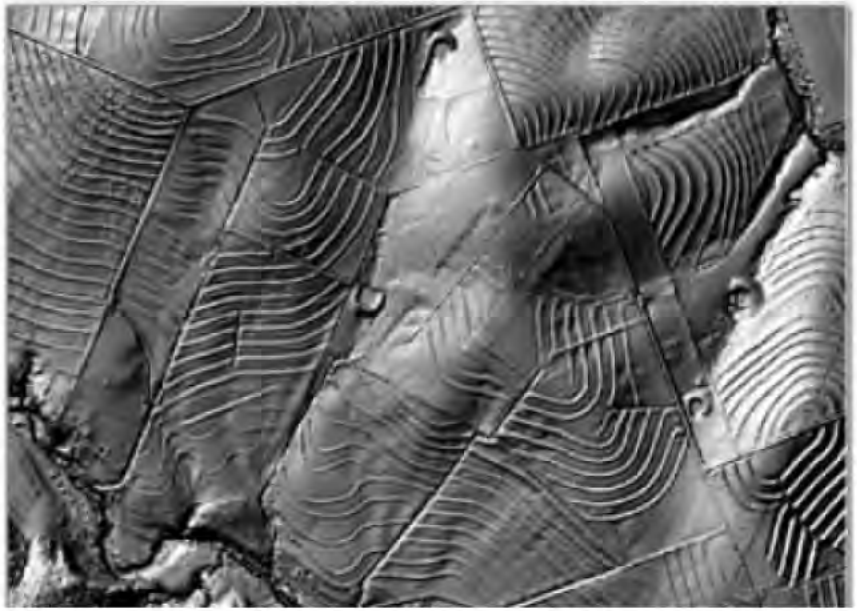
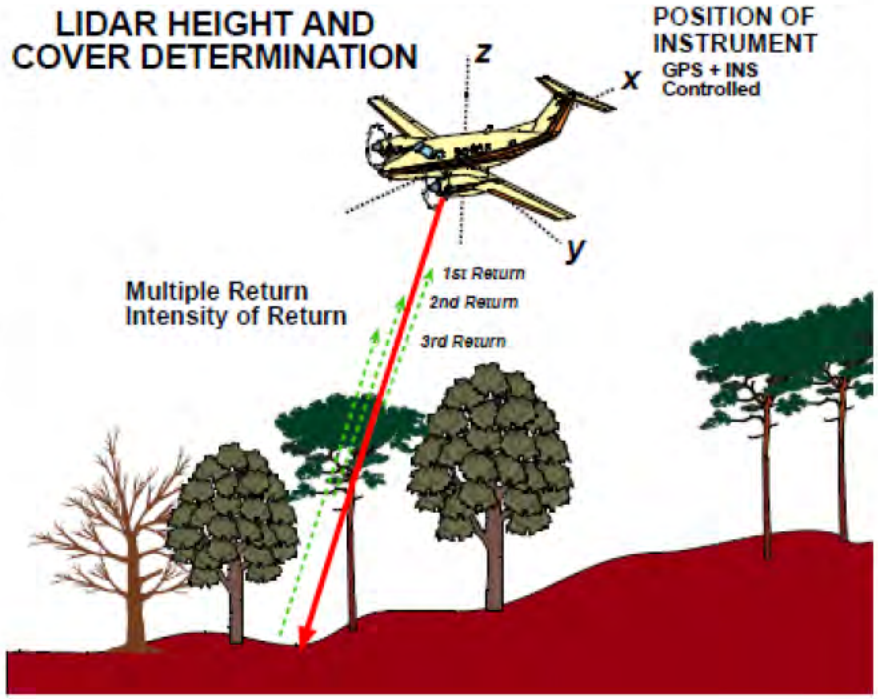
Natural Resources Conservation Service

Leveraging LiDAR for the Field: NRCS-KY Tools Overview

David Chan, GIS Specialist, NRCS-KY
Steve Crabtree, GIS Coordinator, NRCS-KY

LiDAR –
Light Detection and Ranging

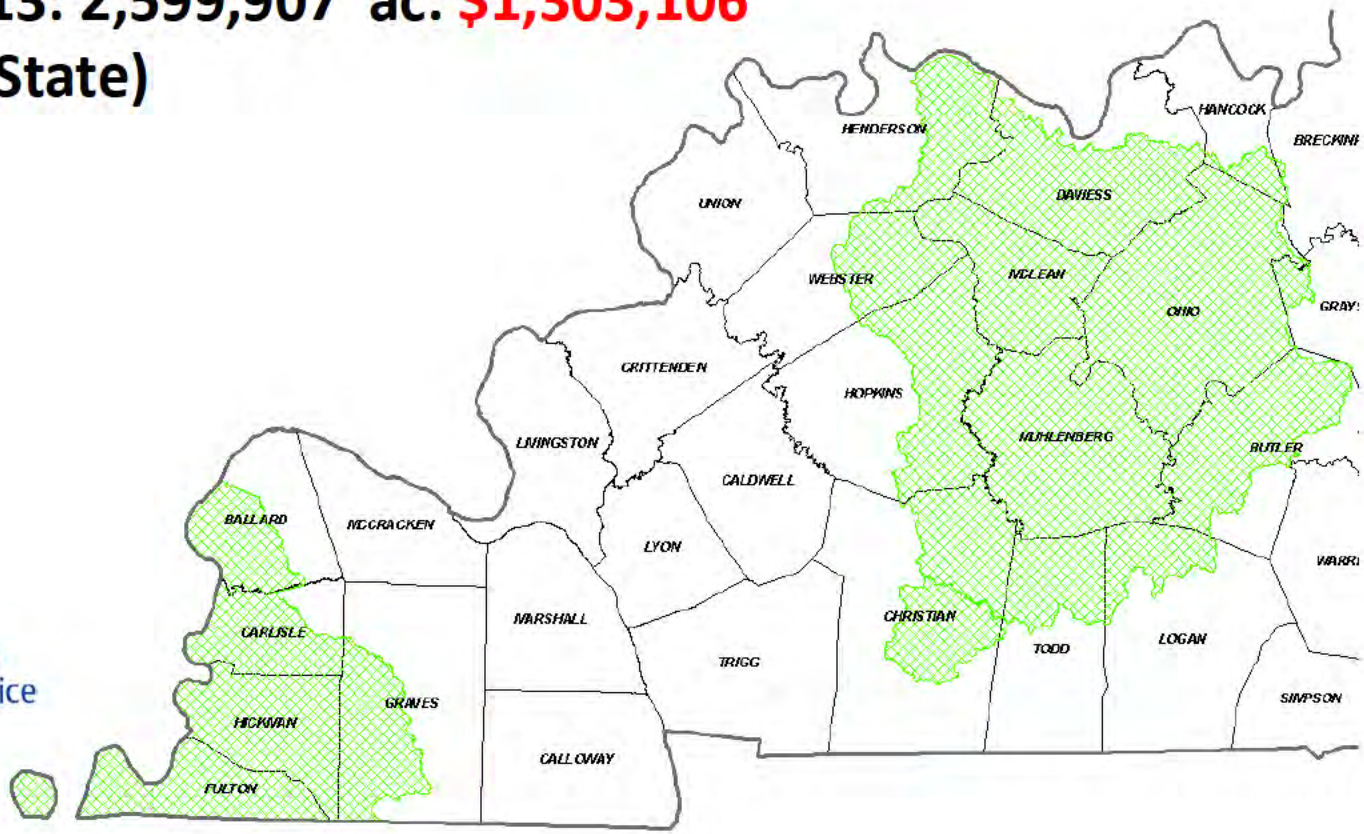




NRCS LiDAR Purchases – Kentucky

FY 2010 Purchase: 82,962 ac.
FY 2011 Purchase: 1,912,867 ac.
FY 2013 Purchase: 604,078 ac. (with KY Div. of Water)

Total NRCS thru 2013: 2,599,907 ac. $1,303,106
(10.05 % of State)



NRCS Natural Resources Conservation Service

NRCS LiDAR Purchases – Kentucky

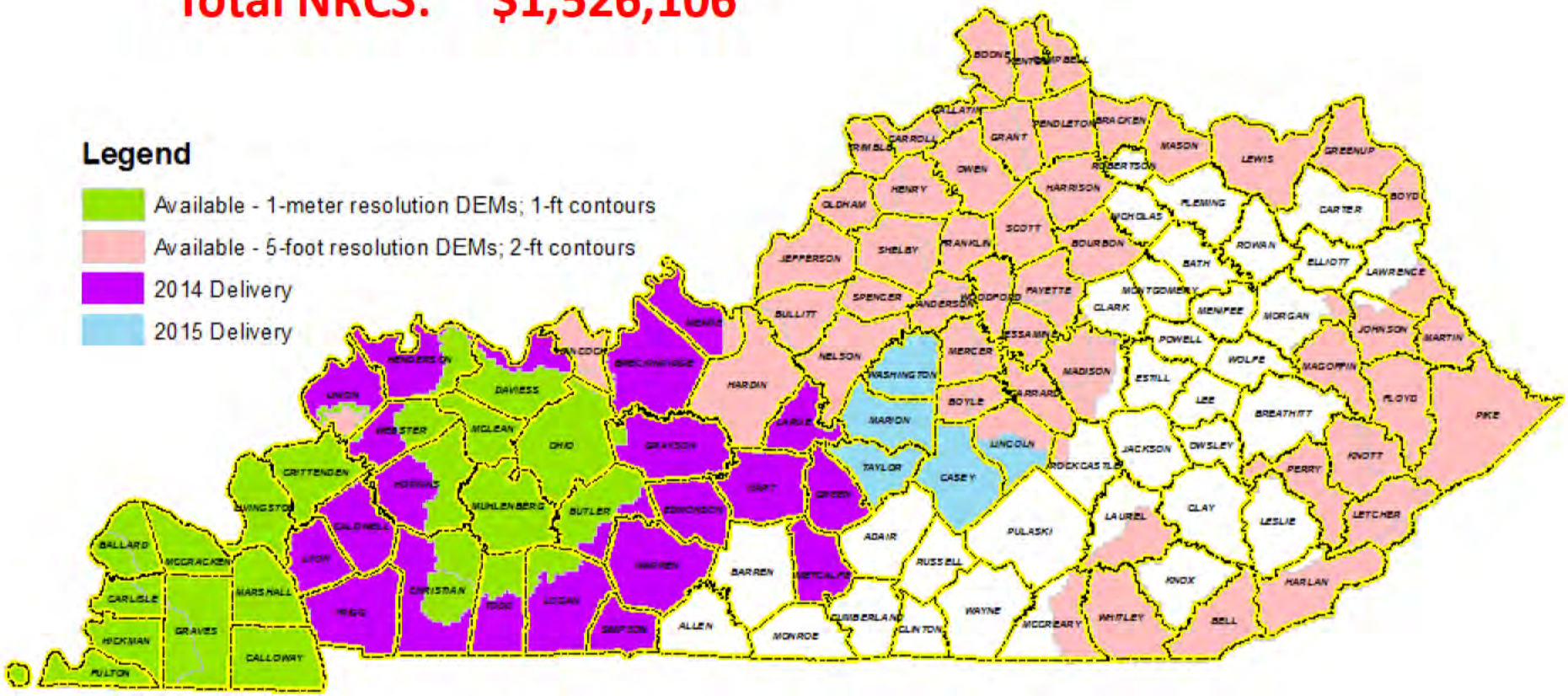
Total NRCS thru 2013: $1,303,106

Contributions to KYAPED (KY Aerial Photography & Elevation Data) program:

FY 2013-14: $173,000

FY 2014-15: $50,000

Total NRCS: $1,526,106

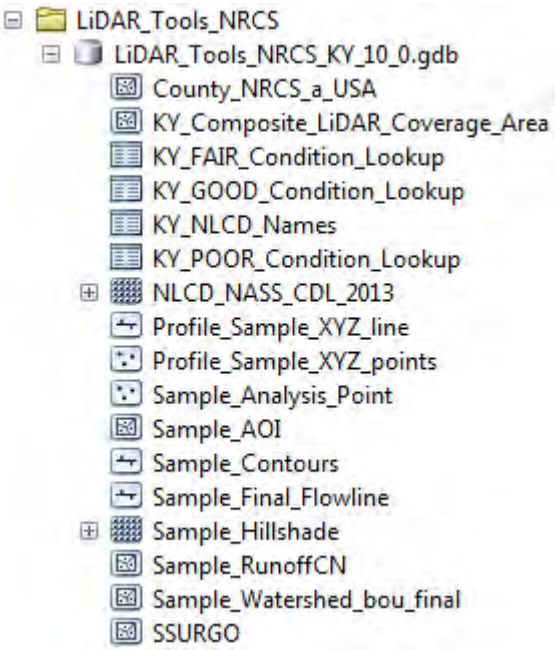


LiDAR Data in KY

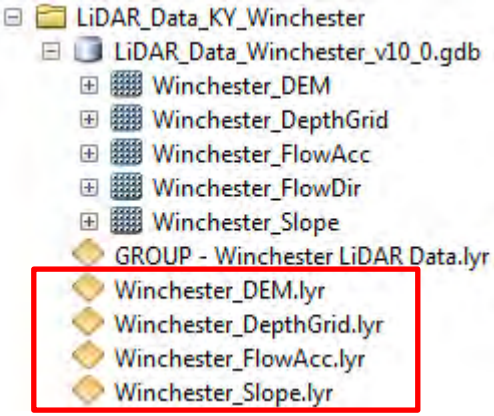
- LiDAR data in 72 counties in Kentucky
- Not user-friendly for users without GIS expertise
  - Big Data: 5ft KY Statewide DEM = 125GB
  - Utilizing data and generating derivatives is computationally taxing and time intensive
- Solution: pre-build derivatives and automate geoprocessing tasks with custom ArcGIS tools written in Python
  - Focused on EASE OF USE
  - DISCLAIMER: Policy on LiDAR use by NRCS is still under development

“Practical Use” Tools and Derivatives

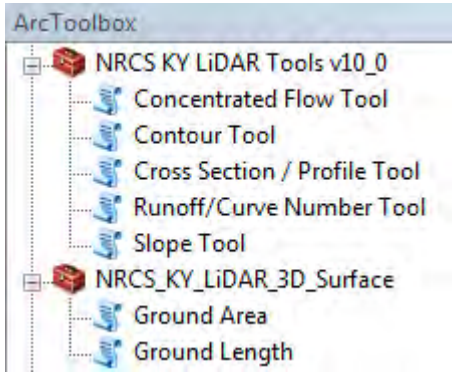
Statewide Database



County Database



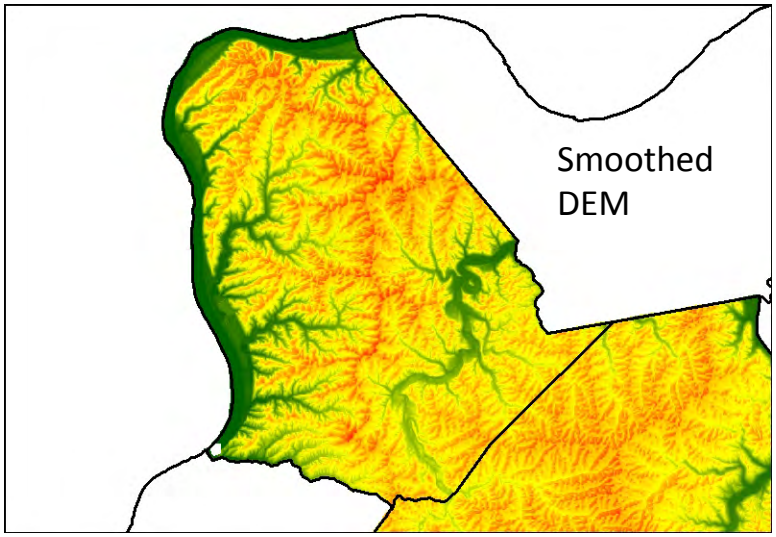
ArcToolbox

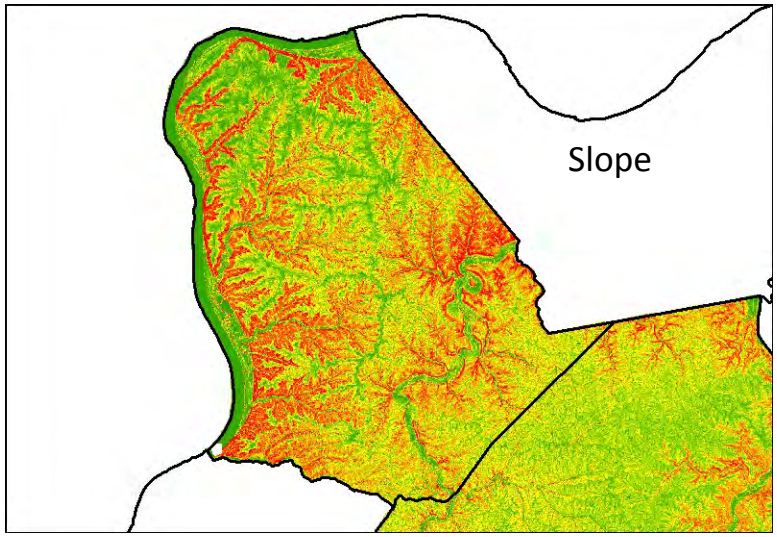


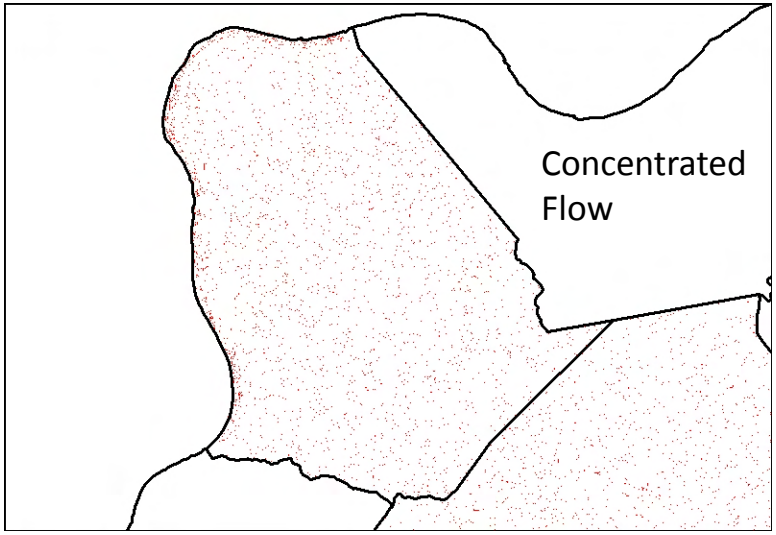
LiDAR Derivatives

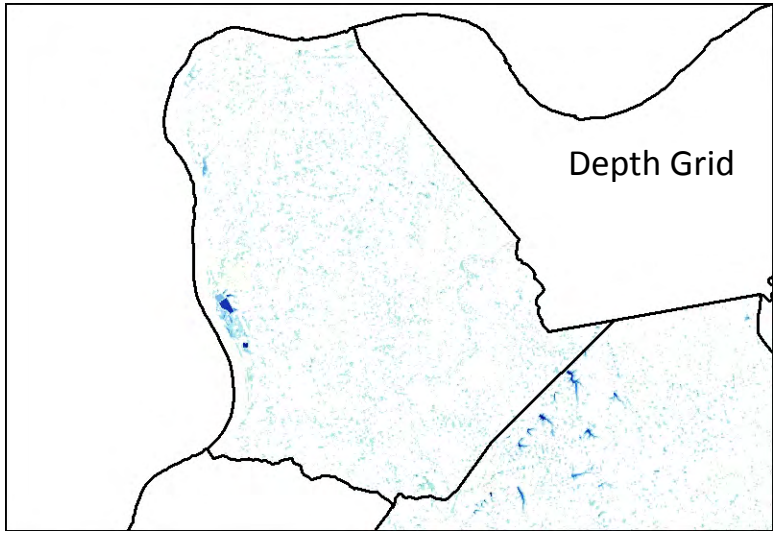
- County/area-wide DEM gridded rasters
  - We don’t provide raw LiDAR files (LAS) to field offices
    - Size, processing issues
- Pre-processed LiDAR derivatives are provided to field offices
  - Smoothed bare-earth DEM
  - Slope
  - Concentrated Flow
  - Depth Grid

LiDAR Derivatives

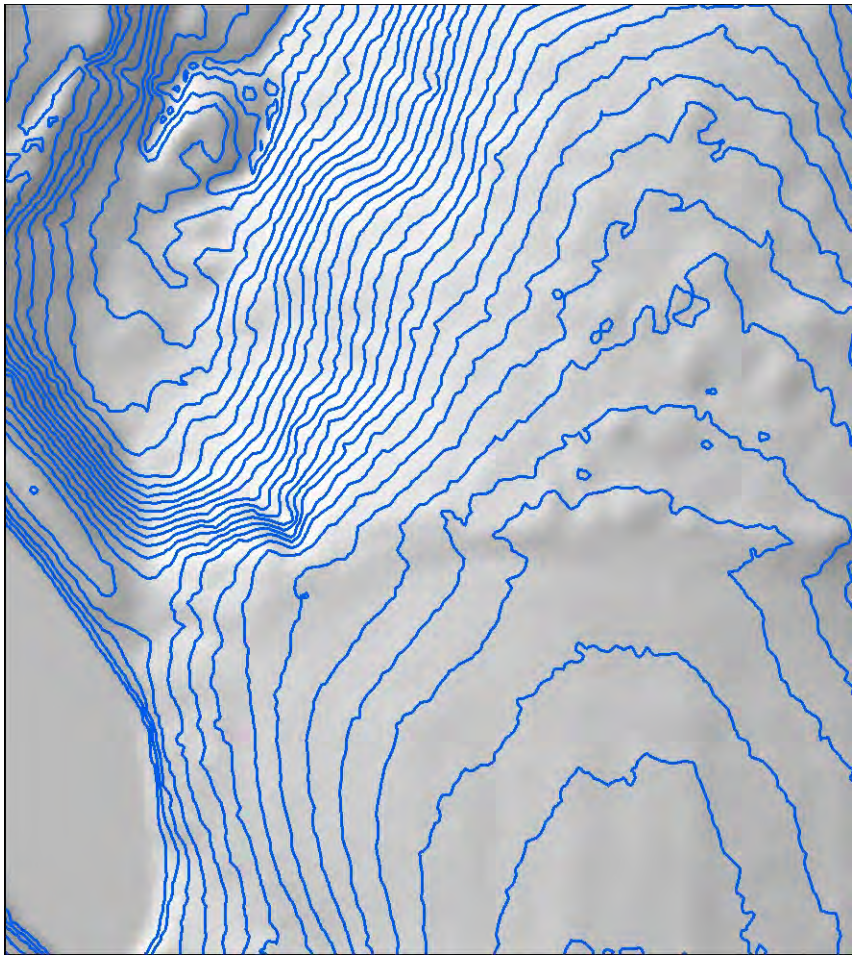


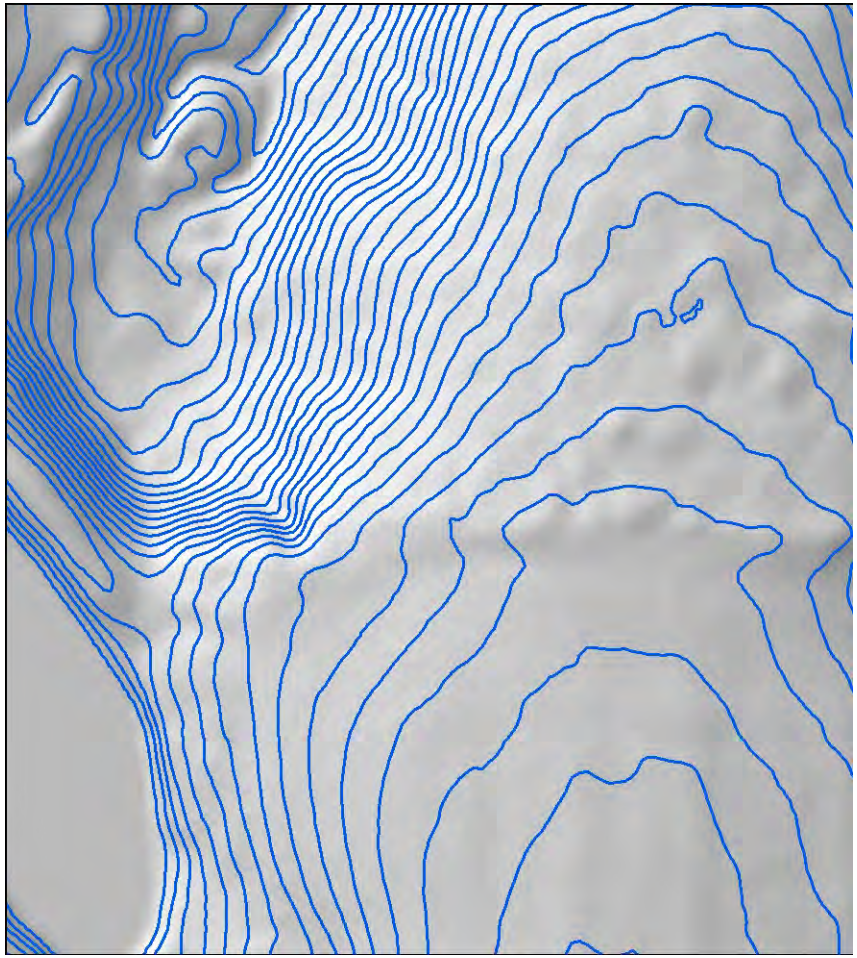




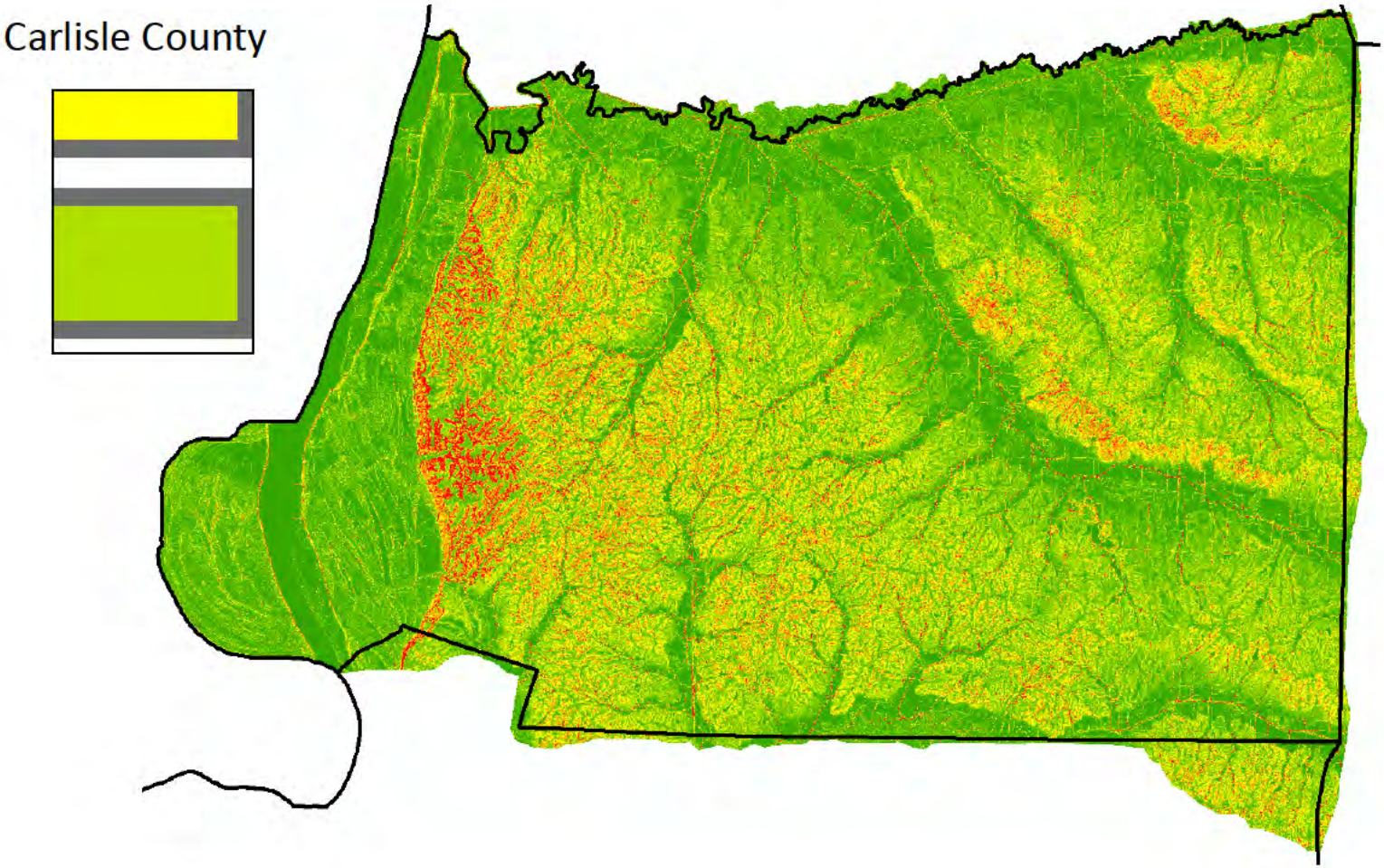


Digital Elevation Model (DEM) Unsmoothed vs. Smoothed





Slope



Concentrated Flow

- Accurately depicts stream flow networks
- Highlights areas of potential erosion and rill/gully formation
- Symbolized by showing >1,000 cells of drainage (1/2 acre 5ft, ~1/4 acre on 1m data)

Concentrated Flow

LiDAR Derived Flow Path/Flow Accumulation - Ohio County, KY

0 150 300 600 900 1,200 1,500 Feet

Scale: 1:3,600

Source: QL-3 LiDAR-derived DEM Data

LiDAR Derived Flow Path/Flow Accumulation - Ohio County, KY

0 150 300 600 900 1,200 1,500 Feet

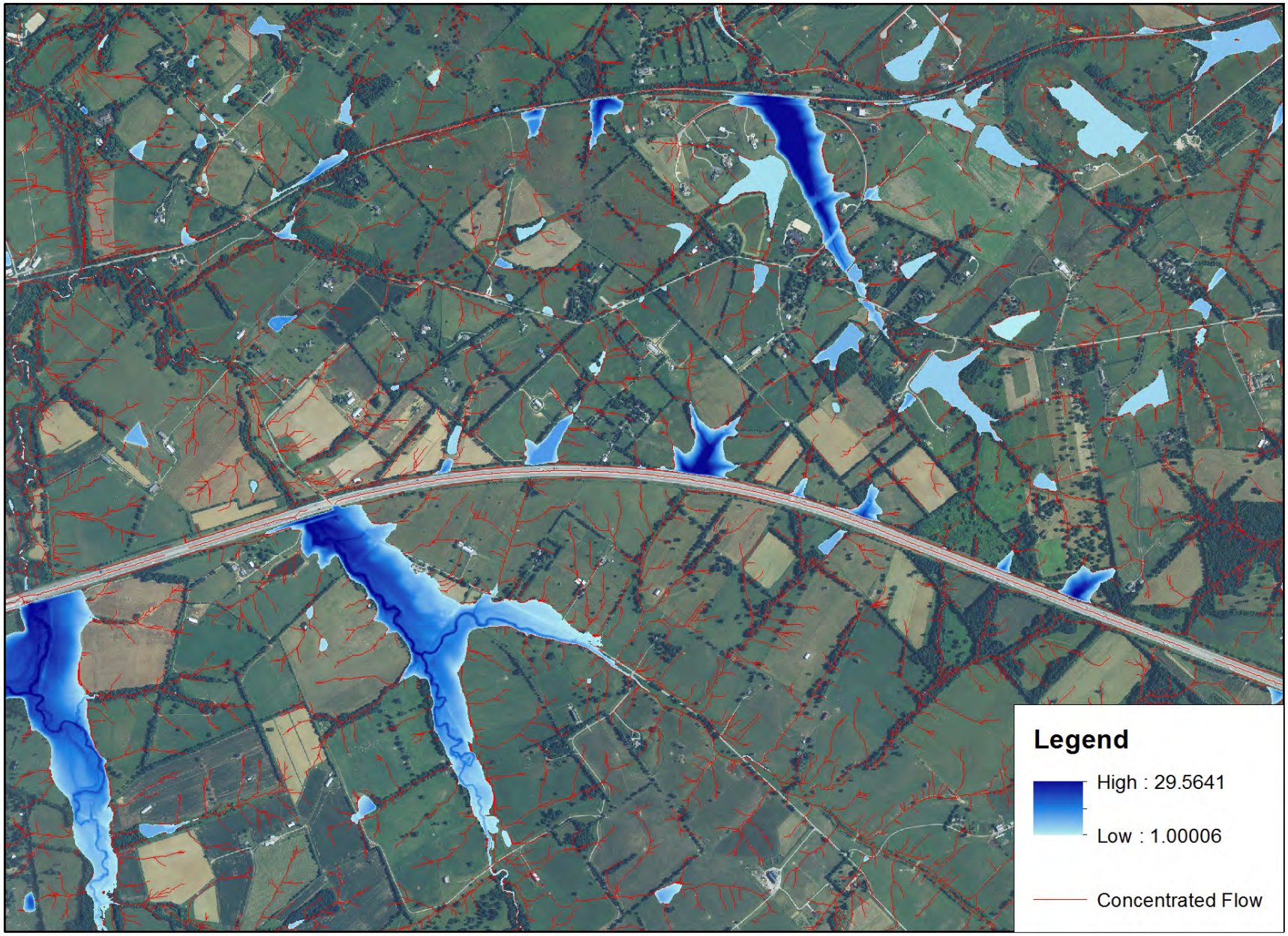
Scale: 1:3,600

Source: QL-3 LiDAR-derived DEM Data

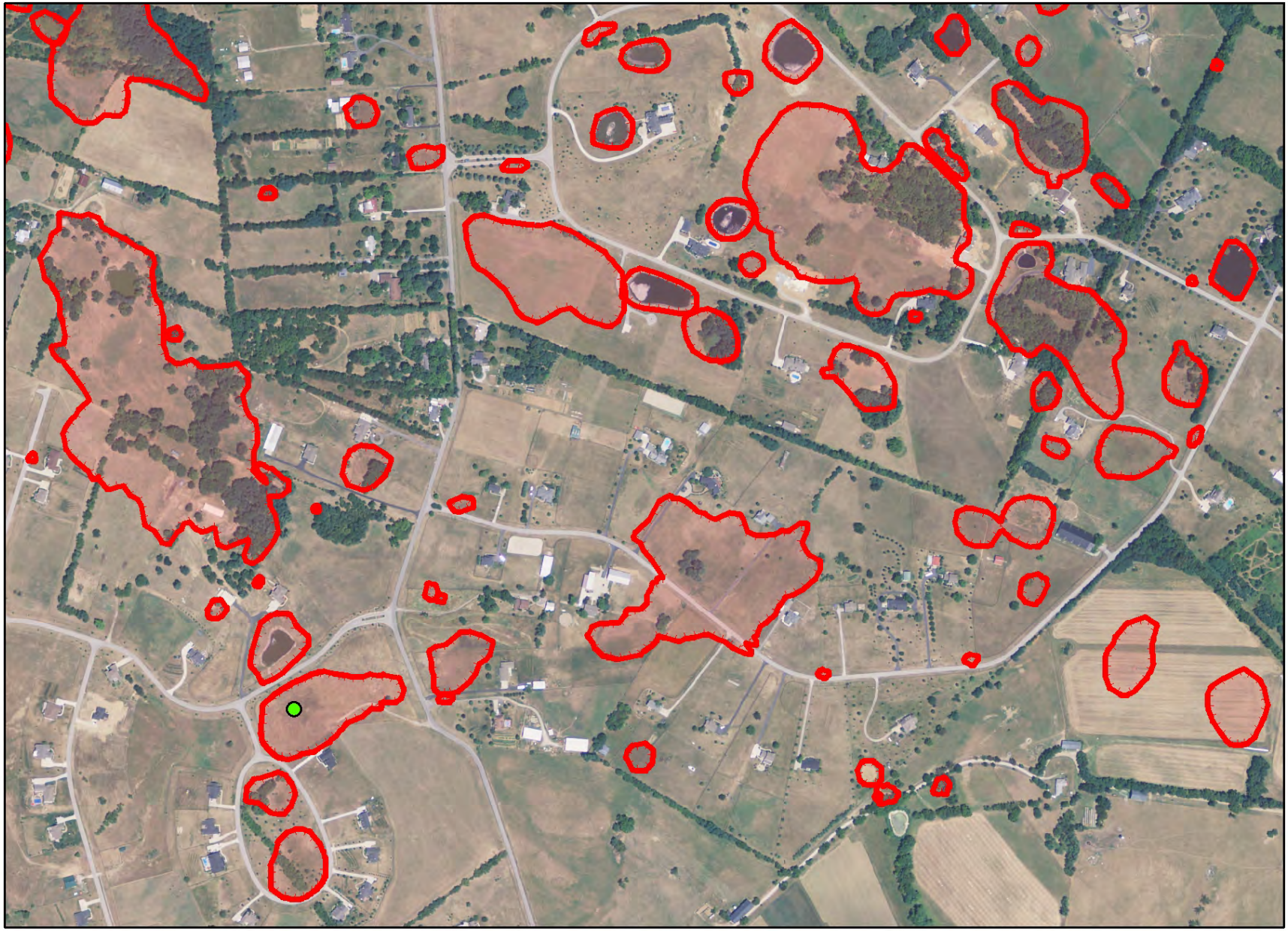
Depth Grid

- Shows depressions in the landscape and where water would theoretically pond up
- Utility: identifies culverts, water bodies, and sinkholes

Culverts and Water Bodies

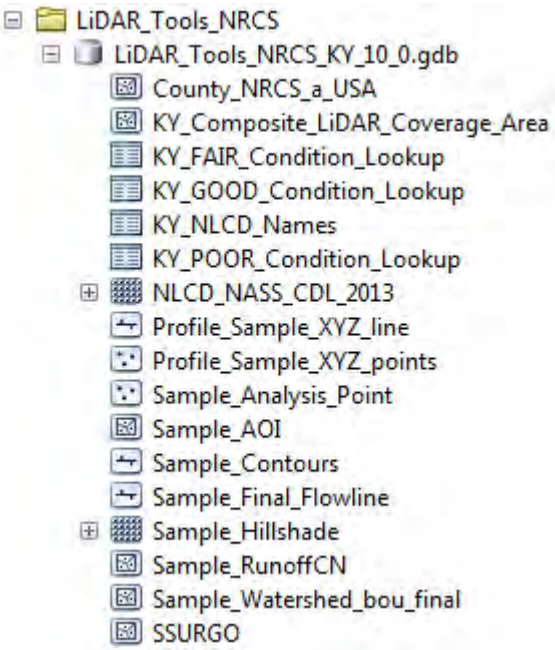


Sinkhole Detection



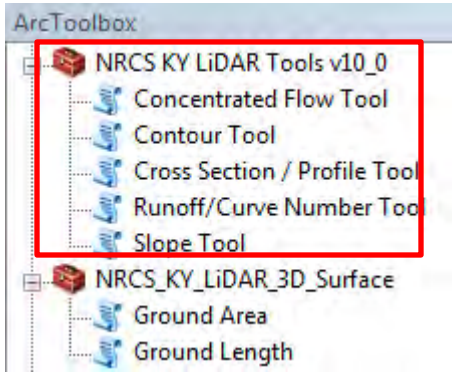
“Practical Use” Tools and Derivatives

Statewide Database



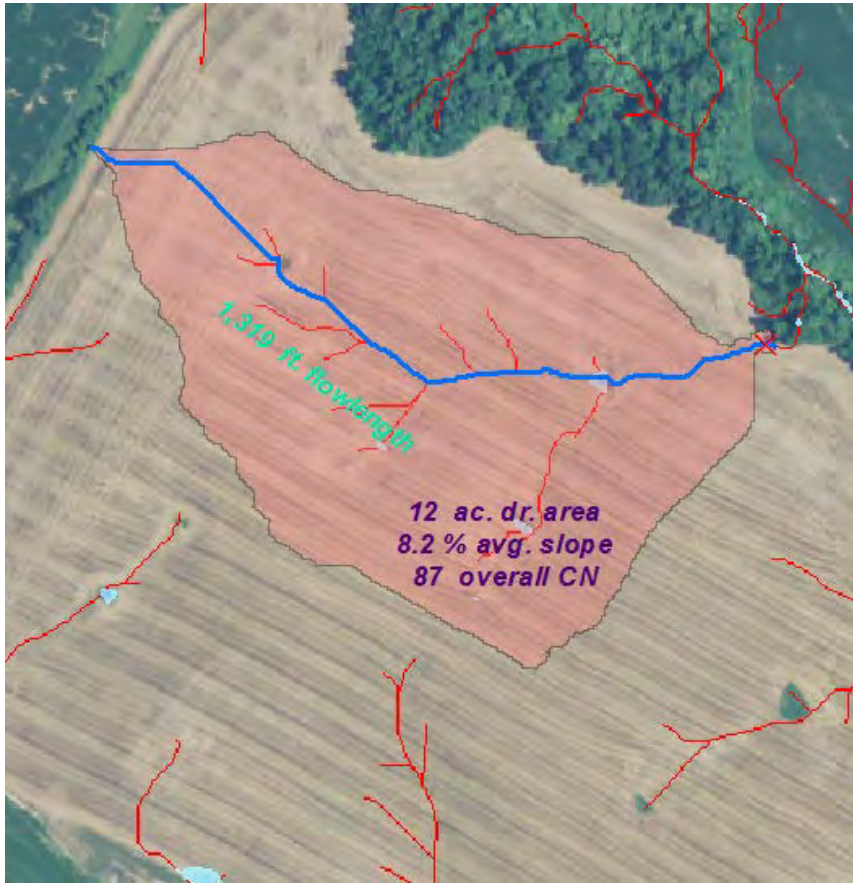
County Database

ArcToolbox



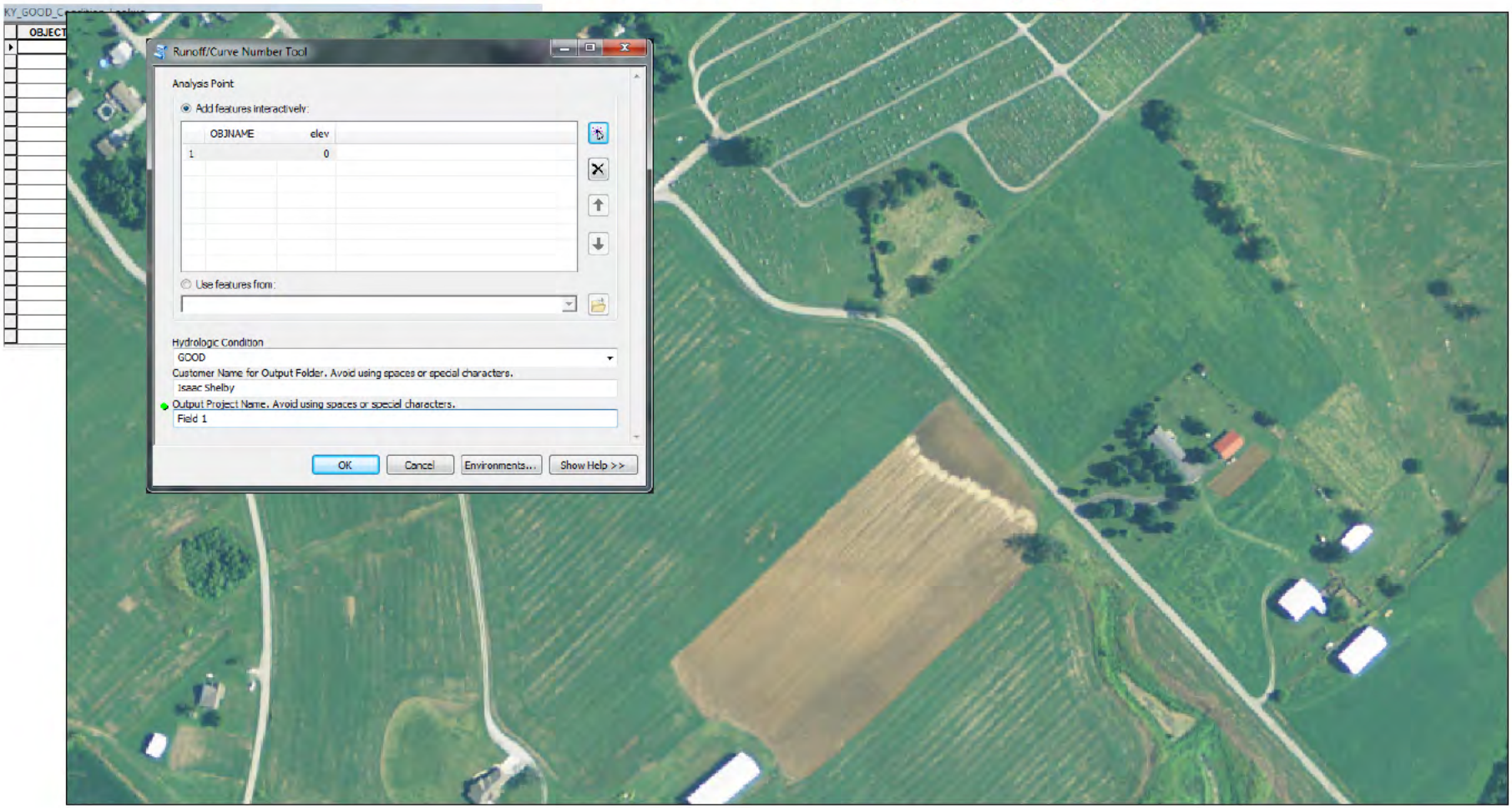
Runoff/Curve Number tool

- Generates required inputs for hydrologic modelling/determining peak discharge
  - Drainage area
  - Average slope
  - Overall curve number
  - Longest flow path
- Utilizes LiDAR DEM, NASS CDL (land cover), SSURGO



Runoff/Curve Number tool

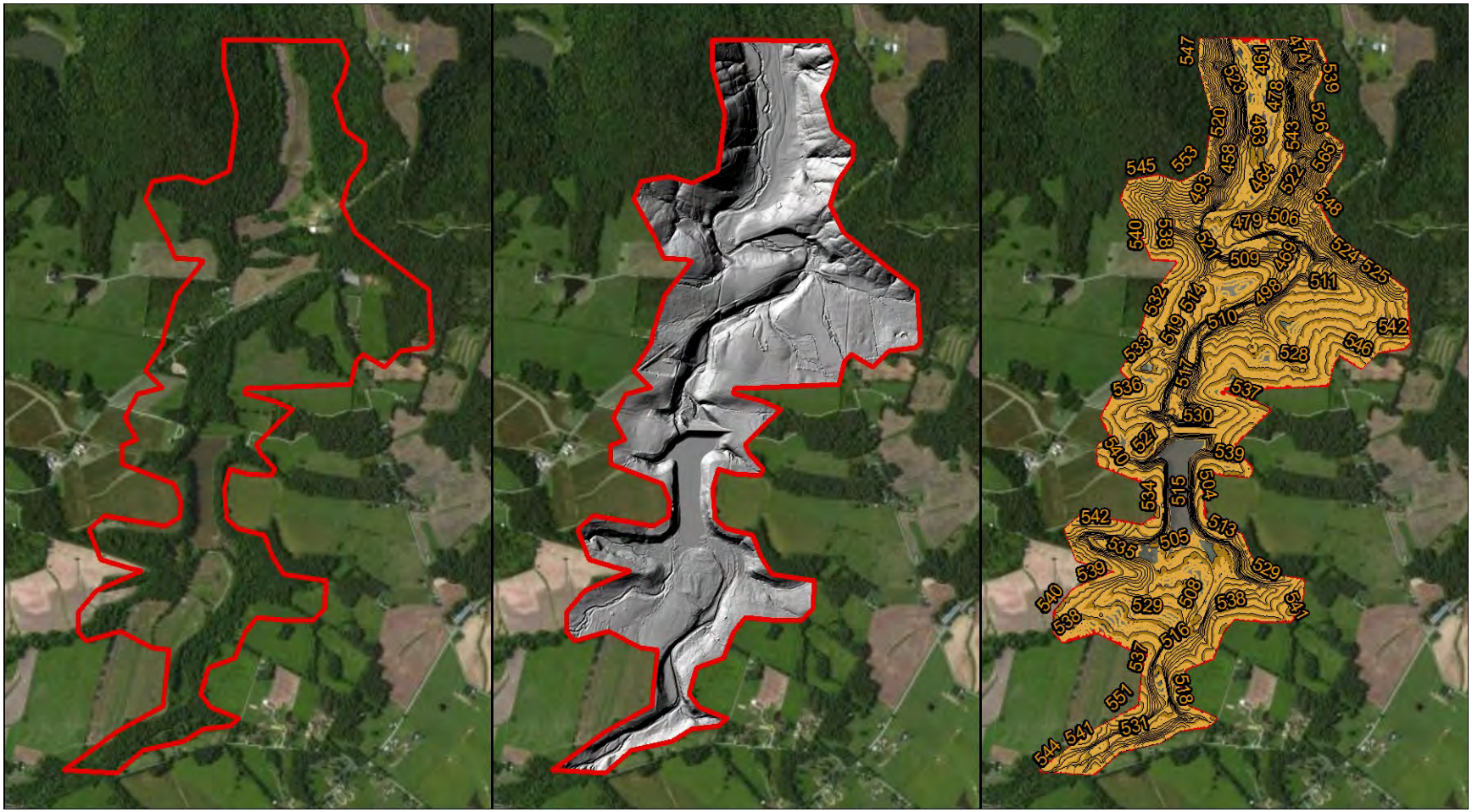
Results automatically displayed



Contour tool

- Allows a user to create contours for an area of interest at a specified contour interval
- Every 5th contour is designated as an Index Contour and a hillshade is automatically generated to enhance the display

Contour tool



Cross Section/Profile tool

- Creates cross sections/profiles along a designated line by capturing elevation values at specified intervals
- Optional output .txt/.dbf file with X,Y,Z values

Table

X-Section-Profile Points_XYZ - Cross_Section

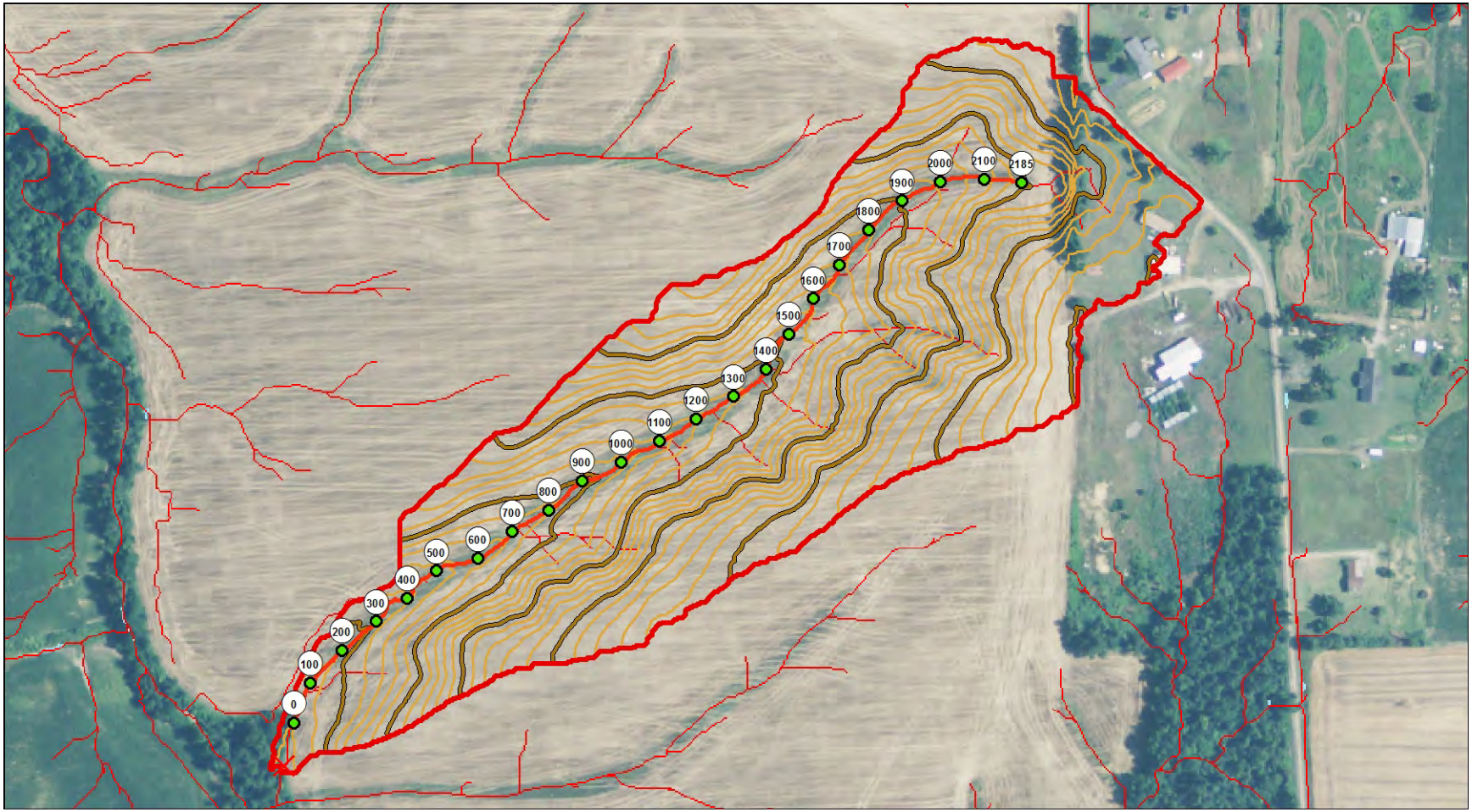
OBJECTID *	Shape *	ID	STATION	POINT_X	POINT_Y	POINT_Z
1	Point ZM	1	0	312120.107034	4064647.909585	333.704041
2	Point ZM	1	20	312121.436953	4064653.859222	334.166199
3	Point ZM	1	40	312122.766872	4064659.808859	334.218018
4	Point ZM	1	60	312124.096791	4064665.758496	334.370361
5	Point ZM	1	80	312125.42671	4064671.708134	334.477814
6	Point ZM	1	100	312126.756628	4064677.657771	334.311432
7	Point ZM	1	113	312127.621076	4064681.525035	334.406769
8	Point ZM	2	0	312120.107034	4064647.512709	333.661133
9	Point ZM	2	20	312117.621495	4064641.947262	333.976868
10	Point ZM	2	40	312115.135955	4064636.381816	334.167969
11	Point ZM	2	60	312112.650416	4064630.816369	334.068878
12	Point ZM	2	80	312110.164877	4064625.250922	334.149353
13	Point ZM	2	100	312107.679337	4064619.685475	334.145996
14	Point ZM	2	120	312105.193798	4064614.120028	334.232727
15	Point ZM	2	140	312102.708259	4064608.554582	334.374054
16	Point ZM	2	146	312101.962597	4064606.884948	334.448669
17	Point ZM	3	0	312072.085063	4064656.640853	334.334961
18	Point ZM	3	20	312074.790454	4064662.10268	334.413696
19	Point ZM	3	40	312077.495845	4064667.564508	334.695801
20	Point ZM	3	60	312080.201237	4064673.026335	334.757751
21	Point ZM	3	80	312082.906628	4064678.488163	334.994141
22	Point ZM	3	100	312085.612019	4064683.949991	335.256409
23	Point ZM	3	120	312088.31741	4064689.411818	335.36731
24	Point ZM	3	140	312091.022802	4064694.873646	335.572021
25	Point ZM	3	155	312093.051845	4064698.970017	335.570099
26	Point ZM	4	0	312072.085063	4064658.228356	334.239044
27	Point ZM	4	20	312069.705638	4064652.615354	334.595764
28	Point ZM	4	40	312067.326214	4064647.002353	334.925049
29	Point ZM	4	60	312064.94679	4064641.389352	335.251129
30	Point ZM	4	80	312062.567365	4064635.776351	335.244476
31	Point ZM	4	100	312060.187941	4064630.16335	335.230682
32	Point ZM	4	120	312057.808516	4064624.550348	335.37088
33	Point ZM	4	130	312056.618804	4064621.743848	335.305969

1 (0 out of 33 Selected)

X-Section-Profile Points_XYZ - Cross_Section

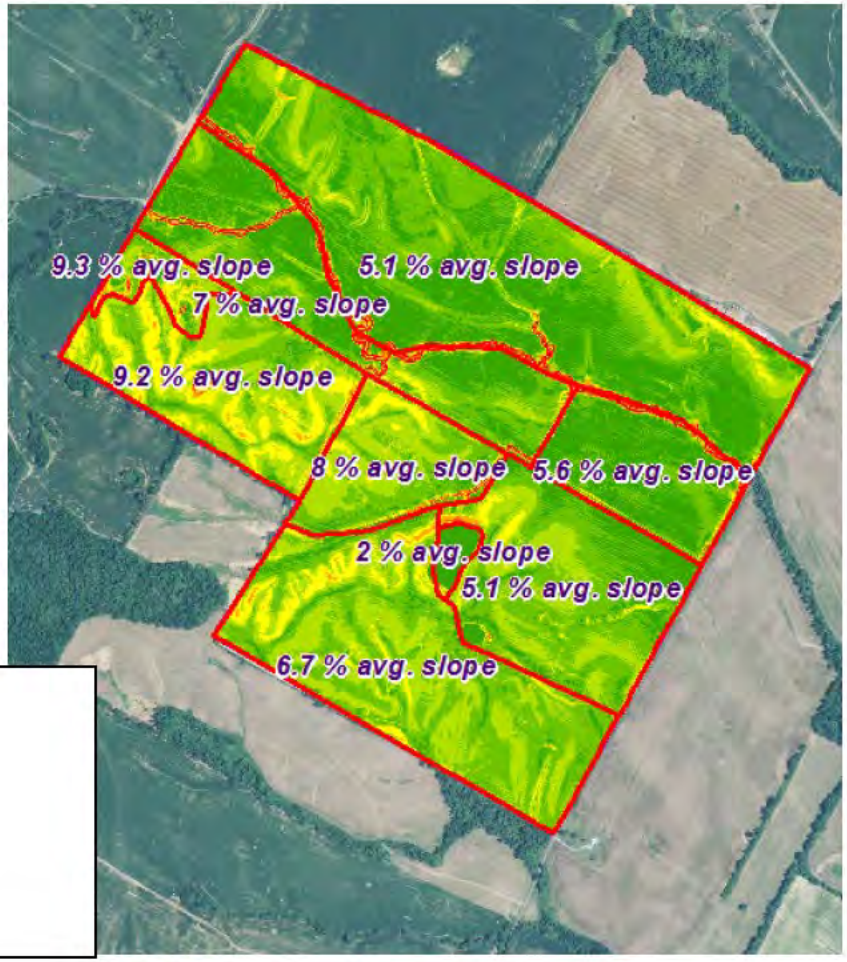
Cross Section/Profile tool

Profile



Slope tool

- Computes average slope for user delineated area(s) or existing polygon feature classes
- Generates and displays pre-symbolized slope raster

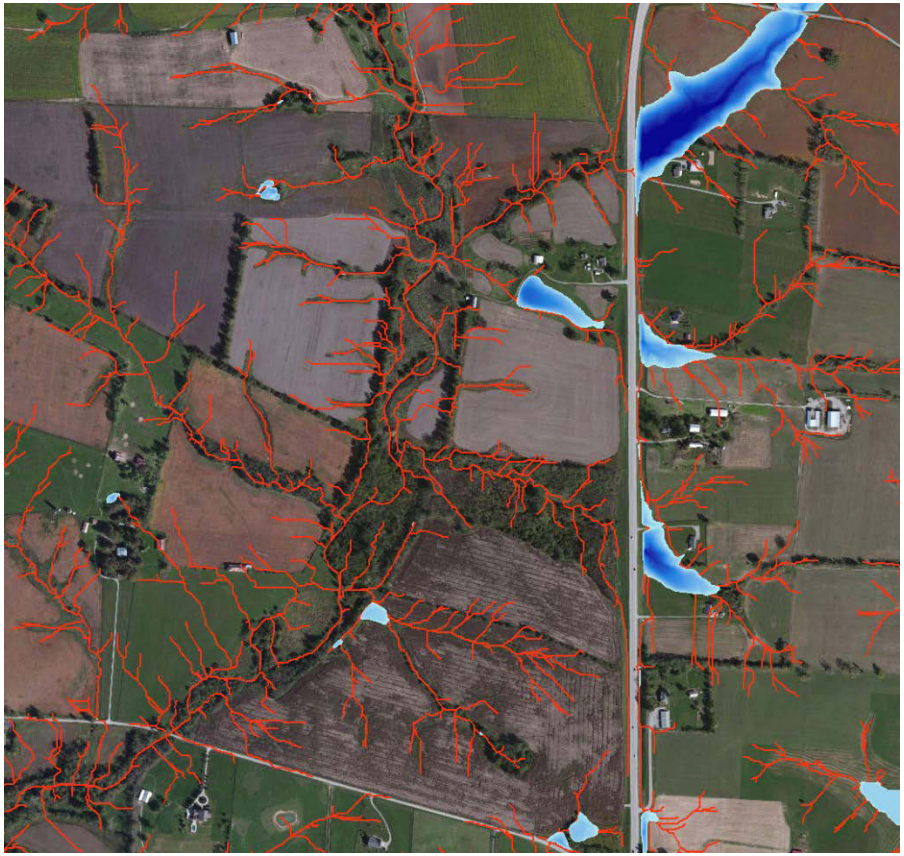


Slope tool for Conservation Compliance

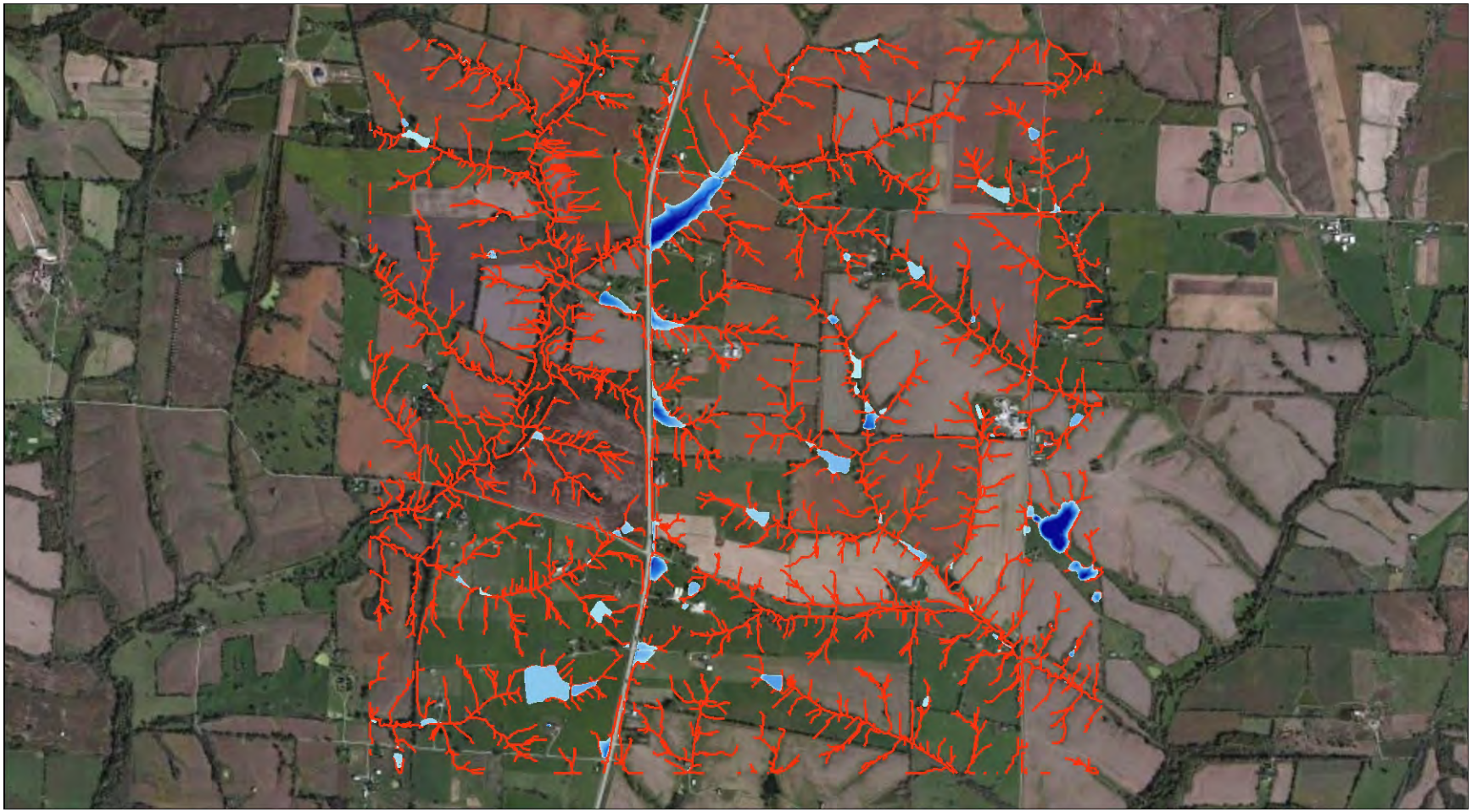
LiDAR provides more accurate information

Concentrated Flow tool

- Generates Concentrated Flow (vectorized) and Depth Grid from DEM raster
- Can modify Flow Accumulation Threshold for finer detail
- Useful for areas without pre-developed derivatives



Concentrated Flow tool



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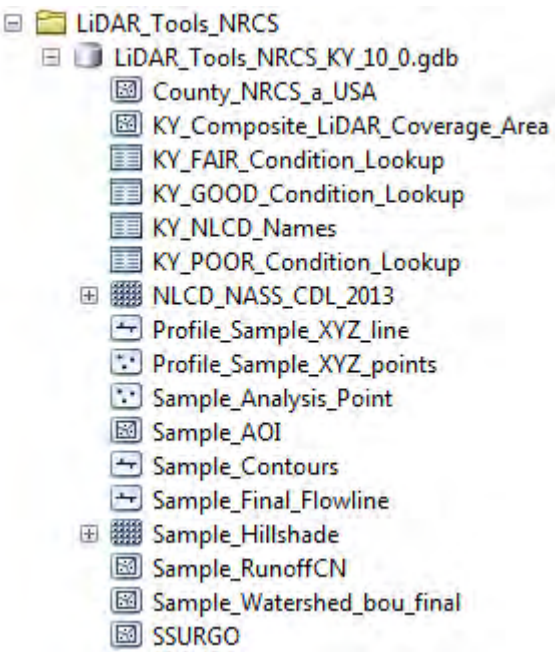
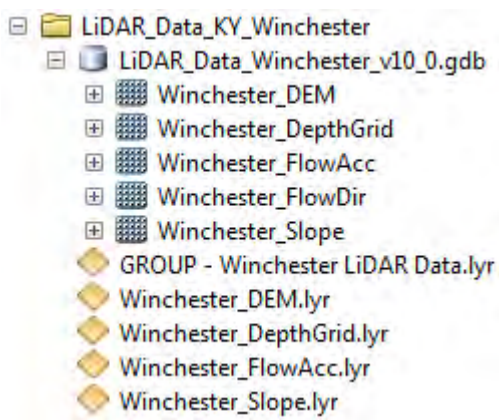
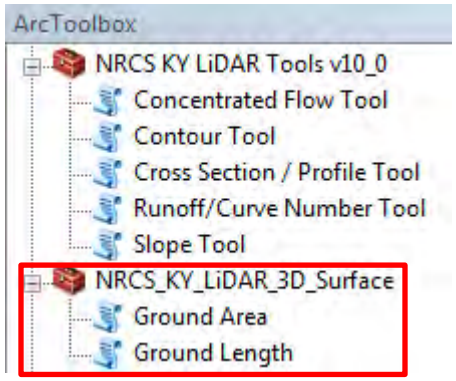


County Database



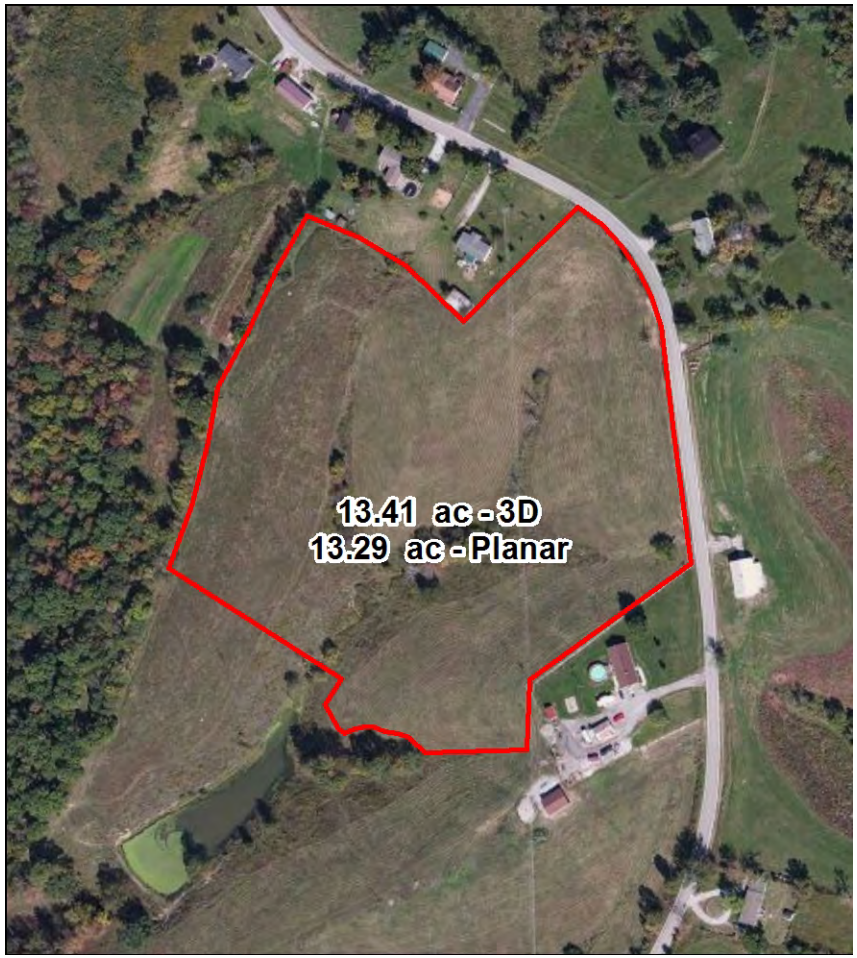
ArcToolbox



- DISCLAIMER: Policy on LiDAR use by NRCS is still under development
- 3D Surface tools are not to be used for official acreage determinations

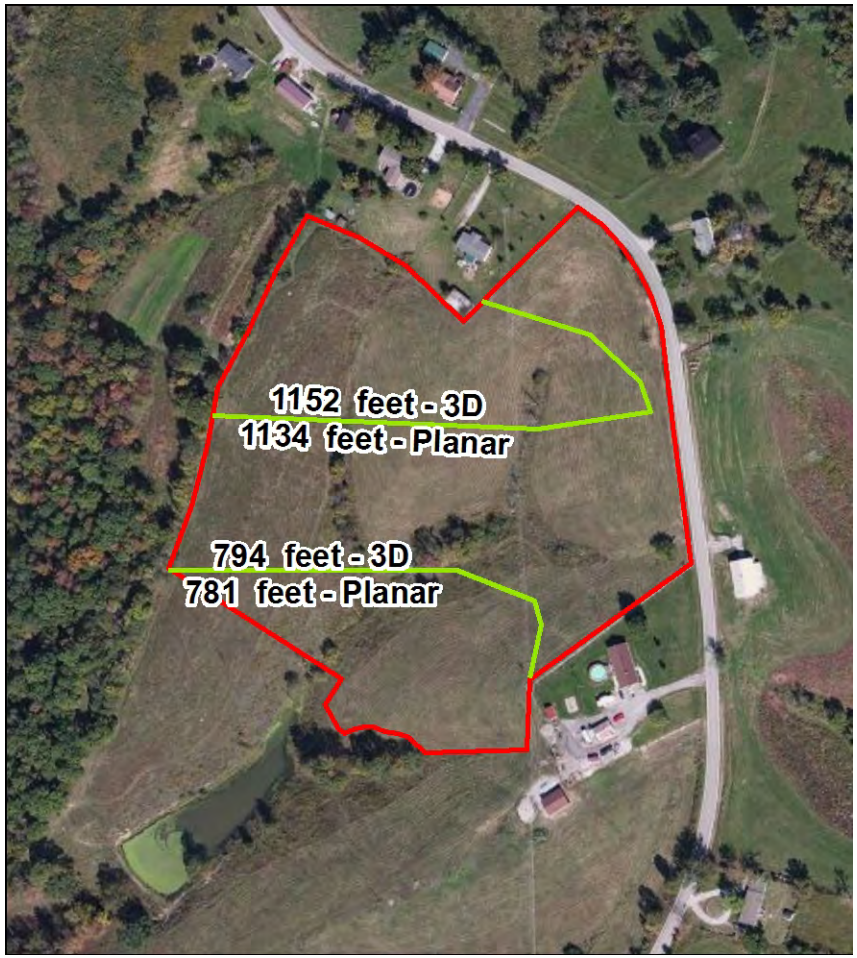
Ground Area tool

- Computes Surface Area for a given Area of Interest
- Converts buffered raster to TIN
- Utilizes “Polygon Volume” tool from 3D Analyst



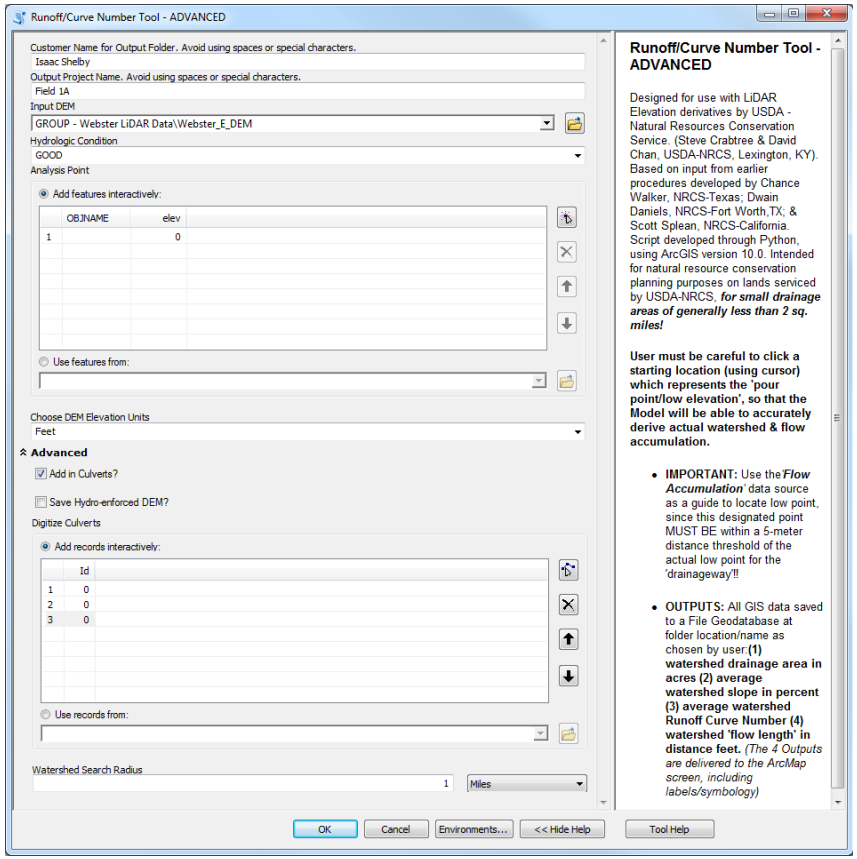
Ground Length tool

- “Wheeled Distance” vs. “As the Crow Flies”
- Uses the “Surface Length” output from the “Add Surface Information” tool in 3D Analyst



Runoff/Curve Number tool - Advanced

- LiDAR cannot recognize culverts, which results in incorrect drainage patterns
- To address this, we added functionality to manipulate the LiDAR elevation data on-the-fly to create a 'hydro-enforced' DEM and model actual conditions (culverts)
- It can also be used to compute drainage area for large watersheds
- Additionally, this tool can also use cloud-based elevation servers for the input DEM



Scenario 1

- We want to build a grassed waterway to handle the runoff reaching the red X

Concentrated Flow and Depth Grid

- Turning on the Concentrated Flow and Depth Grid, we see that there probably are culverts under the road (which have been missed by LiDAR)
- As it is, the runoff tool will not connect drainage to the other side of the road

Interrupted Flow

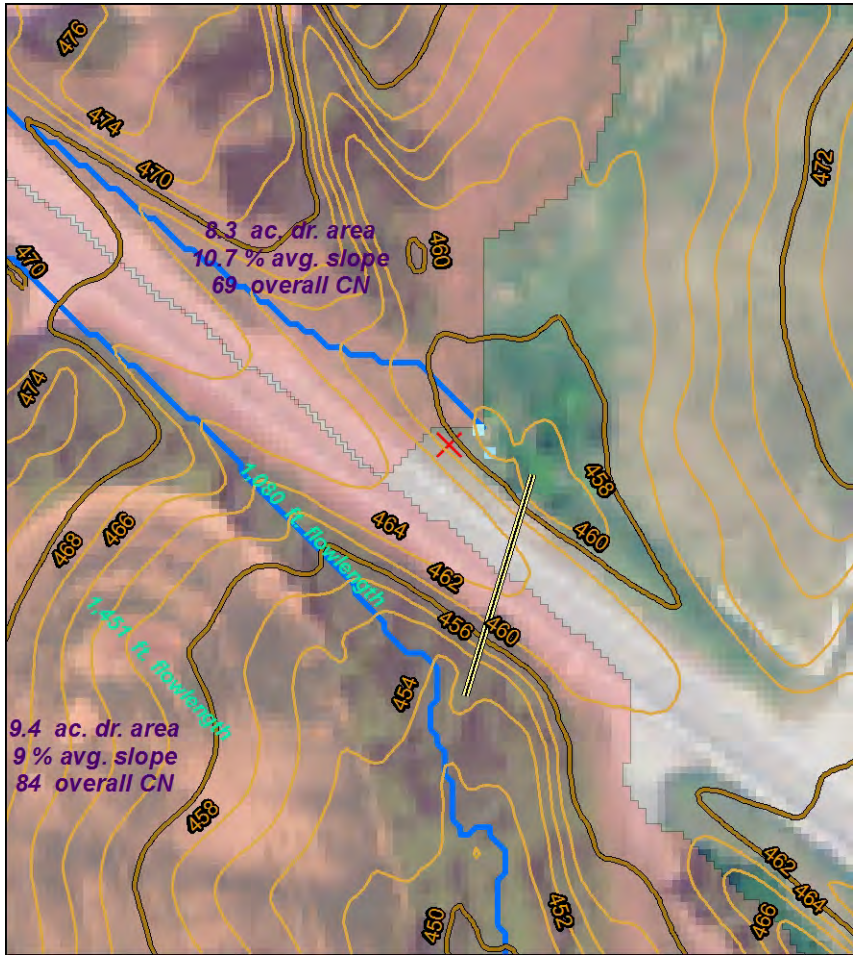
- Running the tool confirms that the drainage is artificially cut off

Above and Below the Culvert

- One solution is to run the runoff tool above and below the culvert
- However, the theoretical longest flow length and overall curve number will not be correct

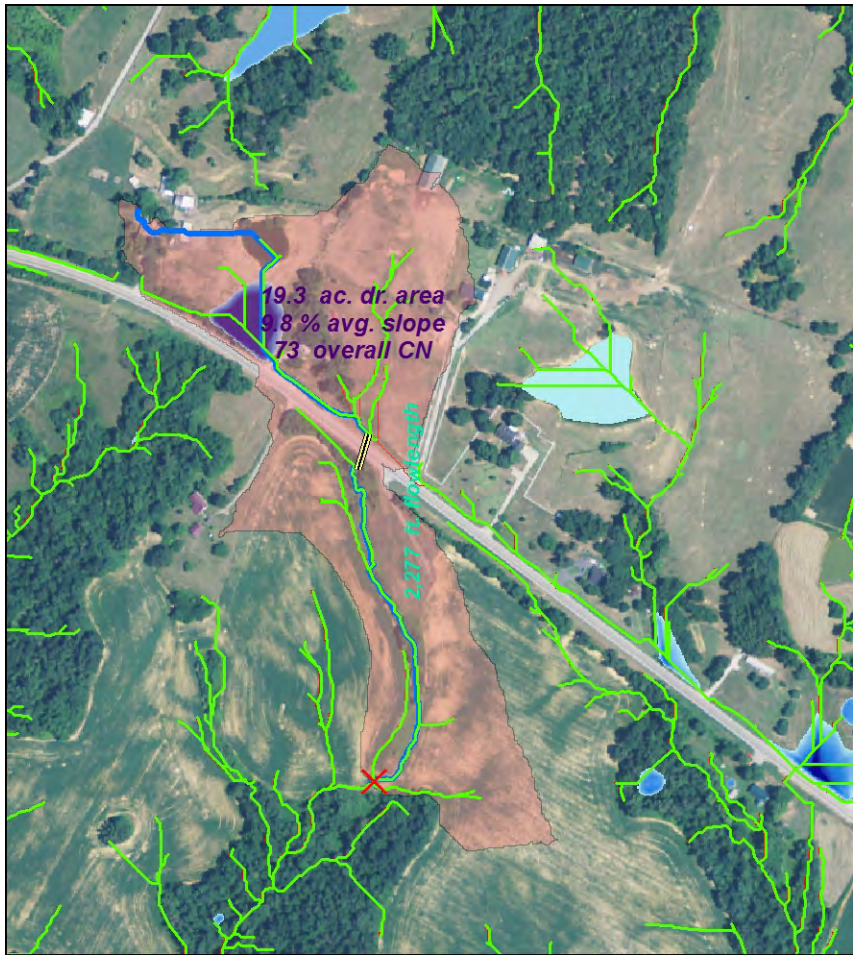
Culvert Placement

- To aid in placing the culverts, visiting the site and having GPS data would be ideal
- Additionally, the Contour tool can be utilized to help find the low spots on either side of the road



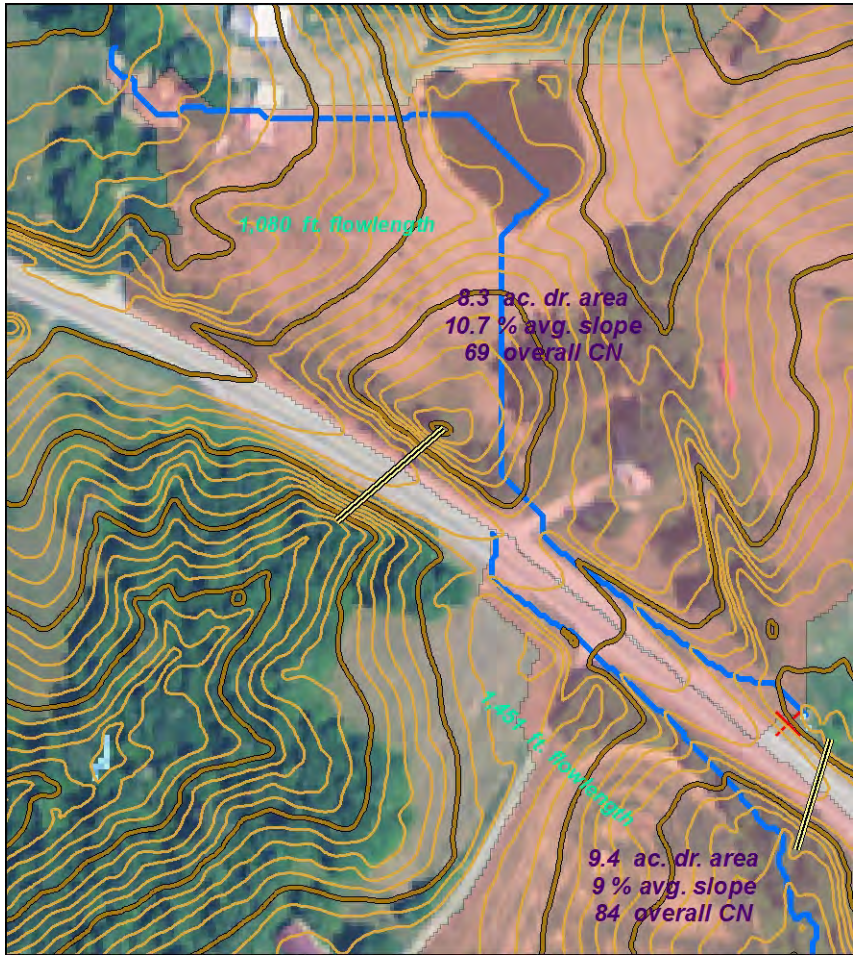
Preliminary Results

- Drainage now continued onto the other side of the road
- However, there is still some Depth Grid visible within the watershed boundary, as well as a few other spots down the road
- This indicates we missed several culverts, which may affect the drainage for our analysis point



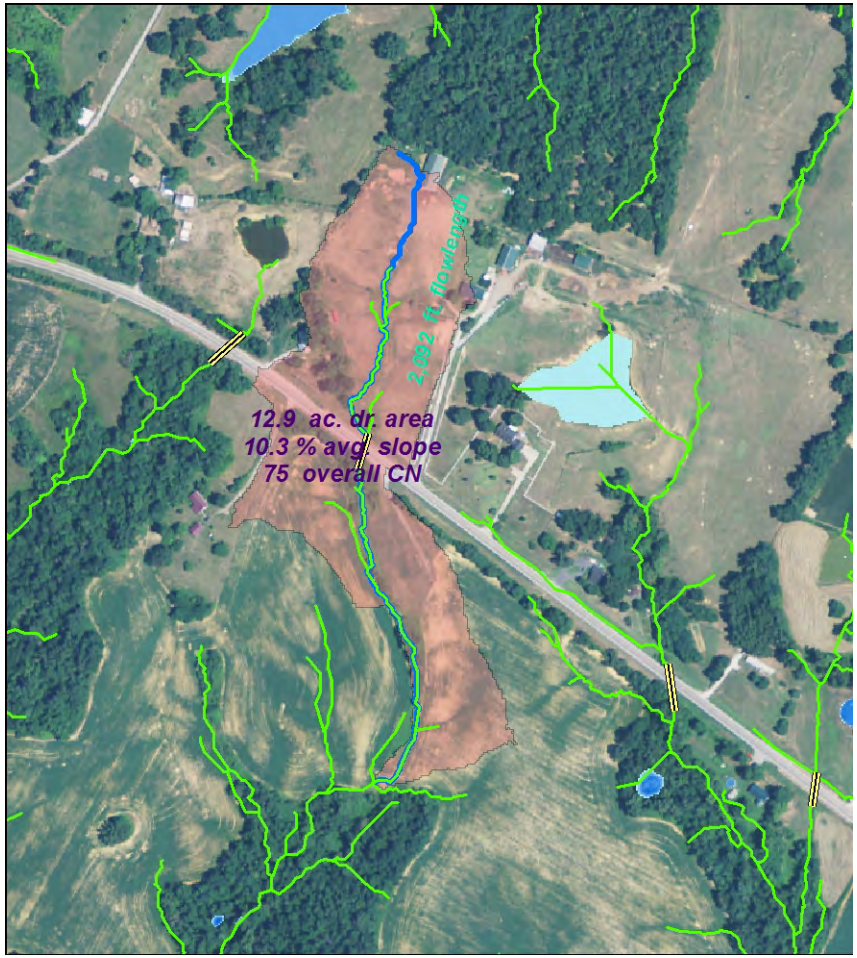
Digitizing Additional Culvert

(to add the missed culvert)



Final Results

- Digitizing the additional culvert on the left side eliminated several acres of drainage
- End result is a corrected watershed derived from a hydro-enforced LiDAR DEM that correctly delineates the drainage area



Advanced Tool Results

Effect of Digitizing Culverts

Drainage Area: 17.7 acres
Flow Length: 2531 feet

Drainage Area: 12.9 acres
Flow Length: 2092 feet

Conclusion

- Automates geoprocessing workflows
  - Displays preset labels and standardized symbology
- Ease of use
  - Point and Click
  - Clean output structure
- Practical use
  - Speed!
  - Tailored for NRCS needs
  - <u>Supplements</u> NRCS field practice design
    - Improved accuracy vs. manual methods
    - Does not replace “boots on the ground”
- These tools have already been adapted for use in other states by NRCS
- We continually enhance and add to our tools to meet field needs based on user feedback

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Questions?

- Tools/scripts available “as is” by request
- We’d be happy to demo the tools for your organization
- Contact Info:
  - David Chan- David.Chan@ky.usda.gov 859.224.7603
  - Steve Crabtree- Steve.Crabtree@ky.usda.gov 859.224.7400