LiDAR and the Kansas Surface Water Landscape

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2017 Governor's Water Conference

Manhattan, KS | November 9, 2017

KANSAS BIOLOGICAL SURVEY

KARS
Kansas Applied Remote Sensing

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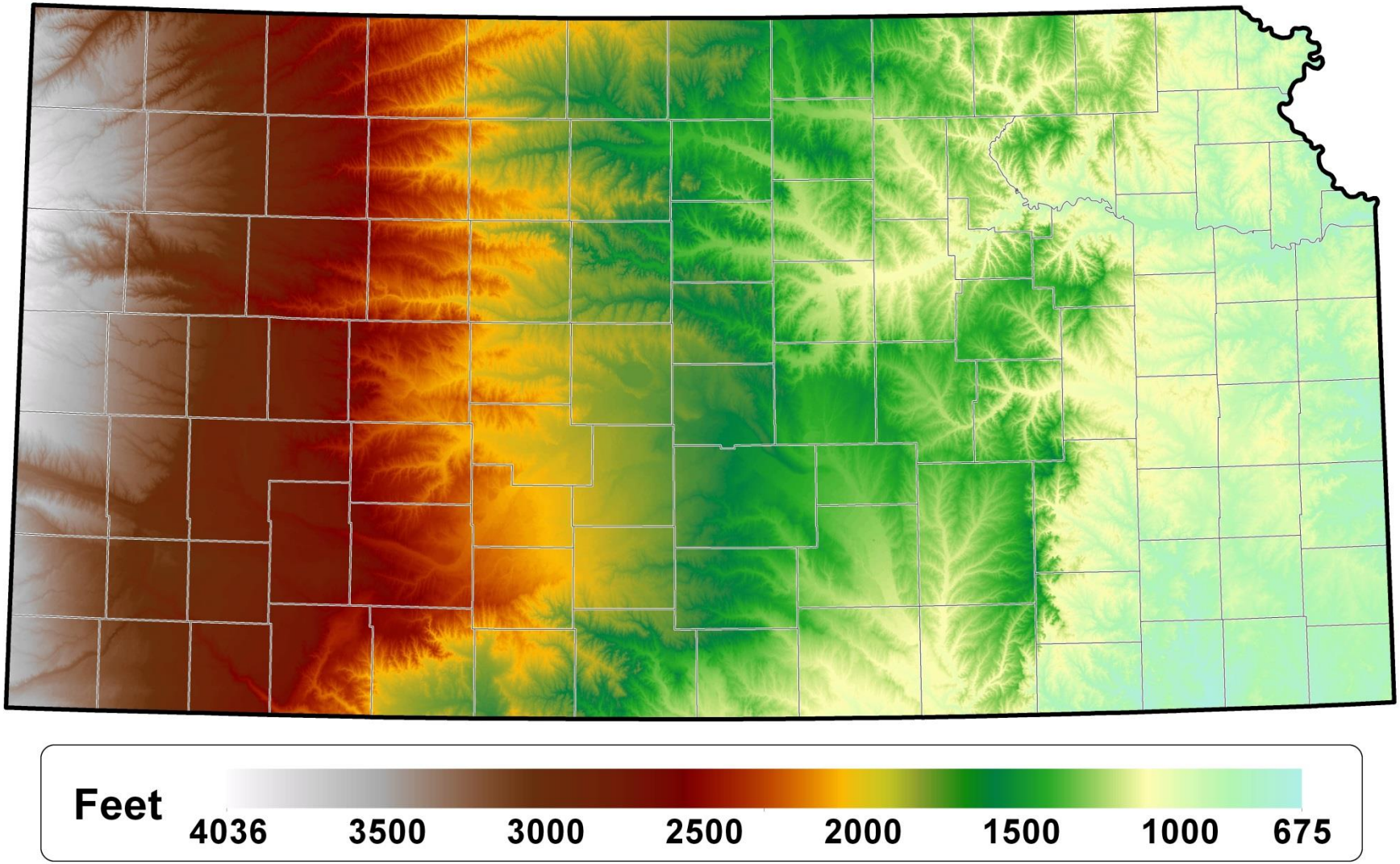
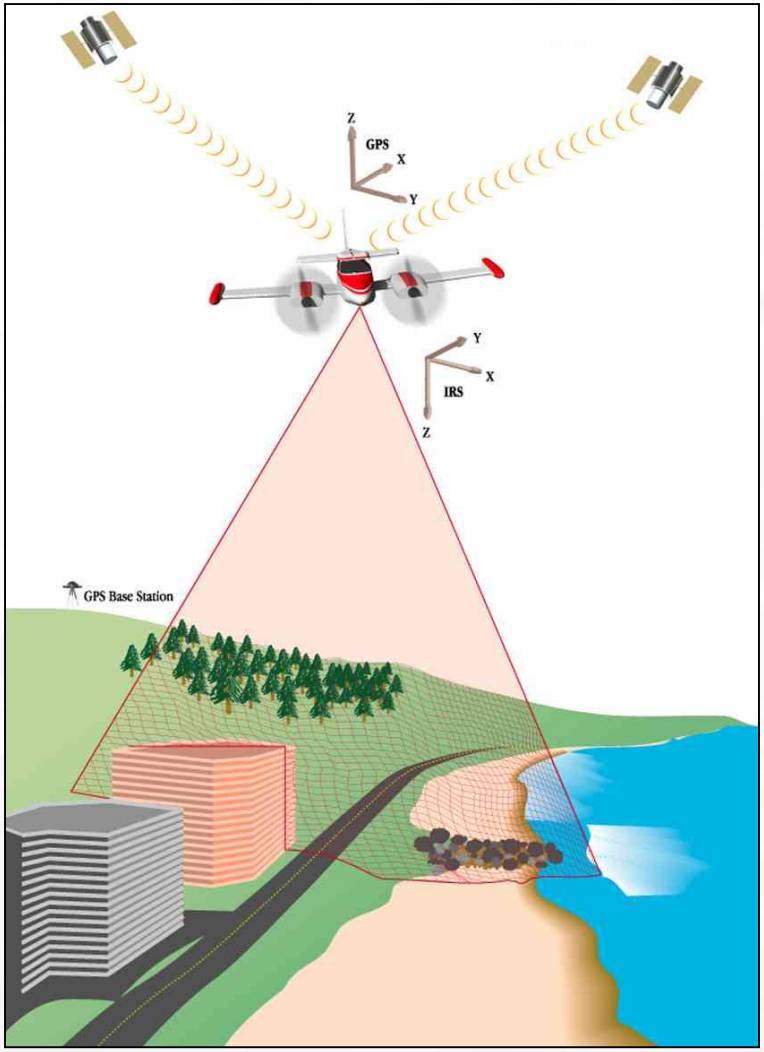
Elevation



How LiDAR Works (LiDAR = Light Detection And Ranging)

- Scanner emits intense, discrete pulses or beams of laser light.
- Measures time for reflections to be detected by the sensor, allowing for **calculation of distance to objects**.
- GPS and IMU provides very accurate position and orientation of the sensor, allowing for **calculation of XYZ coordinates of the reflecting surface**.



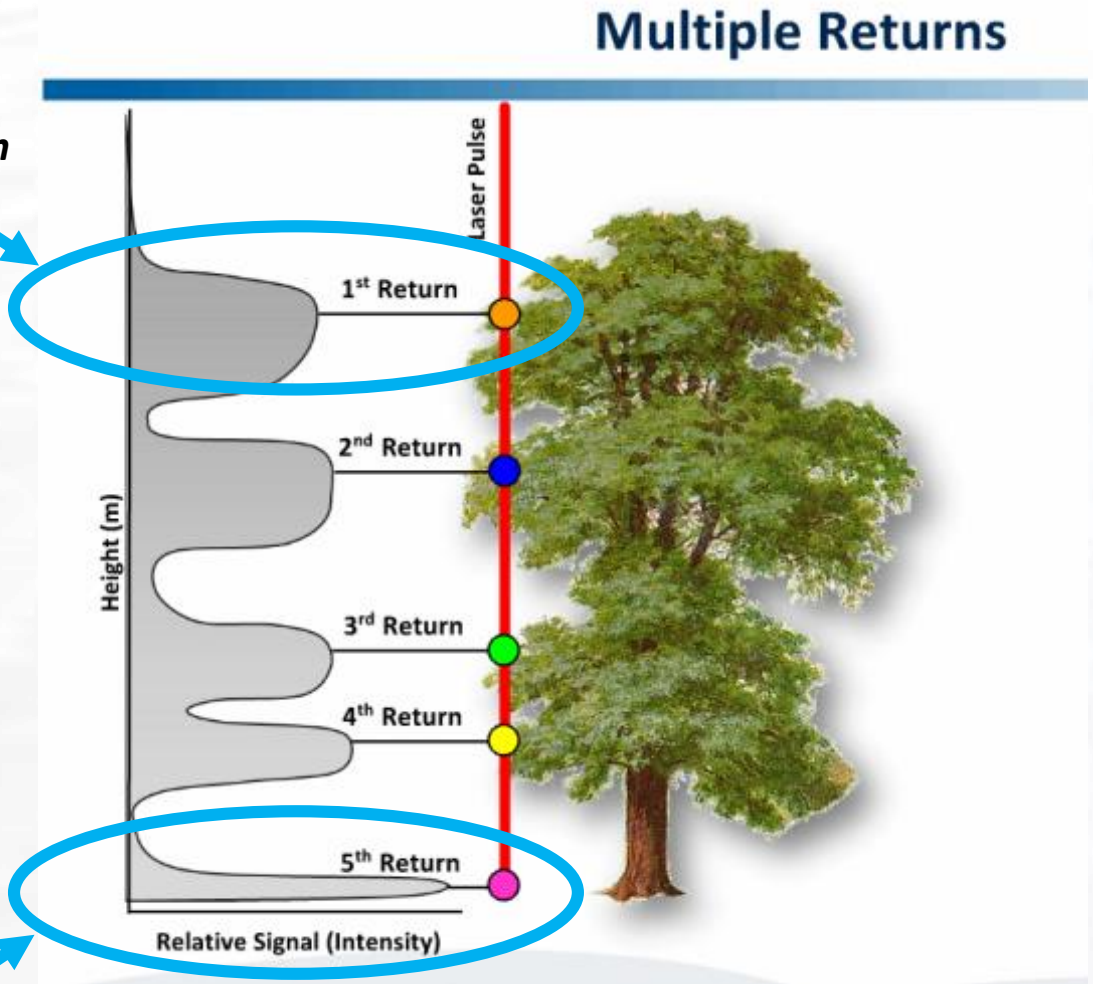
How LiDAR Works

("Full Waveform" is shown)

"First" return

- used for top-of-surface representation
- DSM (digital surface model)

A pulse hits the first reflective surface and the remaining energy in the laser continues to the second reflective surface, and so on, until it <u>reaches the ground or runs out of power</u>.

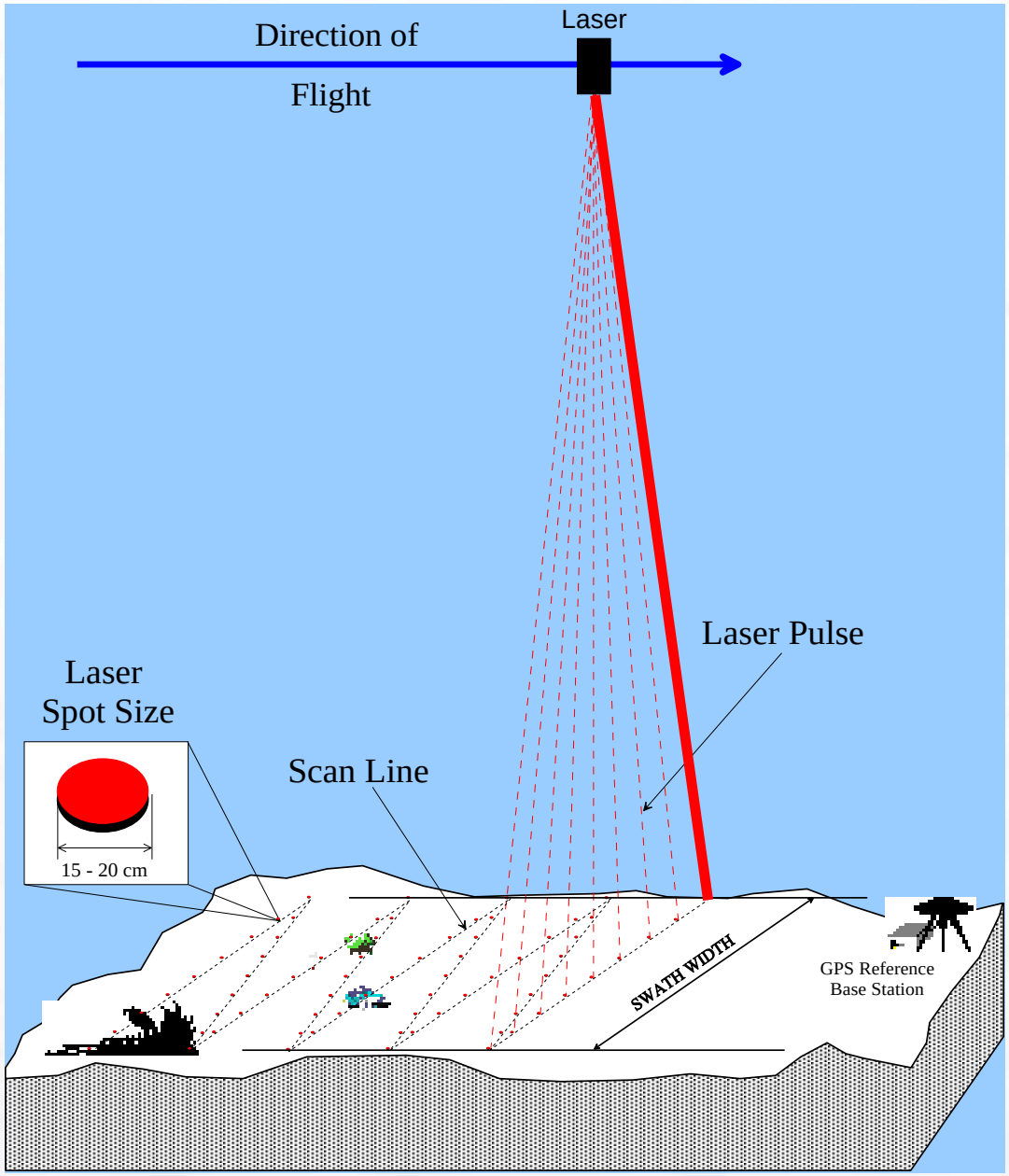


"Last" return

- used for ground ("bare earth") representation
- DEM (digital elevation model) = DTM (digital terrain model)

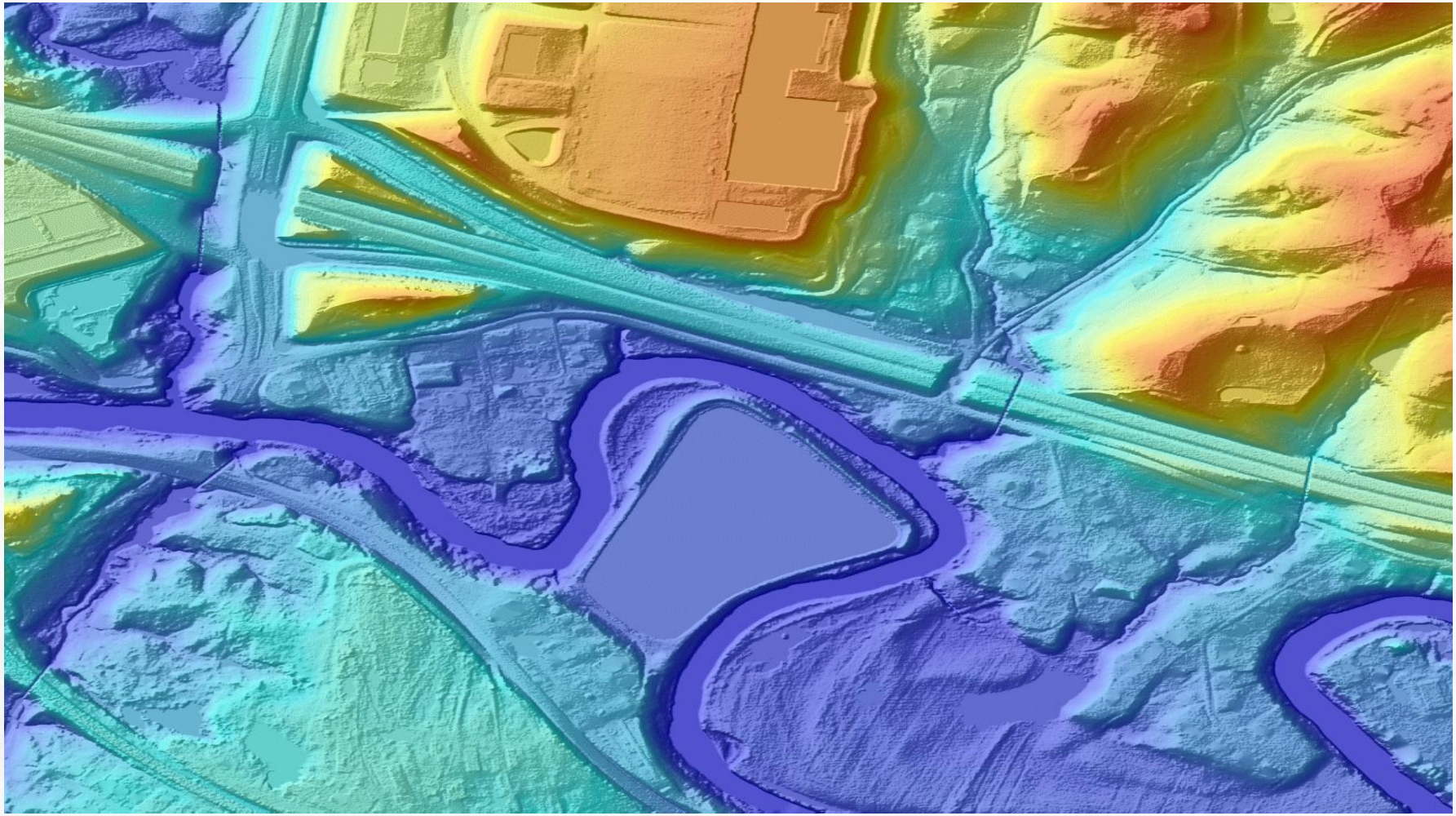
How LiDAR Works

- A scanner laterally sweeps a laser pulse back and forth across the target as the vehicle carrying the LiDAR instrument moves forward.



Ian Madin, DOGAMI

Active Comparison Slide (click the buttons below)

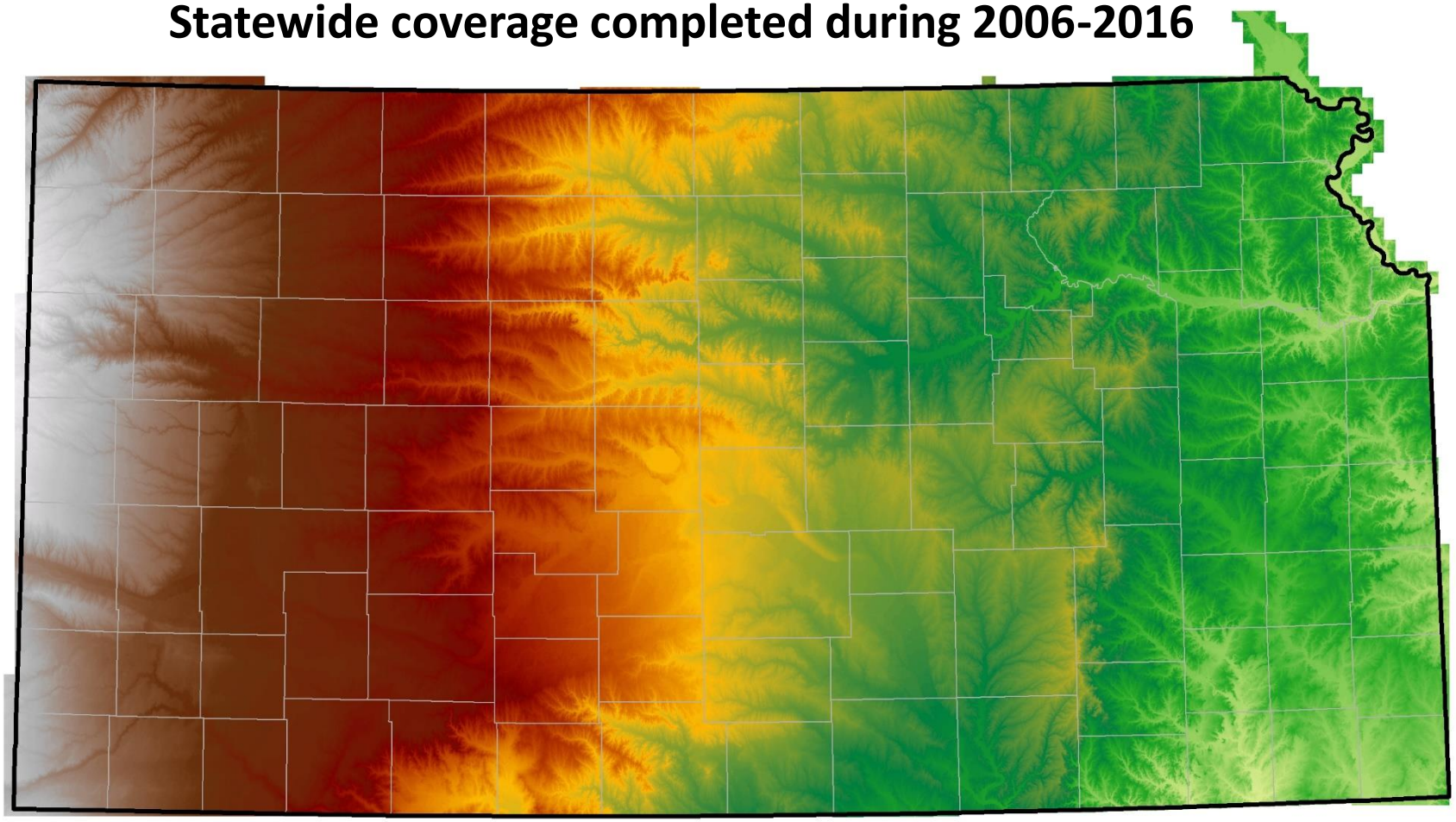


Stereo DTM	Pure Lidar	Hydro Flattened	Full Breaklines	Hydro Enforced	Hydro Conditioned

USGS

Kansas LiDAR

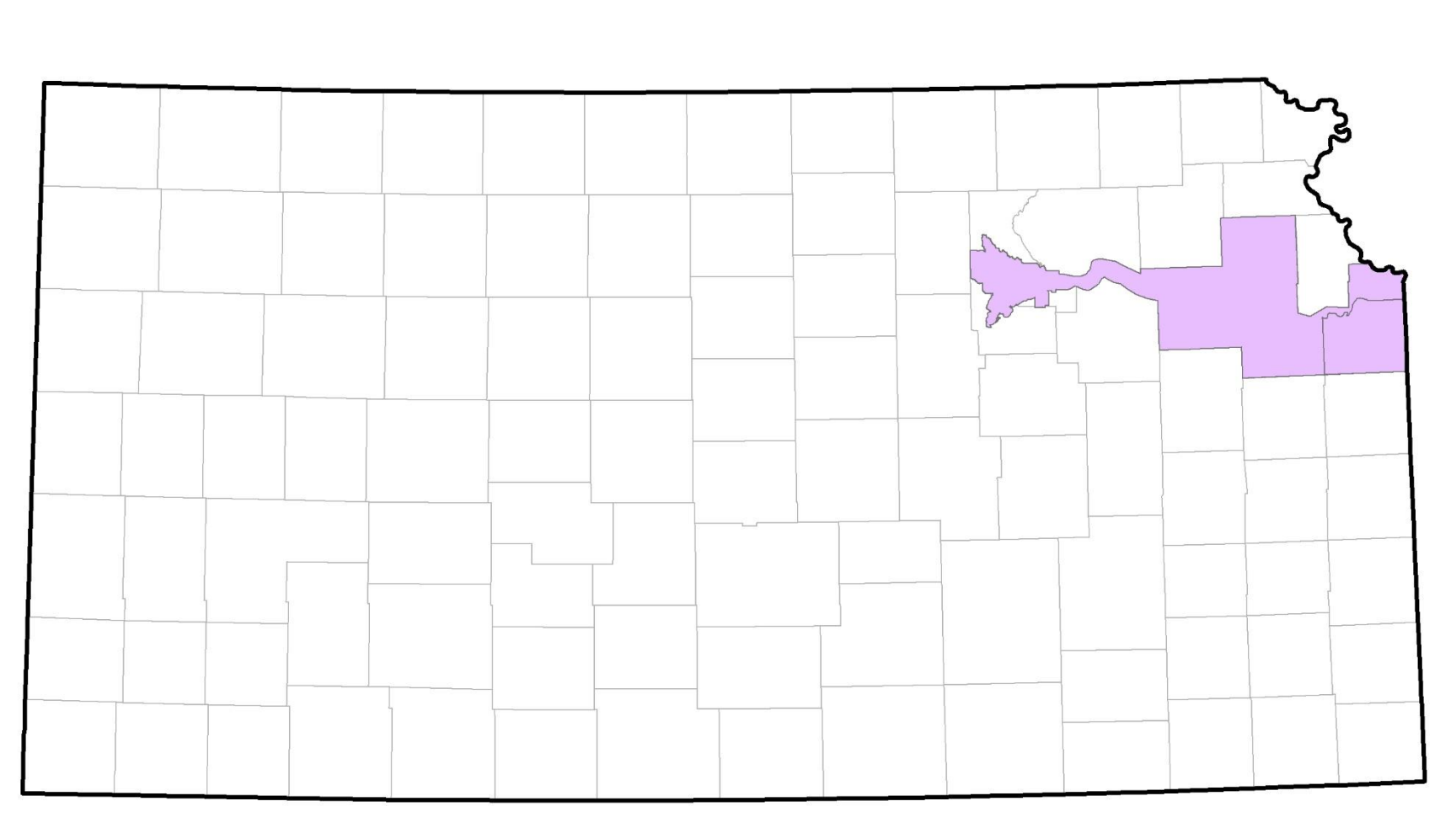
Statewide coverage completed during 2006-2016



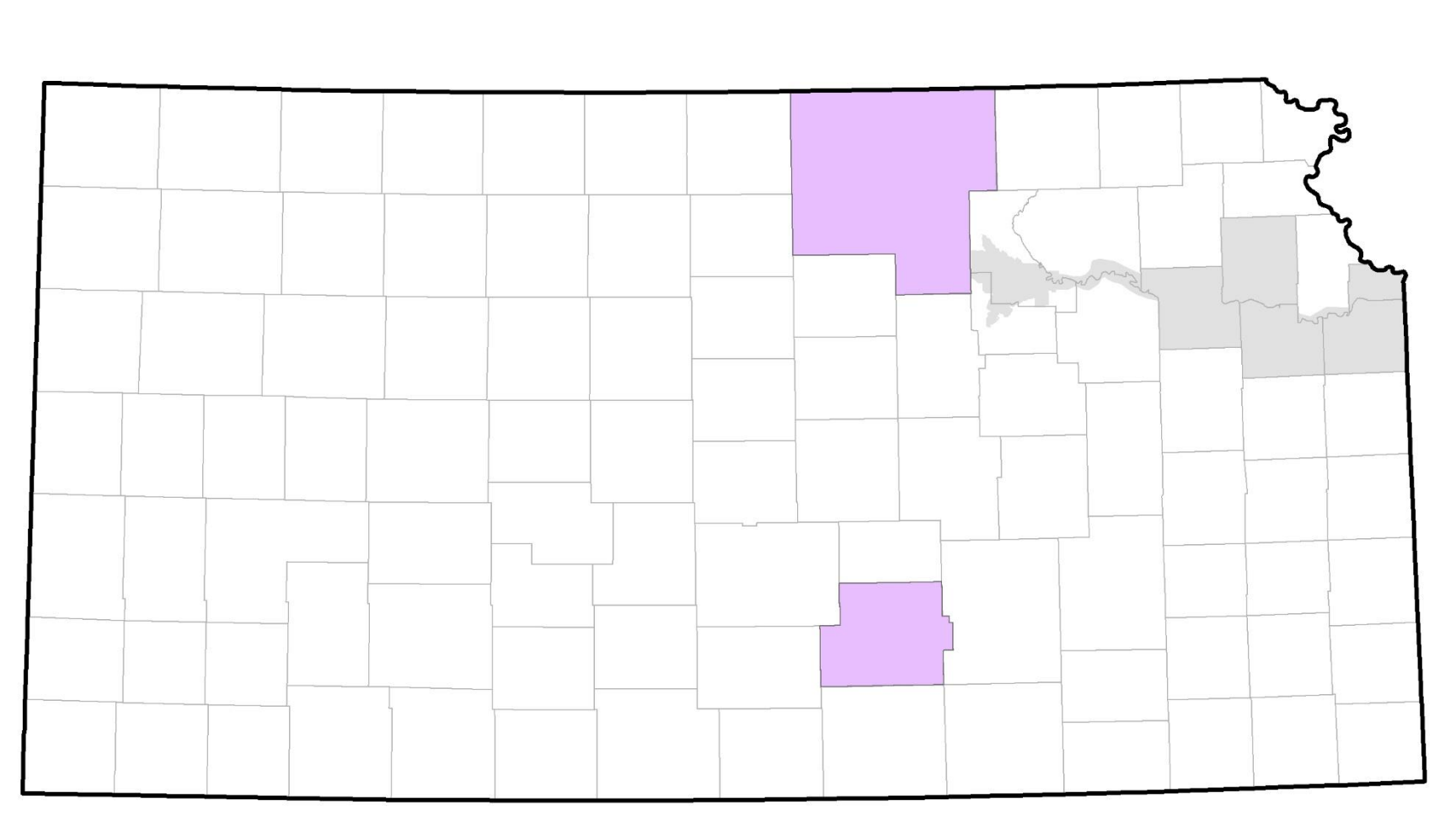
1-m spatial resolution

± 10 cm vertical accuracy (95% of the time)

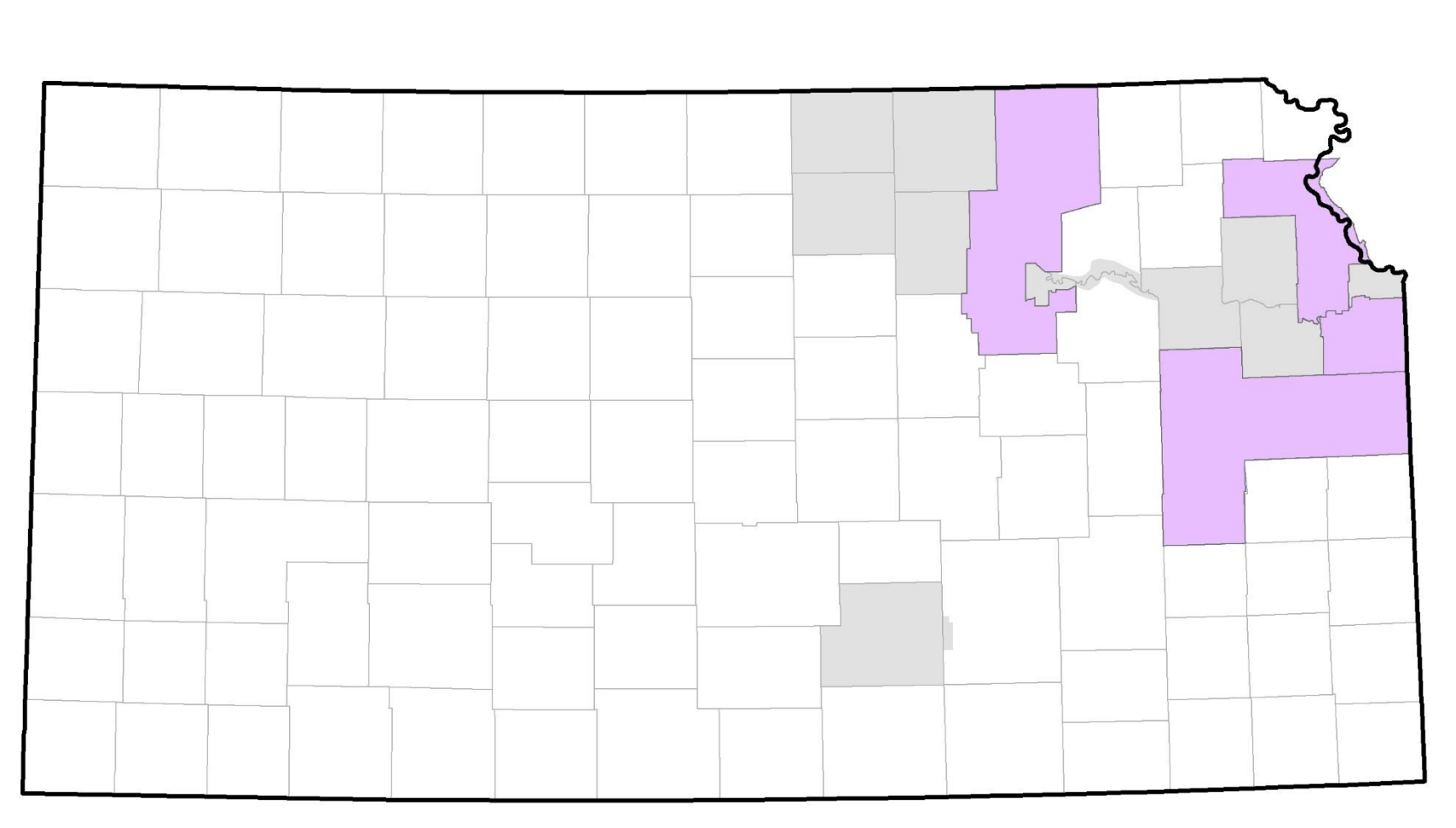
Kansas LiDAR – 2006



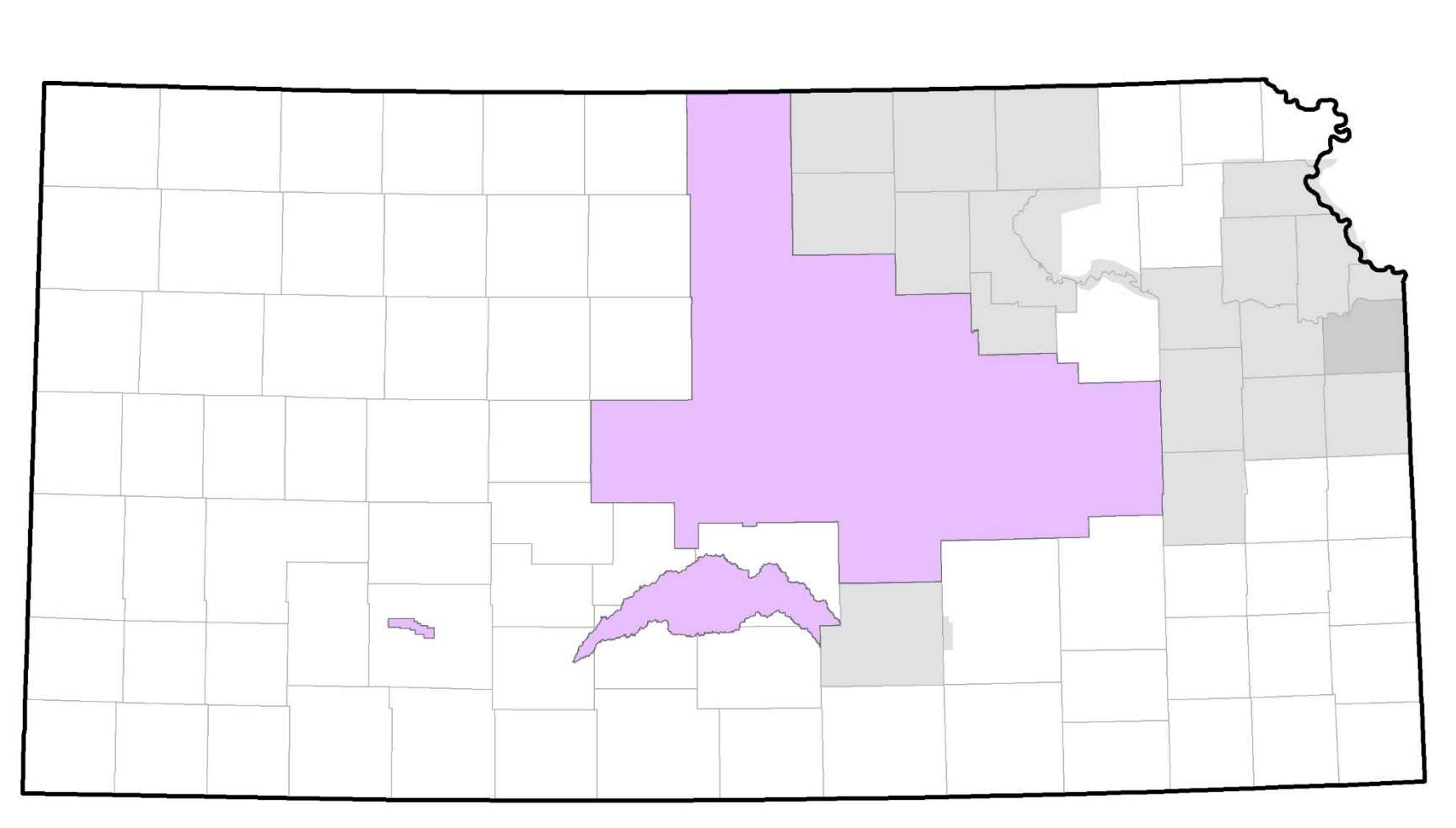
Kansas LiDAR – 2009



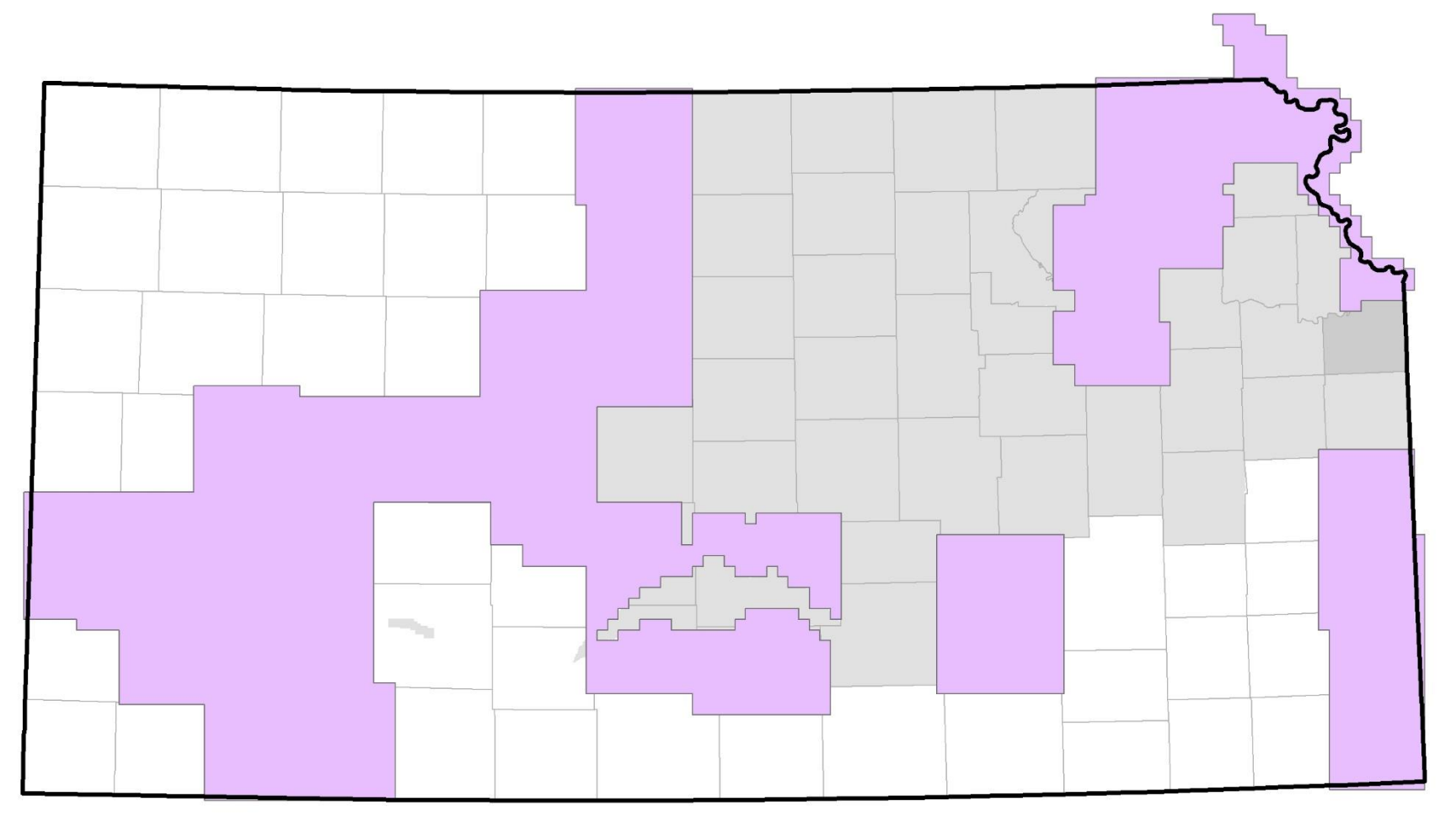
Kansas LiDAR – 2010



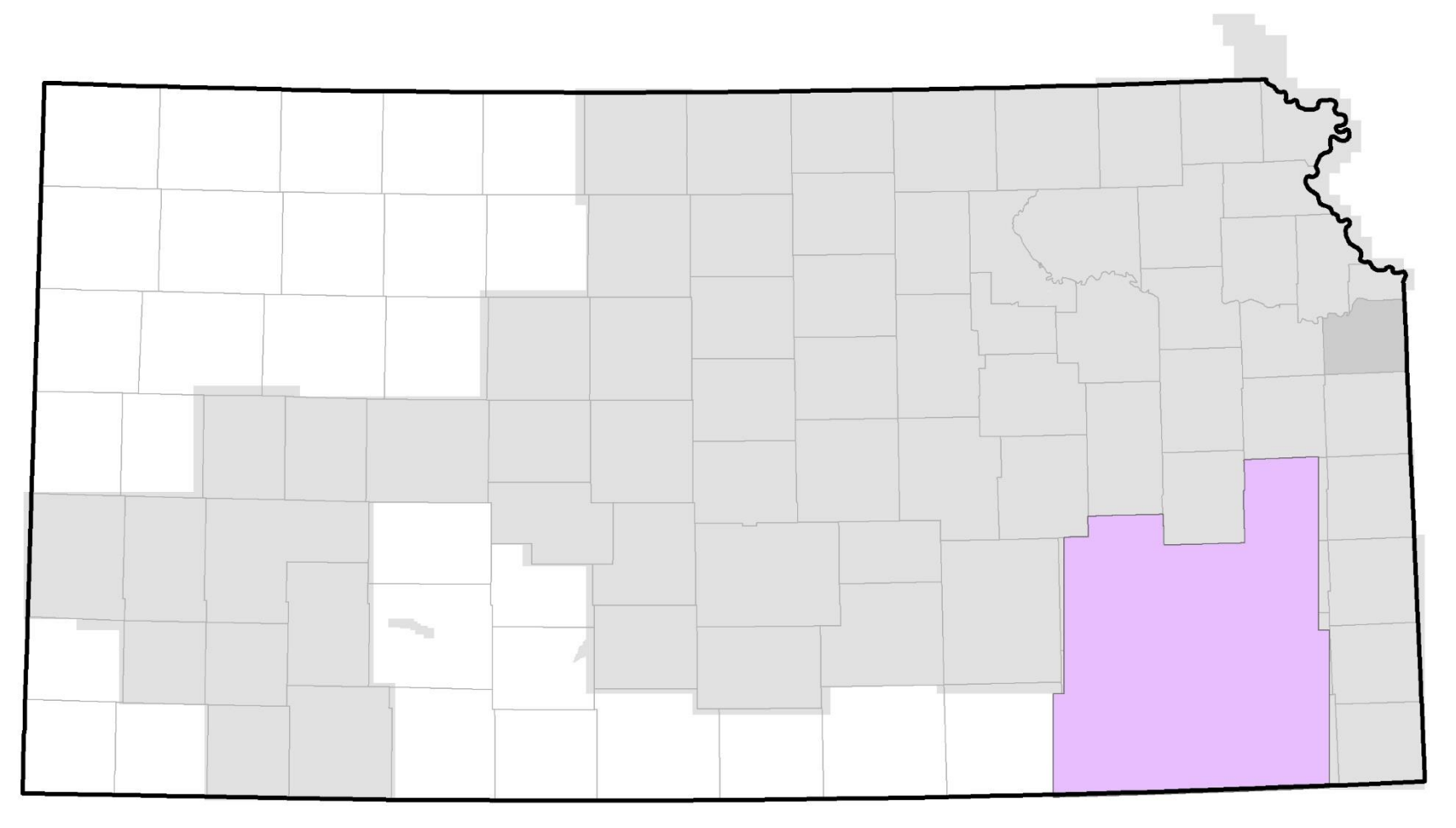
Kansas LiDAR – 2011



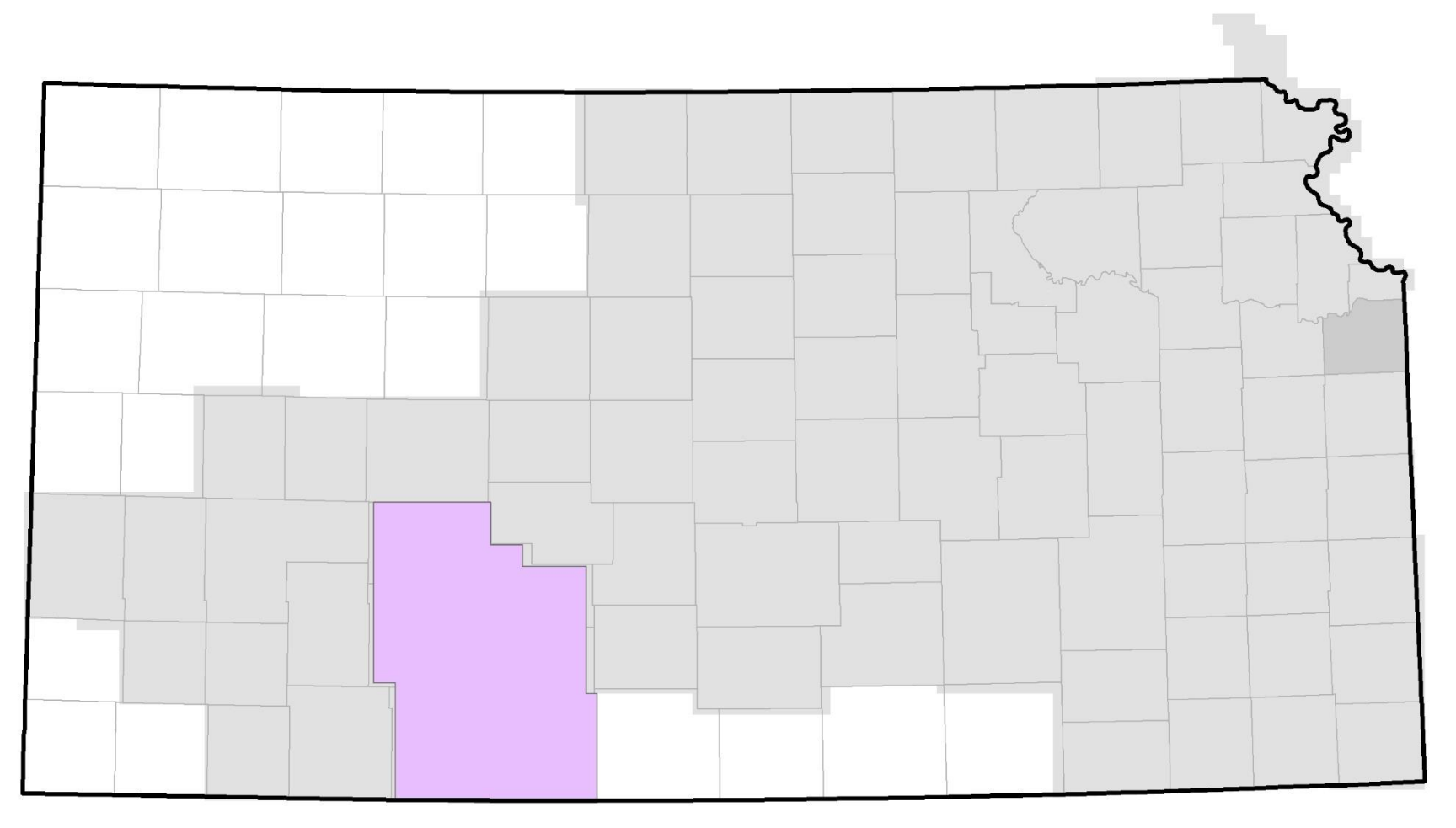
Kansas LiDAR – 2012



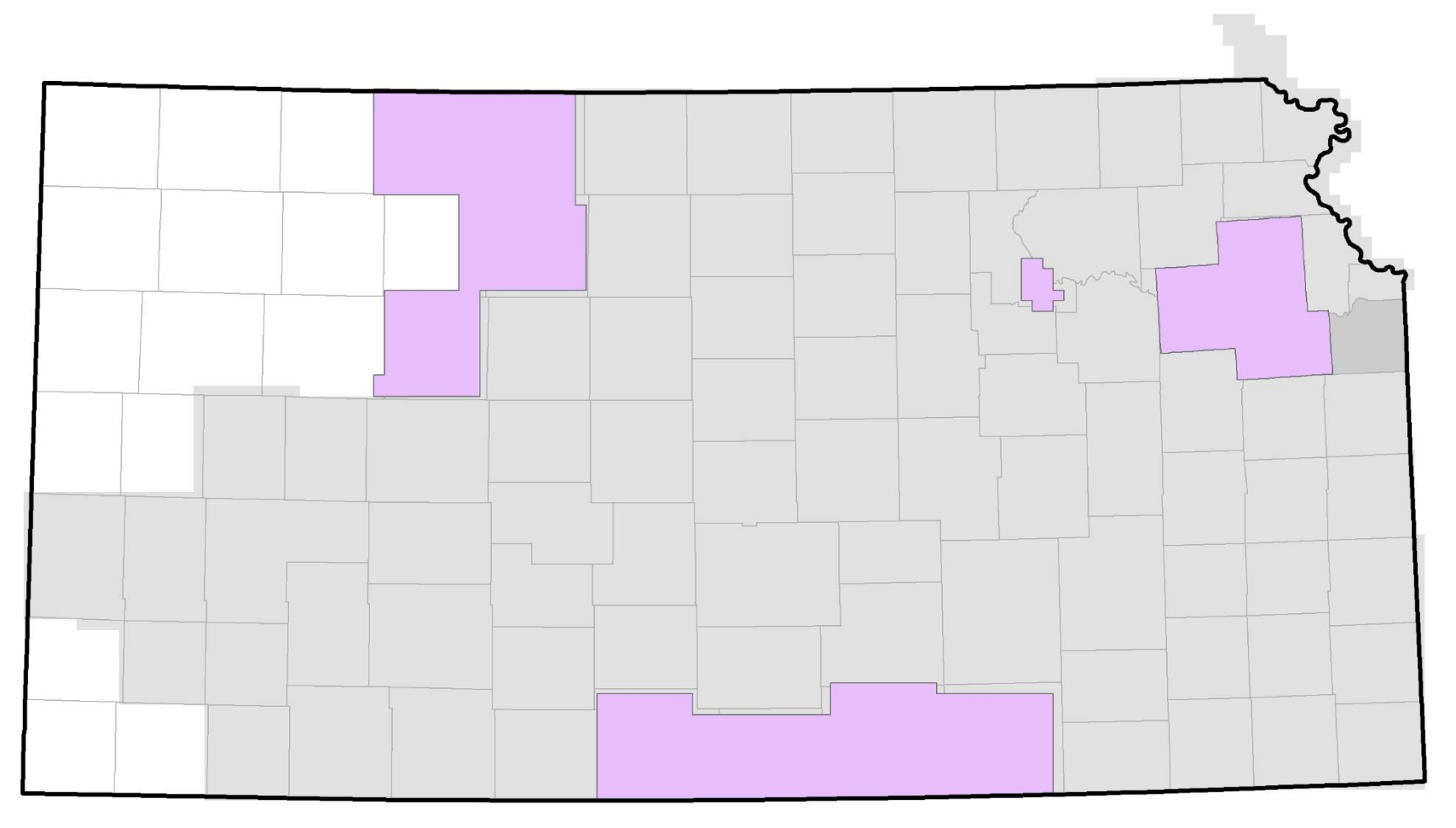
Kansas LiDAR – 2013



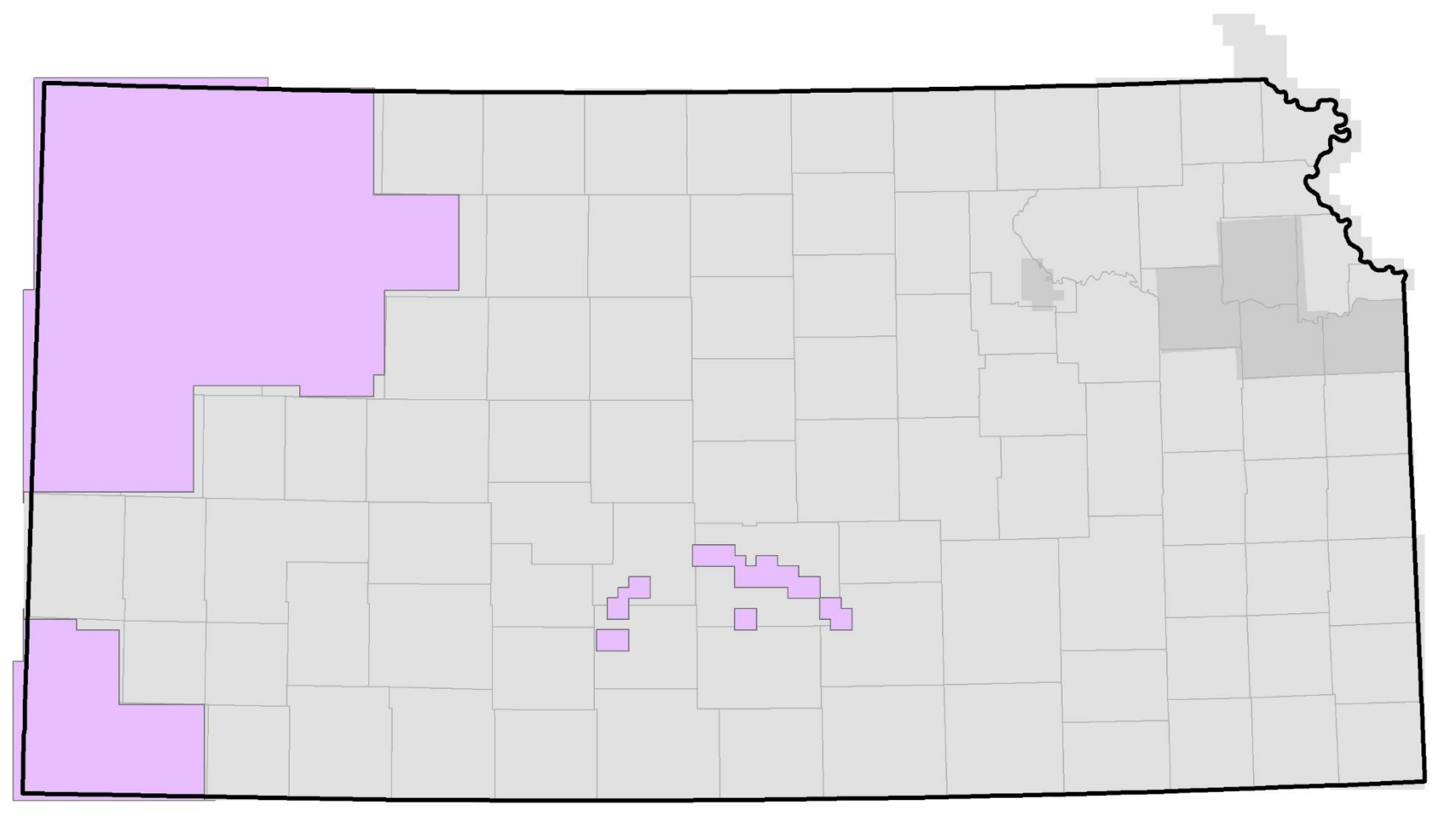
Kansas LiDAR – 2014



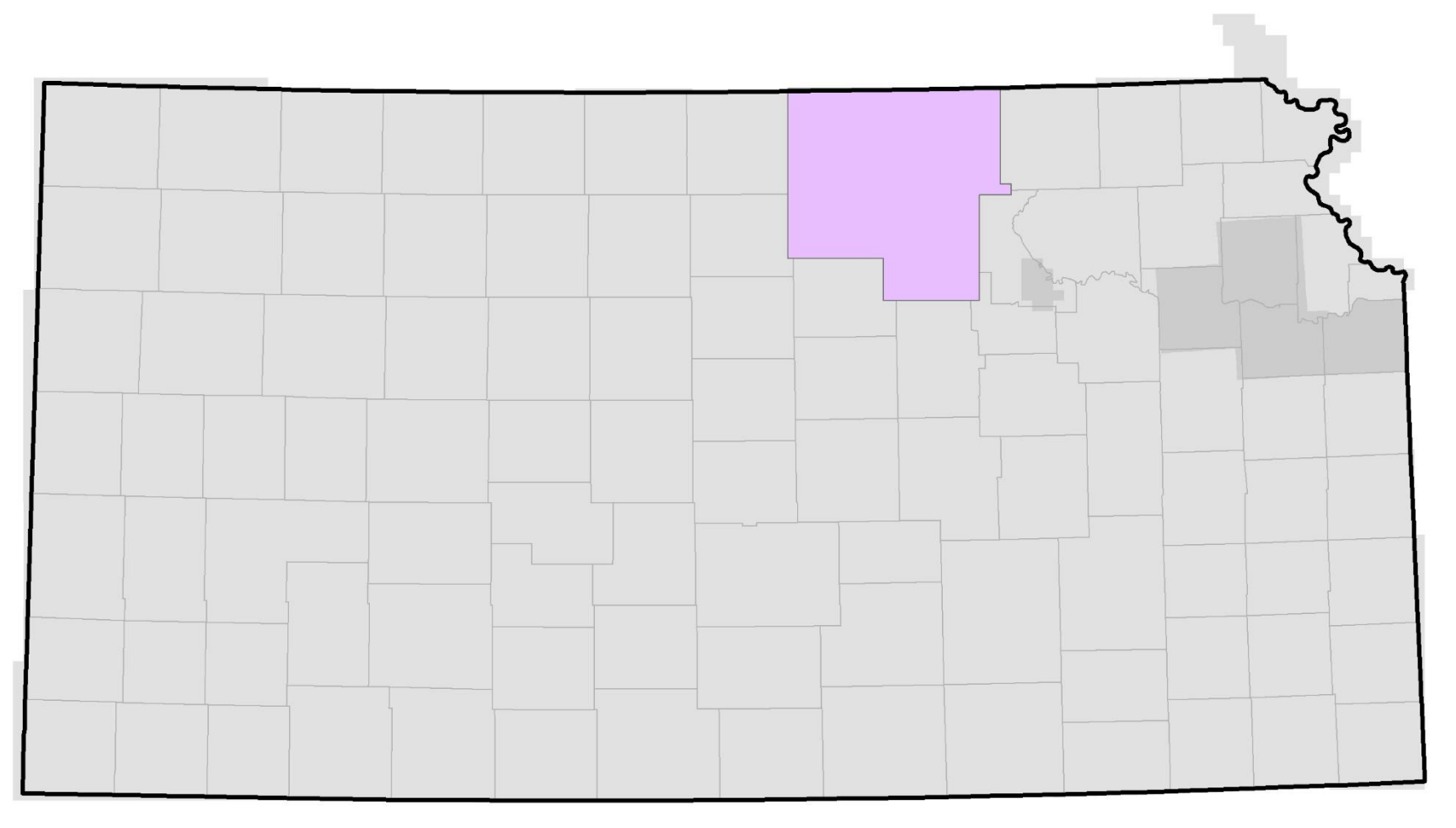
Kansas LiDAR – 2015



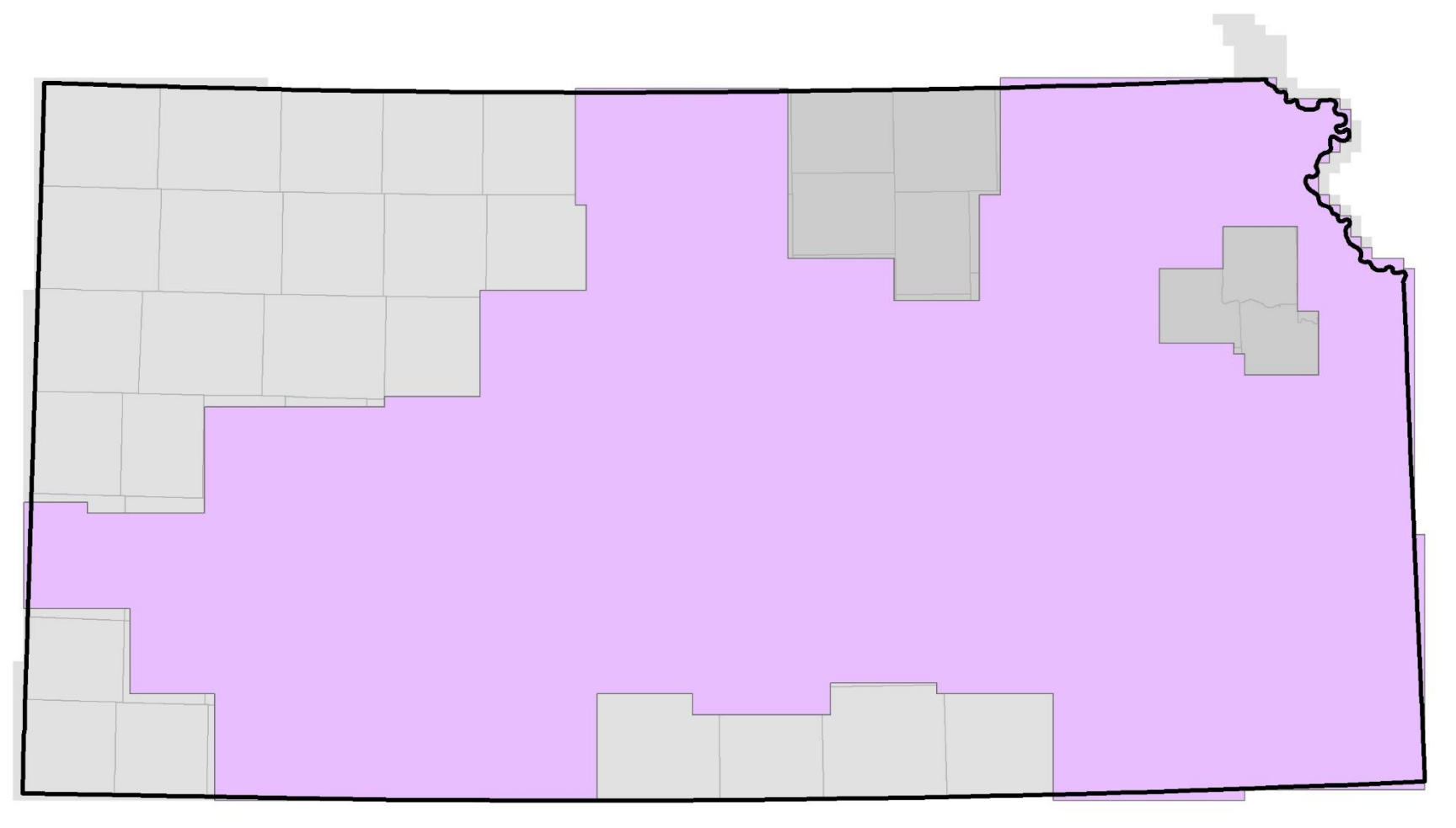
Kansas LiDAR – 2016



Kansas LiDAR – 2017

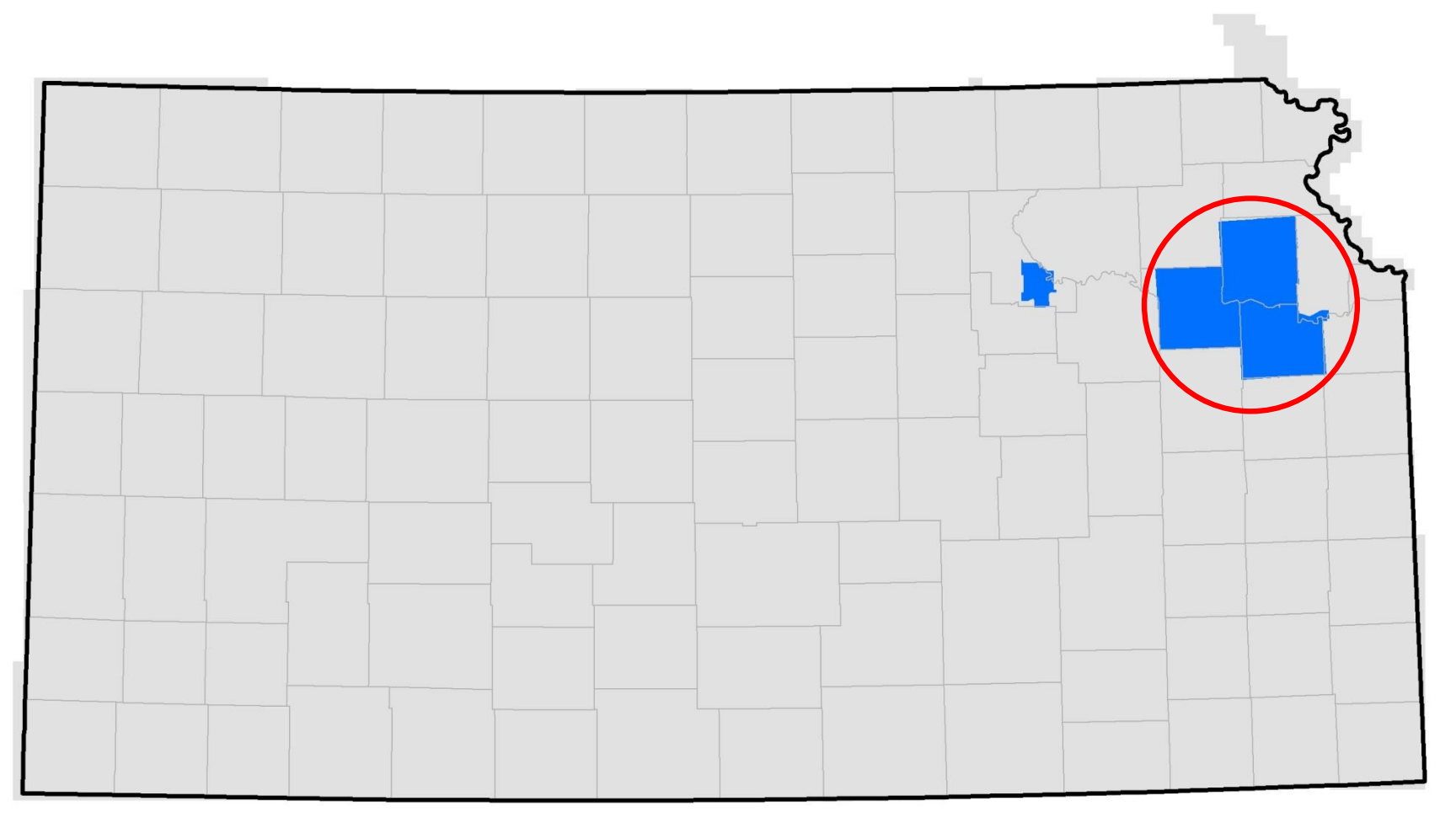


Kansas LiDAR – 2018/19 (proposed)

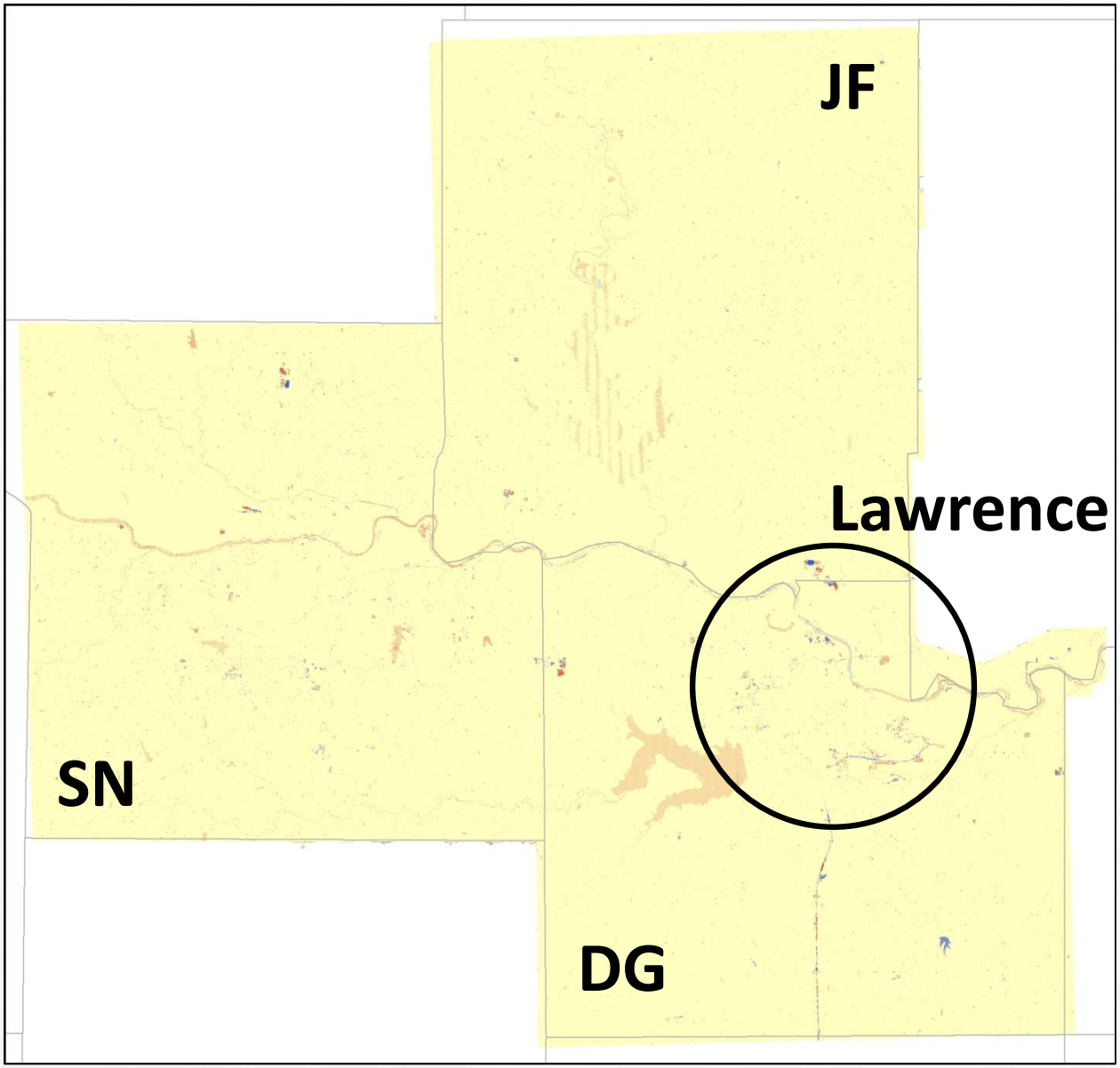


THANKS, USDA-NRCS!

Kansas LiDAR – 2006 vs. 2015



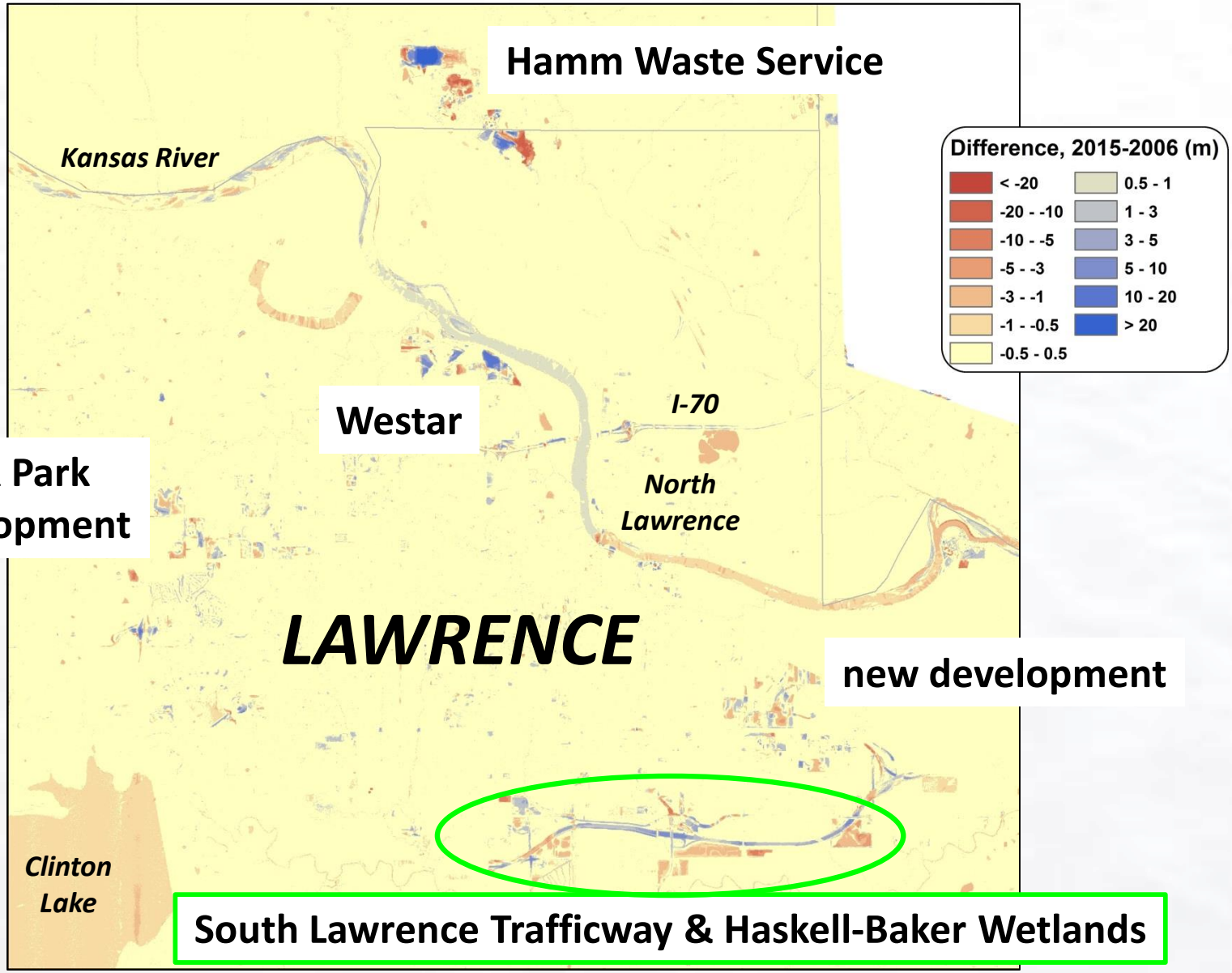
Elevation Difference – 2006 vs. 2015



Difference, 2015-2006 (m)

- < -20
- -20 - -10
- -10 - -5
- -5 - -3
- -3 - -1
- -1 - -0.5
- -0.5 - 0.5
- 0.5 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 20
- > 20

Elevation Difference – 2006 vs. 2015



South Lawrence Trafficway & Haskell-Baker Wetlands

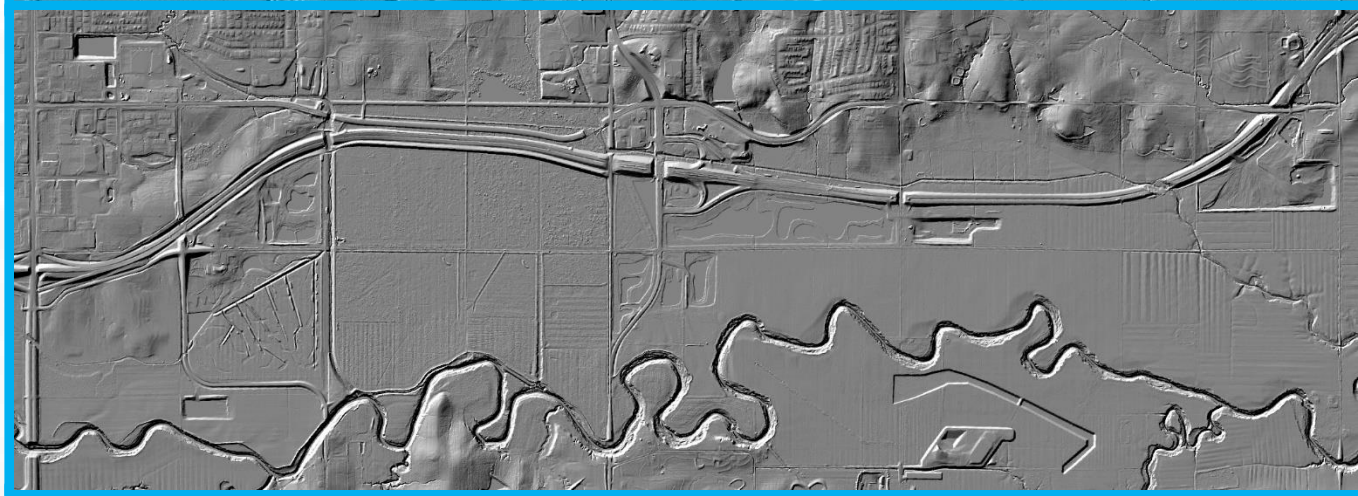
NAIP 2005

NAIP 2015

SLT – H/B Wetlands

LiDAR 2006

LiDAR 2015



Difference, 2015-2006 (m)

- < -20
- -20 - -10
- -10 - -5
- -5 - -3
- -3 - -1
- -1 - -0.5
- -0.5 - 0.5
- 0.5 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 20
- > 20

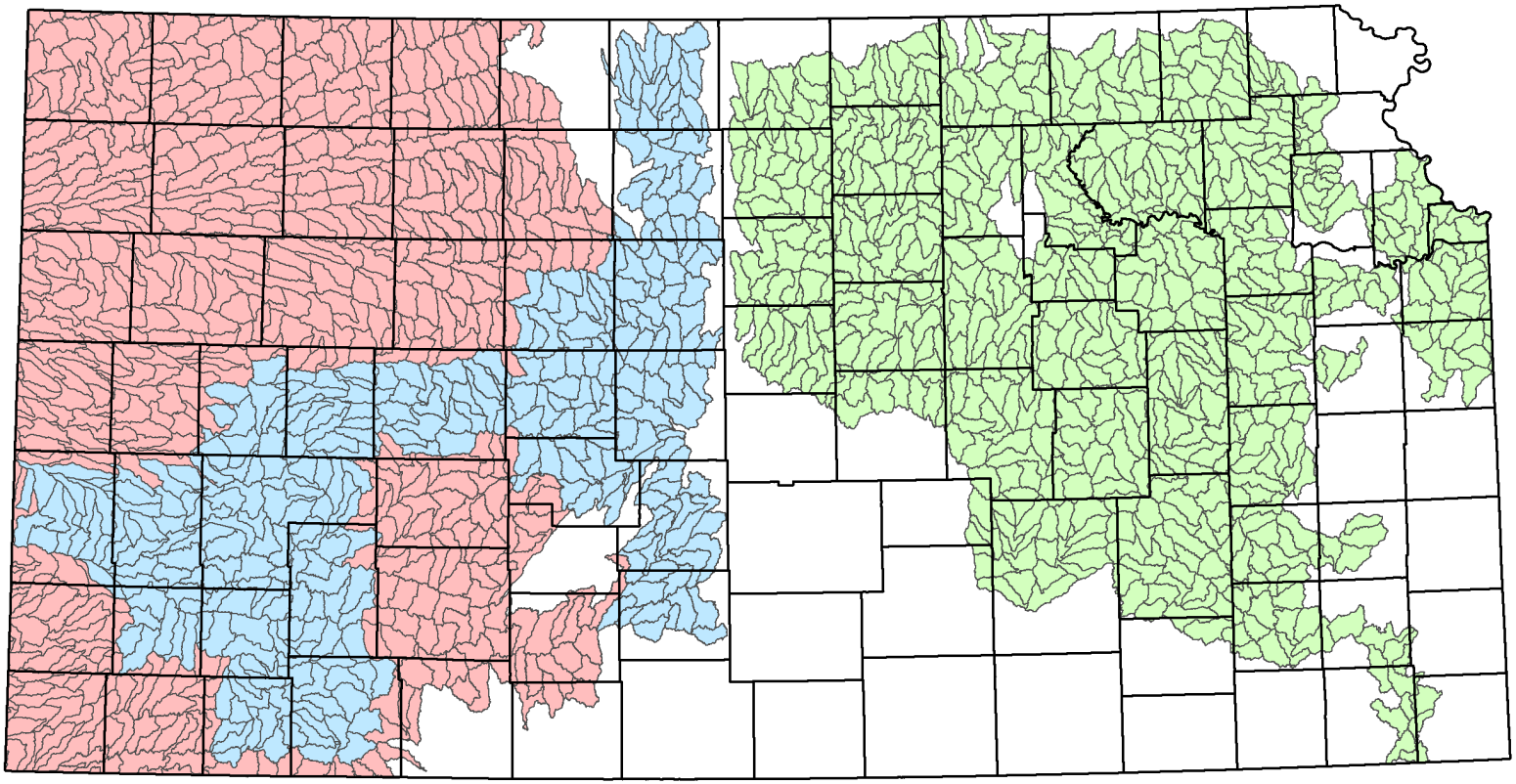
WETLANDS

Dry playa in western Kansas

Emergent wetland in eastern Kansas

Mapping Potential Wetlands Using LiDAR

- GIS-PB (PWAs) & EPA WPDG 2014/2018 (PPAs; with KWO)



Potential playa areas (PPA) currently being mapped

Potential playa areas (PPA) mapped

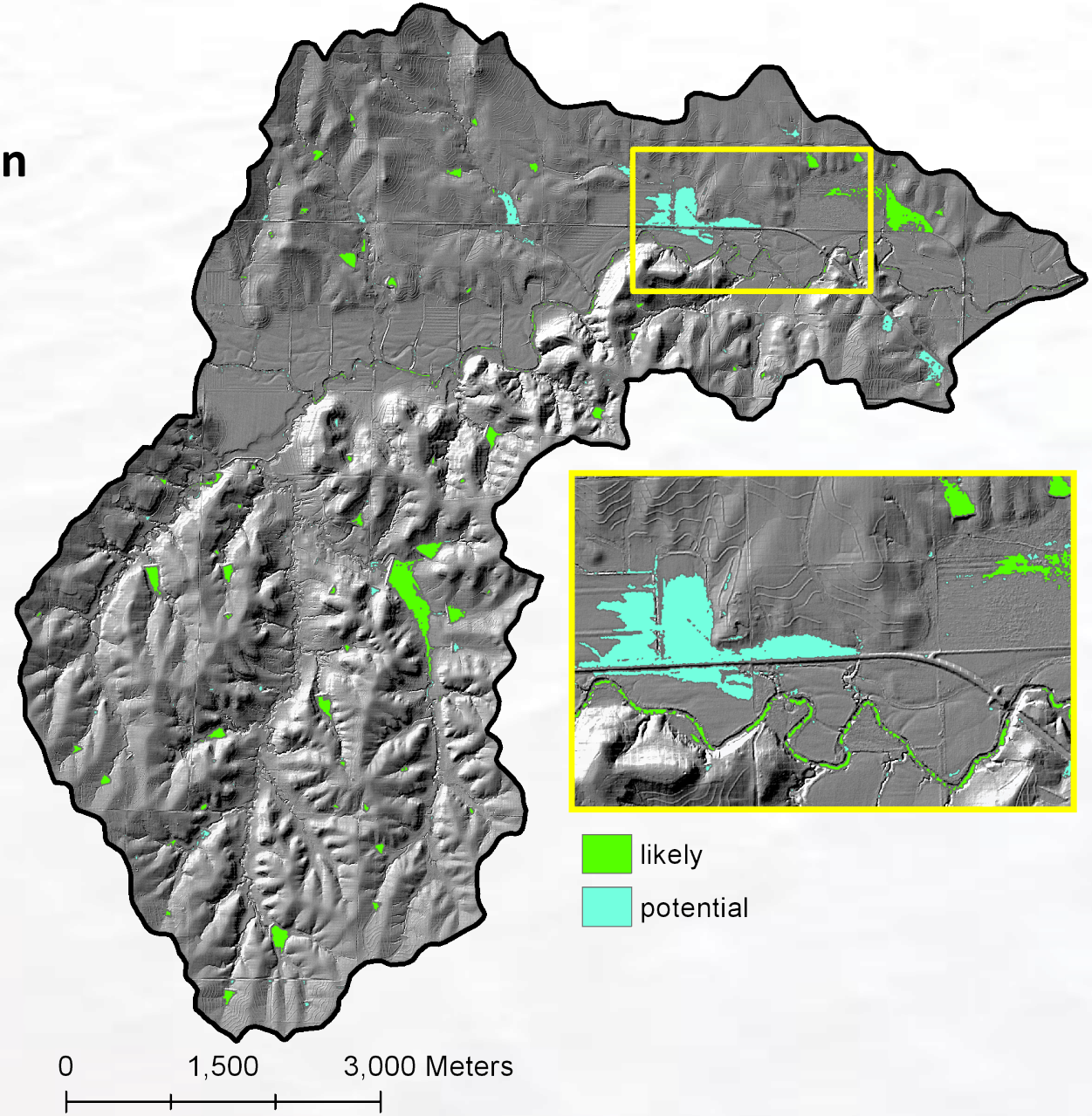
Potential wetland areas (PWA) mapped

Mapping Potential Wetland Areas Using LiDAR

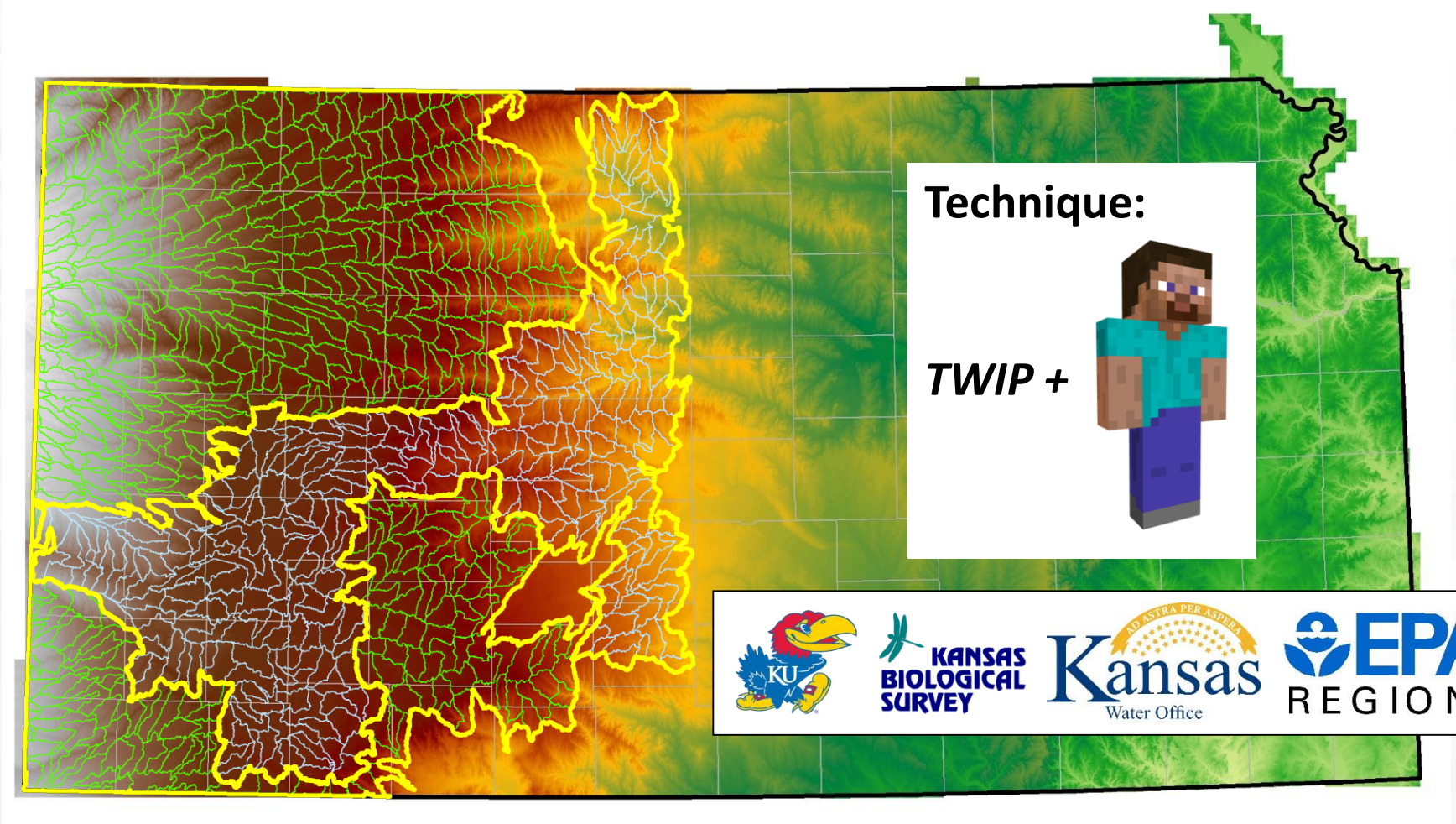
Example:
HUC-12 in western Jefferson County

Mapping Technique:

Topographic
Wetland
Identification
Process



Playa Mapping Using LiDAR



Phase 1 (EPA WPDG 2014) Study Area – 294 HUC 12s

Phase 2 (EPA WPDG 2018) Study Area – 539 HUC 12s

World-famous Ehmke playa

Lane County

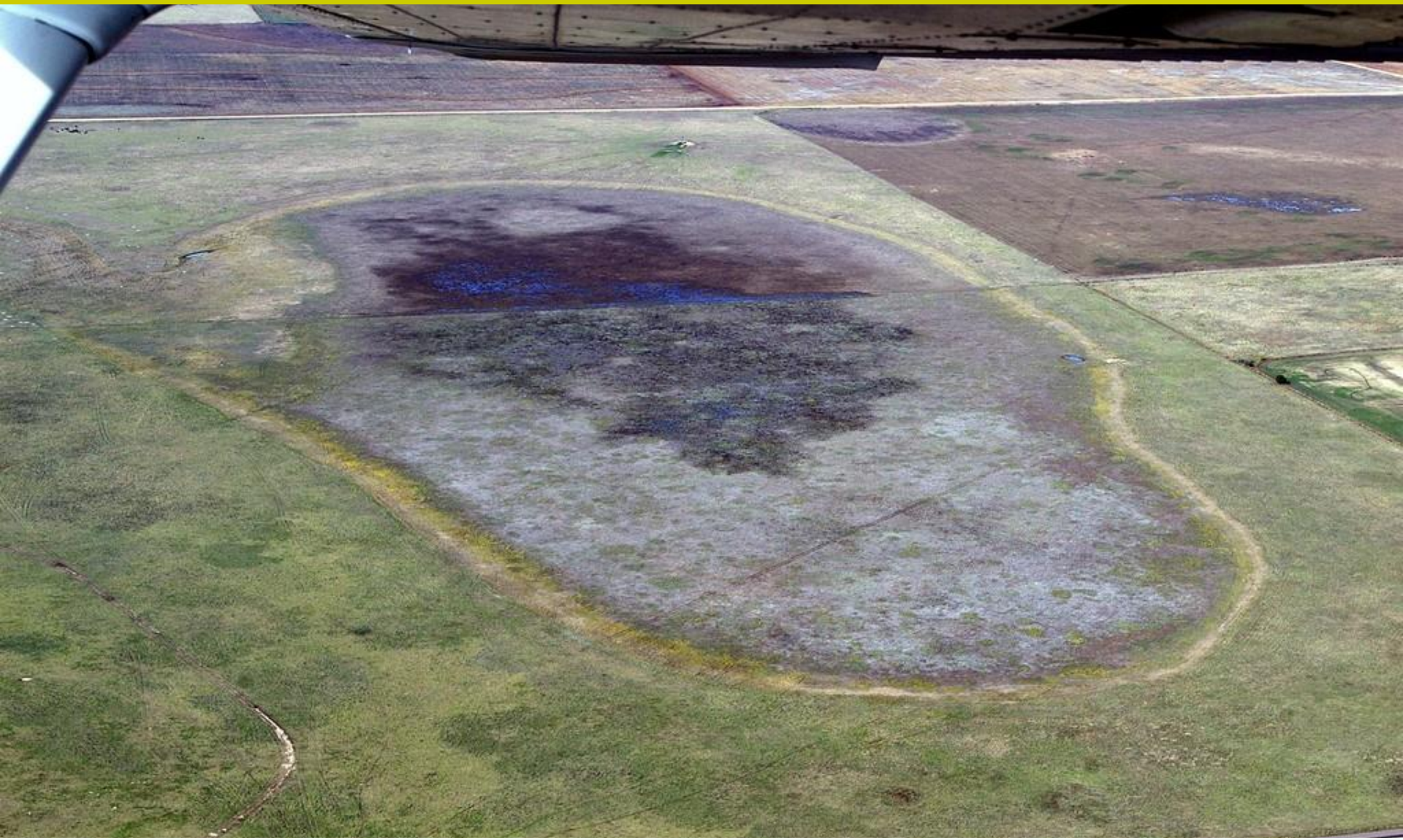
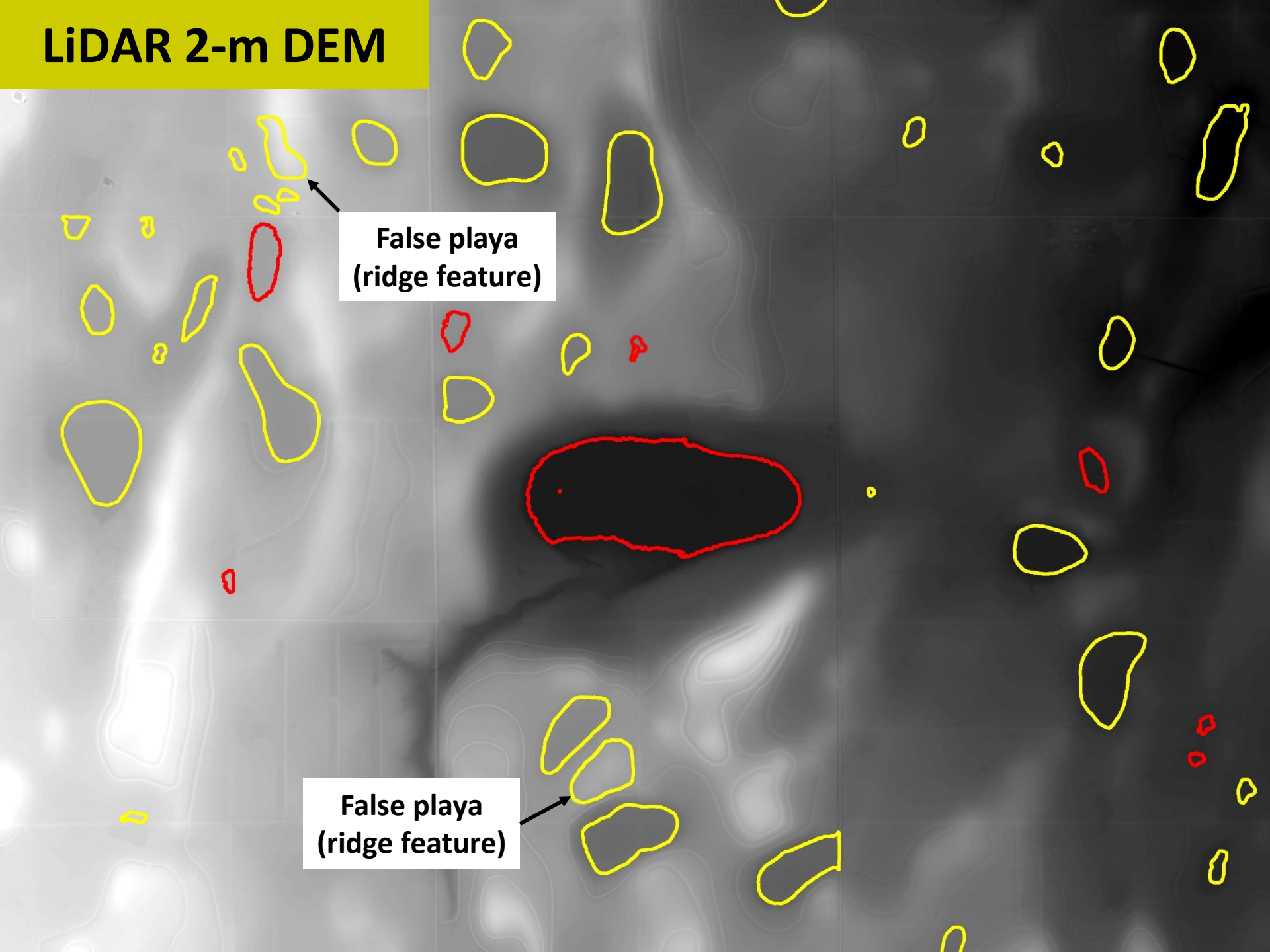


Image source:
http://www.uwosh.edu/facstaff/bowenm/Ehmkeplane.JPG/view

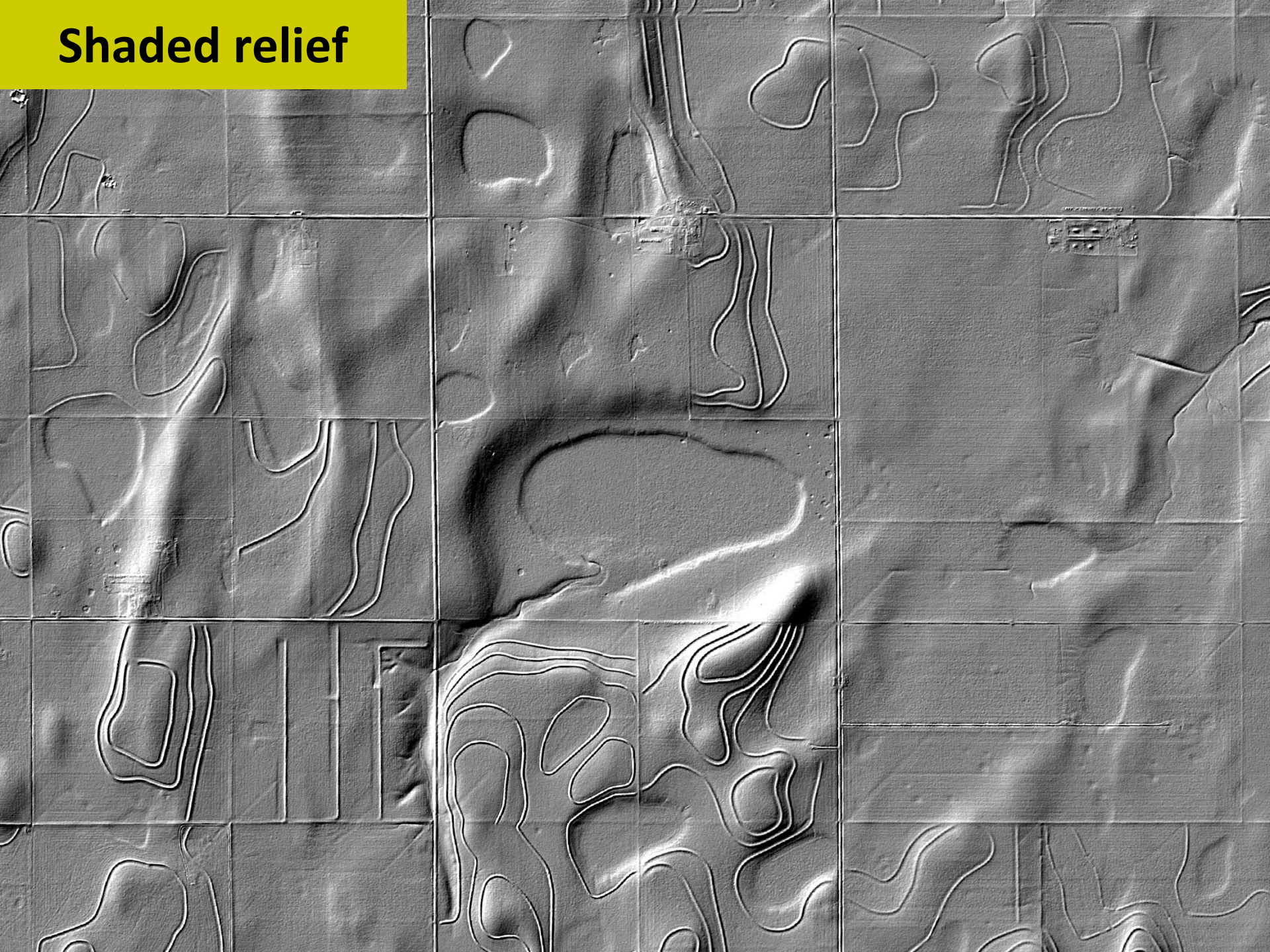
NAIP 2010 (PLJV – yellow, PPA – red)

PLJV = Playa Lakes Joint Venture probable playa (from imagery)

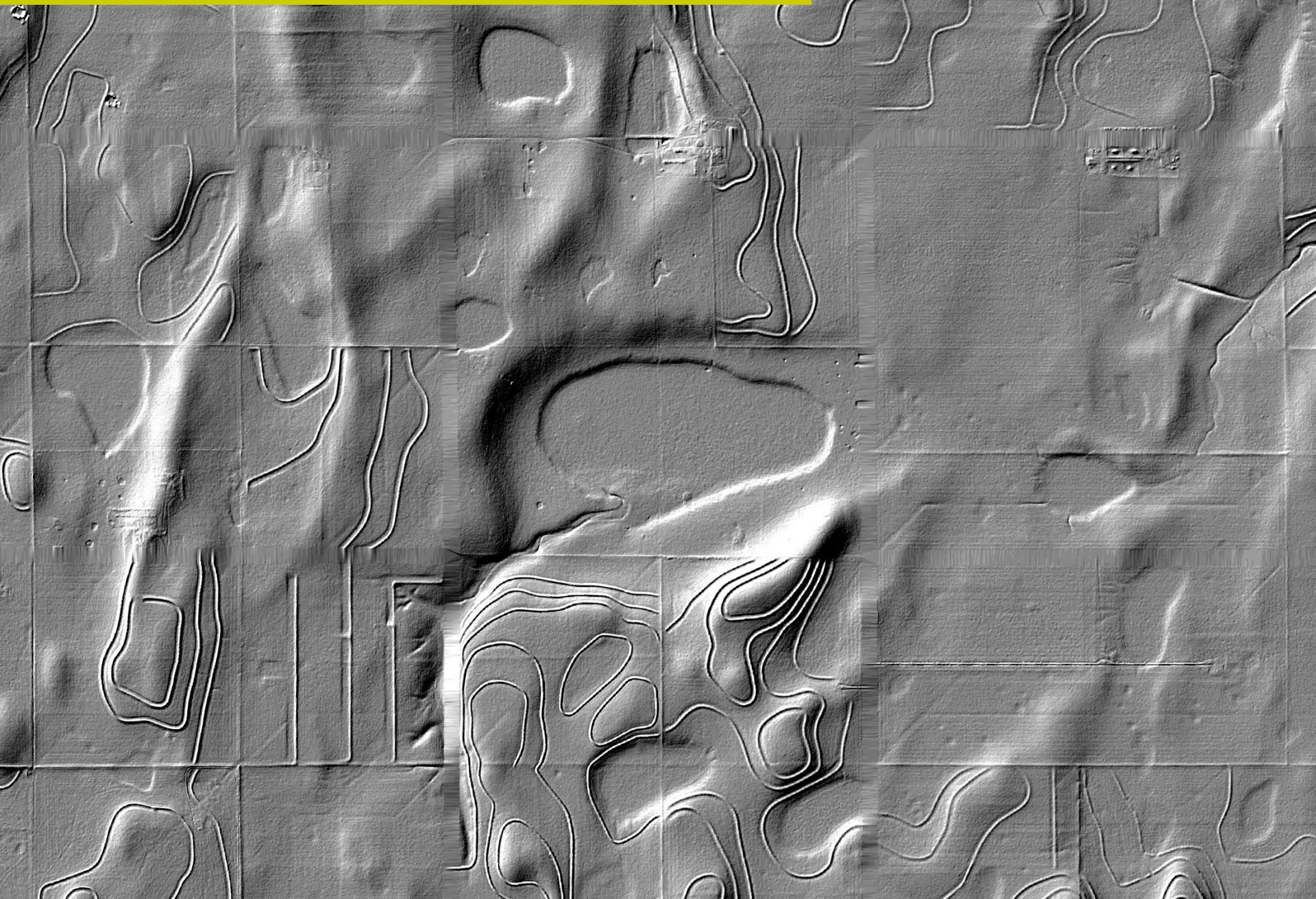
PPA = potential playa area (from LiDAR)


LiDAR 2-m DEM
False playa
(ridge feature)
False playa
(ridge feature)

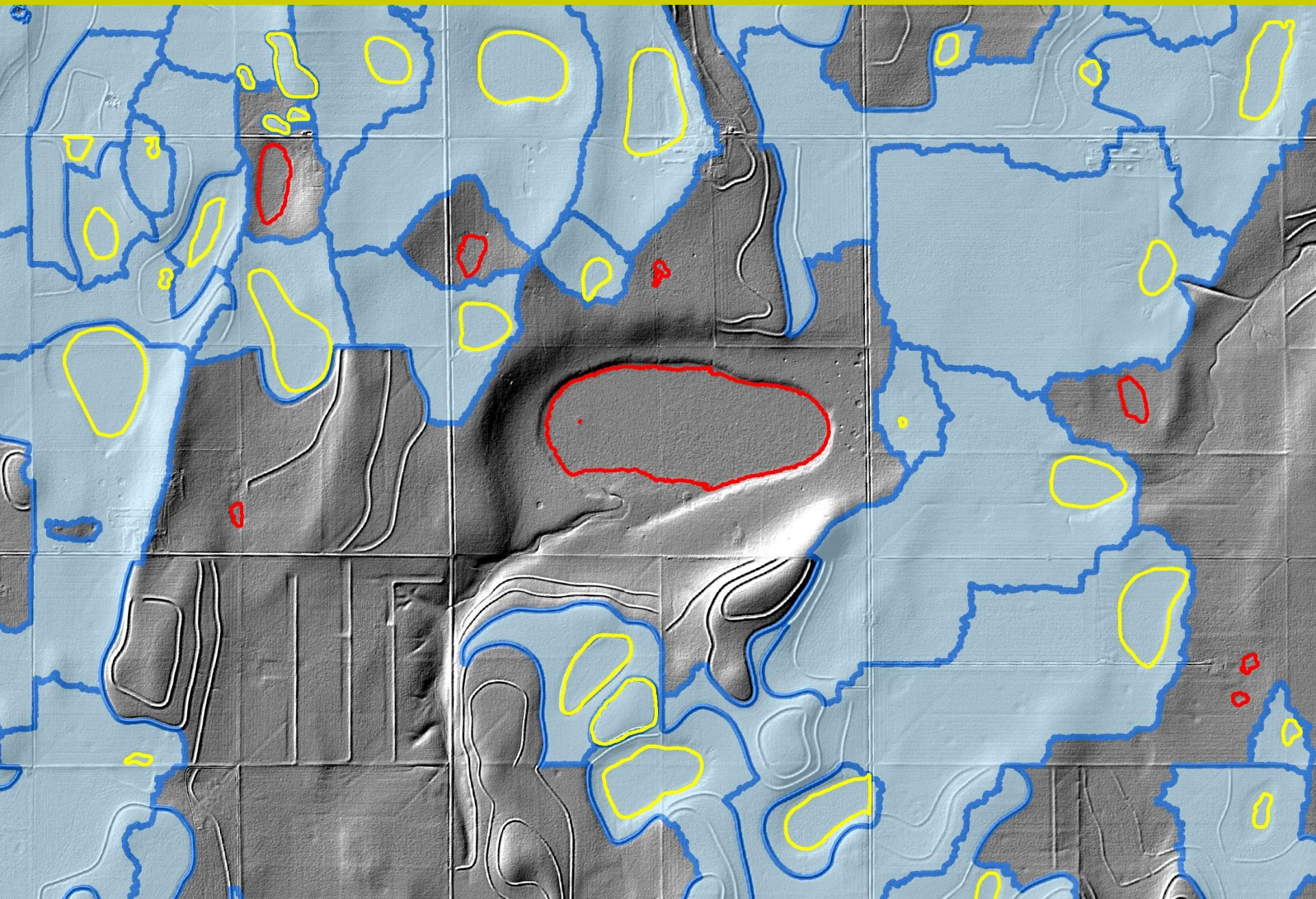
Shaded relief



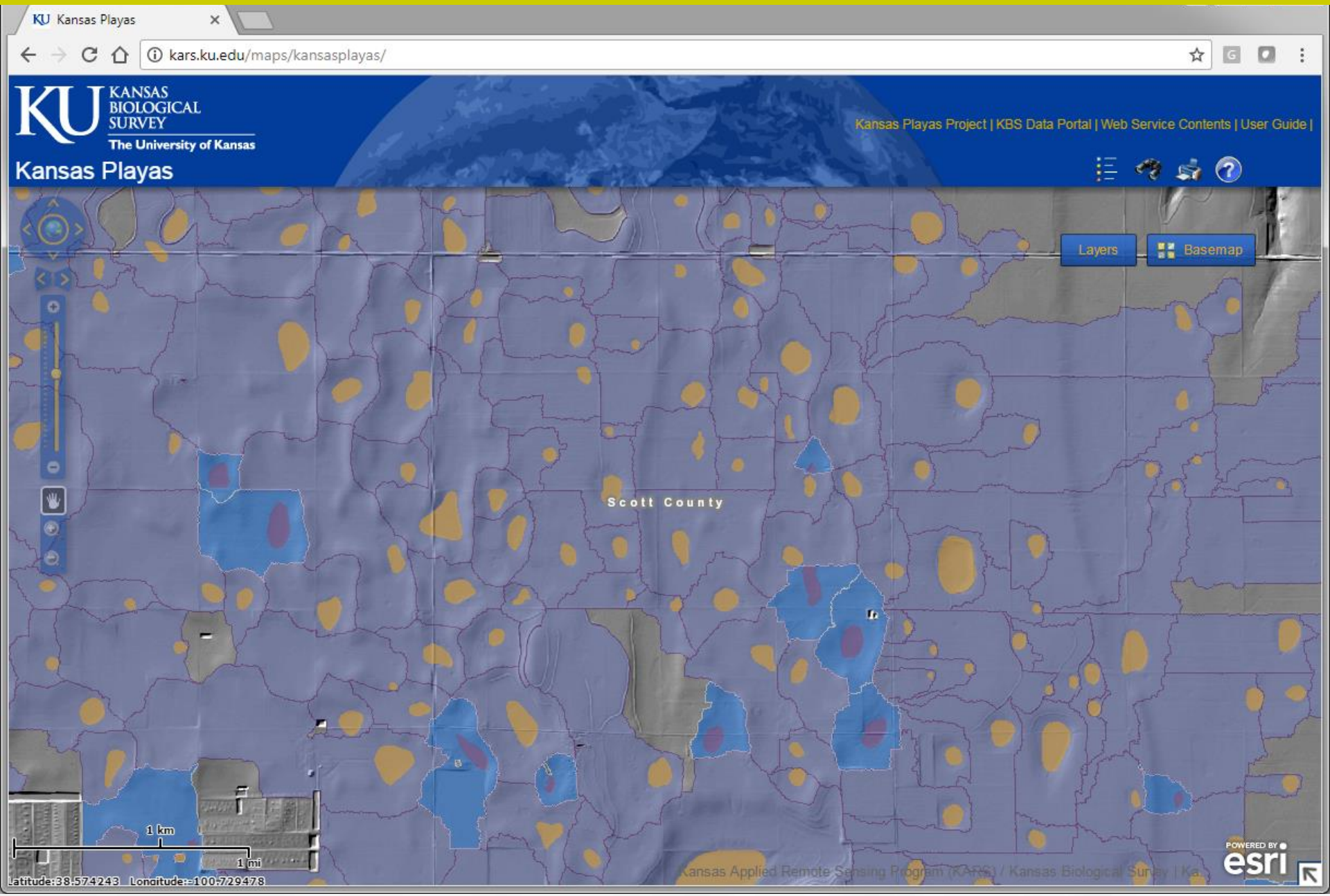
Shaded relief (roads removed)



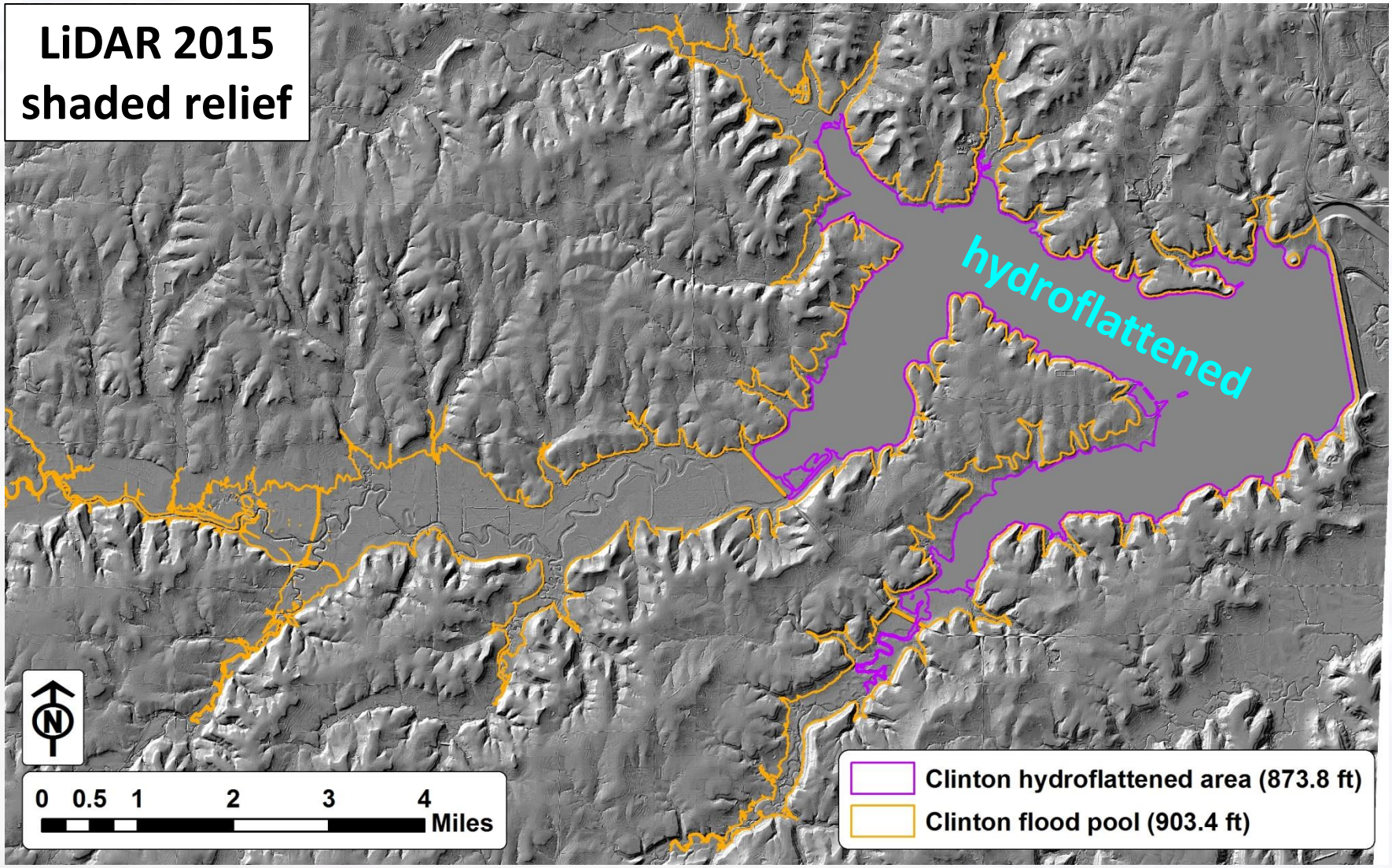
PLJV watersheds



KBS Web Map Application and Service



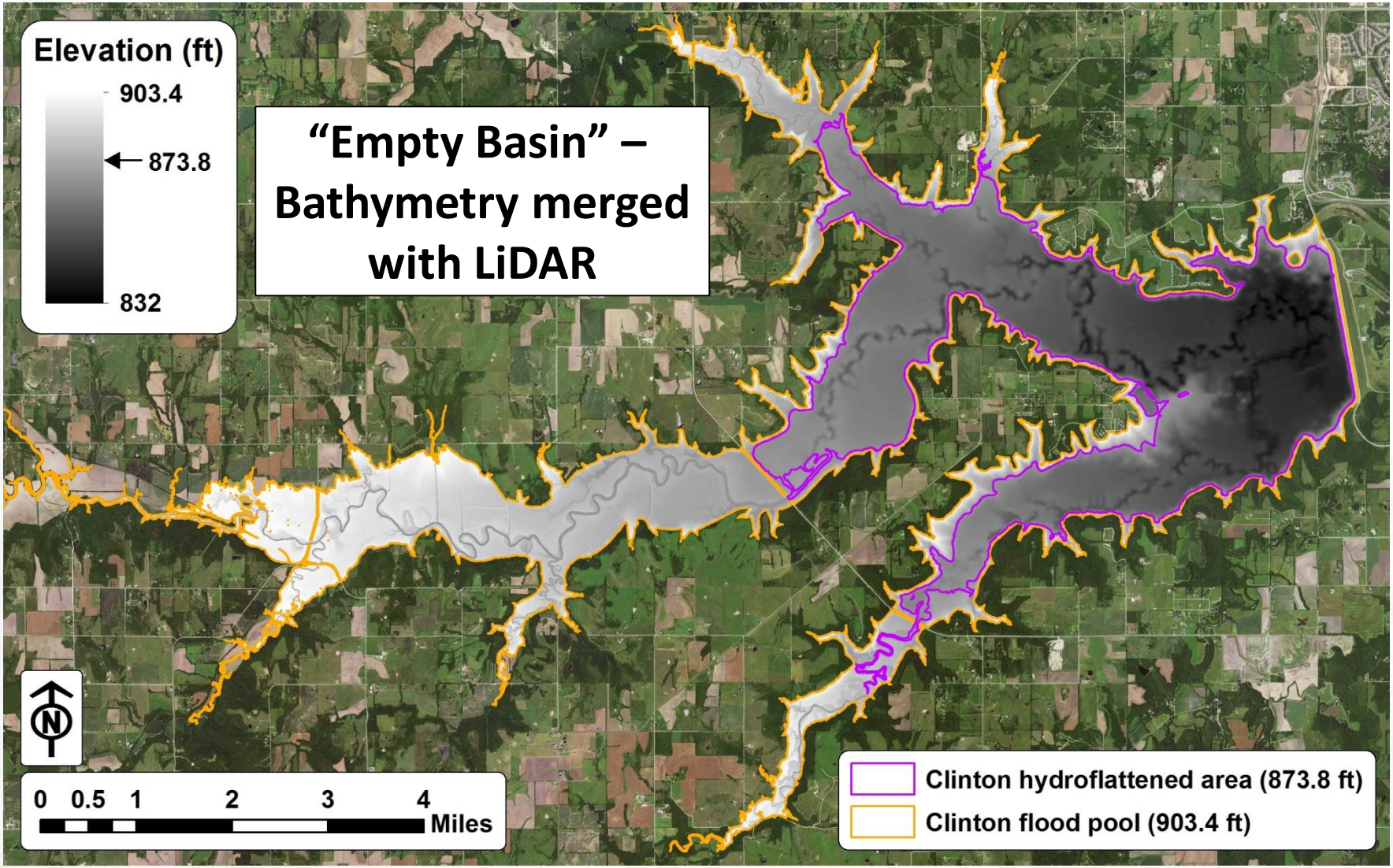
Potential Wetland Formation Around Federal Reservoirs



Clinton Lake, Douglas County

EPA WPDG 2016 (KWO & KBS)

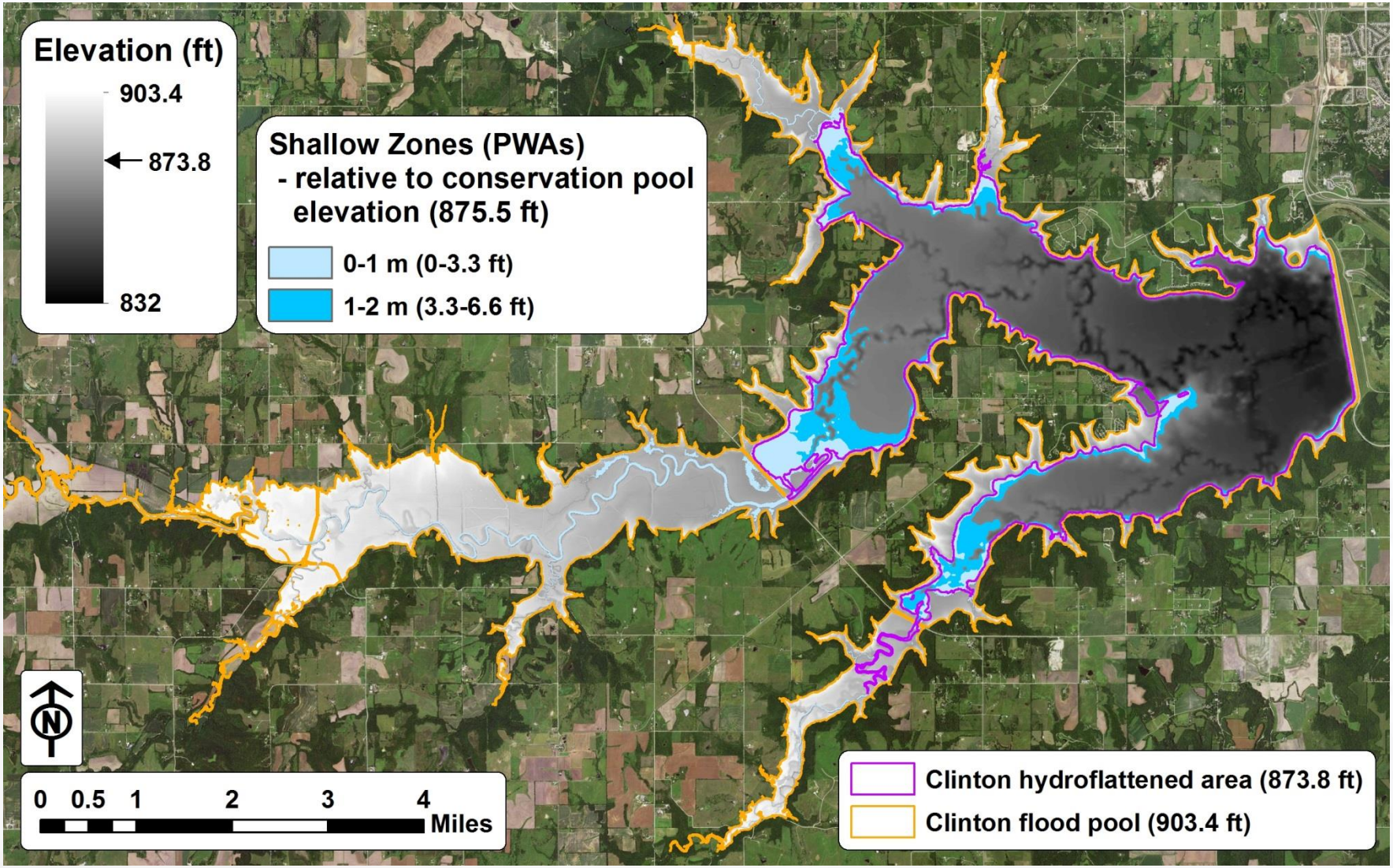
Potential Wetland Formation Around Federal Reservoirs



Clinton Lake, Douglas County

EPA WPDG 2016 (KWO & KBS)

Potential Wetland Formation Around Federal Reservoirs

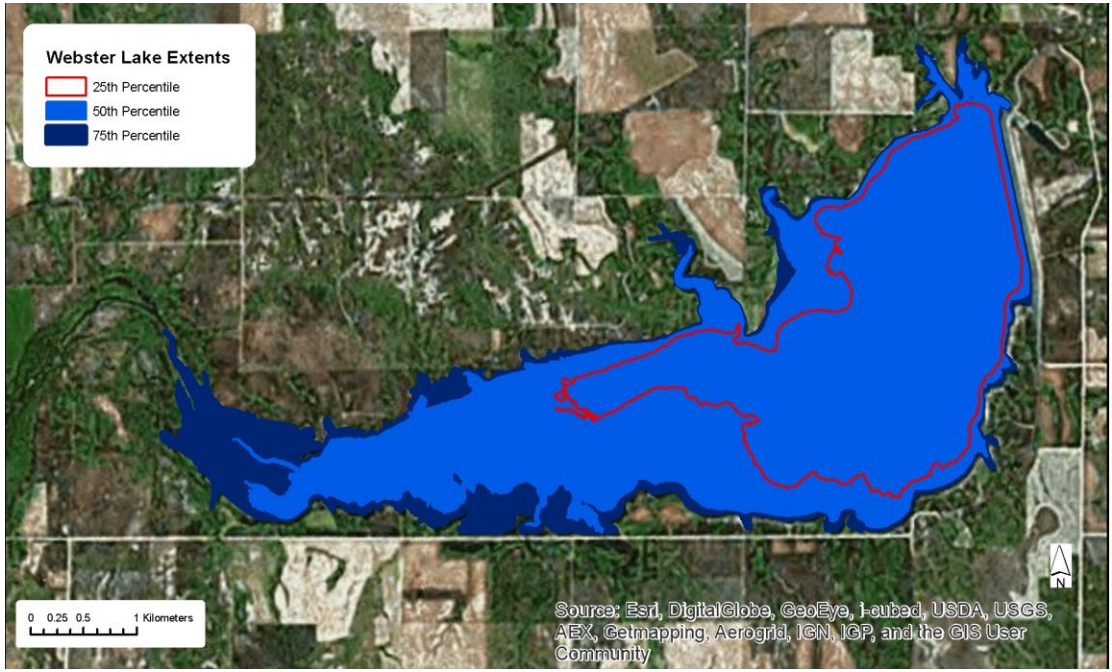


Clinton Lake, Douglas County

EPA WPDG 2016 (KWO & KBS)

Potential Wetland Formation in High-Water Zone

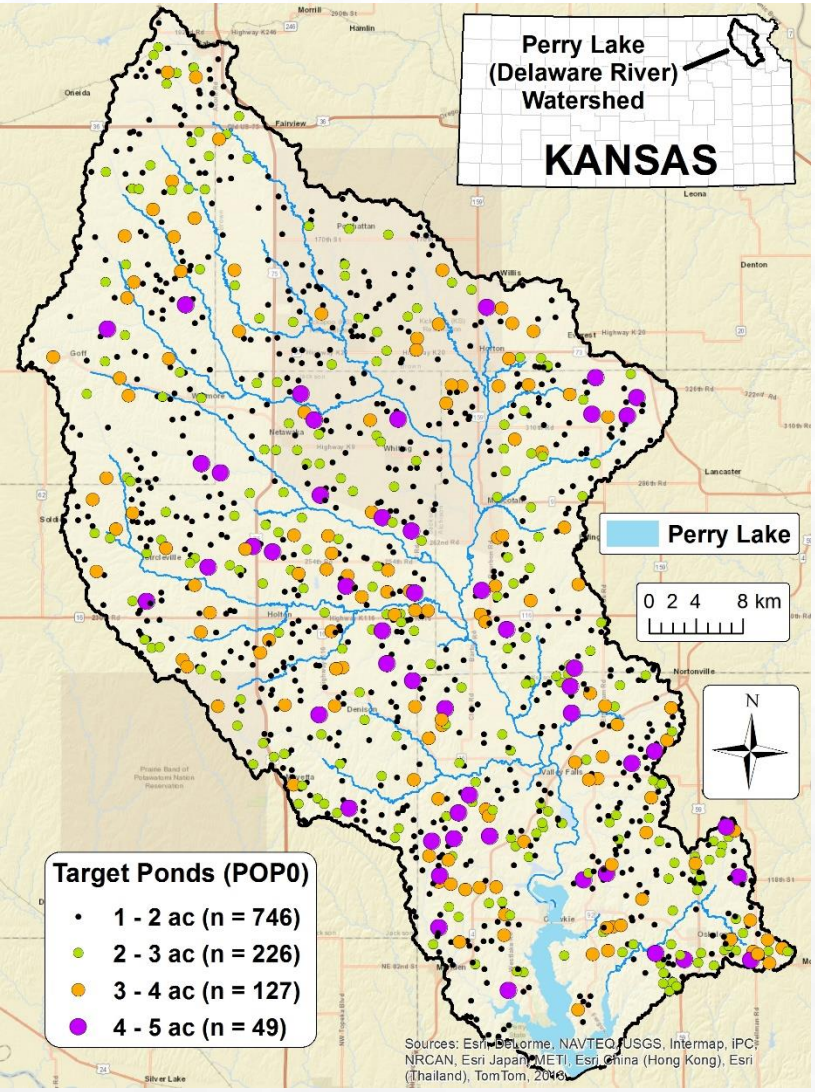
Historic Lake Level daily data allows us to determine inundation frequency

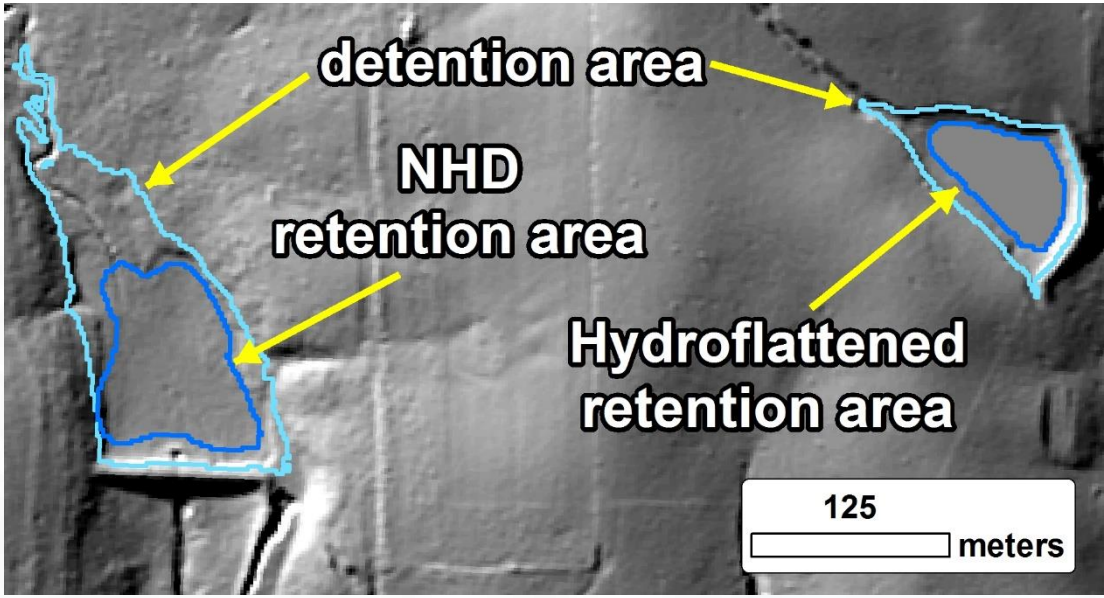


Low-slope areas in frequently inundated high-water zones tend to be wetlands

EPA WPDG 2016 (KWO & KBS)

Farm Ponds to Wetlands *(EPA WPDG 2015 – KWO & KBS)*





Retention area:

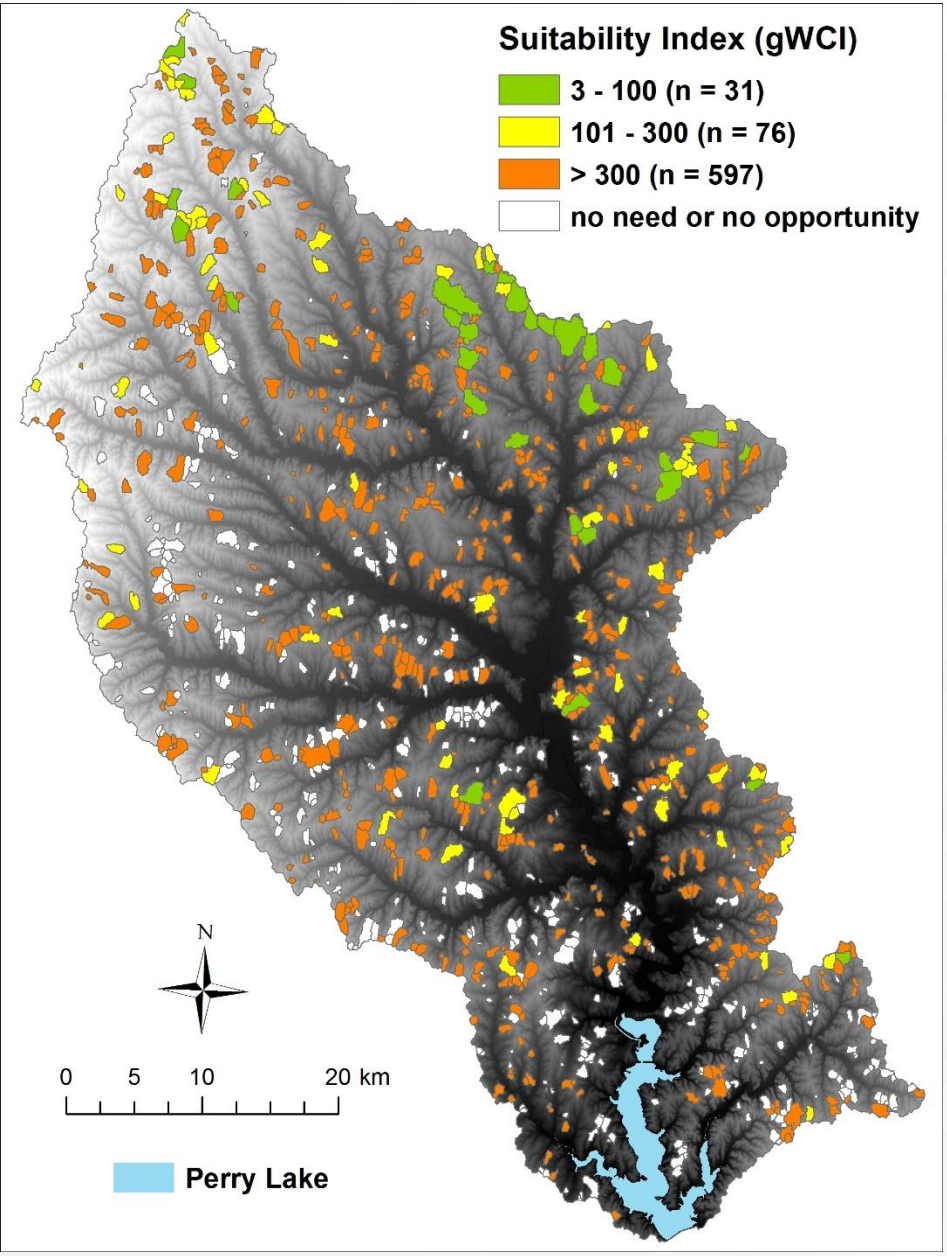
"normal pool" (lake level at primary spillway, usually a drain tube)

Detention area:

"flood pool" (lake level at overflow spillway)

Idea: *If outer detention area is large and flat, then* ***opportunity*** *is good for wetland development*

Farm Ponds to Wetlands



Idea: *If catchment erosion potential is high (function of cropland area and slope), then* ***need*** *is high for wetland development.*

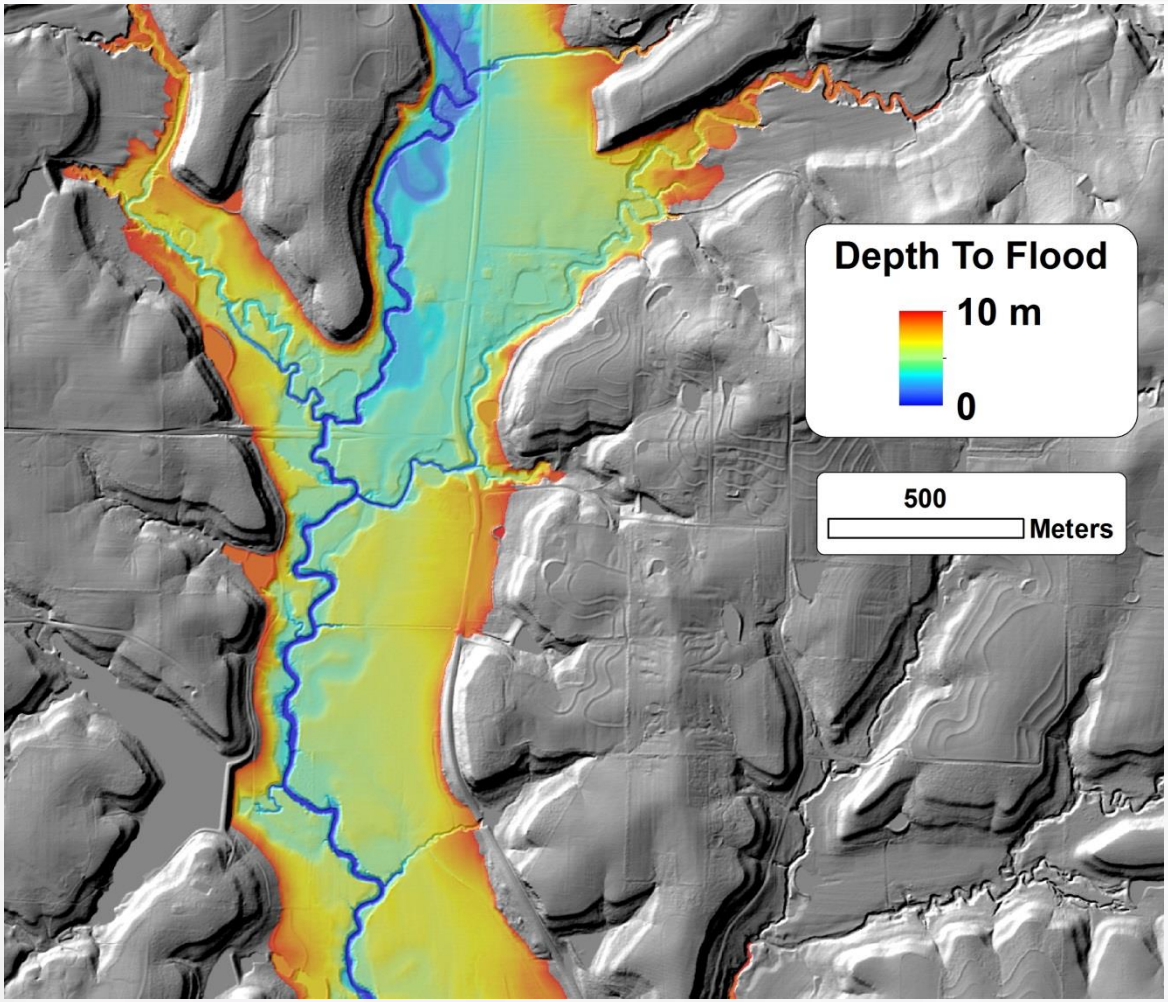
gWCI = *GIS-based wetland conversion suitability index (regional rank)*

- **low gWCI value** = **high ranking**

opportunity ↑, *need* ↑ → *gWCI rank* ↑

EPA WPDG 2015 (KWO & KBS)

Rapid Flood Mapping Using Inundation Libraries



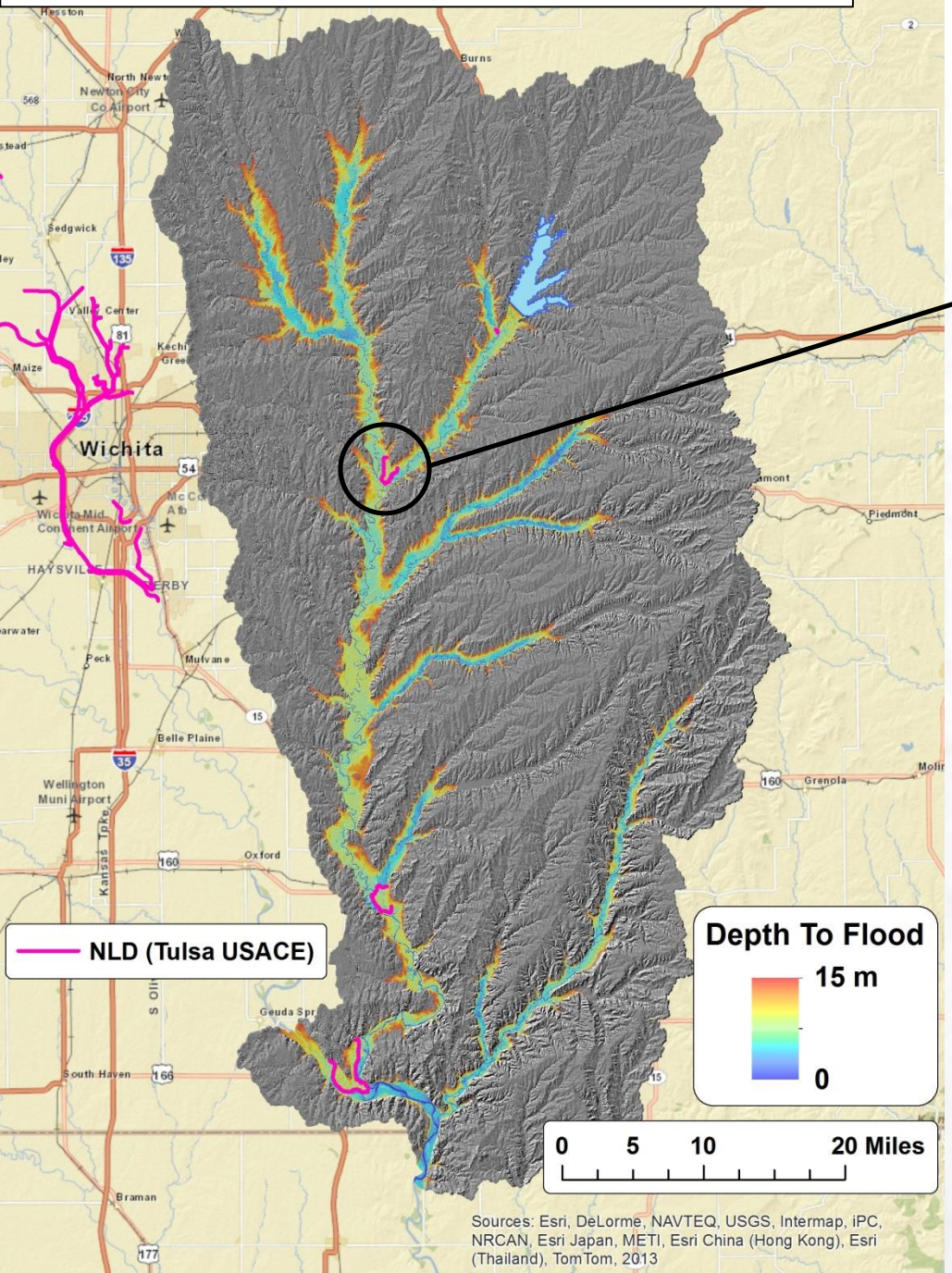
The 10-m floodplain was computed using **<u>the FLDPLN model</u>**.

FLDPLN is a static, 2D hydrologic model that requires only DEM data as input.

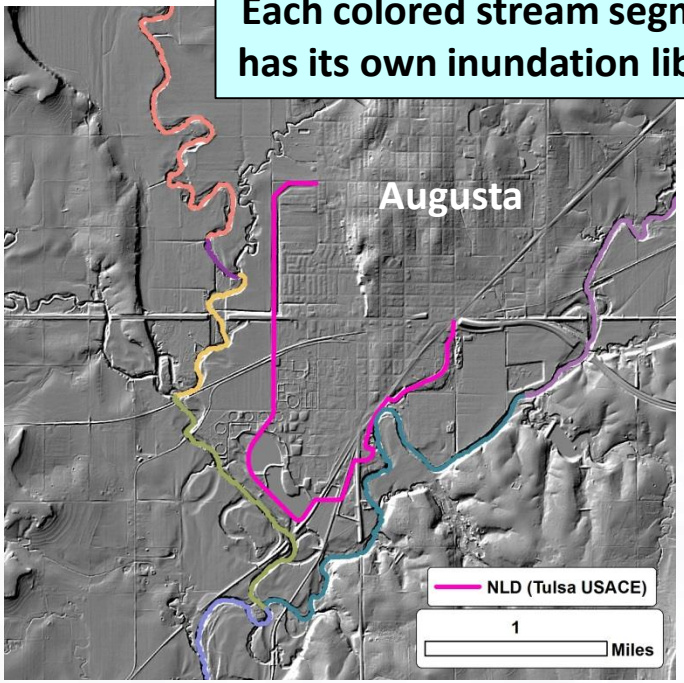
Using simple surface flow properties, FLDPLN identifies the depth-varying floodplain in reference to the input stream network (floodwater source).

10-m Floodplain (DTF Map)

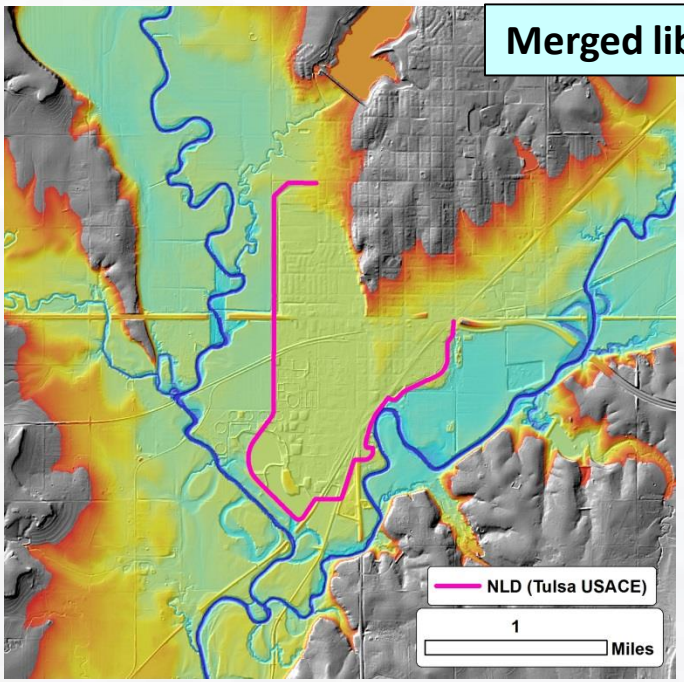
Example: Walnut River Basin in southeast Kansas



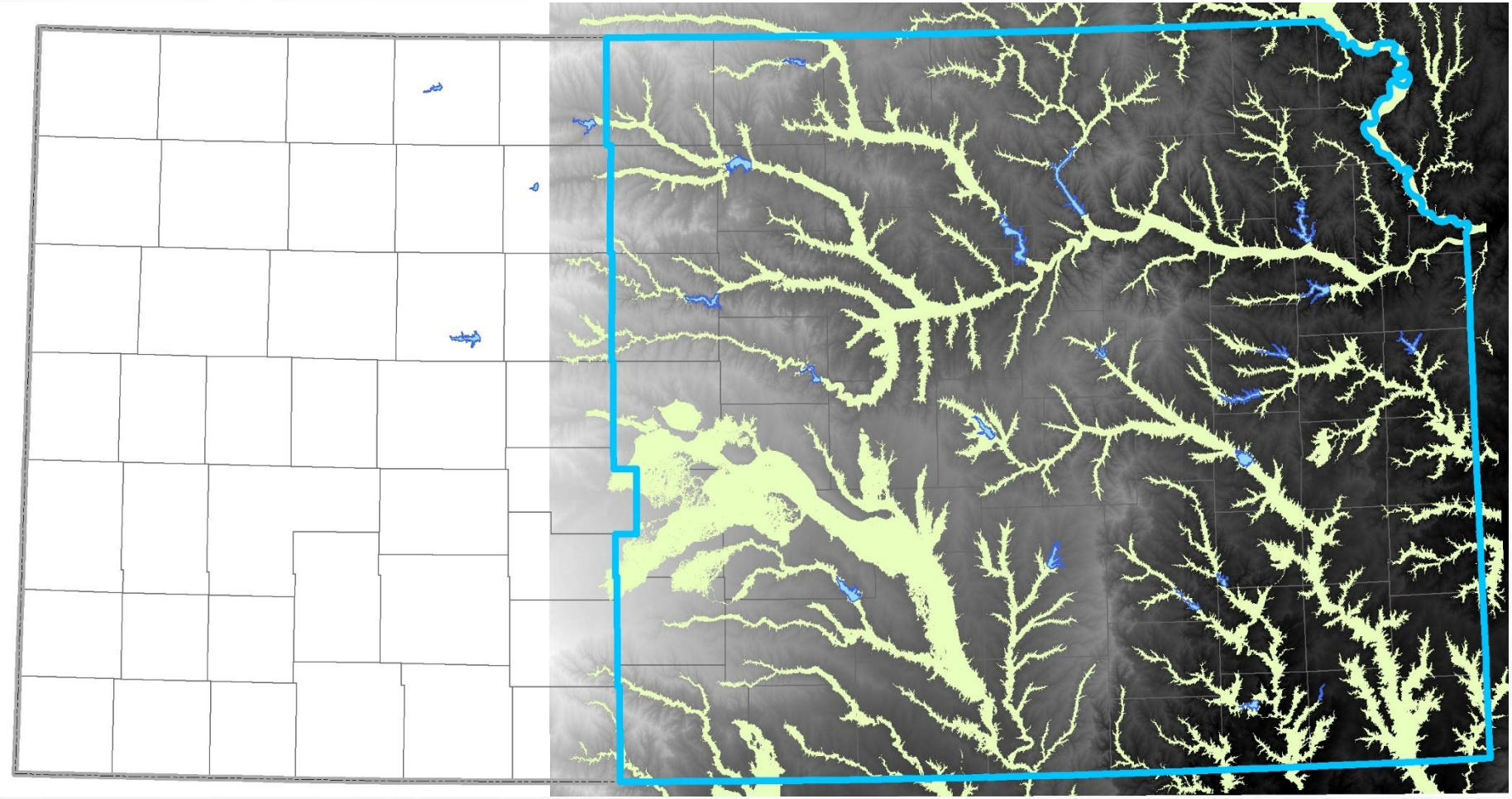
Each colored stream segment has its own inundation library



Merged library



Kansas Inundation Library Coverage

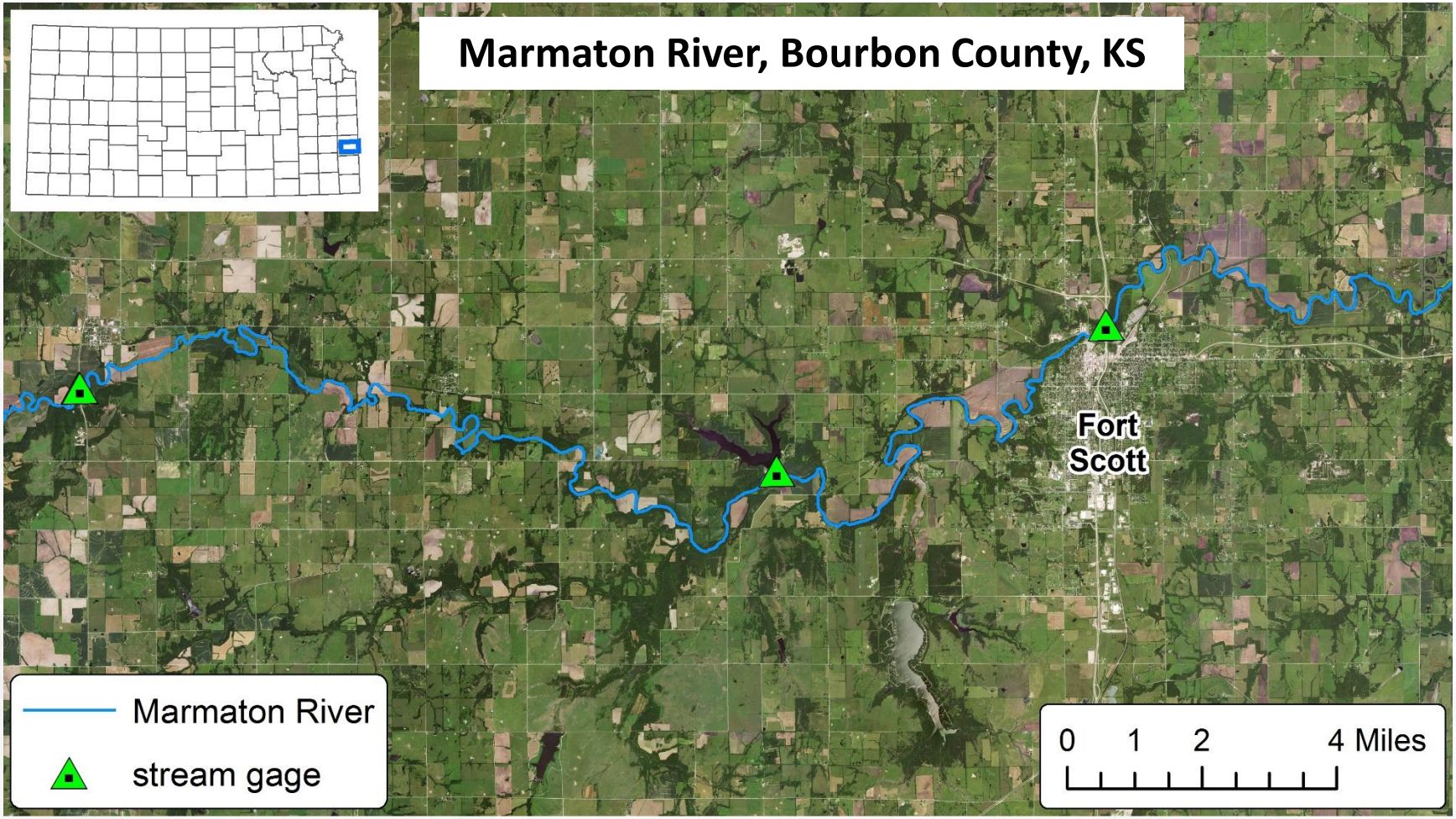


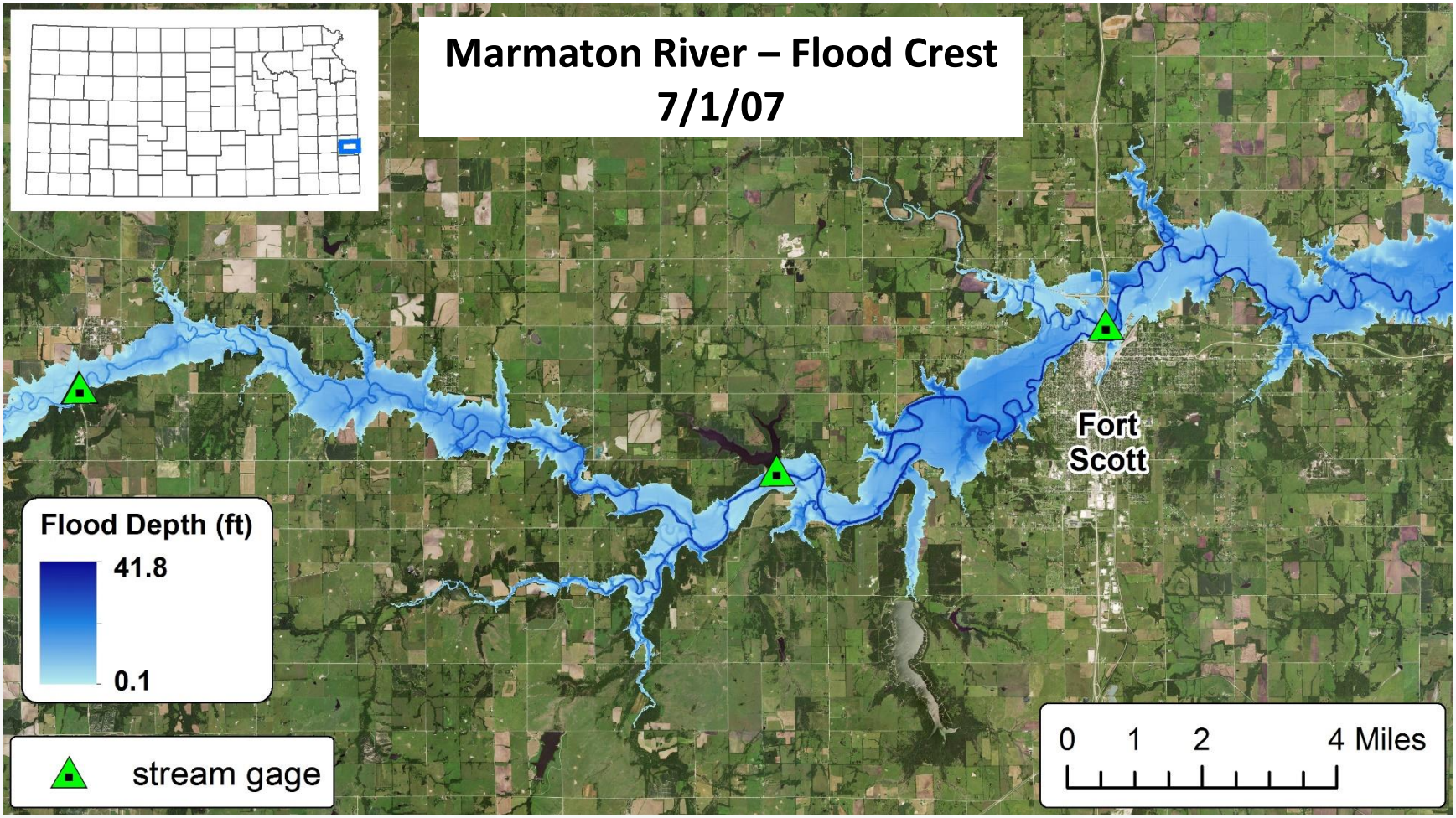
RIVERSIDE

global science solutions

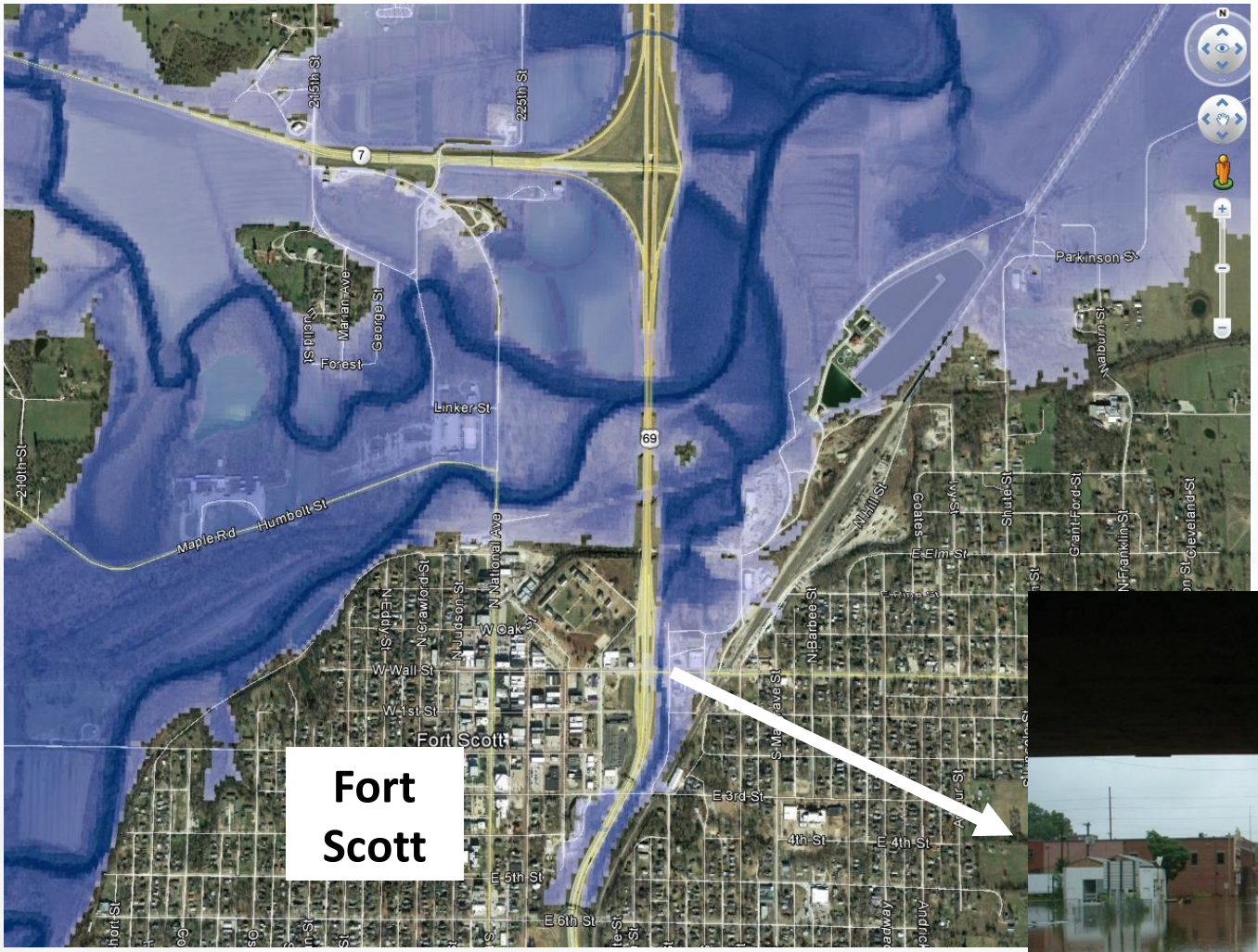
RiverTrak

http://www.riverside.com/rivertrak-1


Marmaton River, Bourbon County, KS
Fort Scott
Marmaton River
stream gage
0 1 2 4 Miles


Marmaton River – Flood Crest
7/1/07
Fort Scott
Flood Depth (ft)
41.8
0.1
stream gage
0 1 2 4 Miles

RiverTrak



With inundation libraries already constructed for most of Kansas, we are working with Riverside to expand RiverTrak coverage to the state. *We are seeking support for this effort.*

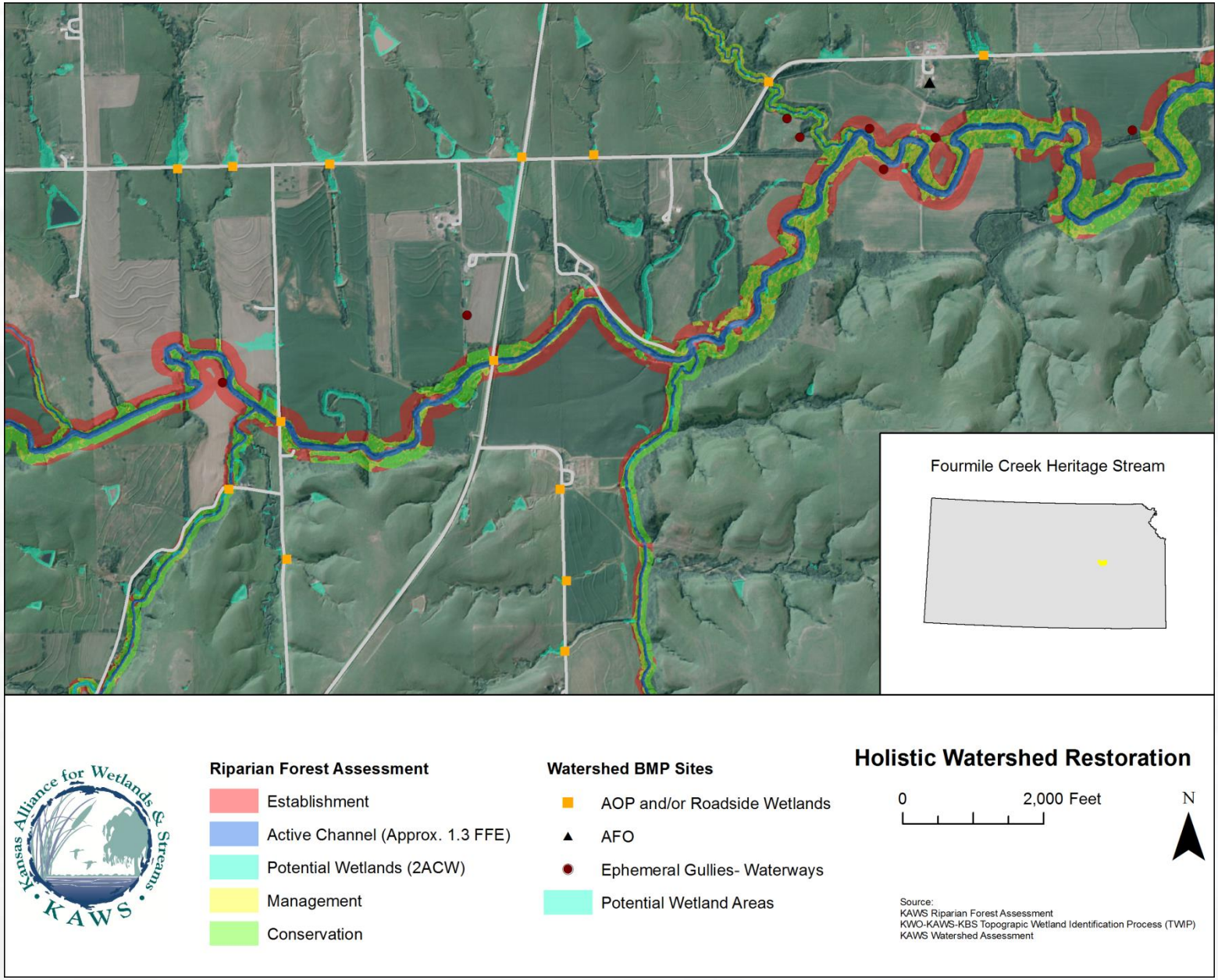
RiverTrak

Watershed Health & Maintenance

Kansas Alliance for Wetlands & Streams

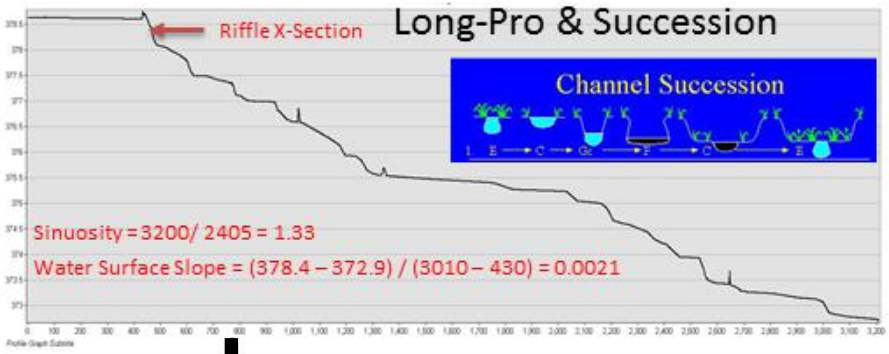
KAWS

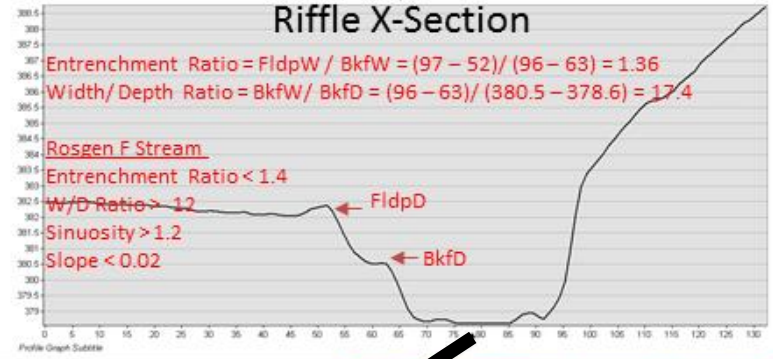
Using LiDAR to Support Holistic Watershed Restoration

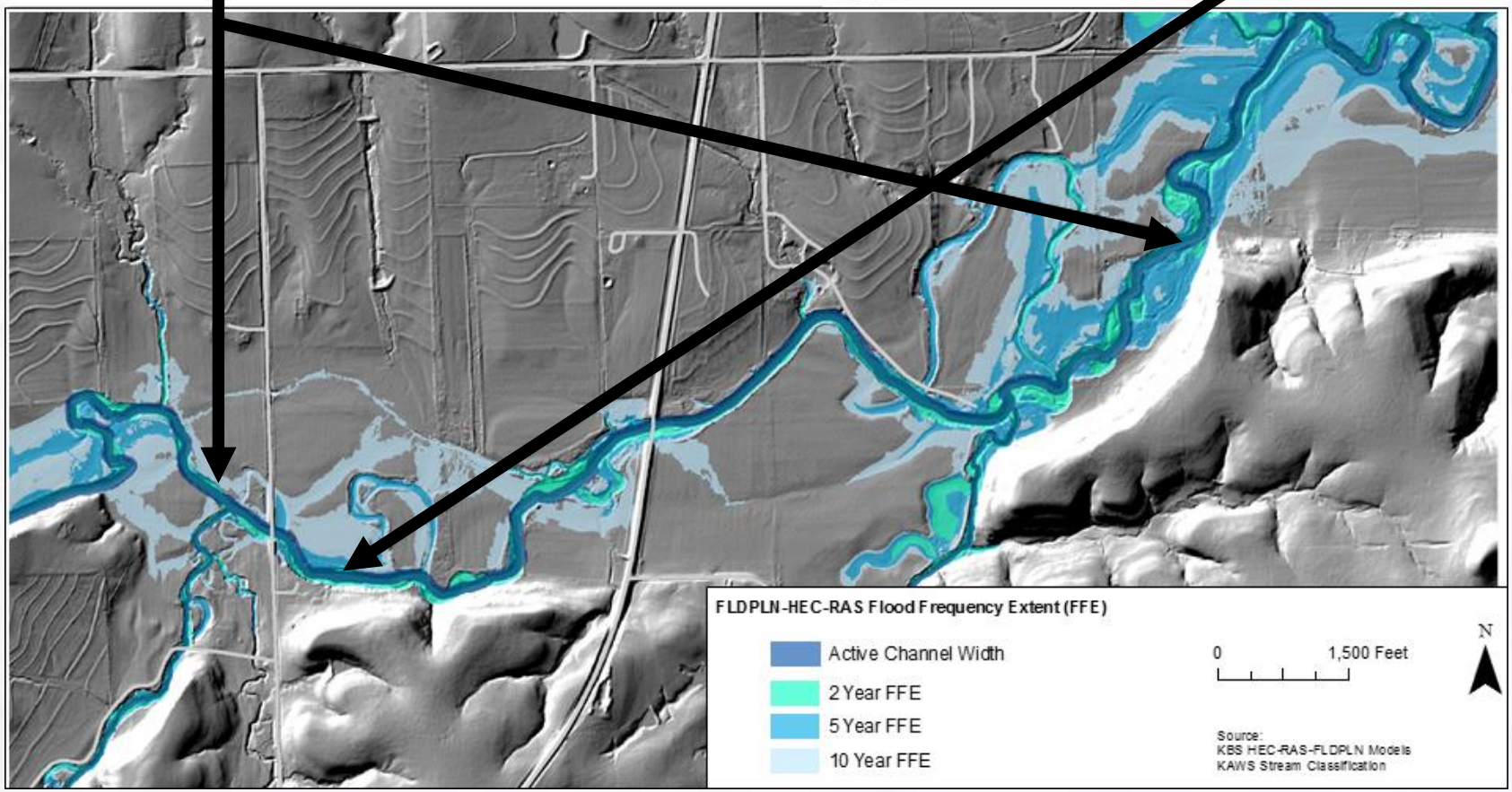


Fourmile Creek, Morris County

Identifying High-Impact Riparian Areas

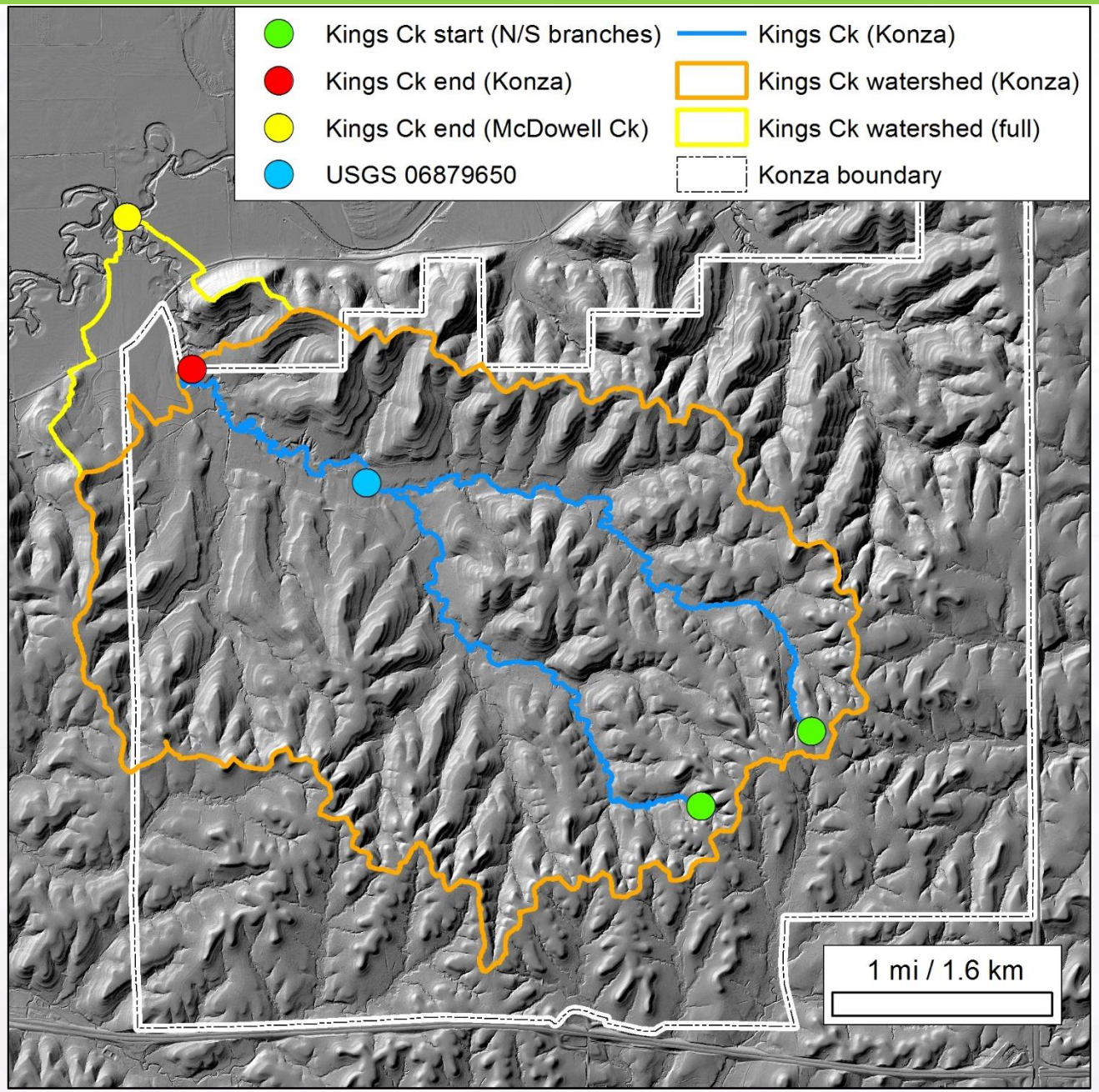






Fourmile Creek, Morris County, KS

Holistic Watershed Management – Konza Study



KU Field Station, Douglas County
Thanks for Listening…
Any Questions?
Height (m)
30
1
0.15
km
jkastens@ku.edu