TWIP and FLDPLN applications for Watershed Restoration Activities

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Talking Points

Agenda

- Soapbox
- Job at Hand
- Toolbox & Example Applications
  - TWIP, FLDPLN, Fluvial Geomorphology & Integration
- Summary

Watershed Restoration

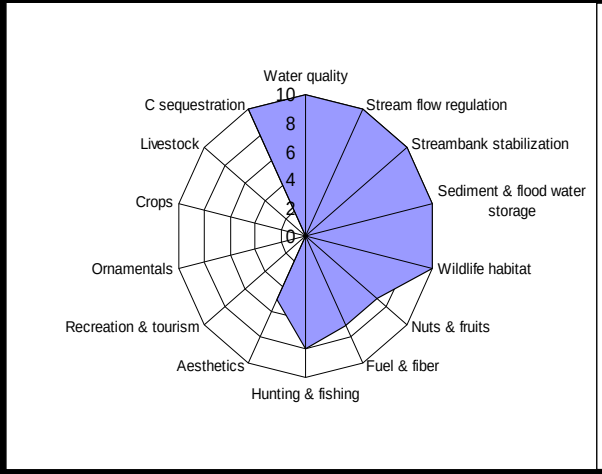
- Shift from a program-by-program, source-by-source, pollutant-by-pollutant approach => integrated, place-based watershed protection & restoration effort

"synergistic systems approach"

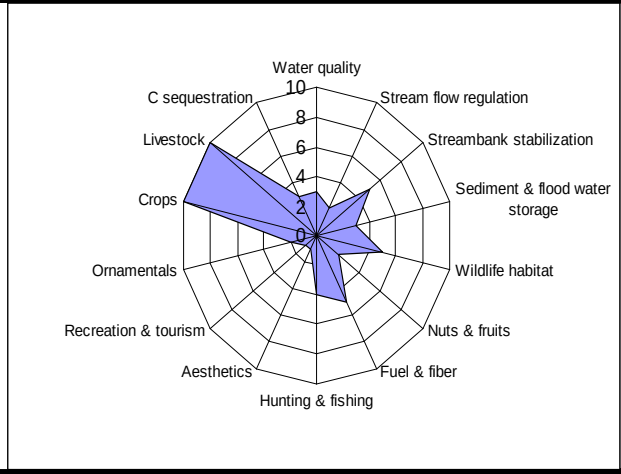
- Land use change (root problem)
- Hydrologic change
- Geomorphologic change
- NPS pollution (TMDLs)
- Critical habitats for declining species
- Wildlife corridors connected to uplands
- Fresh water supplies
- Long-term system health

To What Future Are We Going?

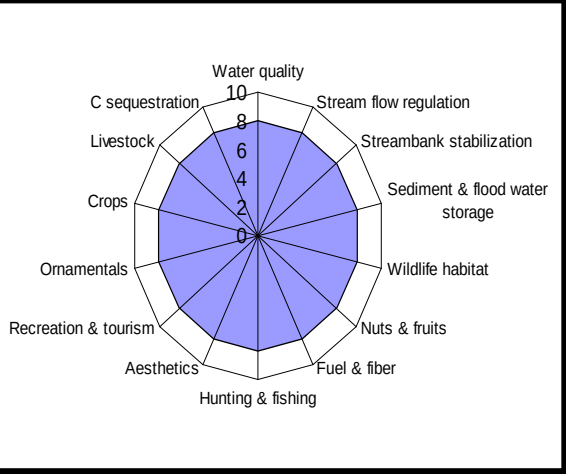
Native & Early Pioneer (Past)



Ag-dominated (Present)



Healthy Systems (Future)

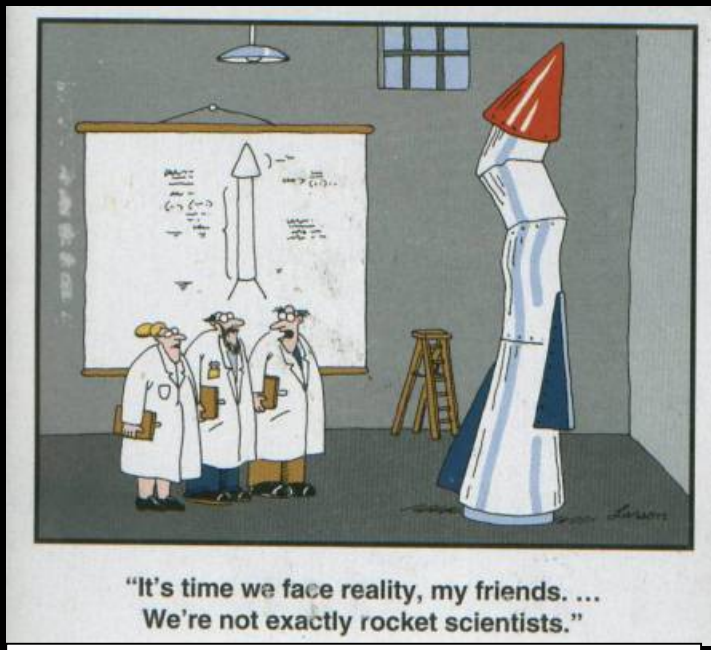


Watershed Restoration: Multiple Objectives But Common Threads

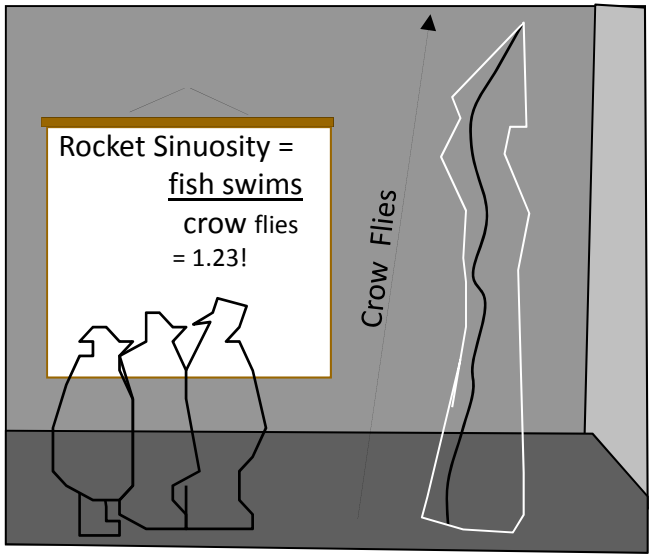
- Restore or approximate natural hydrologic function
- Attenuate effects of NPS pollution and erosion
- Improve native habitat connectivity and ensure redundancy
- Sequester carbon and increase pollinators
- Clean fresh water supplies
- Use scientific, systems approach & natural designs as guides

⇒ Restore and protect wetland and floodplain functions in watershed context

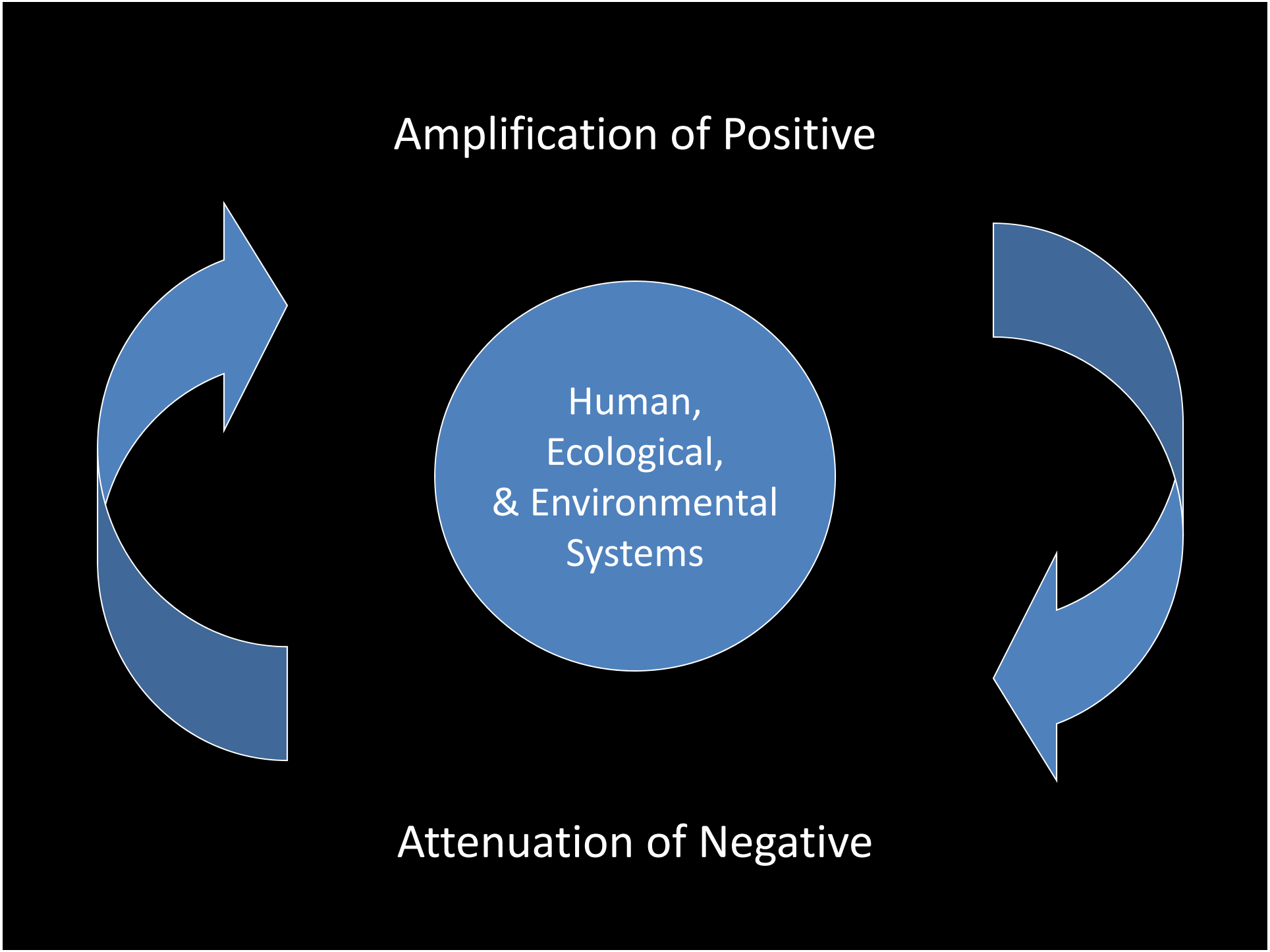
- ⇒ Increased water storage and filtration
- ⇒ Treats NPS pollution and captures sediment
- ⇒ Flood mitigation and stream maintenance
- ⇒ High biodiversity
- ⇒ Sequestered carbon and more pollinator habitat
- ⇒ Improves water quality and storage



"It's time we face reality, my friends. … We're not exactly rocket scientists."

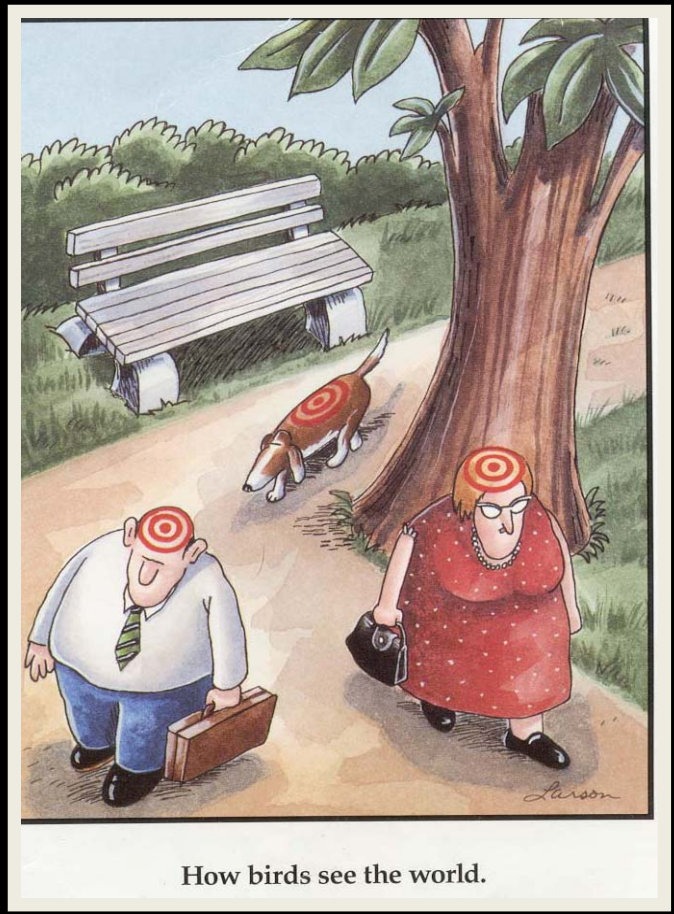


"…and gainful employment in caricature & comedy careers aren't looking real promising either."


Amplification of Positive
Human,
Ecological,
& Environmental
Systems
Attenuation of Negative

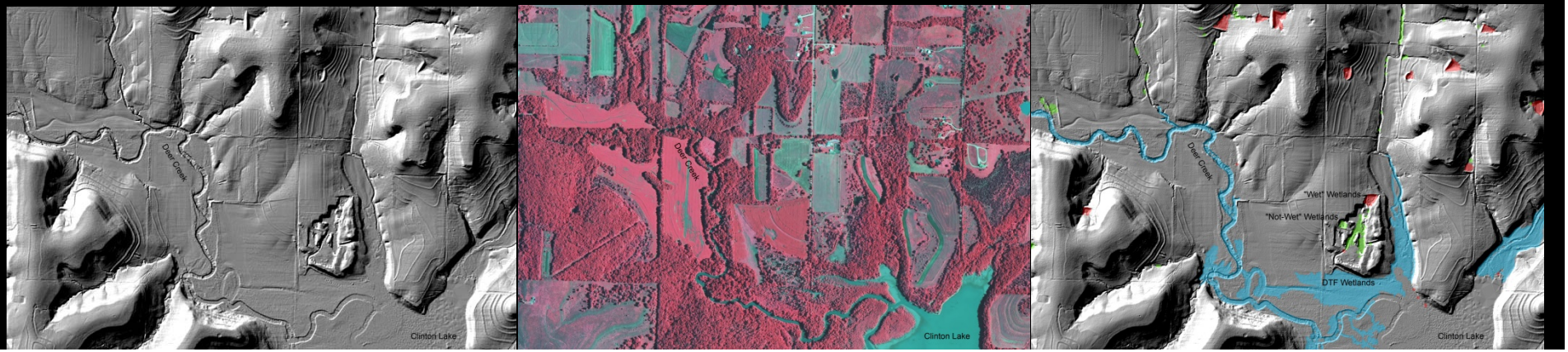
Job at Hand

- Inventory actual and potential wetlands (TWIP)
- Evaluate floodplain connectivity (FLDPLN)
- Assess stream geomorphology and channel evolution
- Integrate tools so practical planning, design, and implementation at watershed scales

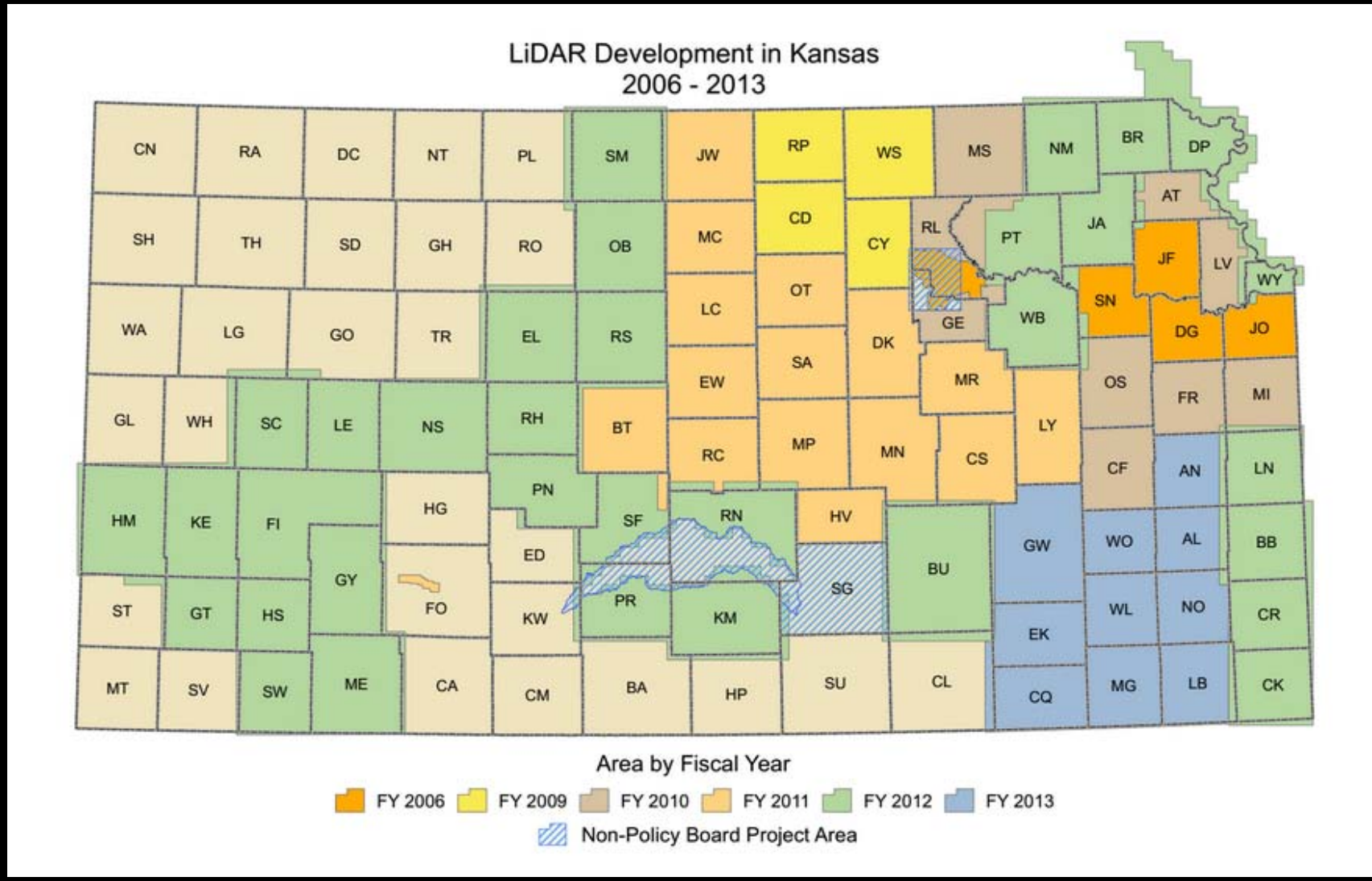


Topographic Wetland Identification Process (TWIP)

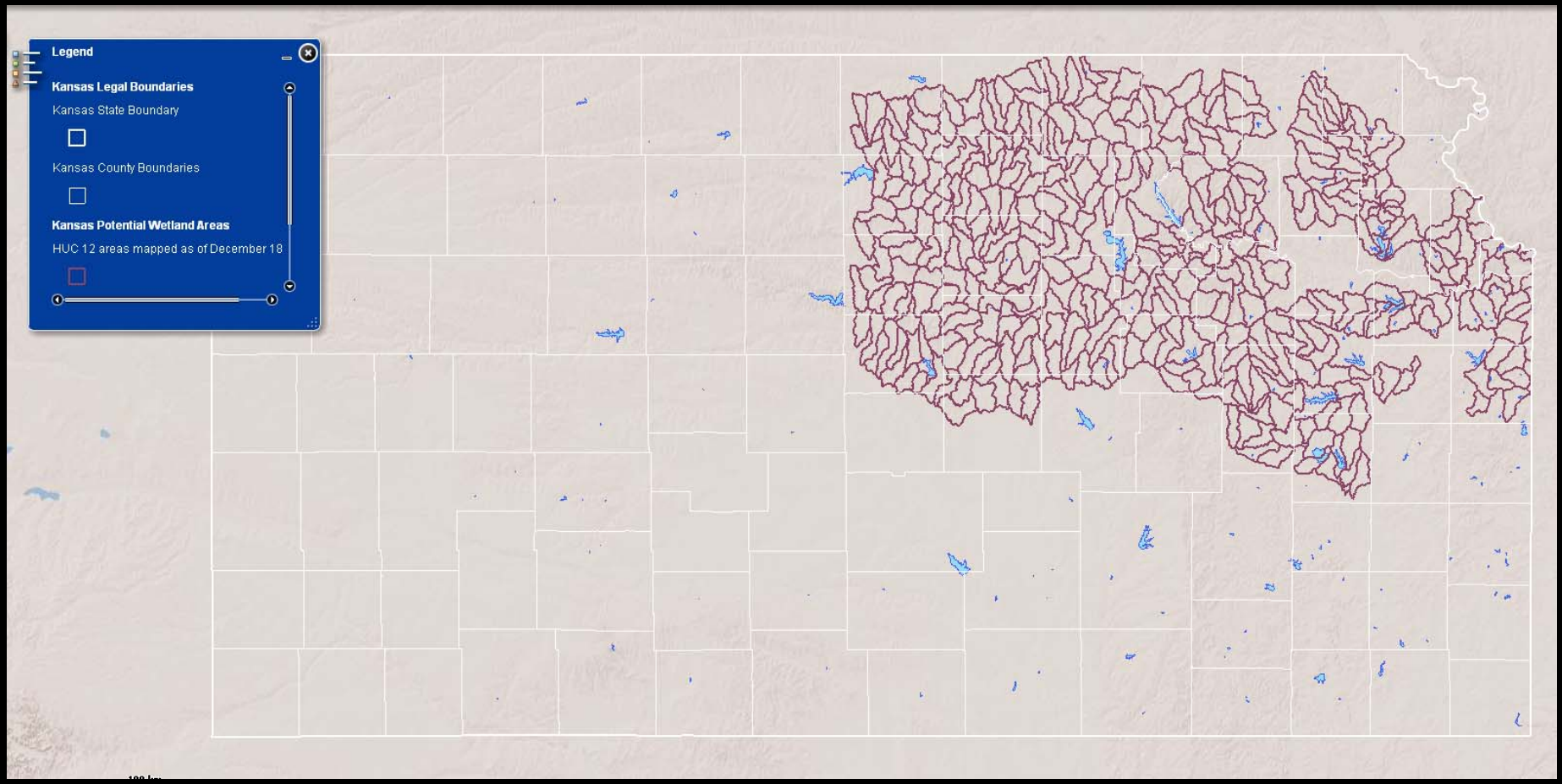
- TWIP Development:
  - 2008, 2009, 2010, 2011, 2013 EPA WPDGs
  - Develop uniform, agency-accepted process to ID wetlands
    - Upper Wakarusa R. watershed (HUC-10)
    - Cottonwood R. and Neosho R. sub-watersheds (4 HUC-12s) above John Redmond
    - LiDAR acquisition
    - Rock Creek-Neosho Watershed (HUC 10)
    - KBS applying to 100 sub-watersheds (HUC-12) through add'l grant/ intern program
    - KBS modifying for applications to playas in western Kansas



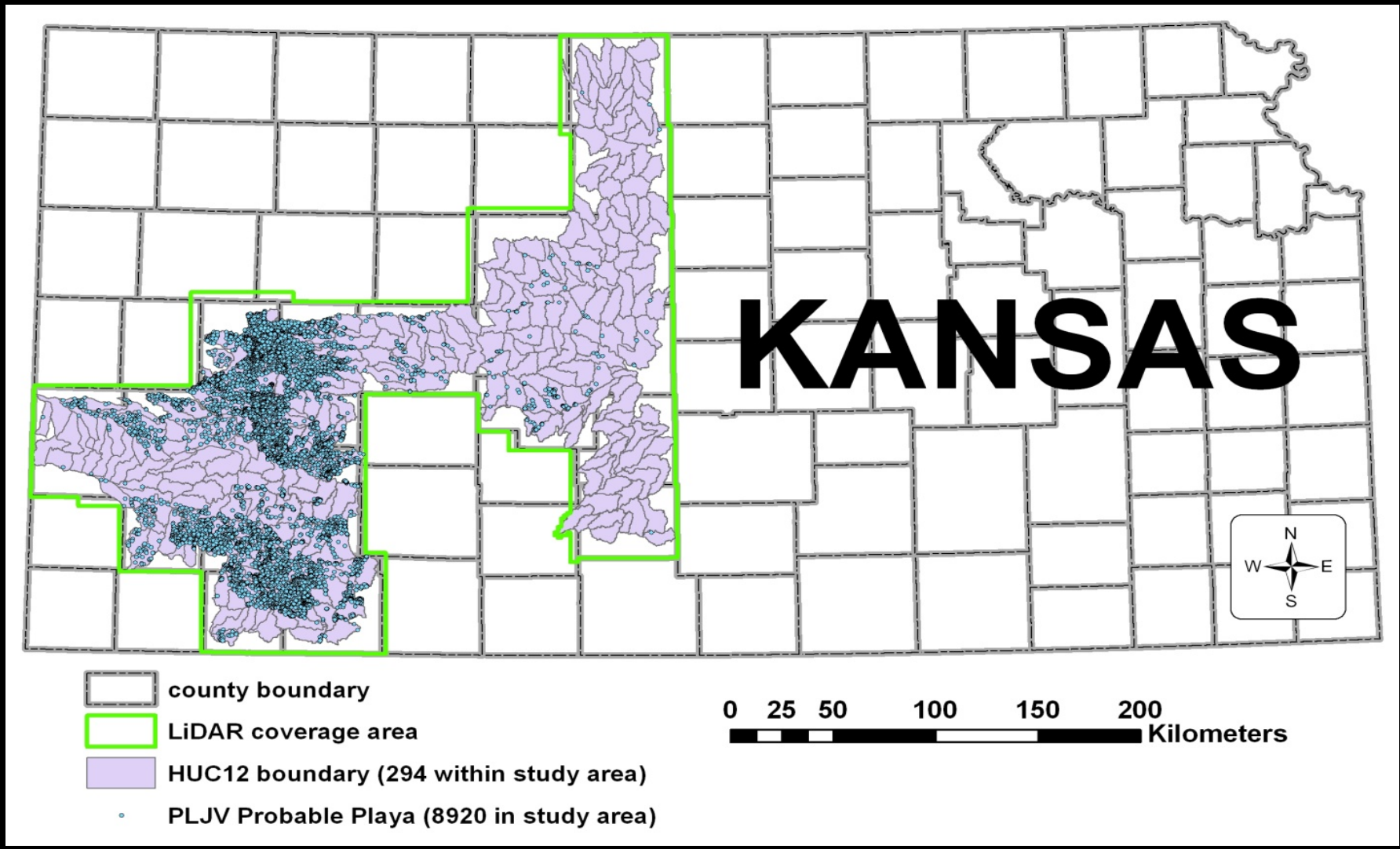
LiDAR Inventory



TWIP Inventory



TWIP Playas


KANSAS
N
W
E
S
county boundary
LiDAR coverage area
HUC12 boundary (294 within study area)
PLJV Probable Playa (8920 in study area)
0 25 50 100 150 200
Kilometers

TWIP: Topographic Wetland Identification Process

TWIP primarily based on:

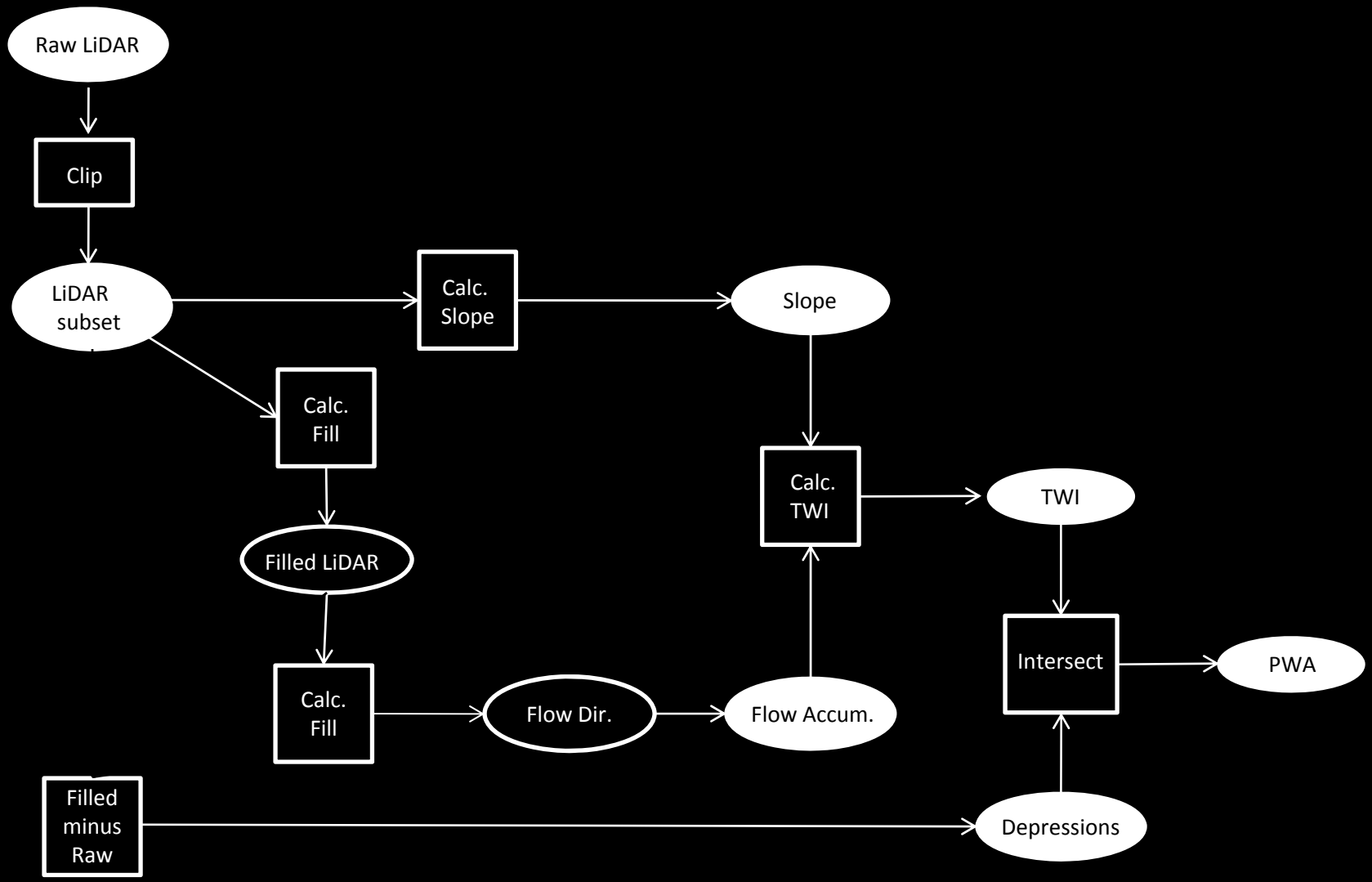
- **Topographic Wetness Index (TWI)**
  - flow accumulation and slope => LN ([flowacc]/ tan [slope])
  - identifies areas where soils may remain wetter
- **Depressions**
  - Sink analysis of LiDAR to ID “fill” locations
  - Sink fill level equals depth

So…if an area is a depression, then its possibly a wetland

And if an area is identified by the TWI, then its possibly a wetland

Therefore…if its is both…then it’s a Potential Wetland Area (PWA)

Topographic Wetland Identification Process (TWIP) to Calculate Potential Wetland Areas (PWA)



TWIP: Topographic Wetland Identification Process

TWIP enhanced by:

- **Detected Wetness**
  - Landsat ETM (bands 4,5,7)
  - NAIP-NIR Imagery (bands 3, 4)
- **Landscape Context**
  - Land use, water bodies, stream channels, roads
- **Channel masking, culvert/ bridge breaching, pond masking**

So…if an area is a Potential Wetland Area (PWA)

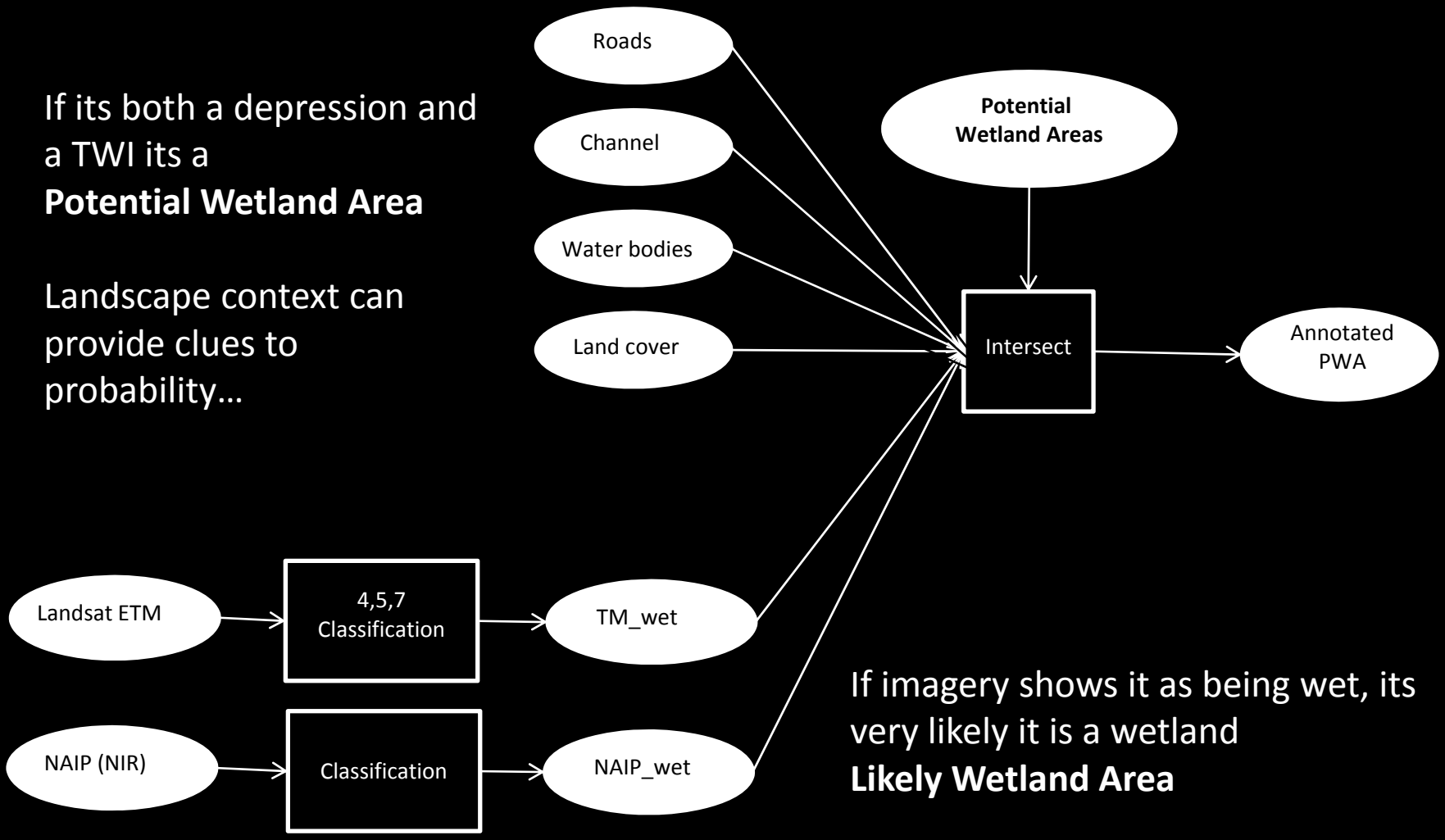
And is also wet in the imagery… it is a Likely Wetland Area (LWA)

PWA and LWA classification enhanced by context and masking

Addition of ancillary attributes

If its both a depression and a TWI its a **Potential Wetland Area**

Landscape context can provide clues to probability…

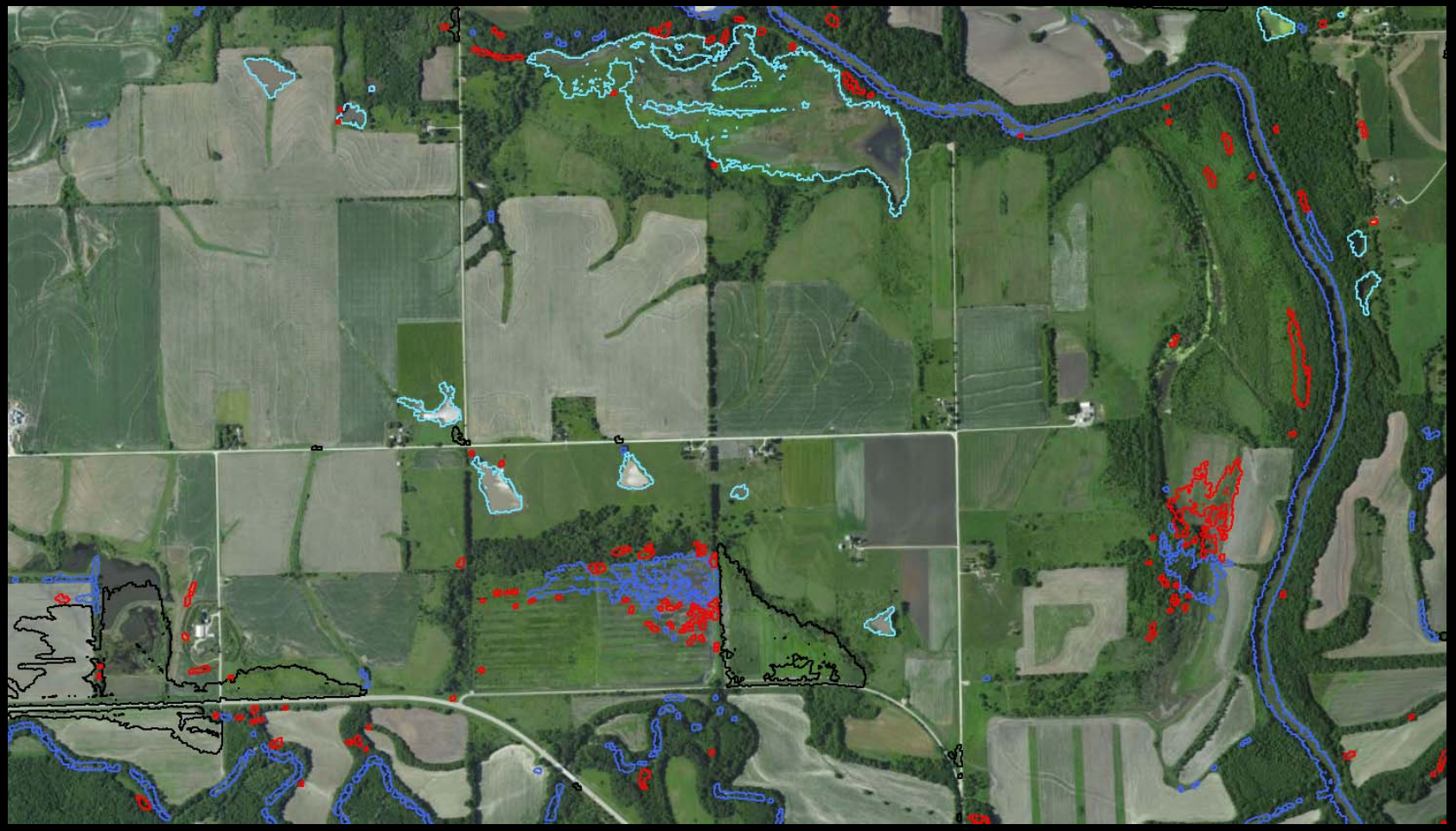


If imagery shows it as being wet, its very likely it is a wetland **Likely Wetland Area**

TWIP: Upper Wakarusa Example

"Wet" Wetlands"
Likely

"Not-Wet" Wetlands"
Potential

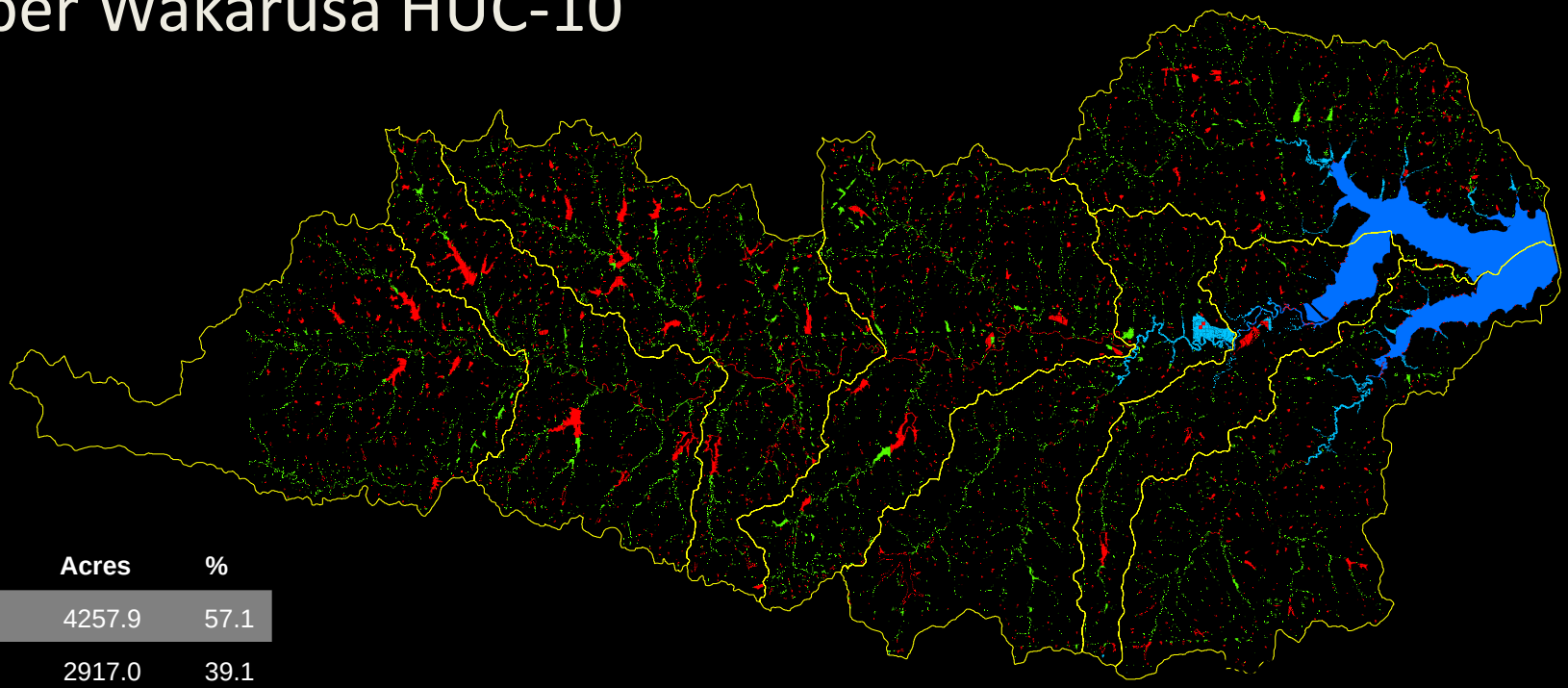


waterbodies channel roadside upland

perry_pwa

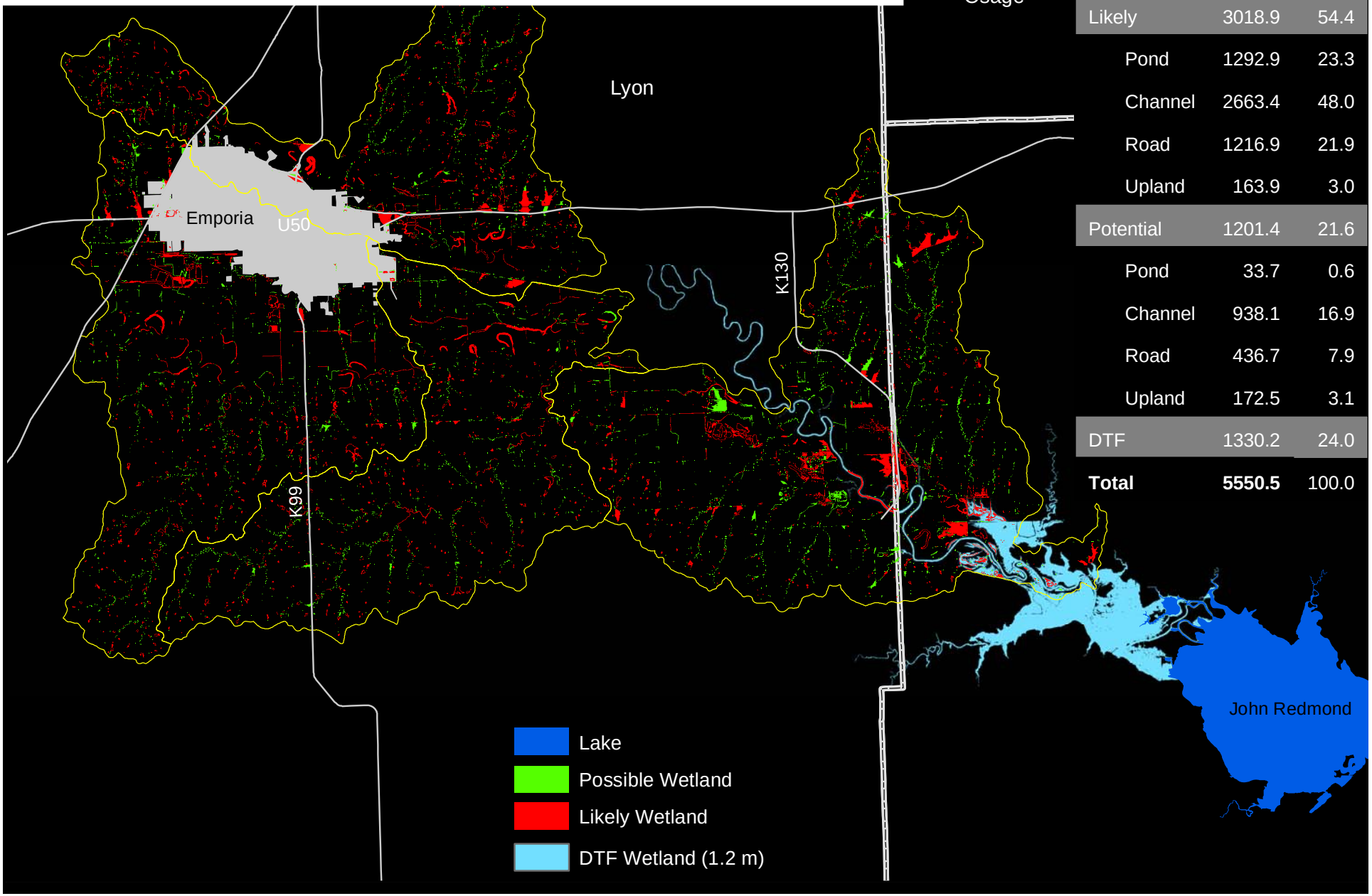
	FID	Shape	Id	sq_mtrs	acres	channel	water	road	upland	LC	TM_wet	wtlnd_prob
▸	6203	Polygon	0	6432.196167	1.589424	yes	yes	no	no	50	yes	likely
	6204	Polygon	0	186.37677	0.046055	no	no	no	yes	20	no	potential
	6205	Polygon	0	213.542092	0.052767	no	no	yes	no	30	no	potential
	6206	Polygon	0	1996.547871	0.493356	no	yes	no	no	30	yes	likely
	6207	Polygon	0	9475.403195	2.341414	no	yes	no	no	50	yes	likely
	6208	Polygon	0	146.483755	0.036197	no	no	no	yes	40	no	potential

TWIP: Example Inventory
Upper Wakarusa HUC-10

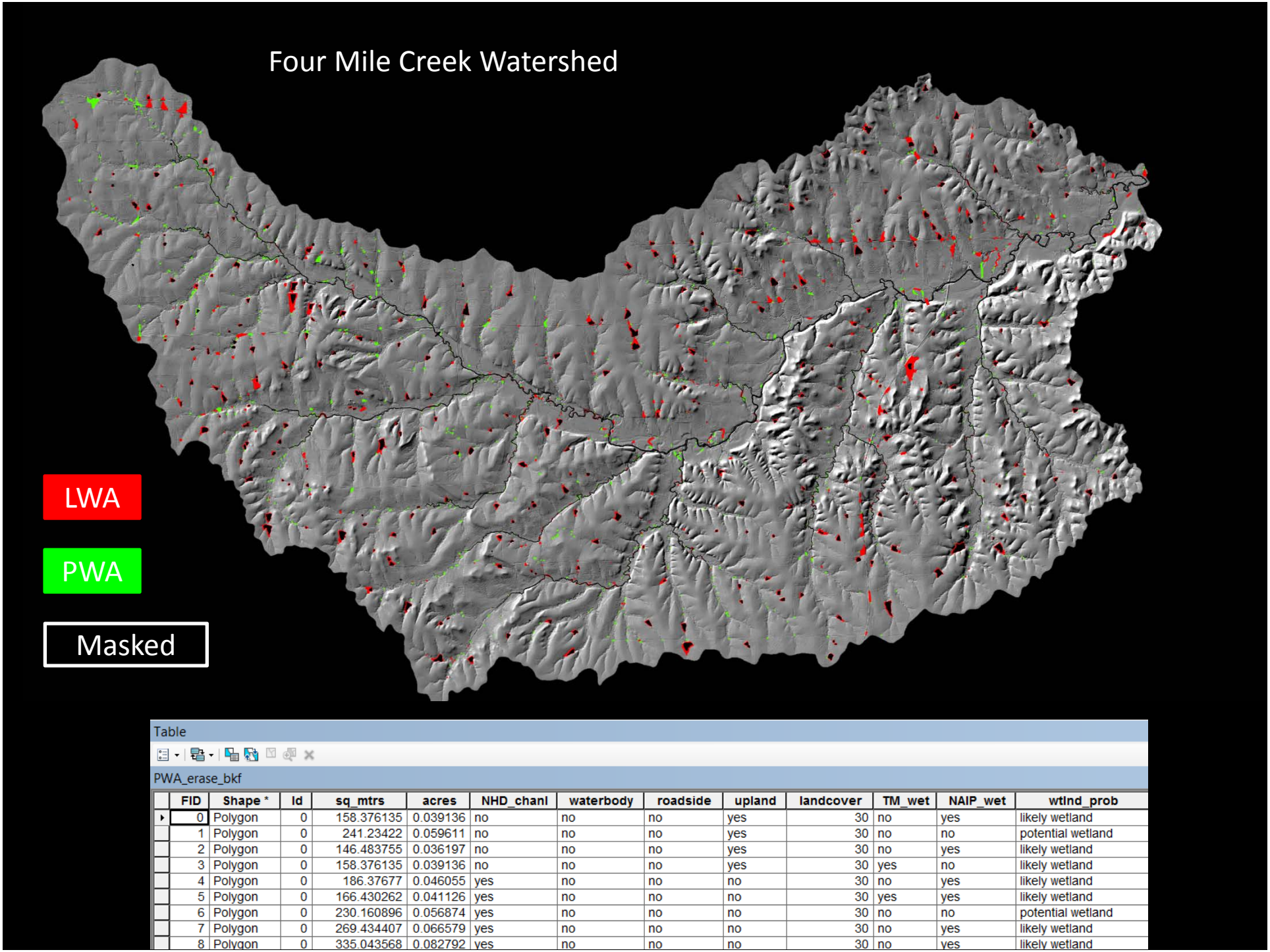


Wetlands	Acres	%
Likely	4257.9	57.1
Pond	2917.0	39.1
Channel	3432.3	46.0
Road	622.5	8.3
Upland	410.6	5.5
Potential	2463.1	33.0
Pond	23.2	0.3
Channel	1868.3	25.1
Road	735.8	9.9
Upland	457.0	6.1
DTF	735.3	9.9
Total	**7456.4**	**100.0**

TWIP: Example Inventory
Cottonwood & Neosho HUC-12s



Wetlands	Acres	%
Likely	3018.9	54.4
Pond	1292.9	23.3
Channel	2663.4	48.0
Road	1216.9	21.9
Upland	163.9	3.0
Potential	1201.4	21.6
Pond	33.7	0.6
Channel	938.1	16.9
Road	436.7	7.9
Upland	172.5	3.1
DTF	1330.2	24.0
Total	**5550.5**	100.0



Table

PWA_erase_bkf

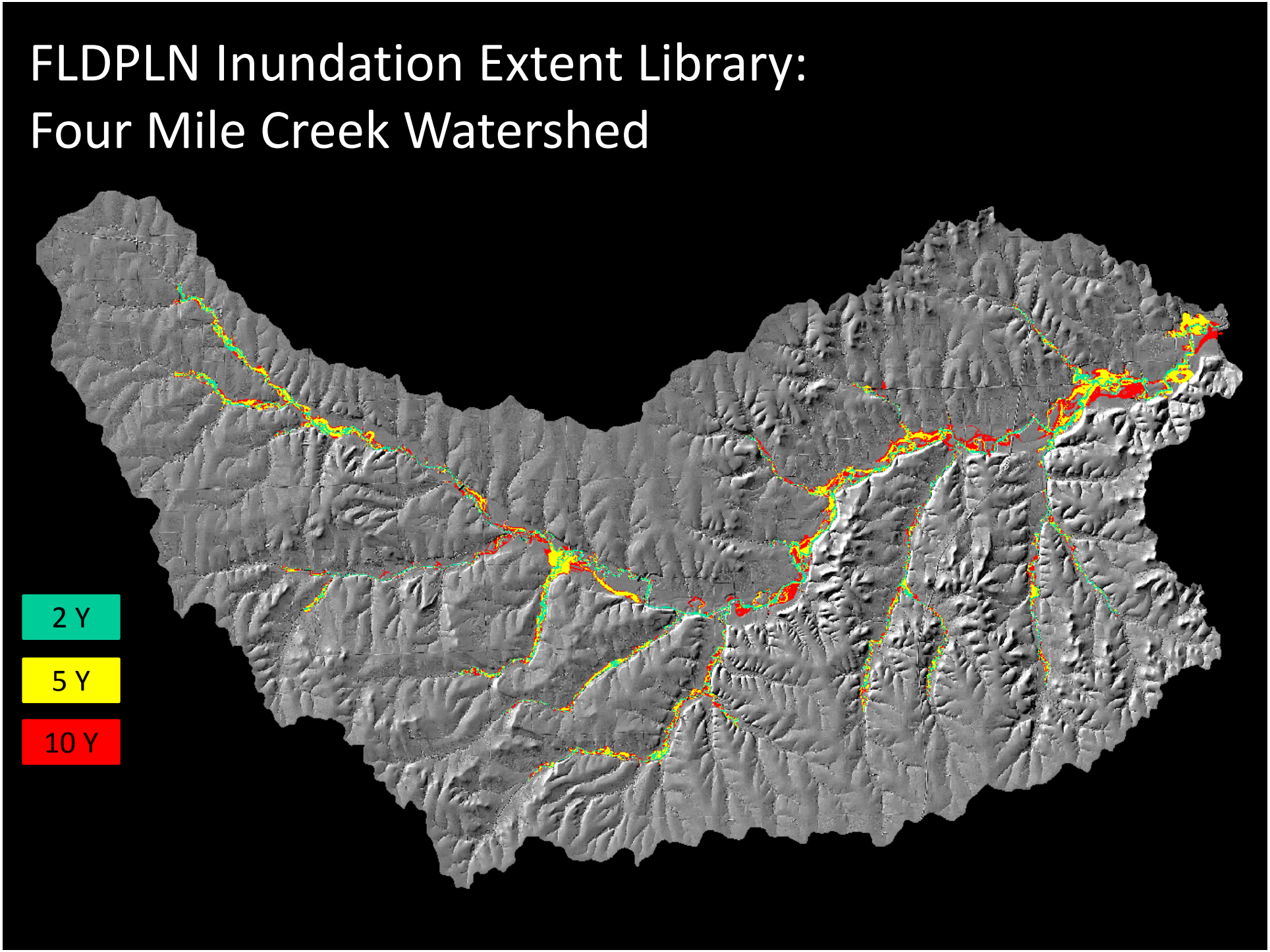
FID	Shape *	Id	sq_mtrs	acres	NHD_chanl	waterbody	roadside	upland	landcover	TM_wet	NAIP_wet	wtlnd_prob
0	Polygon	0	158.376135	0.039136	no	no	no	yes	30	no	yes	likely wetland
1	Polygon	0	241.23422	0.059611	no	no	no	yes	30	no	no	potential wetland
2	Polygon	0	146.483755	0.036197	no	no	no	yes	30	no	yes	likely wetland
3	Polygon	0	158.376135	0.039136	no	no	no	yes	30	yes	no	likely wetland
4	Polygon	0	186.37677	0.046055	yes	no	no	no	30	no	yes	likely wetland
5	Polygon	0	166.430262	0.041126	yes	no	no	no	30	yes	yes	likely wetland
6	Polygon	0	230.160896	0.056874	yes	no	no	no	30	no	no	potential wetland
7	Polygon	0	269.434407	0.066579	yes	no	no	no	30	no	yes	likely wetland
8	Polygon	0	335.043568	0.082792	yes	no	no	no	30	no	yes	likely wetland

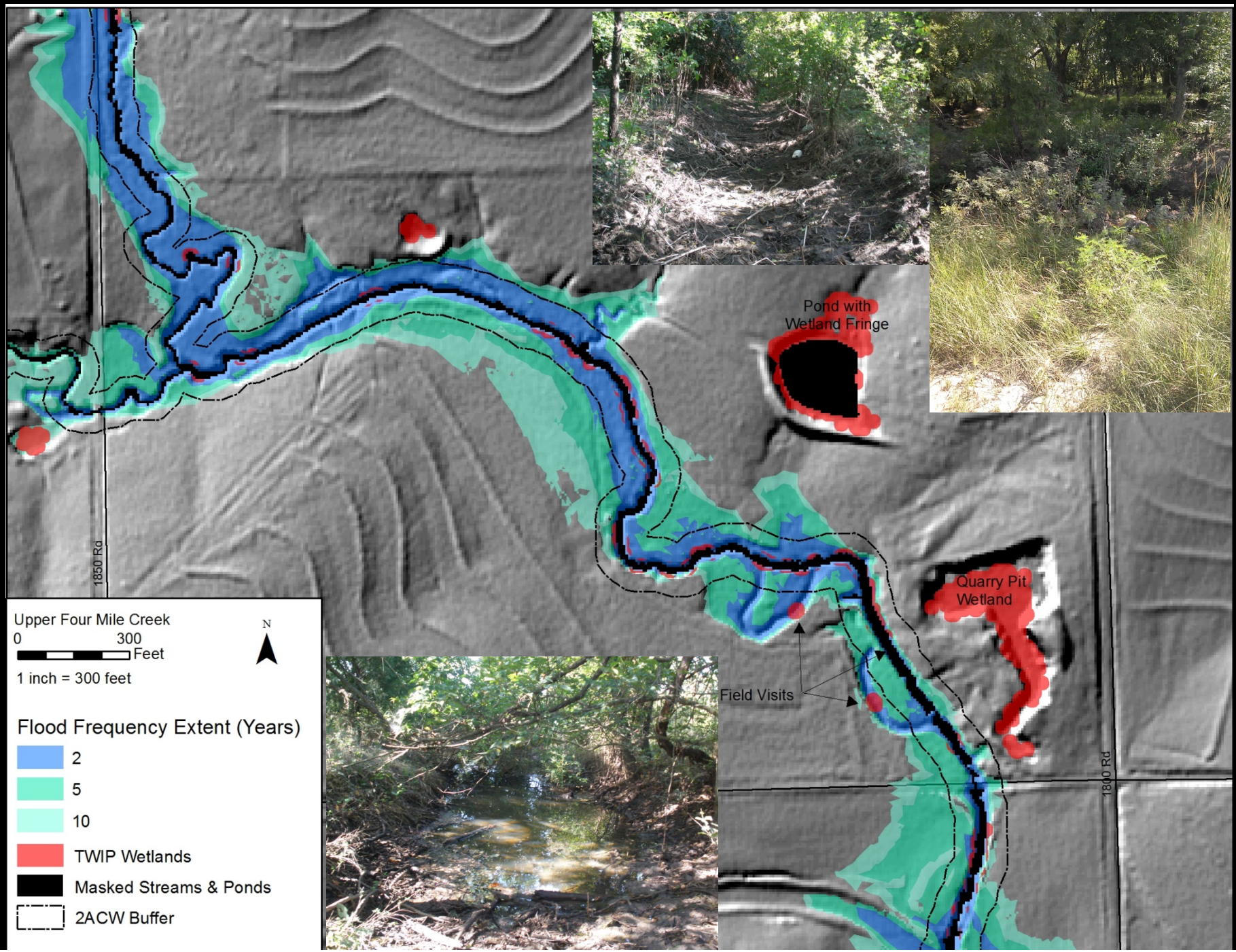
Toolbox: FLDPLN Inundation Libraries

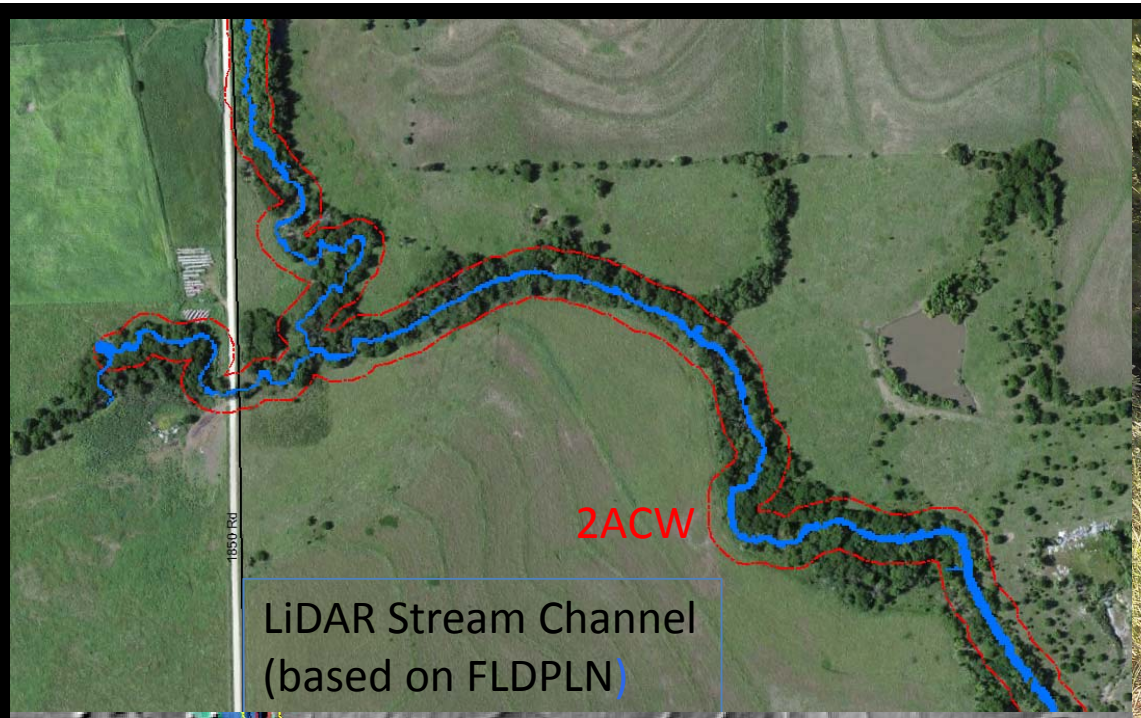
FLDPLN can be used to:

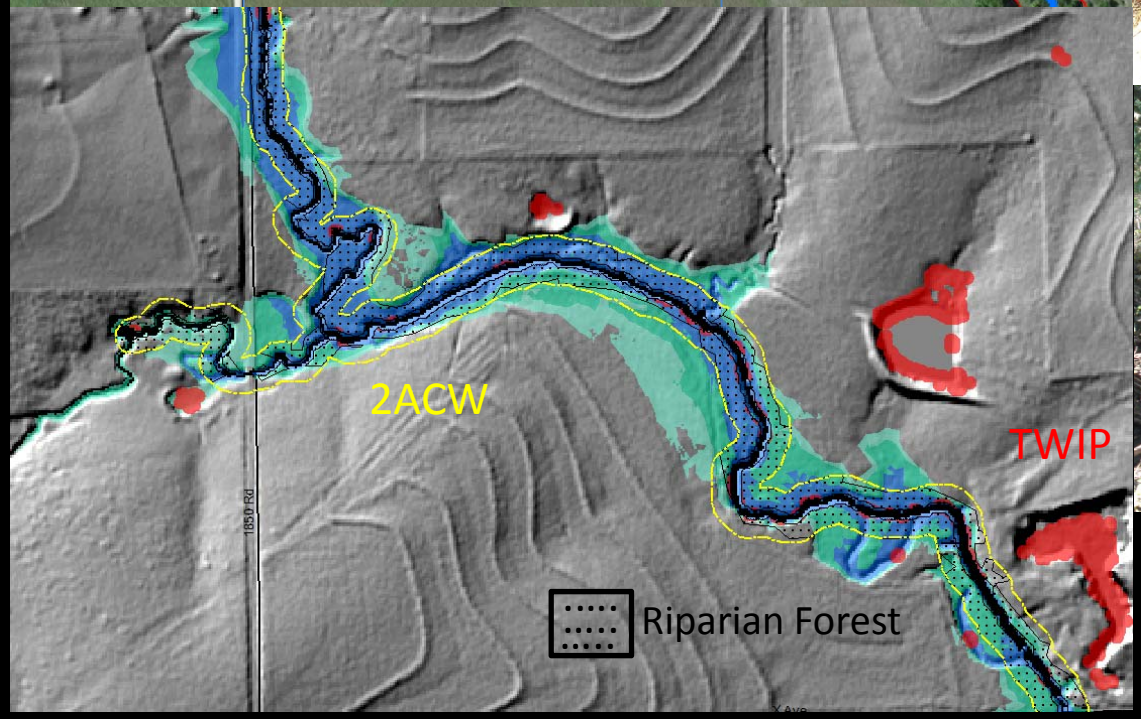
- Create stage dependent floodplain extent libraries
- Identify connective relationships between floodwaters and floodplain features
  - Wetlands & riparian areas
  - Flood frequency extent
  - Proper functioning condition
- Evaluate stream geomorphologic and evolutionary processes
  - Approximate bankfull channel and floodprone area
  - Extract geomorphological variables (W/D ratio, Entrenchment)
  - Visually assess stream conditions

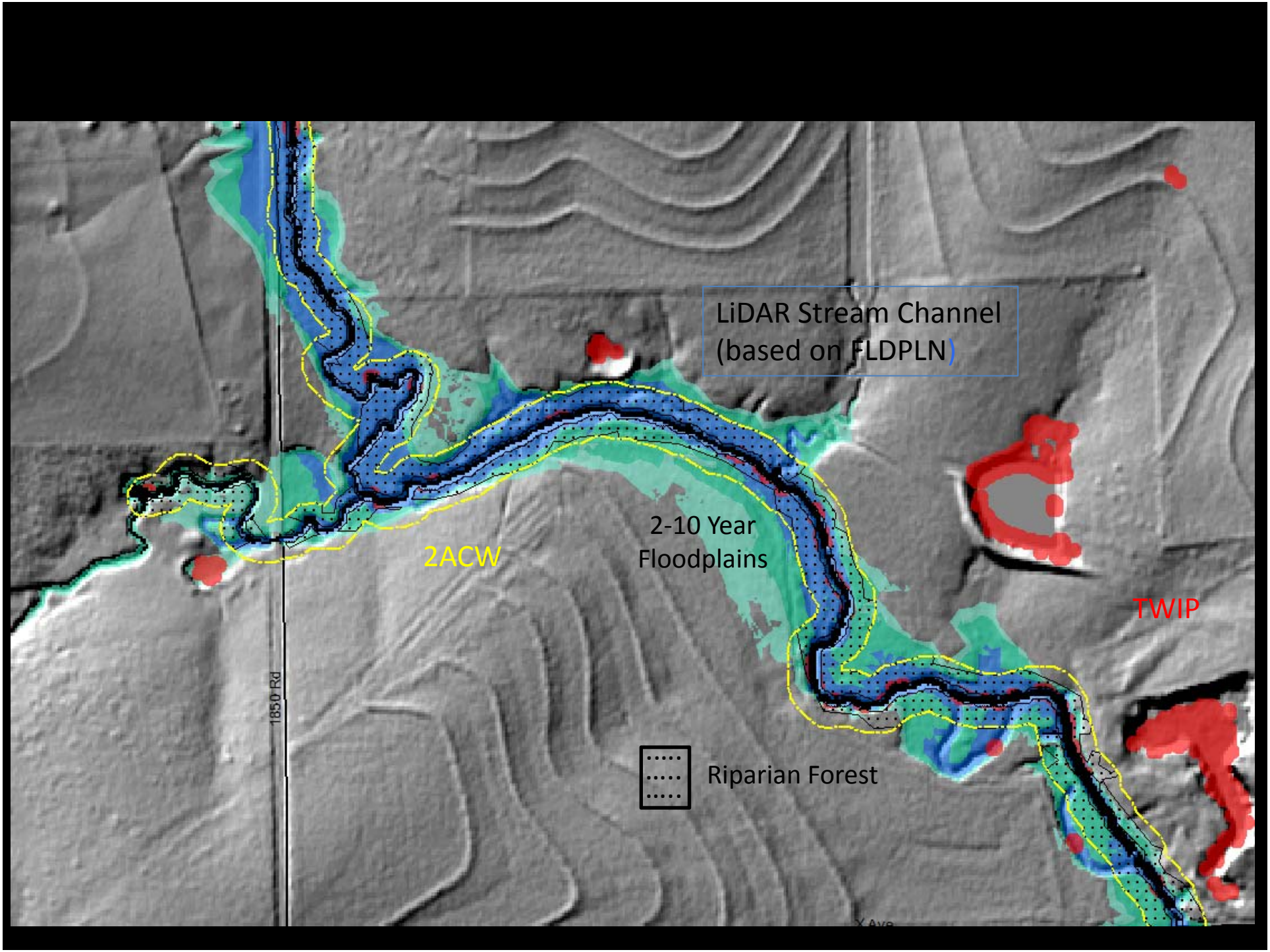
FLDPLN Inundation Extent Library: Four Mile Creek Watershed




Upper Four Mile Creek
0
300
Feet
1 inch = 300 feet
N
Flood Frequency Extent (Years)
2
5
10
TWIP Wetlands
Masked Streams & Ponds
2ACW Buffer
1850 Rd
1800 Rd
Pond with
Wetland Fringe
Quarry Pit
Wetland
Field Visits


1650 Rd
2ACW
LiDAR Stream Channel
(based on FLDPLN)

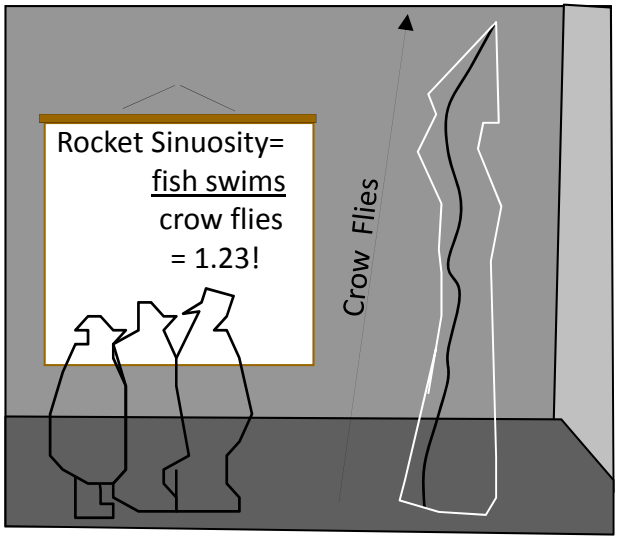

1850 Rd
2ACW
TWIP
Riparian Forest


LiDAR Stream Channel
(based on FLDPLN)
2ACW
2-10 Year
Floodplains
TWIP
1850 Rd
Riparian Forest

Fluvial Geomorphology

- Regional Curves
- "Assessment, Geomorphic Definition and Documentation of Kansas Stream Corridor Reference Reaches
  - EPA WPDG to State Conservation Commission
- Blue-print for "stable" channel forms in different hydrophysiographic provinces
- Drainage area regression equations for:
  - Bankfull discharge, cross-section, width, depth
- E.g., Flint Hills Regional Curves

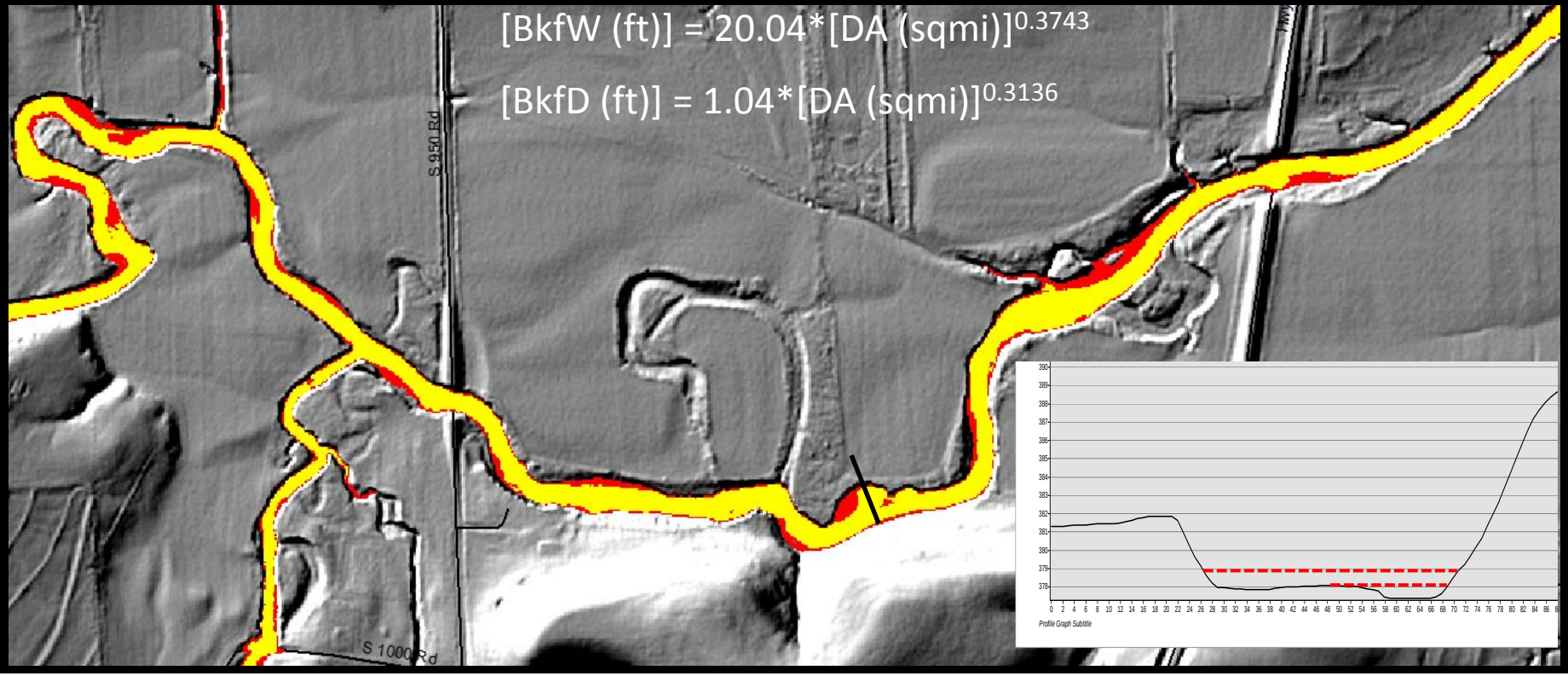
$$[BkfW\ (ft)] = 20.04*[DA\ (sqmi)]^{0.3743}$$

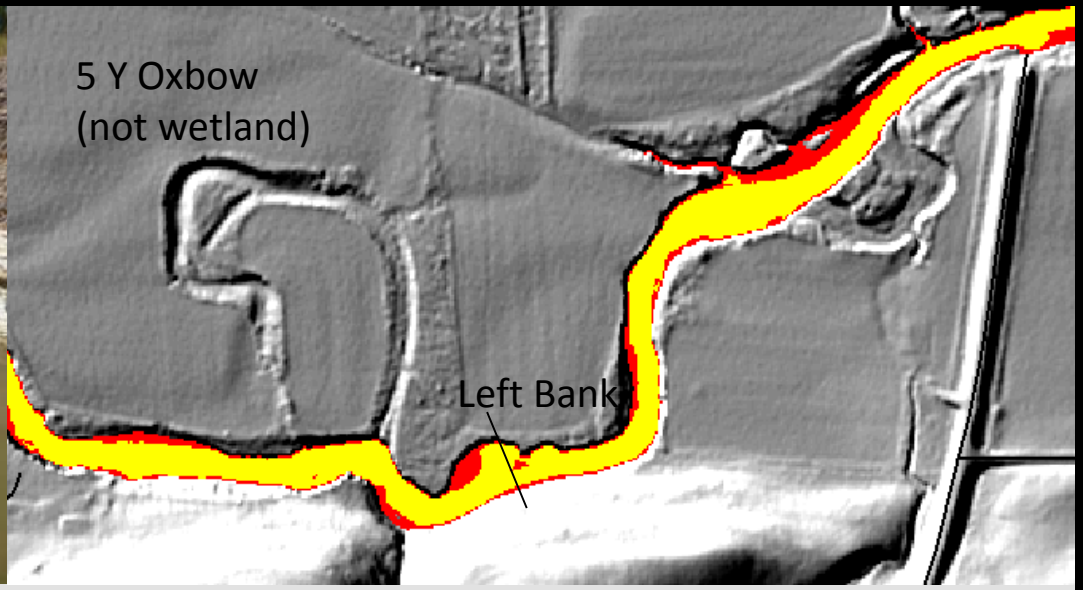


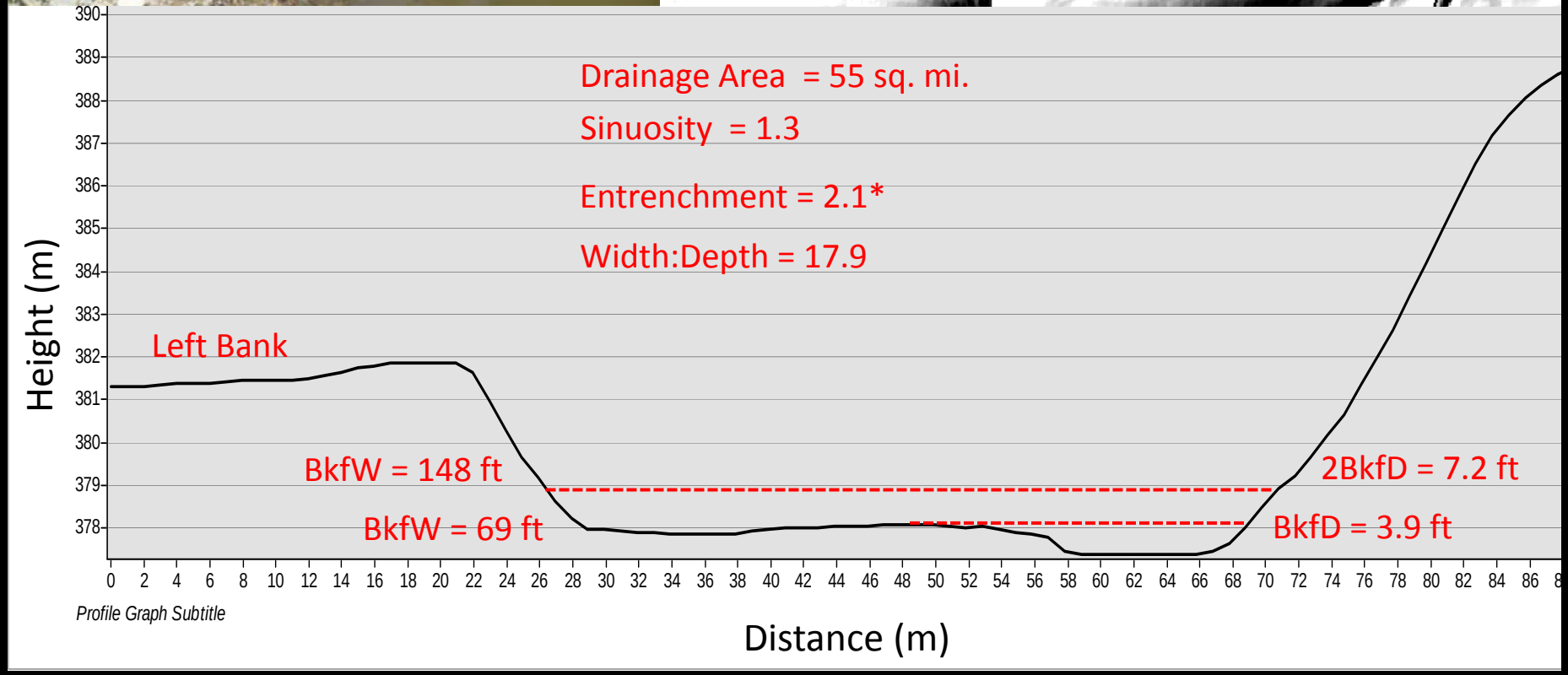
"…and gainful employment in caricature & comedy careers aren't looking real promising either."

Fluvial Geomorphology

- Regional Curves Incorporated into FLDPLN
- Flint Hills Regional Curves, Kansas
  - BkfD inundation extent should approximate bankfull stream channel
  - 2BkfD inundation extent should approximate floodprone area
  - Floodprone Width: Bankfull Width = Entrenchment Ratio

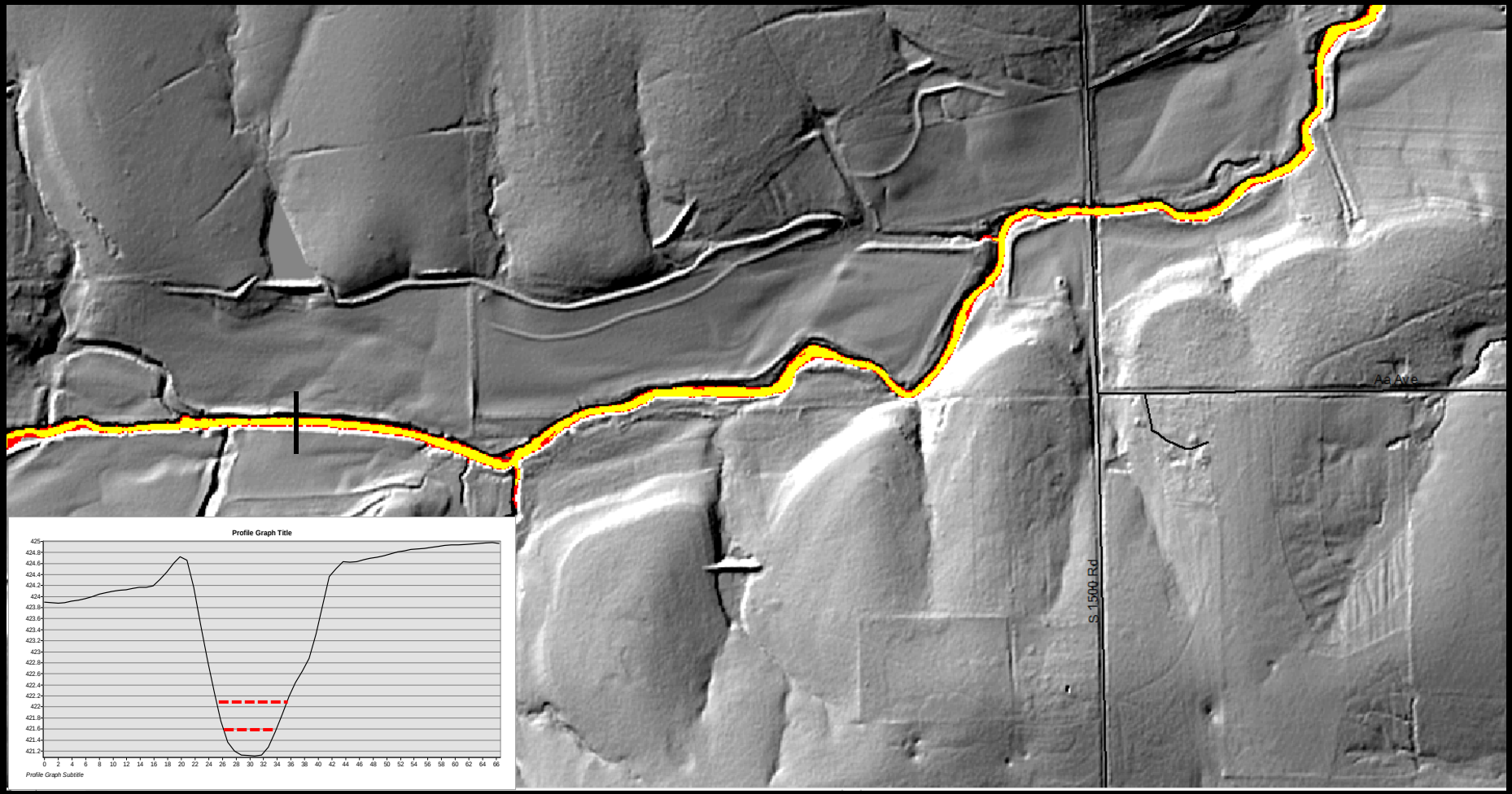



5 Y Oxbow
(not wetland)
Left Bank

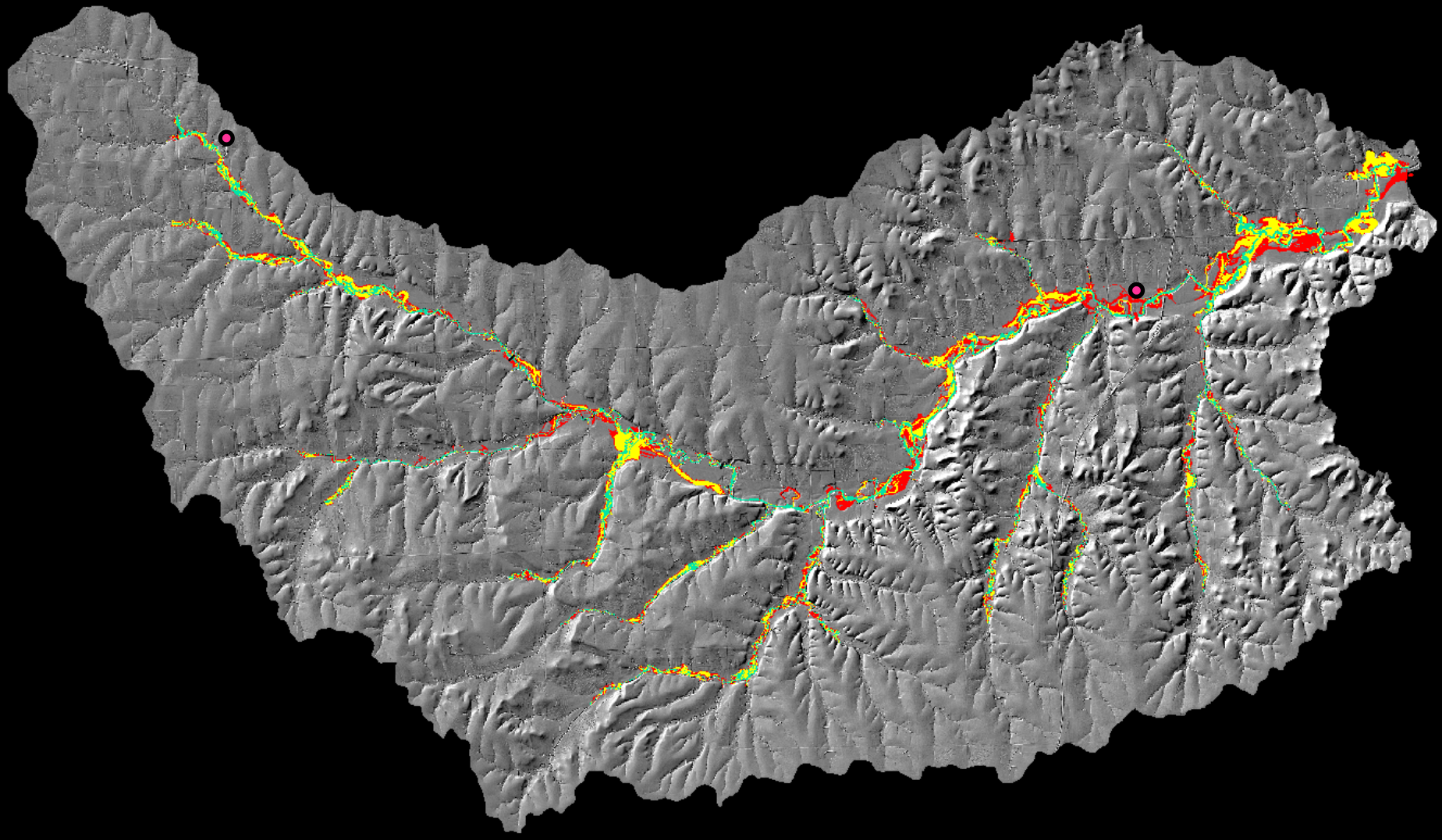

Drainage Area = 55 sq. mi.
Sinuosity = 1.3
Entrenchment = 2.1*
Width:Depth = 17.9
Left Bank
BkfW = 148 ft
BkfW = 69 ft
2BkfD = 7.2 ft
BkfD = 3.9 ft
Height (m)
390
389
388
387
386
385
384
383
382
381
380
379
378
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86
Profile Graph Subtitle
Distance (m)

Fluvial Geomorphology

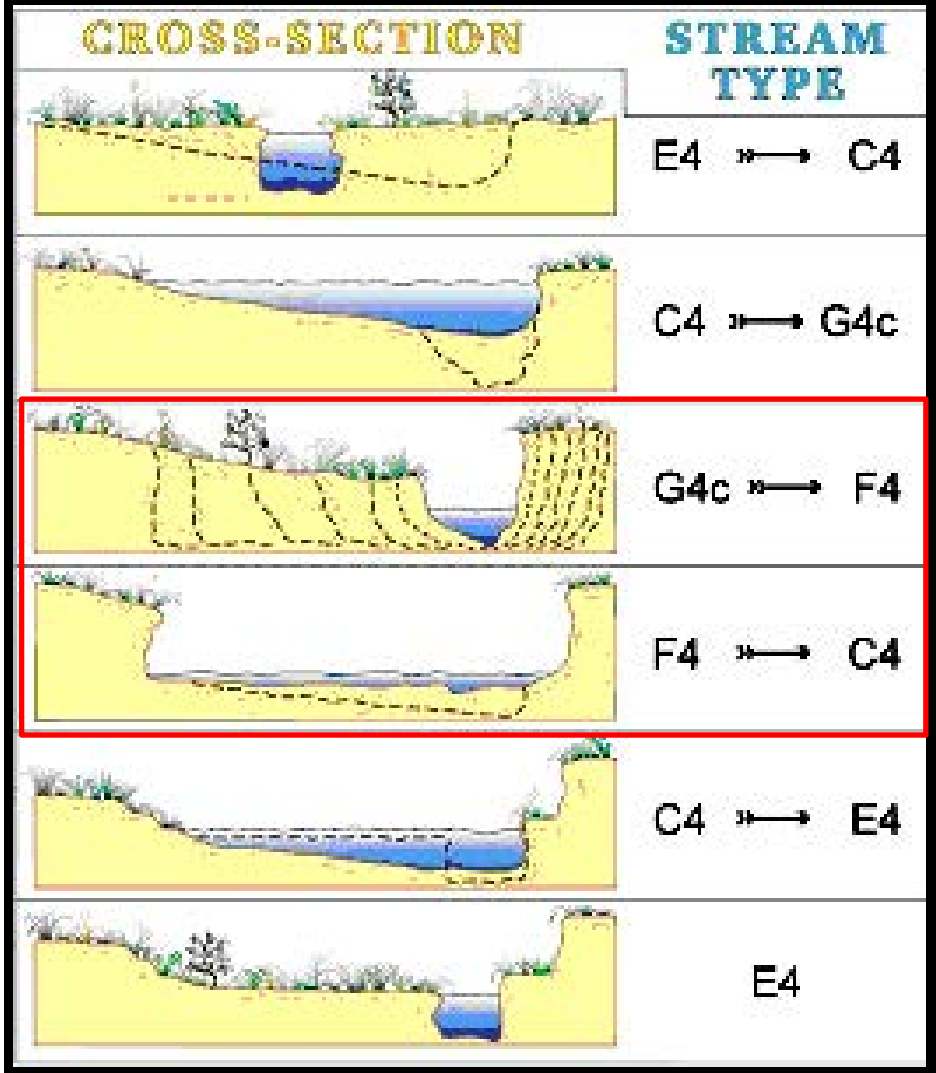
BkfD inundation extent should approximate bankfull stream channel
2BkfD inundation extent should approximate floodprone area

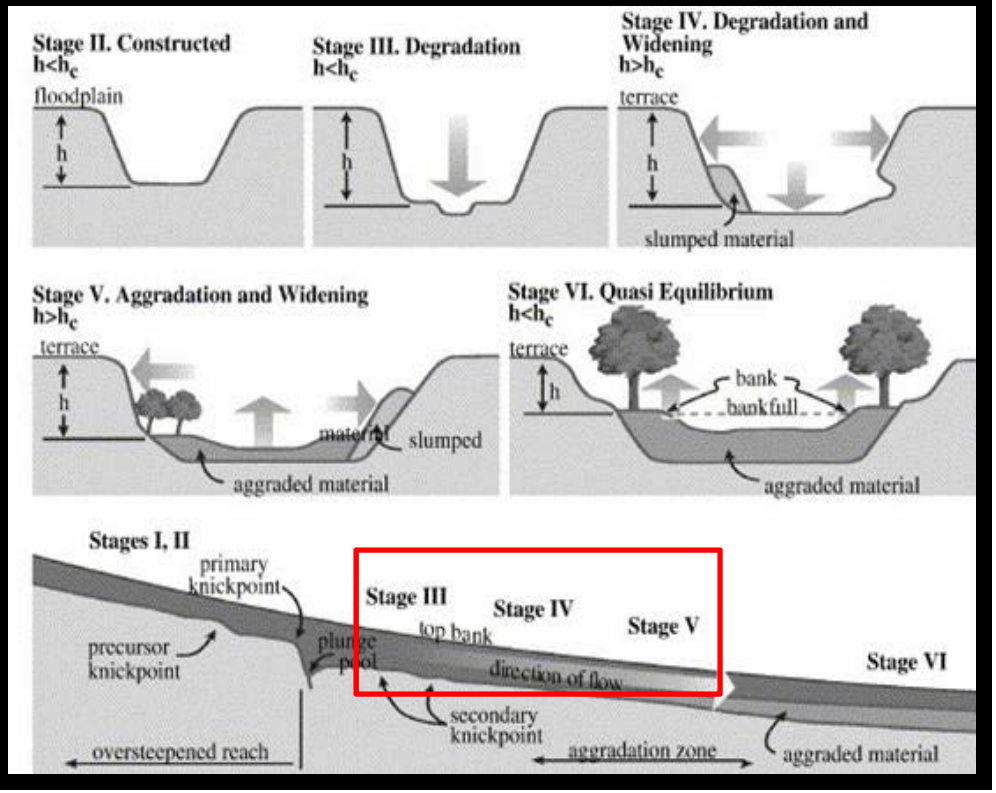


Fluvial Geomorphology



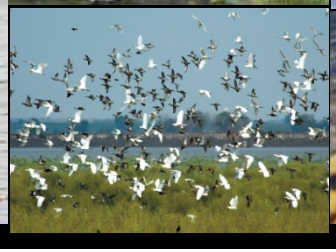
Fluvial Geomorphology





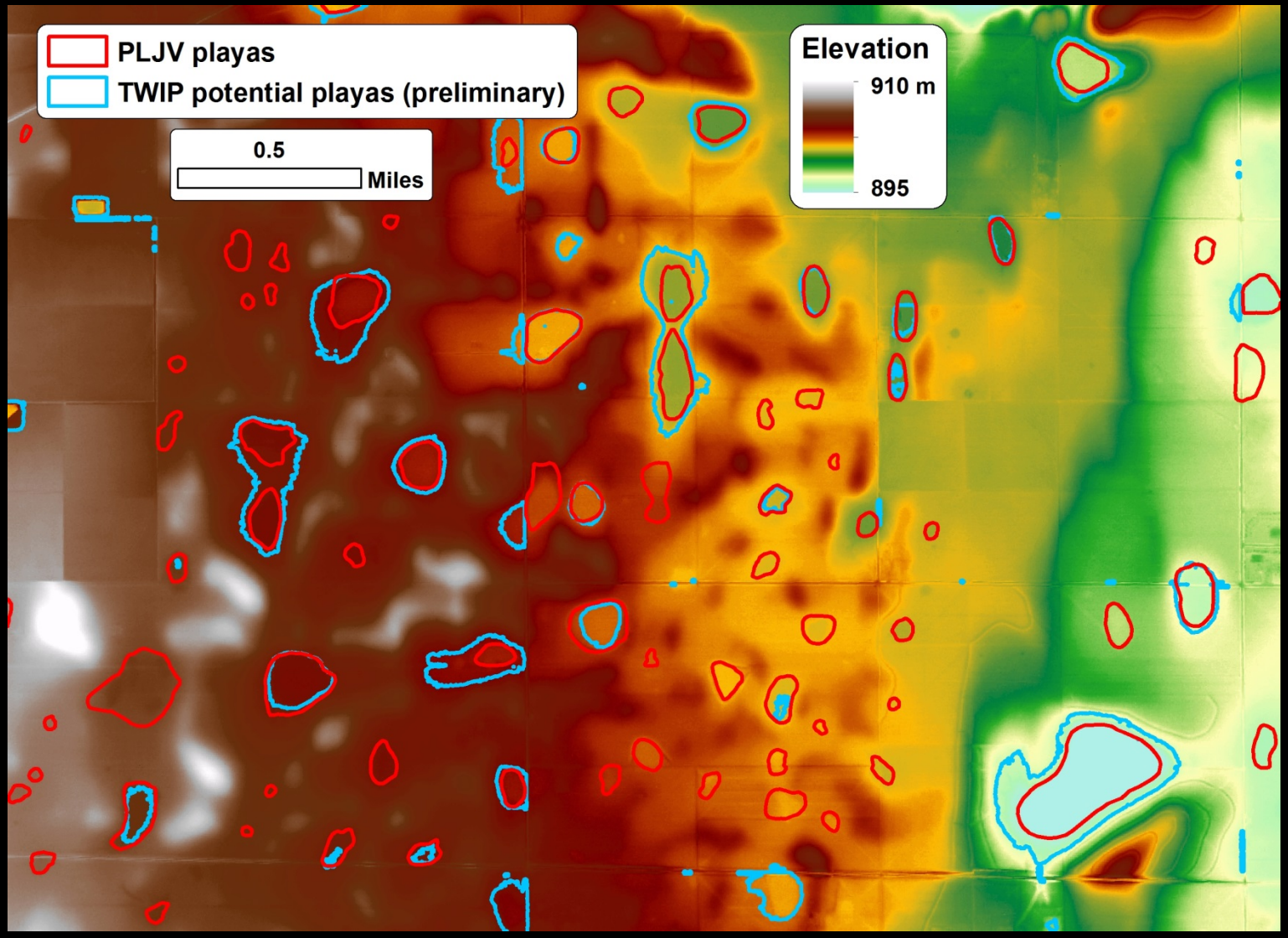
Other Applications

- Playa Mapping
- Riparian Potential & Proper Functioning Condition
- BMP Locator
- “Waffle” and wetland capacity for watershed storage and natural hydrology

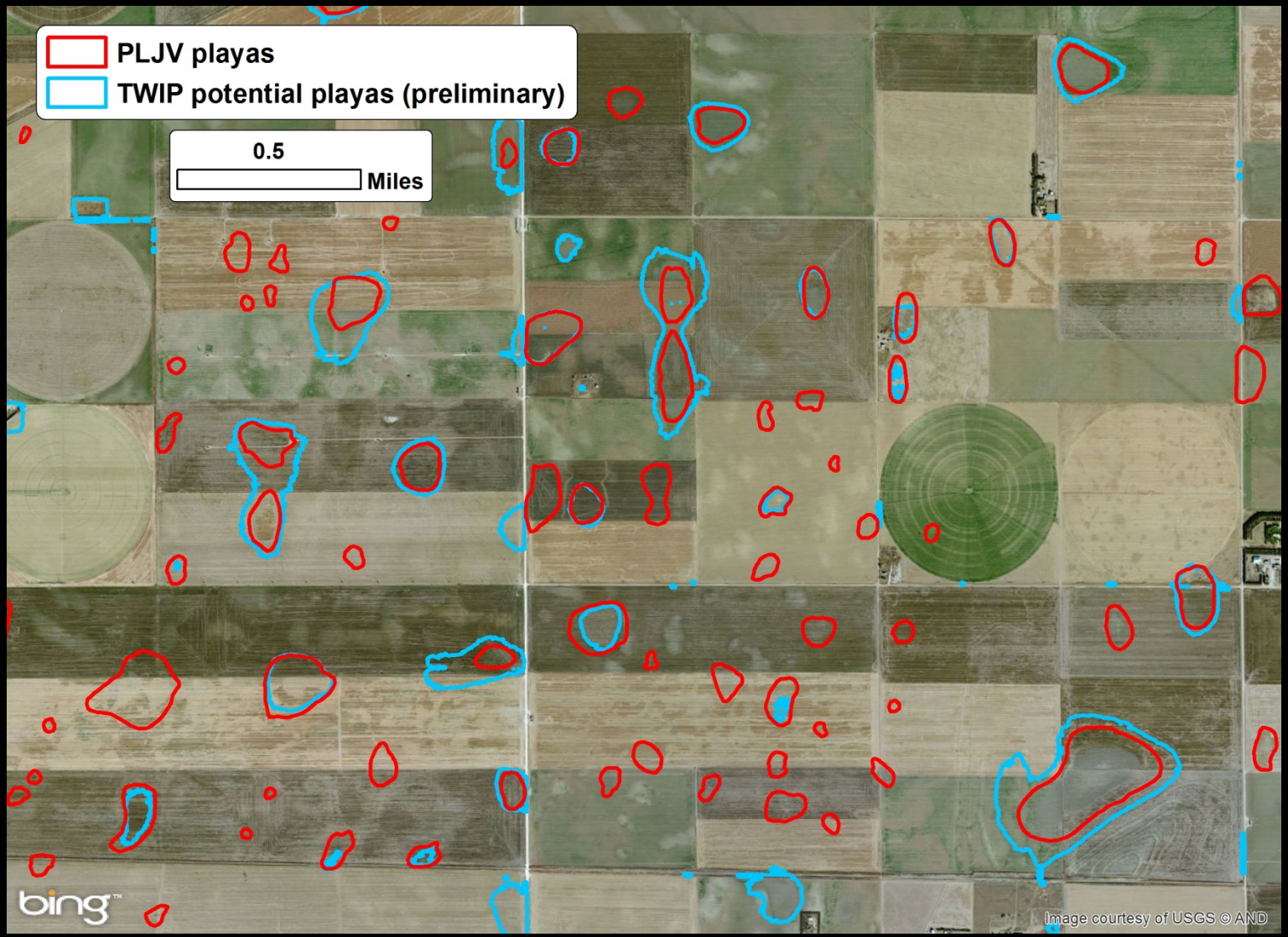


Judd Patterson Photography

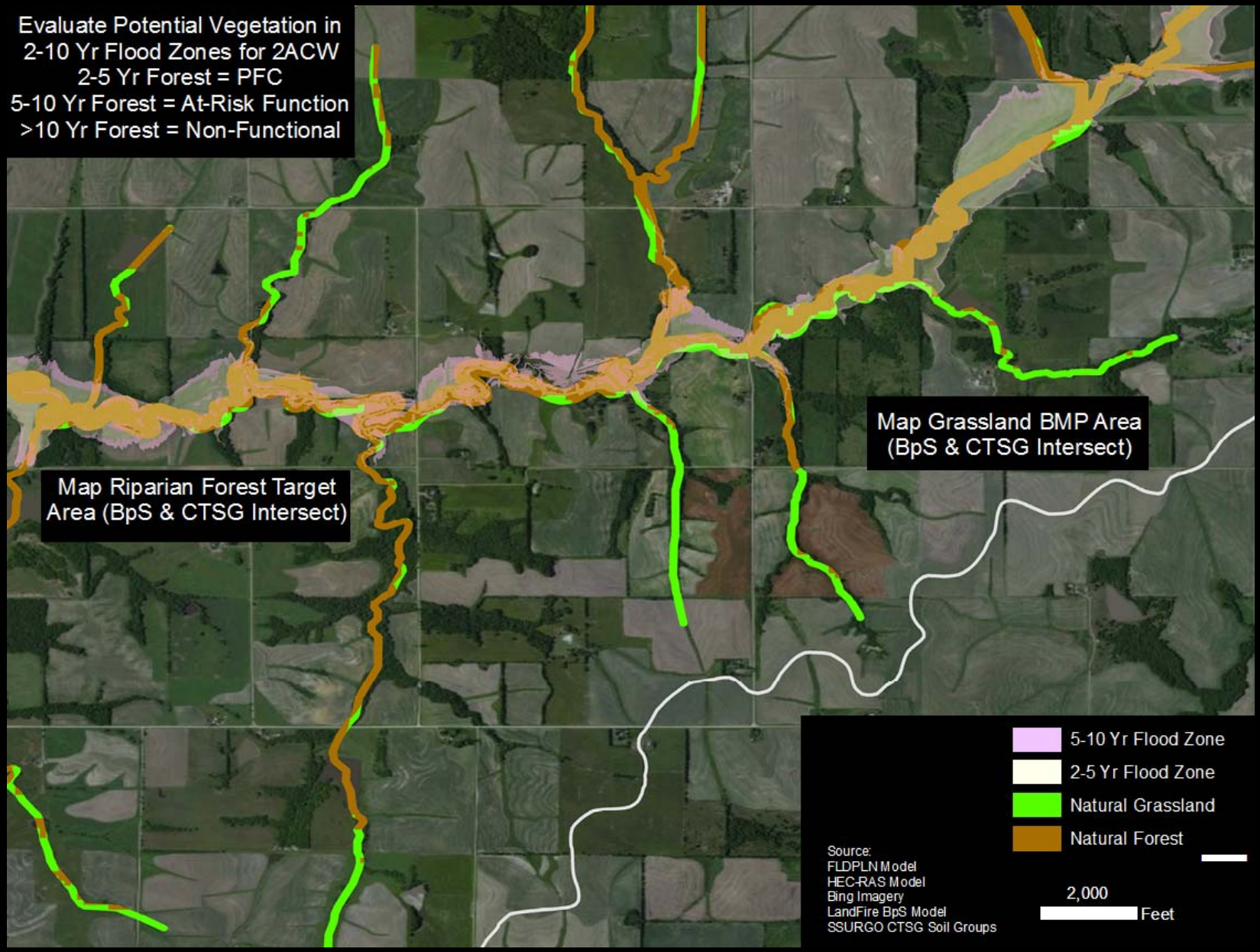
Playa Mapping: LiDAR & TWIP



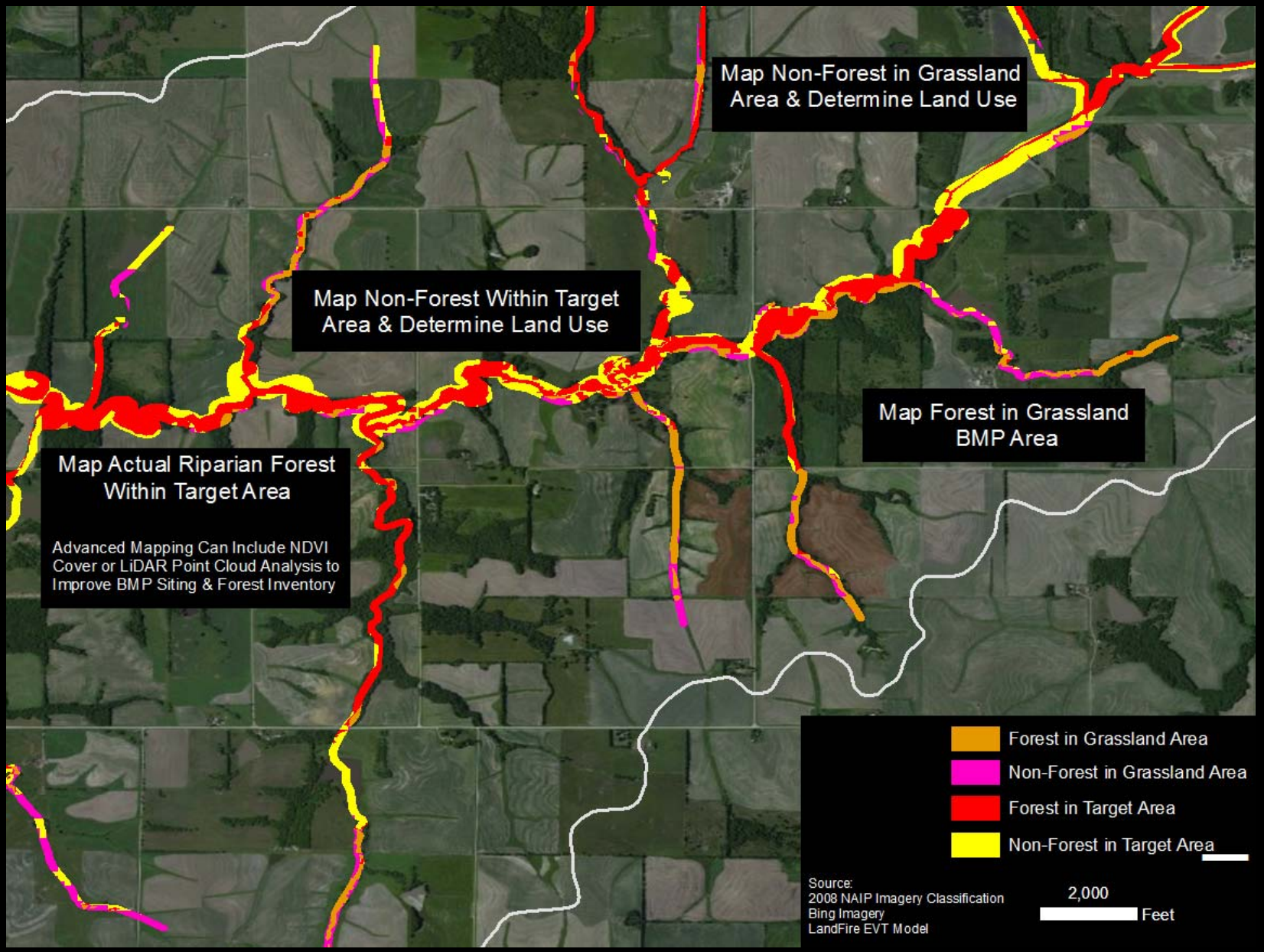
Playa Mapping: LiDAR & TWIP

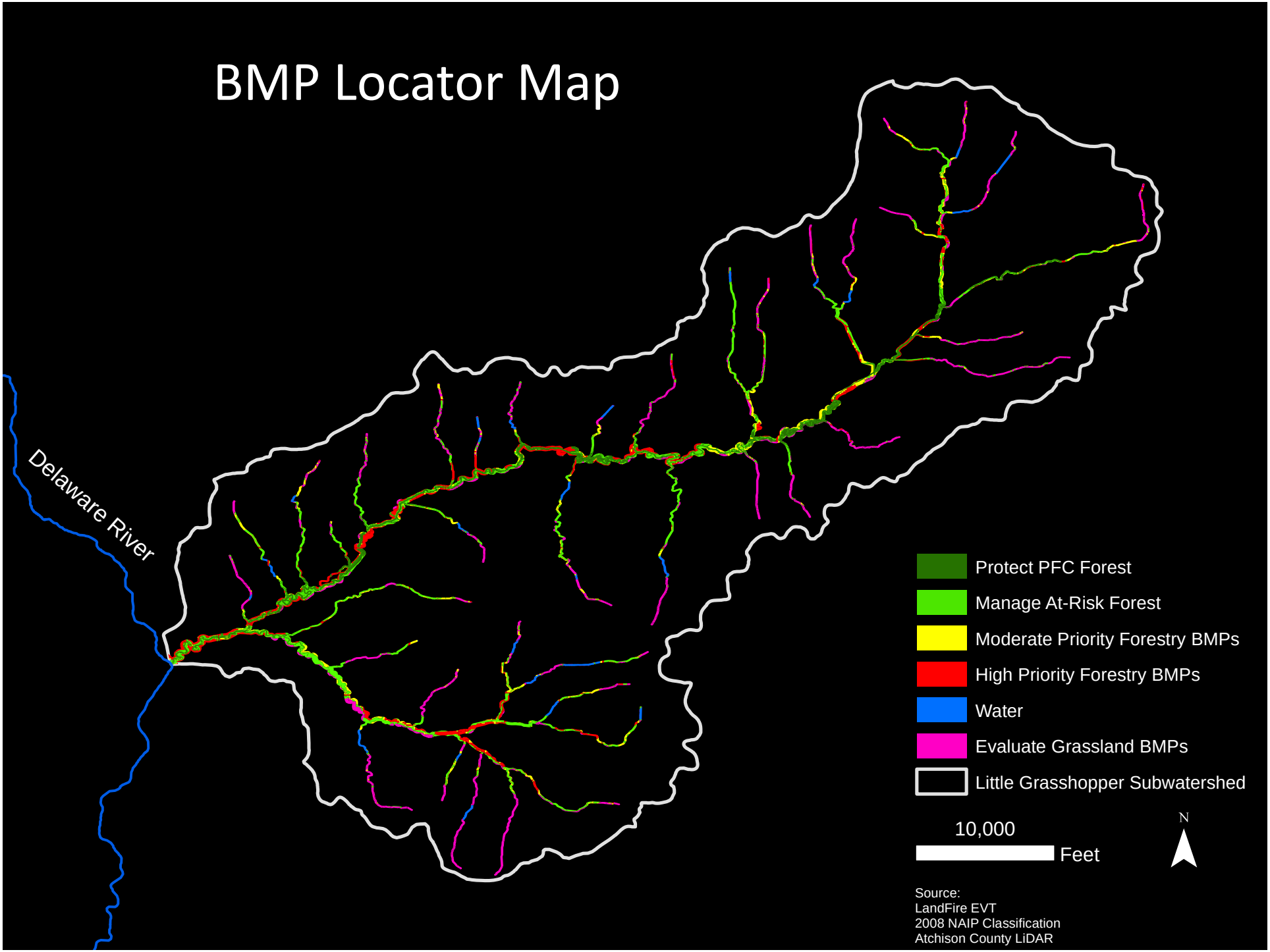


Potential Natural Vegetation & Target Population



Riparian Forest Mapping (RIP-FOR)




BMP Locator Map
Delaware River
Protect PFC Forest
Manage At-Risk Forest
Moderate Priority Forestry BMPs
High Priority Forestry BMPs
Water
Evaluate Grassland BMPs
Little Grasshopper Subwatershed
10,000
Feet
N
Source:
LandFire EVT
2008 NAIP Classification
Atchison County LiDAR

BMP Applications

Little Grasshopper Creek Watershed

Parameter	**Acres**	**Watershed Percentage**
Watershed	30749	100.0
Riparian Area (2ACW buffer + 1ACW channel)	1783	5.8
Riparian Forest Target Area*	1322	4.3
Riparian Non-Forest Area*	461	1.5
Riparian Forest Target Area	**Acres**	**Potential BMPs to be Delivered by Conservation Program Partners**
Riparian Forest Target Area	1322	Evaluate Floodplain Connectivity, PFC, & Forest BMPs
Riparian Forest Within Target Area	771	Evaluate PFC & Identify Forest Stand Improvement Projects
Non-Forest Within Target Area	551	Evaluate Floodplain Connectivity & Establish Forest
Grassland	271	Low Priority Forest Establishment
Cropland or Developed	280	High Priority Forest Establishment
Properly Functioning Riparian Forest in 5Y Floodplain of Target Area	251	Protect PFC Forest
Functional-at-Risk Riparian Forest in 5-10Y Floodplain of Target Area	79	Manage/ Improve At-Risk Forest
Non-Functioning Forest Not Connected to 10Y Floodplain in Target Area	599	Investigation & Potential Remedial Action (Riparian Hotspots)
Riparian Non-Forest in 5Y Floodplain of Target Area	137	Establish Forest
Riparain Non-Forest in 5-10Y Floodplain of Target Area	67	Establish Forest
Riparain Non-Forest Not Connected to 10Y Floodplain in Target Area	347	Investigation & Potential Remedial Action (Riparian Hotspots)
Riparian Non-Forest Area	**Acres**	**Potential BMPs to be Delivered by Conservation Program Partners**
Riparian Non-Forest Area*	461	Evaluate Floodplain Connectivity & Grassland Buffer BMPs
Riparian Forest Outside Target Area	207	Manage/ Evaluate Forest
Riparian Non-Forest Outside Target Area	254	Evaluate Floodplain Connectivity & Evaluate Projects
Grassland	196	Grassland Management
Cropland or Developed	58	High Priority Grassland and Waterway Establishment
Riparian Area (Forest or Non-Forest) in 5Y Floodplain Outside Target Area	14	Protect Riparian-Wetland Floodplain
Riparian Area (Forest or Non-Forest) in 5-10Y Floodplain Outside Target Area	7	Manage/ Improve Riparian-Wetland Floodplain
Riparian Area (Forest or Non-Forest) Not Connected to 10Y Floodplain	440	Improve Method to Evaluate Upstream Tributaries as Necessary#

Waffle Project

Using Raised roads as natural levees to store/slow water run-off

Red River, North Dakota

Since 1880's major floods every 4-6 years…. plus a devastating flood every decade.

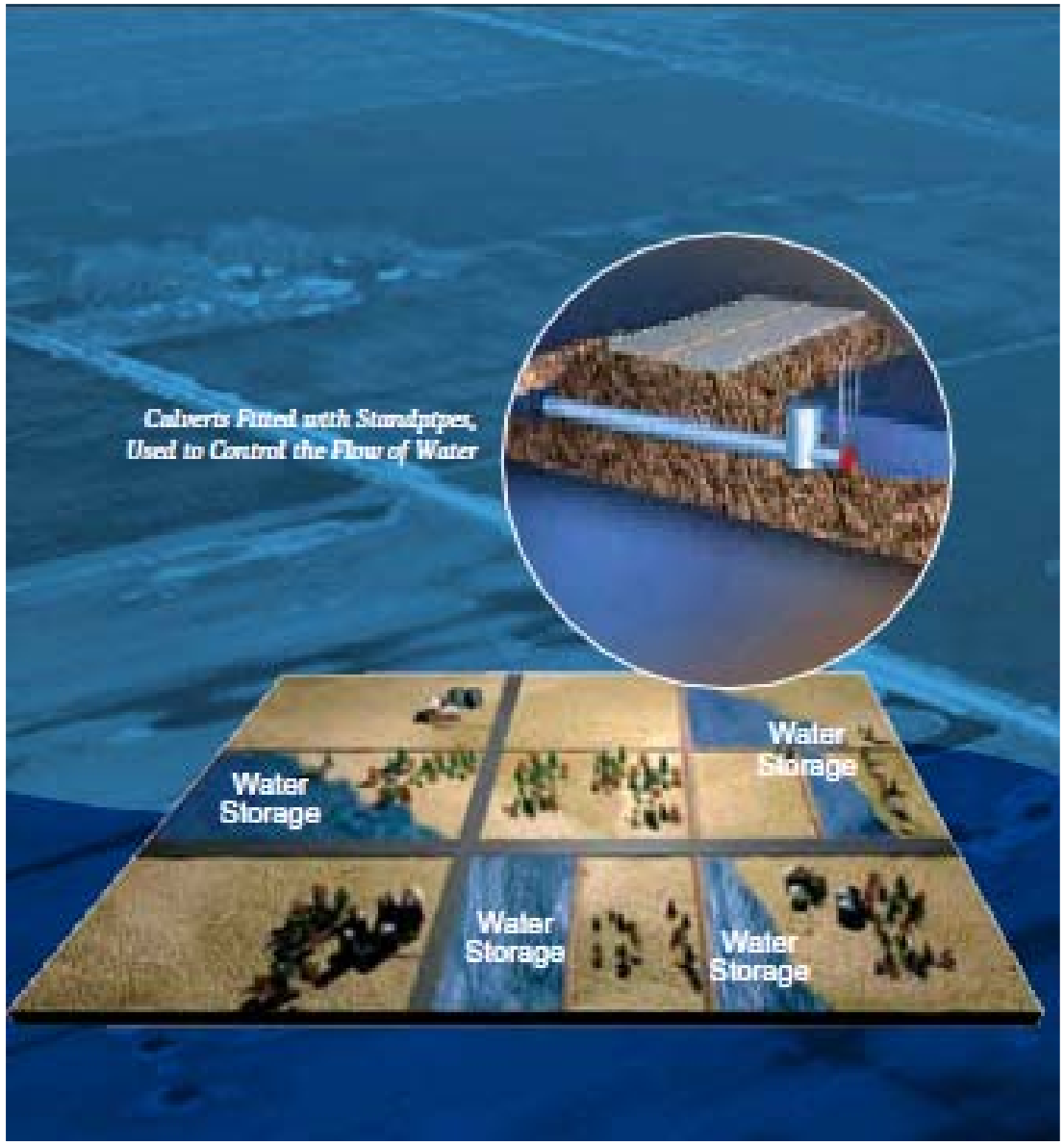
Drought also common to the region.

Waffle is an effort to be better prepared to handle both scenarios.

Applications in KS:
Develop wetland capacity to slow, store & treat runoff; increase infiltration; increase lateral flow & GW recharge; Increase wildlife refugia and landscape biodiversity

An Overview of the Waffle Concept, Energy and Environmental Research Center, 2008

Waffle Concept



Summary: Watershed Restoration Toolbox

TWIP

- **Inventories of potential and likely wetlands with descriptors**
- **Identify wetland creation, restoration, and protection sites**
- **Future: use TWIP to identify watershed storage potential and evaluate hydrographs**
- **Future: map playas, playa watersheds, and playa capacity**

FLDPLN

- **Ability to map lake affected wetlands**
- **FLDPLN inundation libraries showing promise to map flood frequency, floodplain connectivity, bankfull width, and floodprone area**
- **Helps to predict floodplain wetland presence and riparian forest connectivity (PFC)**

Fluvial Geomorphology

- **FLDPLN showing promise for integration with stream classification approaches, but more evaluation required**
- **Indicating some usefulness for understanding stream evolutionary sequences, with watershed implications for restoration**

Integration

- **Integration of tools into watershed restoration approaches will increase understanding of design, planning, and implementation needs**

If you want a happy ending, it

depends, of course, on where you stop the story