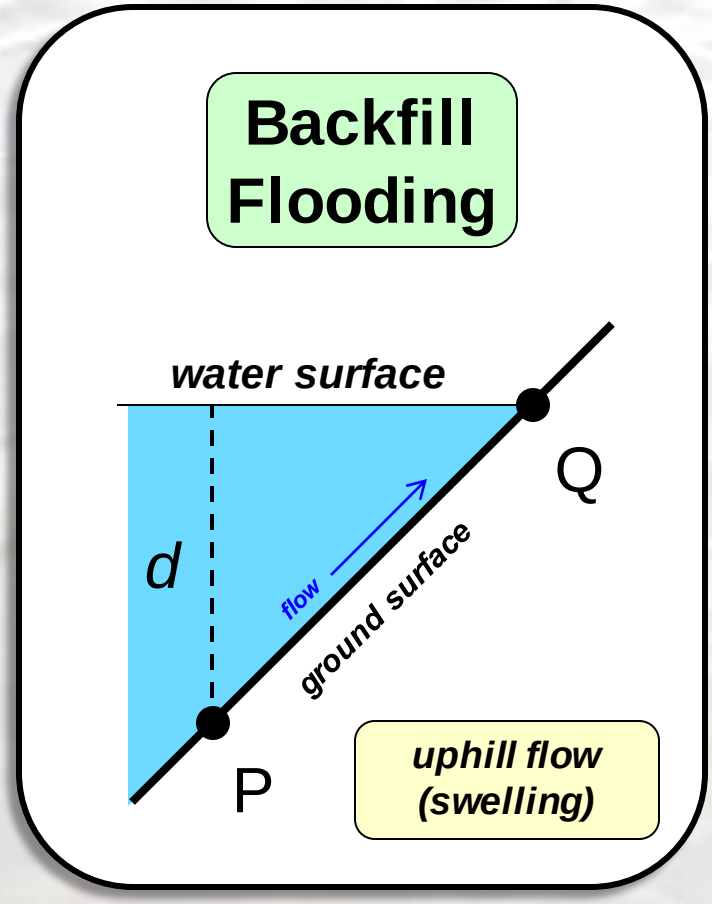
The 10-m floodplain was computed ***for Mud Creek*** using **<u>the FLDPLN model</u>**.

FLDPLN is a pseudo-kinematic, 2-D wave propagation model that requires only DEM data as input.

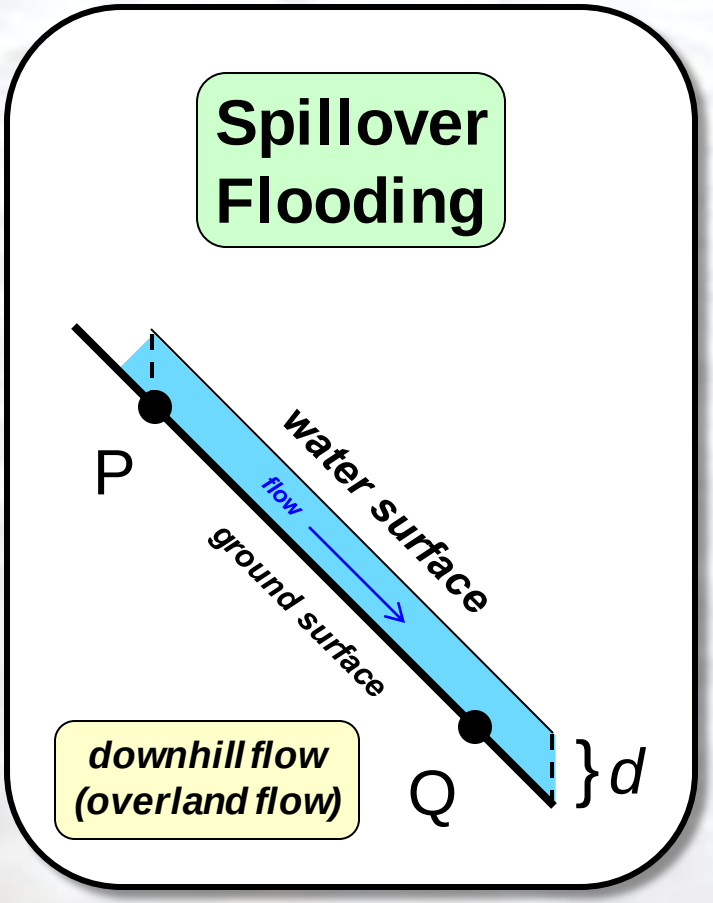
Using simple surface flow properties, FLDPLN identifies the depth-varying floodplain in reference to the input stream network (floodwater source).

The FLDPLN ("Floodplain") Model—

There are two ways that point **Q** can be flooded by water originating from point **P**:



"Water seeks its own level"

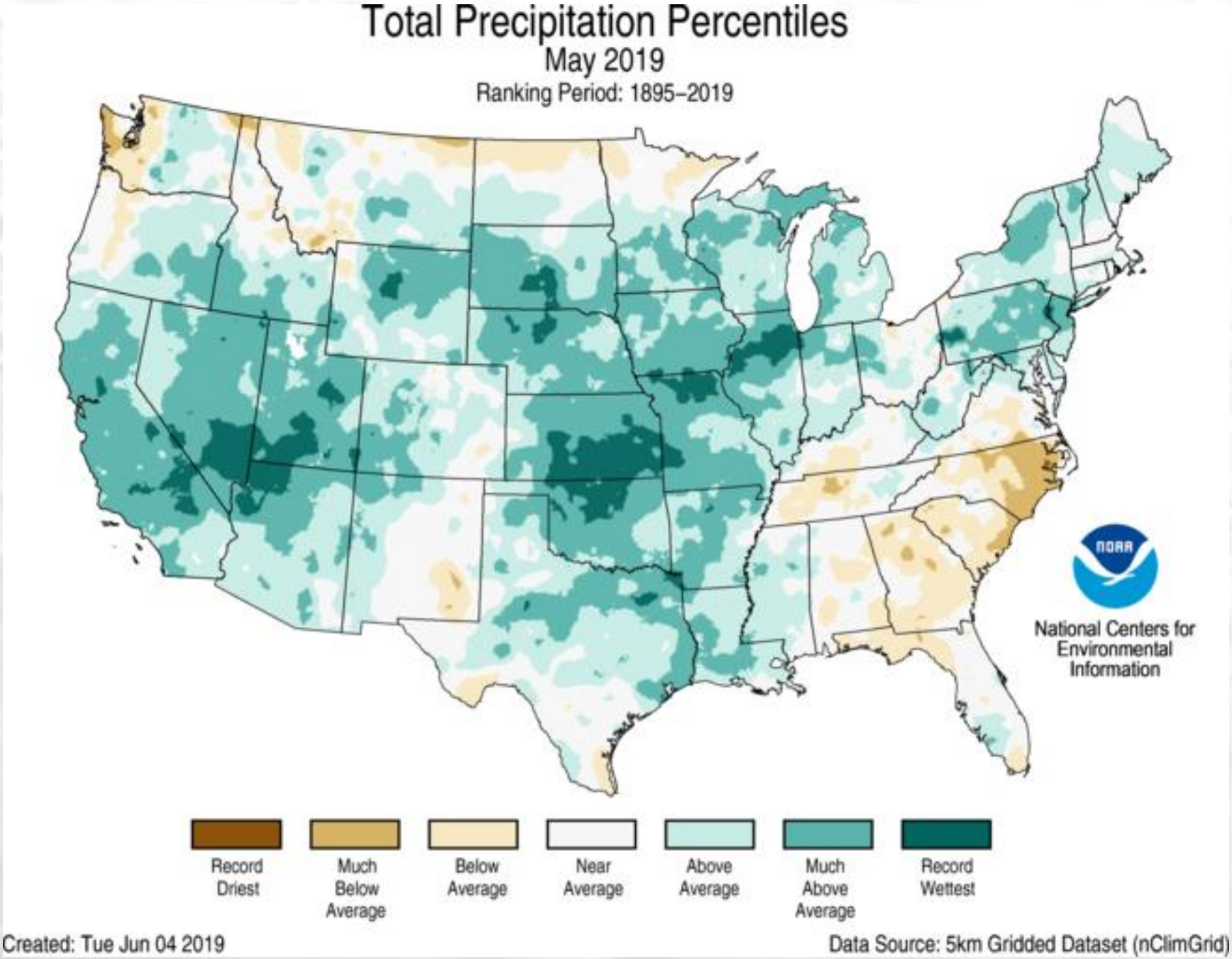


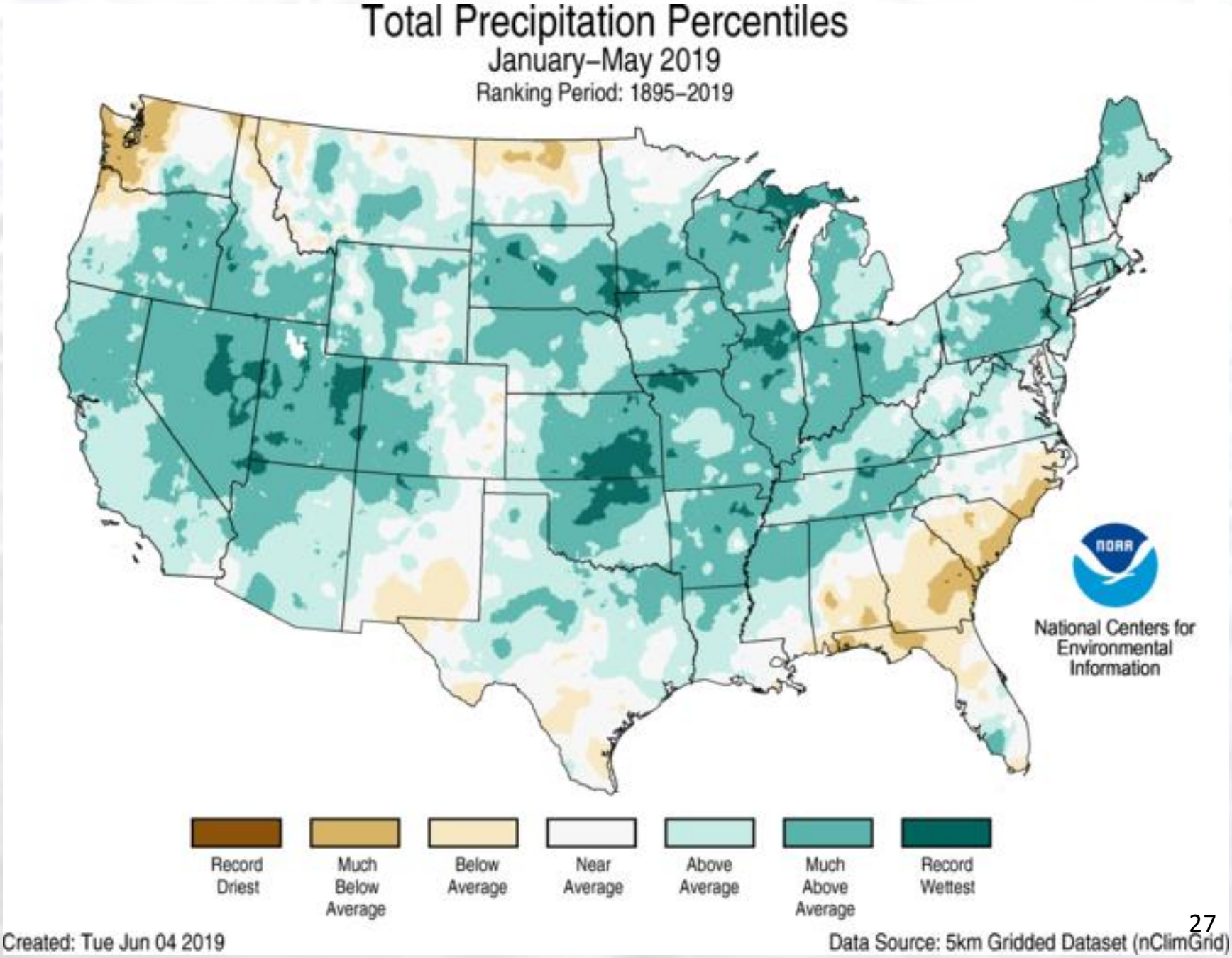
"Water flows downhill"

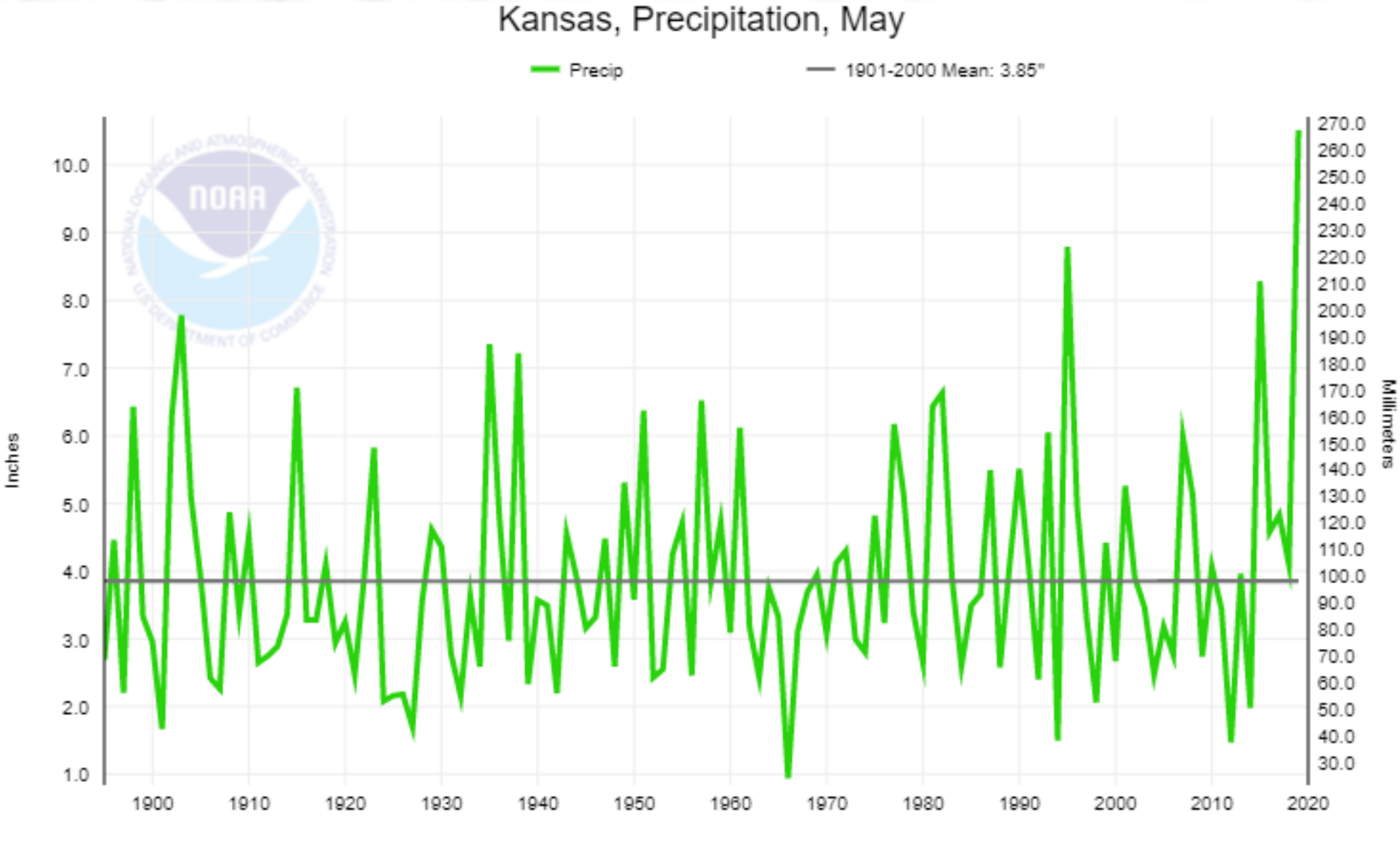
Real-time Flood Mapping in Kansas

May 2019

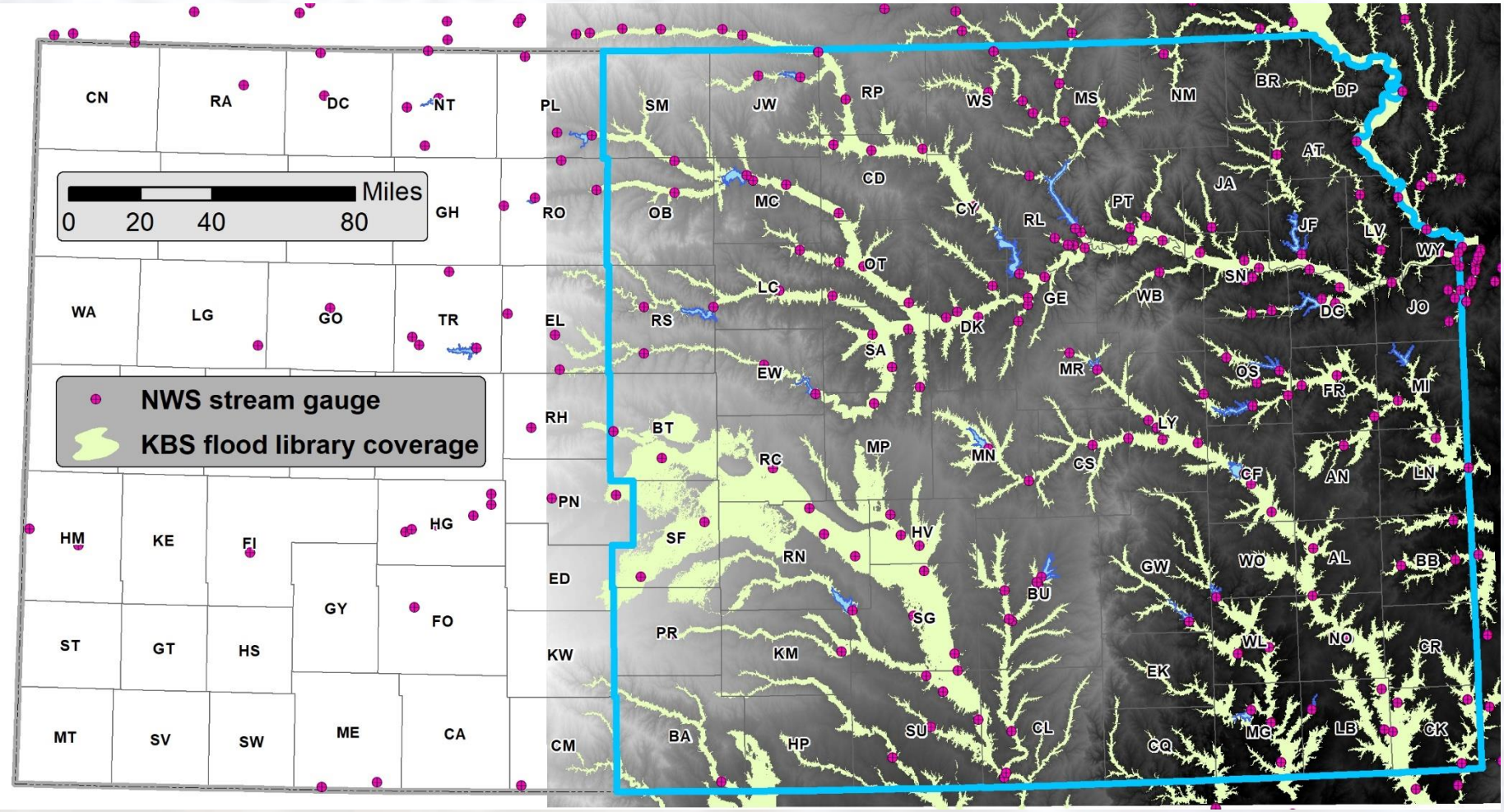
- **May 2019 was the second wettest month on record for the conterminous U.S. in 125 years (for May and for all months)**
- **With an average of 10.26” received statewide, May 2019 was the wettest month ever for Kansas (previously June 1951)**


Total Precipitation Percentiles
May 2019
Ranking Period: 1895–2019
National Centers for Environmental Information
Record Driest
Much Below Average
Below Average
Near Average
Above Average
Much Above Average
Record Wettest
Created: Tue Jun 04 2019
Data Source: 5km Gridded Dataset (nClimGrid)

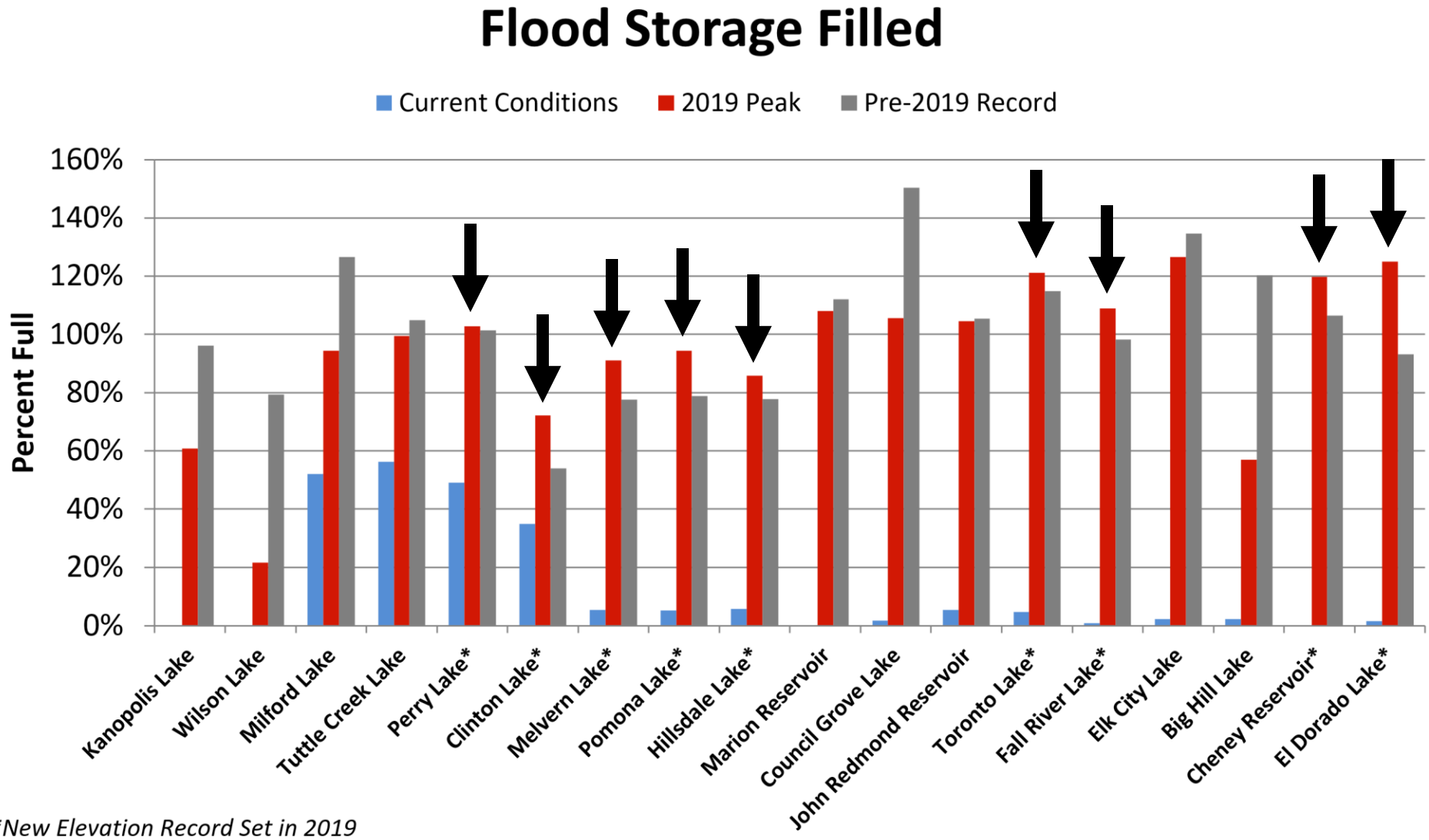

Total Precipitation Percentiles
January–May 2019
Ranking Period: 1895–2019
National Centers for Environmental Information
Record Driest
Much Below Average
Below Average
Near Average
Above Average
Much Above Average
Record Wettest
Created: Tue Jun 04 2019
Data Source: 5km Gridded Dataset (nClimGrid)


Kansas, Precipitation, May
Precip
1901-2000 Mean: 3.85"
Inches
Millimeters
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
270.0
260.0
250.0
240.0
230.0
220.0
210.0
200.0
190.0
180.0
170.0
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020

Kansas Inundation Library Coverage



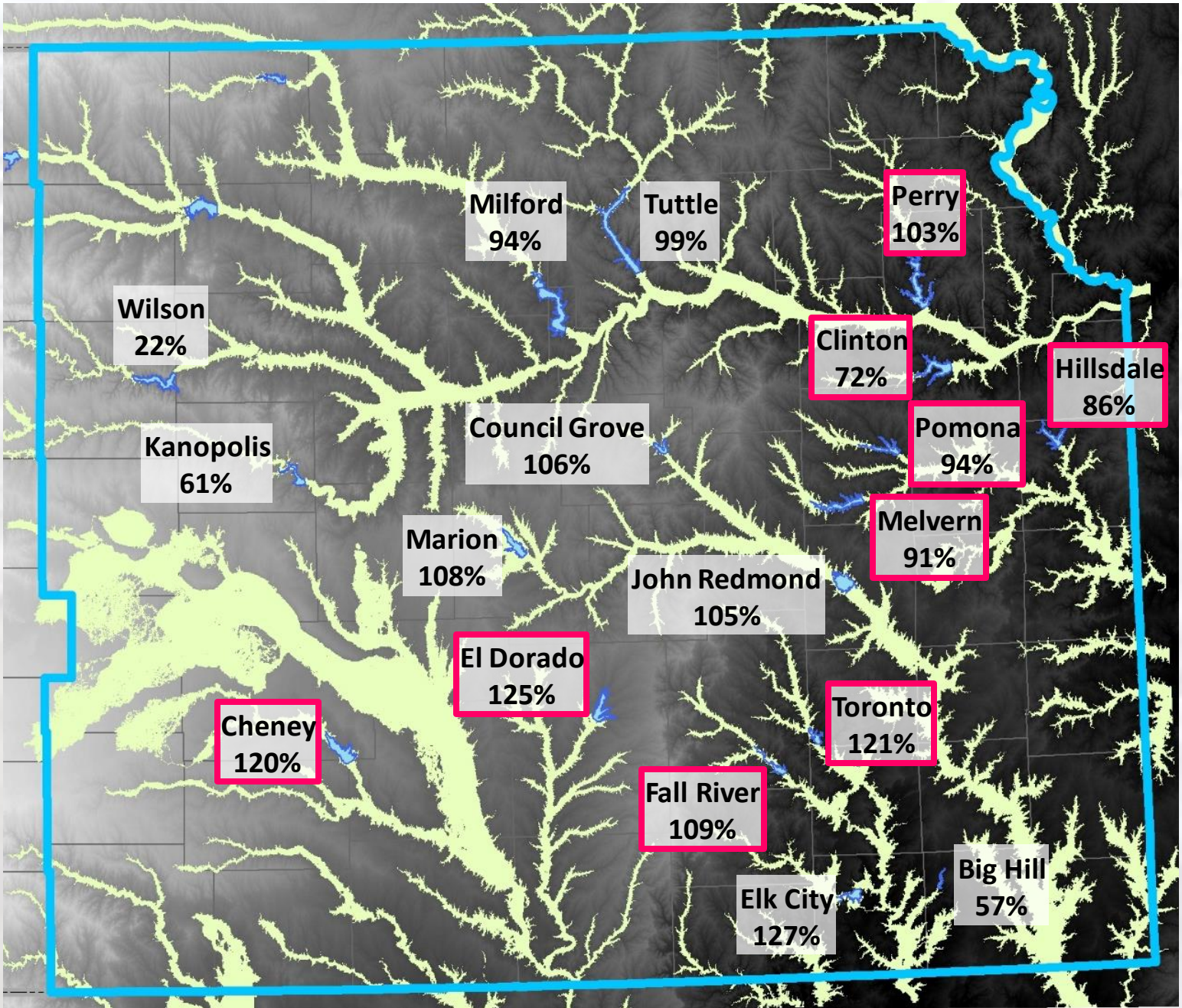
Meanwhile…



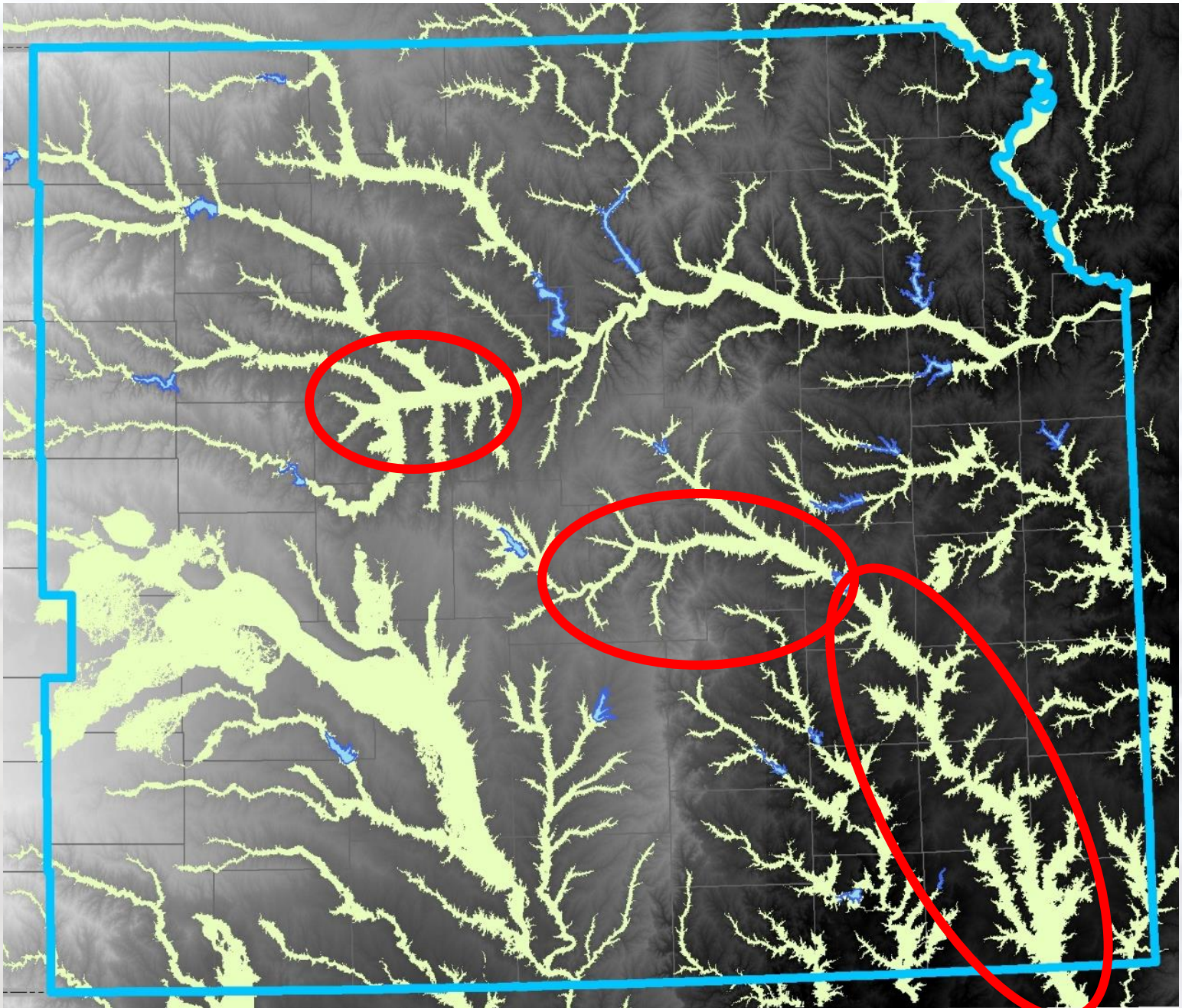
**New Elevation Record Set in 2019*

Source: Kansas Water Office (Chris Shultz)

2019 Flood Storage Max



May 2019 Flood Map Areas



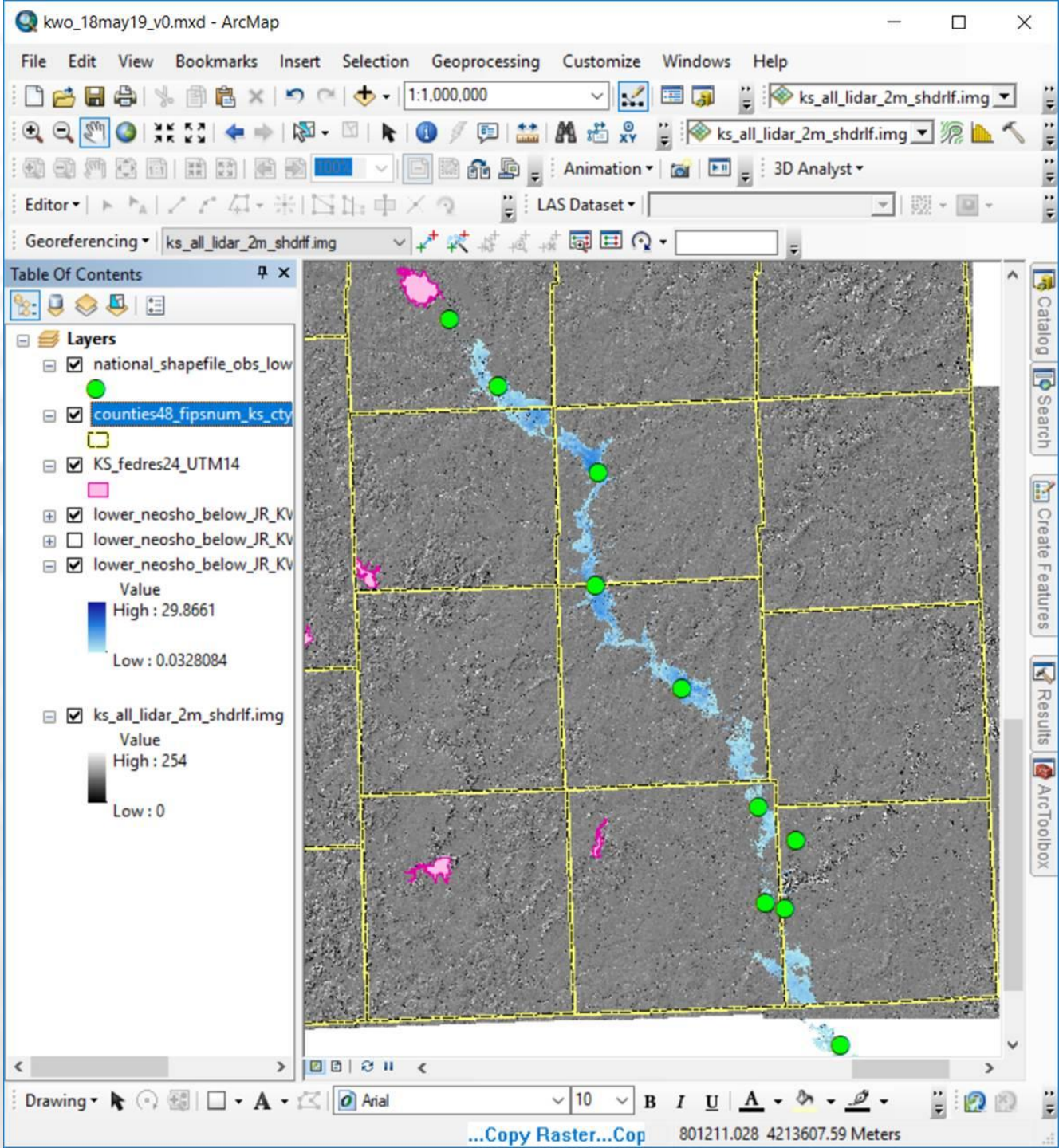
Timeline

<u>May 16:</u> Following GIS-PB meeting, Earl Lewis & Nate Westrup (KWO) corral Kastens (KBS) to discuss the dire precipitation forecast. John Redmond release already on the radar.

<u>May 17:</u> Chris Shultz (KWO) begins compiling stage forecasts for NWS gages along the lower Neosho.

<u>May 18:</u> First flood map delivered to KWO & KDEM for the lower Neosho

First map, Lower Neosho (5/18)



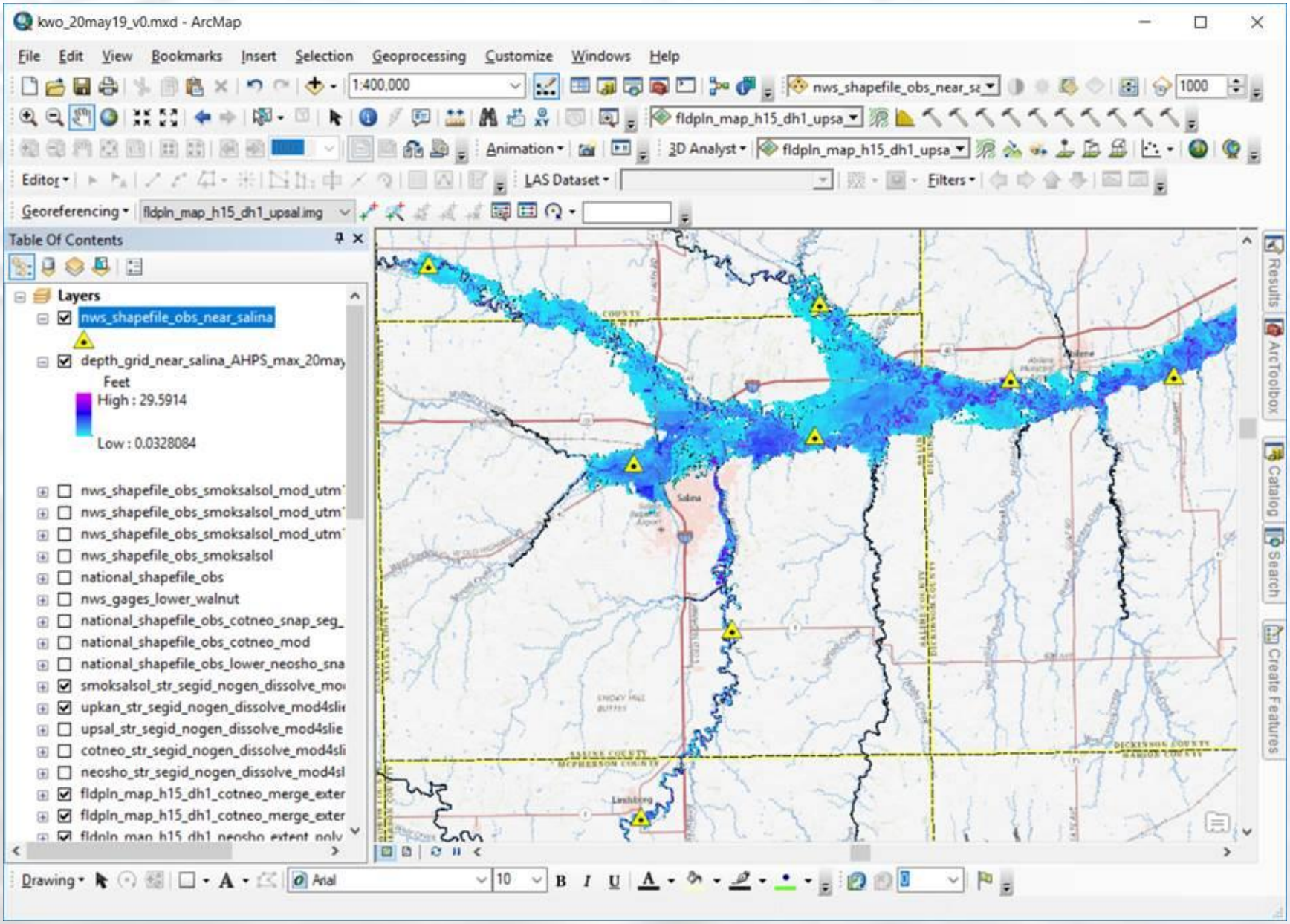
Timeline

<u>May 19:</u> At the behest of KDEM, focus is switched to the Salina area *(Saline, Mulberry, Solomon, Smoky Hill)*

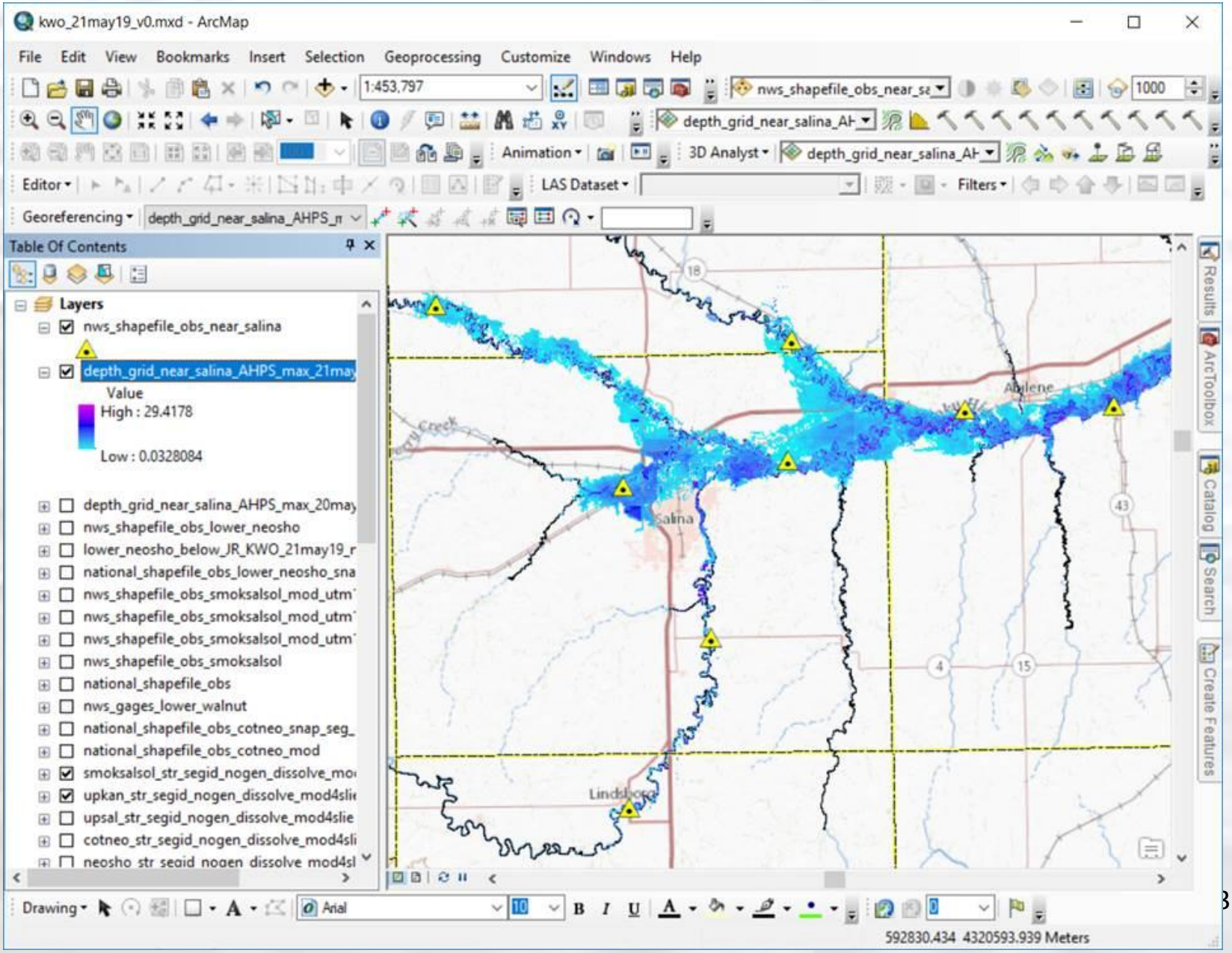
<u>May 20:</u> First flood map delivered to KWO & KDEM for the Salina area

<u>May 21:</u> Working closely with Shultz (KWO) & Luke Finley (KDEM), map updates continue for the lower Neosho & the Salina area

First map, Salina area (5/20)



Map update, Salina area (5/21)



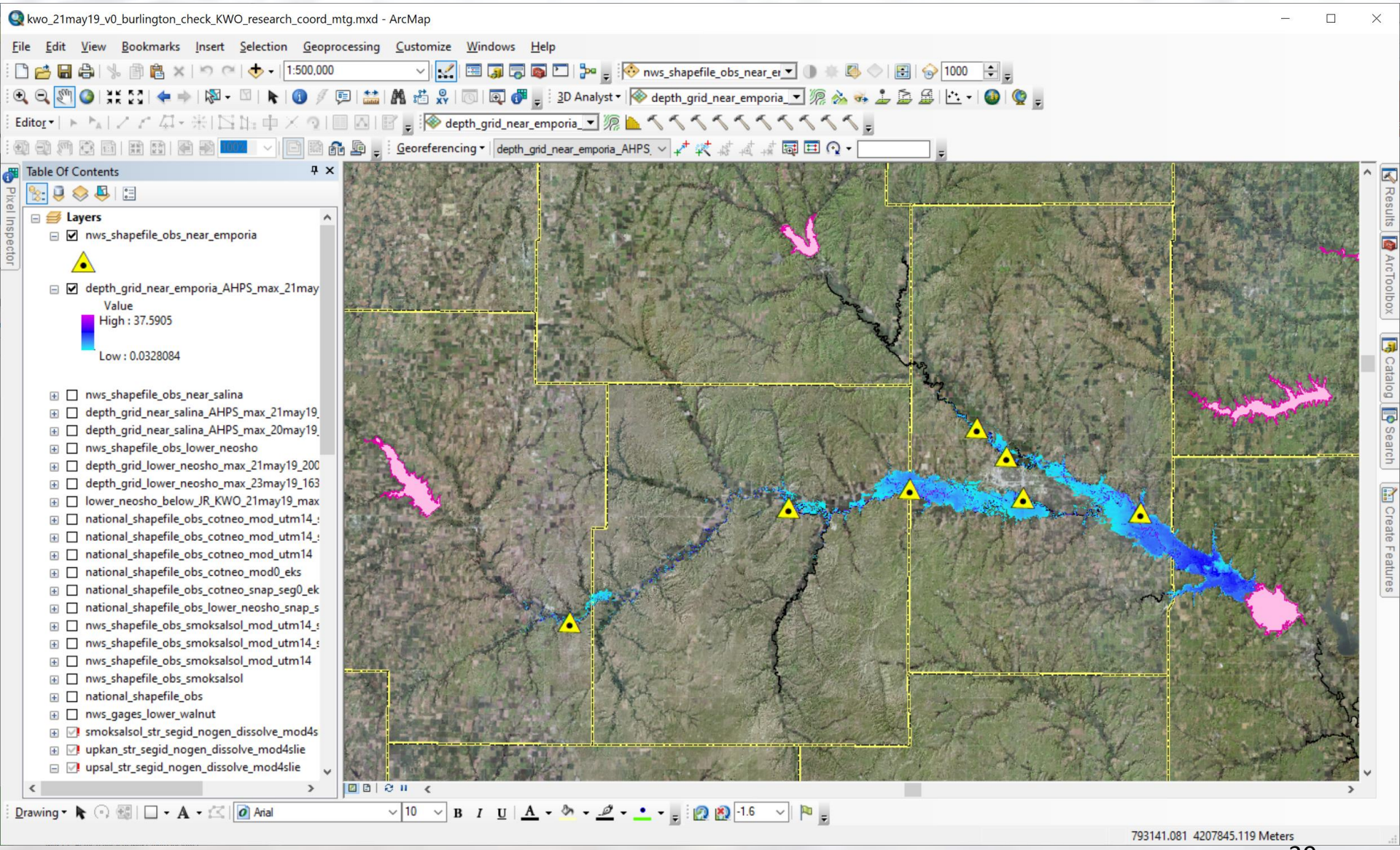
Timeline

<u>May 21:</u> First flood map delivered for the Cottonwood-Upper Neosho (around Emporia). Marion & Council Grove Reservoirs almost out of storage.

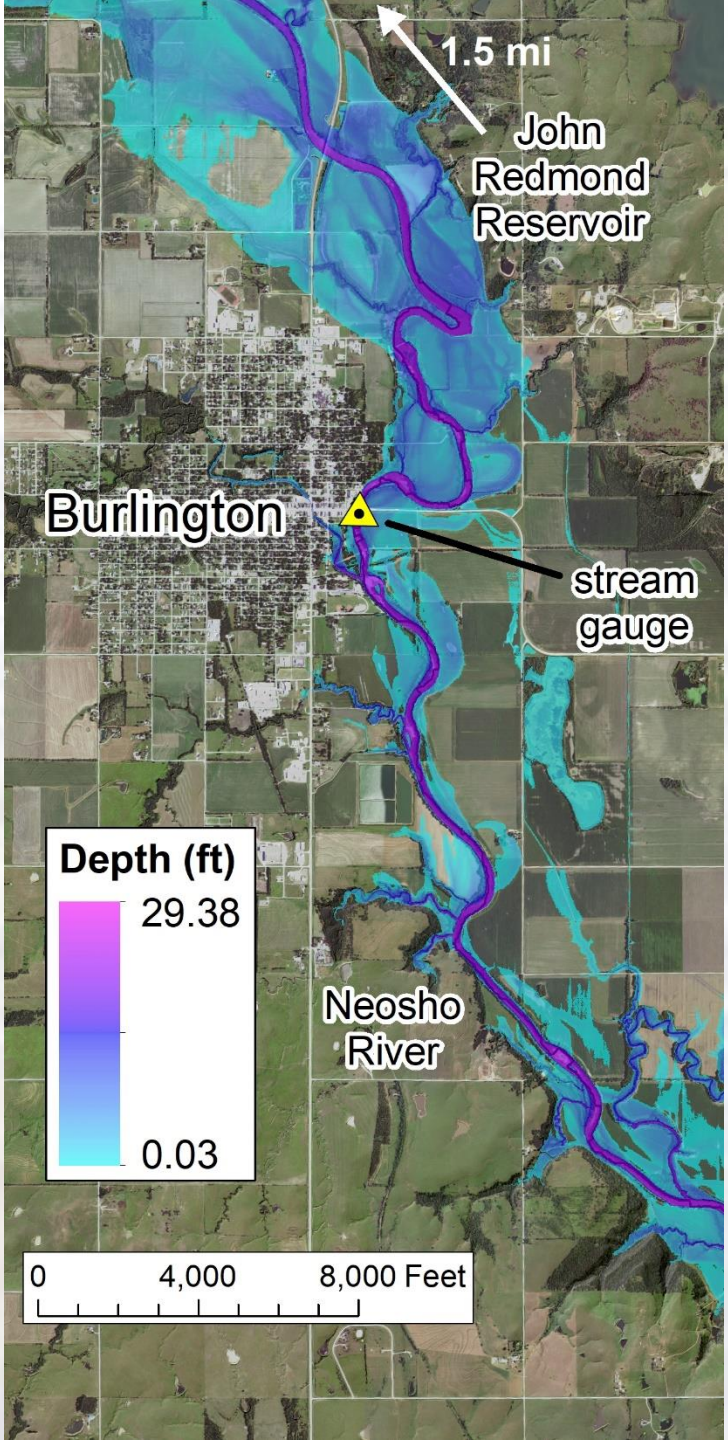
<u>May 21:</u> Cara Mays (Coffey County) contacts KDEM & KBS regarding pending massive release from John Redmond on top of existing flood conditions. KWO looped in & Shultz starts pulling release information.

<u>May 21:</u> Maps updated for lower Neosho, including released floodwater from John Redmond

First map, Emporia area (5/21)



Map update for Lower Neosho around Burlington, including planned release from John Redmond (5/22)



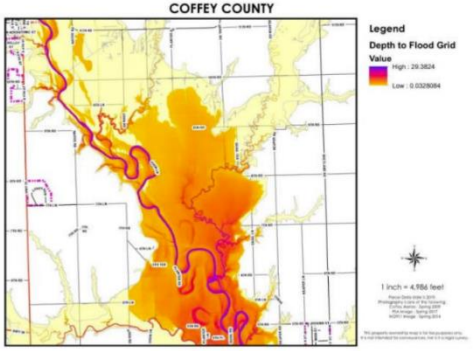
Emergency Notifications | Coffey

https://www.coffeycountyks.org/county-services/emergency-management/emergency-notificatio

UPDATE FOR MAY 22, 2019

The US Army Corps of Engineers opened the gates at John Redmond Reservoir in Coffey County, Kansas at approximately 8:00 am this morning to increase the release of water to approximately 26,000 cubic feet per second (cfs). This release will be maintained at this time. The increase in the release of water throughout the next few days will cause flood prone areas to fill up and become impassable in and around Burlington, KS, LeRoy, KS and Neosho Falls, KS. Local/County Officials are strongly advising anyone in flood prone areas to consider leaving your home and take important belongings with you. The Red Cross has opened a shelter in Iola at the Allen County Community College Red Barn at 1801 N. Cottonwood, Iola, KS for residents needing somewhere to go. The included maps represent the potentially affected areas. The lines could change depending on additional rainfall that could occur over the next several days. If you choose to leave your home, for those living in Coffey County, please contact the Coffey County Sheriff's Office at 620-364-2123 or those living in Woodson County, please contact the Woodson County Sheriff's Office 620-625-8640, in order to keep a proper accounting of those who have evacuated and those who have not. For a list of local road closures or detours, please visit or the Coffey County Emergency Management's Facebook page for updates. For state highways go to http://www.kandrive.org. For further information please stay tuned to 97.7FM DAWG, 580am WIBW, 1400am KVOE, Coffey County Emergency Management Facebook page or the Coffey County Emergency Management website at www.coffeycountyks.org/county-services/emergency-management/emergency-notifications

COFFEY COUNTY



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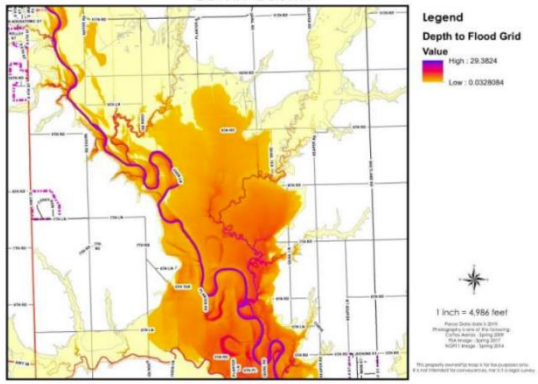
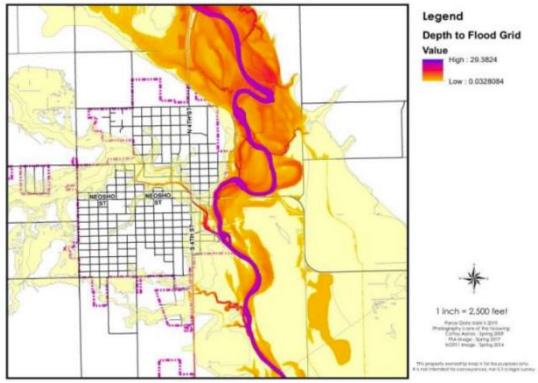
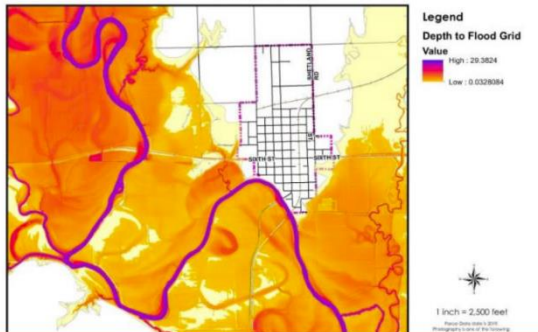
COFFEY COUNTY



CITY OF BURLINGTON



CITY OF LEROY



Timeline

<u>May 23:</u> KDEM receives requests for flood maps along the Kansas River. Upon further discussion between Mike D'Attilio (KDEM) and Kastens, it is decided that river levels are expected to remain low enough to stick with FEMA 100-yr maps as worst case (no sense potentially raising undo alarm).

<u>May 23:</u> At the request of Mays, maps for lower Neosho are updated to accommodate a possibly higher release volume coming out of John Redmond

Timeline

<u>May 25:</u> Worst is mostly behind, so Kastens makes like Homer…

Parting Thoughts

- **Other areas could have been mapped** (e.g. Walnut, Verdigris, Marais des Cygnes…)
- **More comparisons against imagery and ground info are needed for evaluation.** So far, feedback has generally been positive.
- **Flood mapping automation is both possible and needed.** Discussions with KWO & KDEM are underway to make this happen.

Parting Thoughts

- **Map accuracy can be improved** with better handling of data around confluences (e.g. Mulberry Creek caused flooding around Salina to be over-estimated)
- **Map accuracy can be improved** by using existing hydraulic models to guide interpolation between gages (previously established, just need to implement).
- **DREAMING BIG:** Kansas Water Information Center (KWIC or WICK), sort of modeled after the Iowa Flood Center… COMING SOON???

Thanks for Listening…

Any Questions?

jkastens@ku.edu