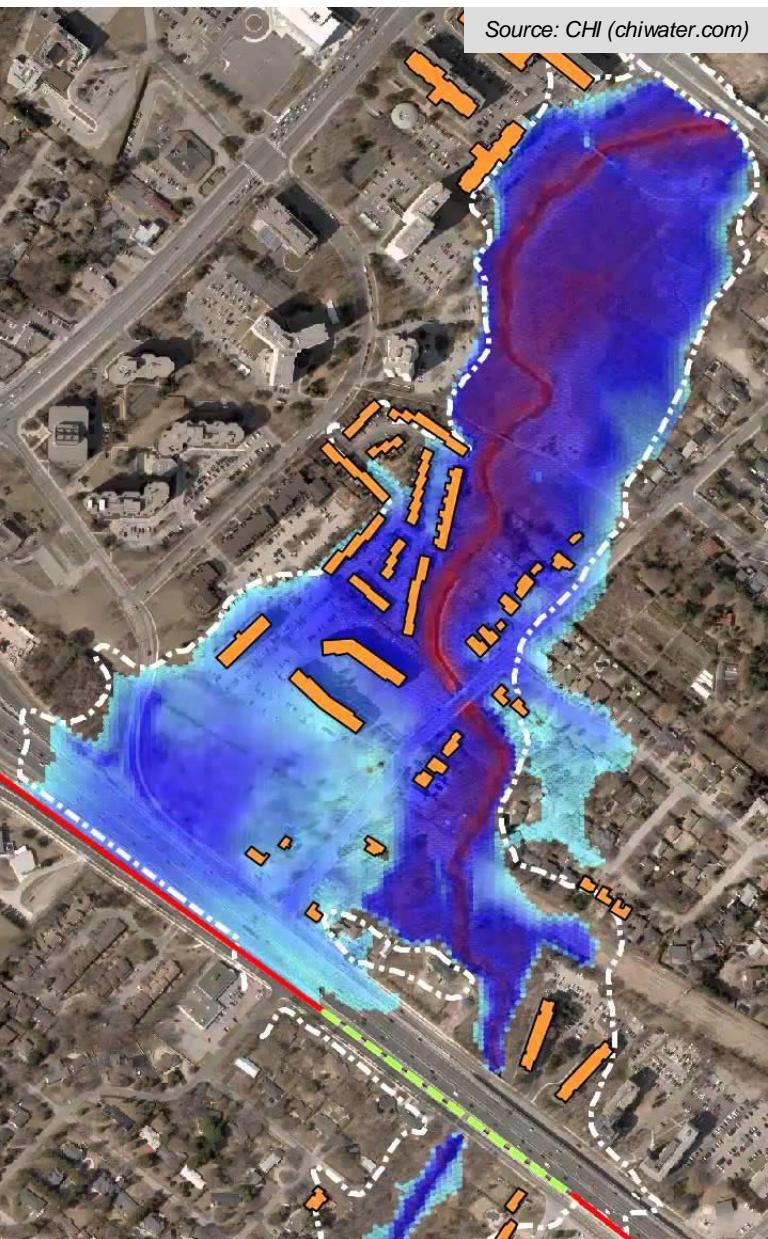


What to do when your lidar is out of date: A modeling perspective

International Conference on Water Management Modeling
51st Annual Conference
February 28th, 2018
Brampton, ON, Canada

water | ecology | community

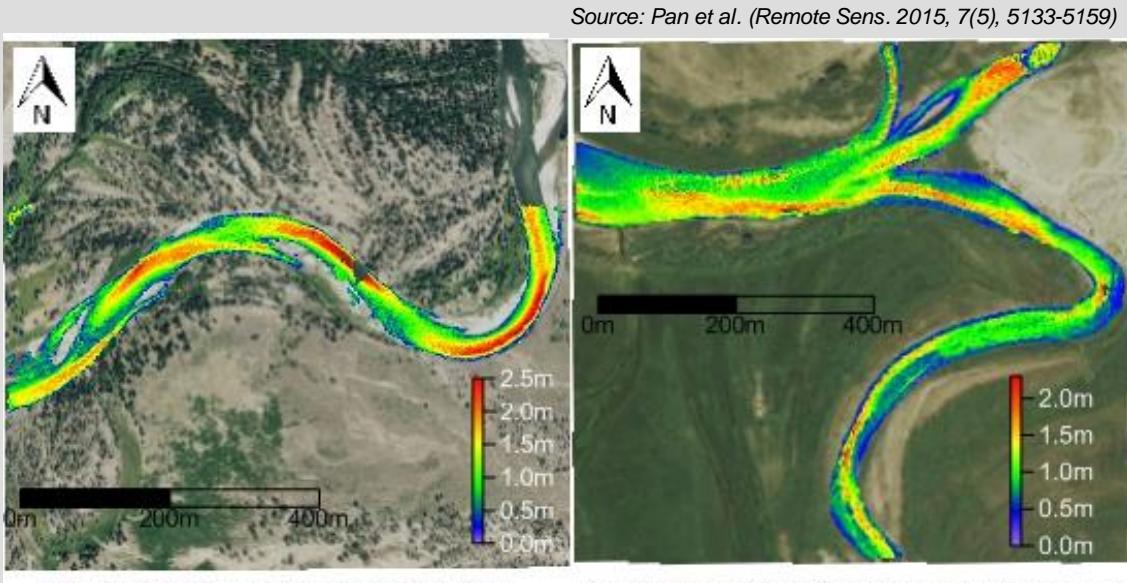
Roadmap



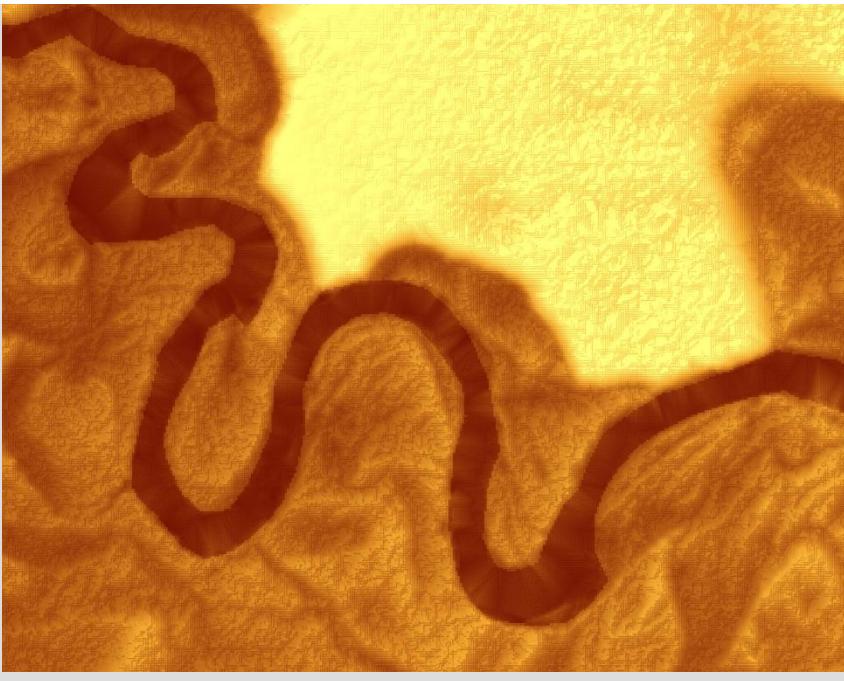
Lidar correction

- Reasons
- Options
- Applications
 - “2D” H&H Modeling

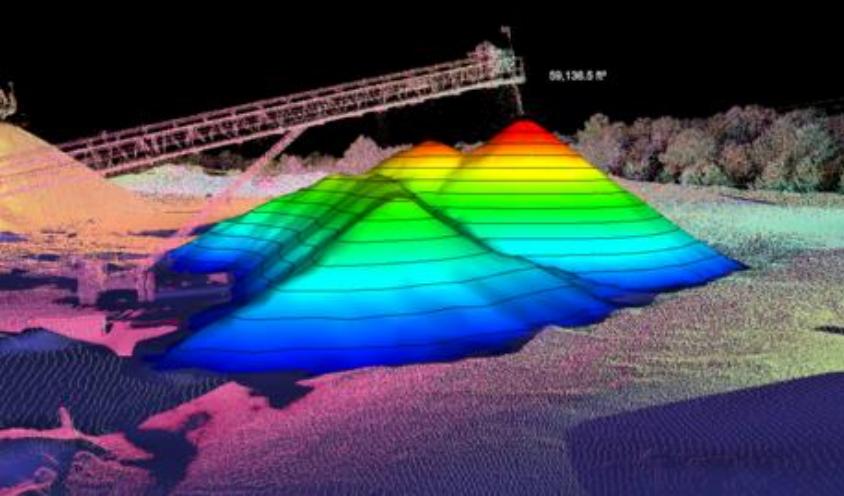
Case Study: Storm Lake, IA



Why your lidar might need correcting



Source: <http://www.wingfieldscale.com/map-measure/>



- “Correct” is purpose-driven
 - Bare-earth vs. tree canopy, e.g.

- Increase precision/accuracy

- Interference
 - Structures
 - Stockpiles

- Hydrocorrection

- Culverts
 - Bridges
 - Water surfaces

- Landscape changes

- Vegetative growth
 - Terrain: natural or anthropogenic

Options for correcting lidar



Source: <https://www.dronezon.com/>



Source: <https://www.indiamart.com/>

Best method?

- Application specific

Collect... more lidar

- Manned aircraft
- UAV
- Ground-based

Stereoscopy

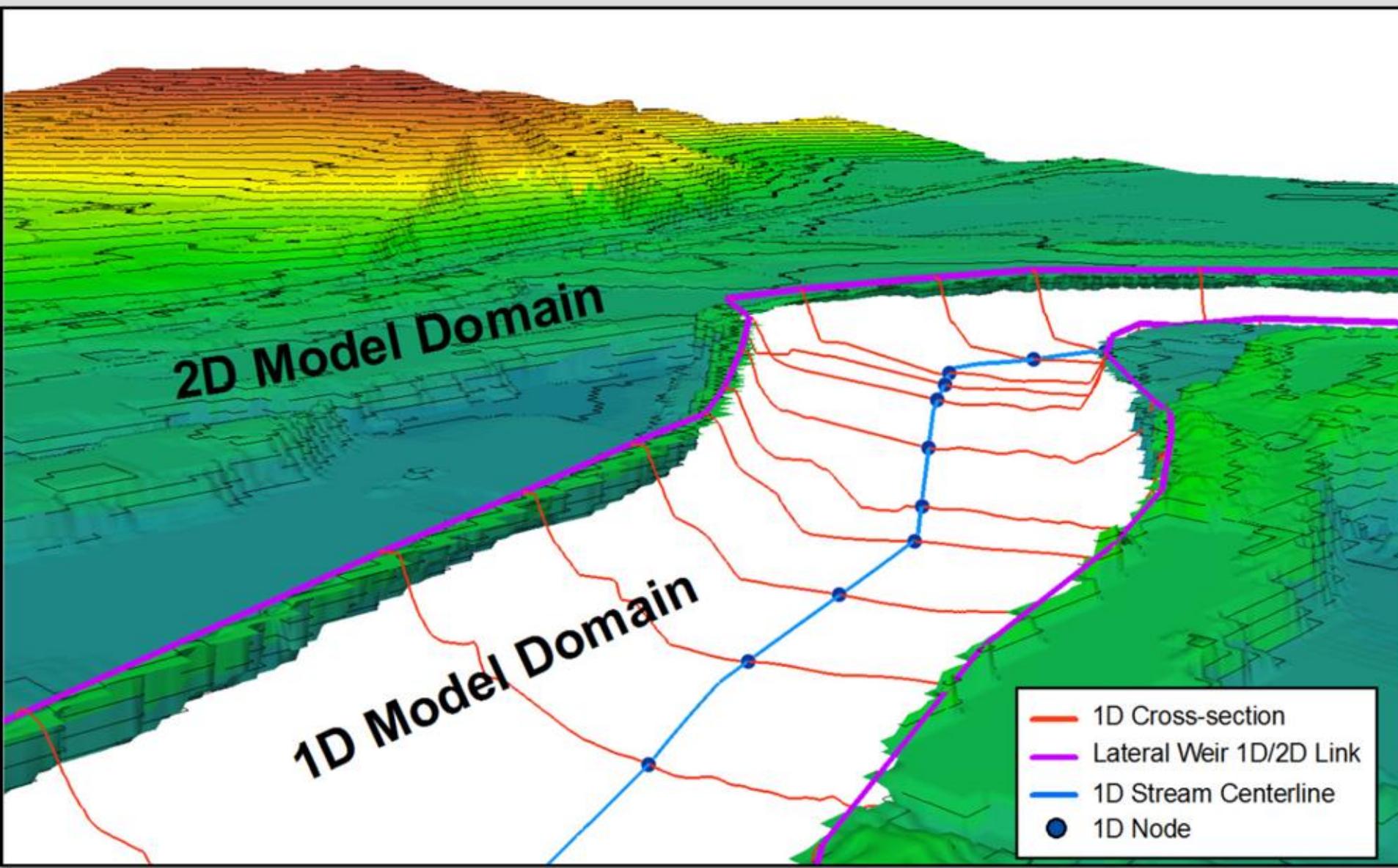
Transformation

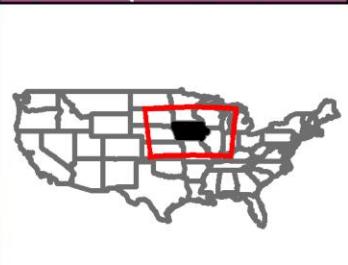
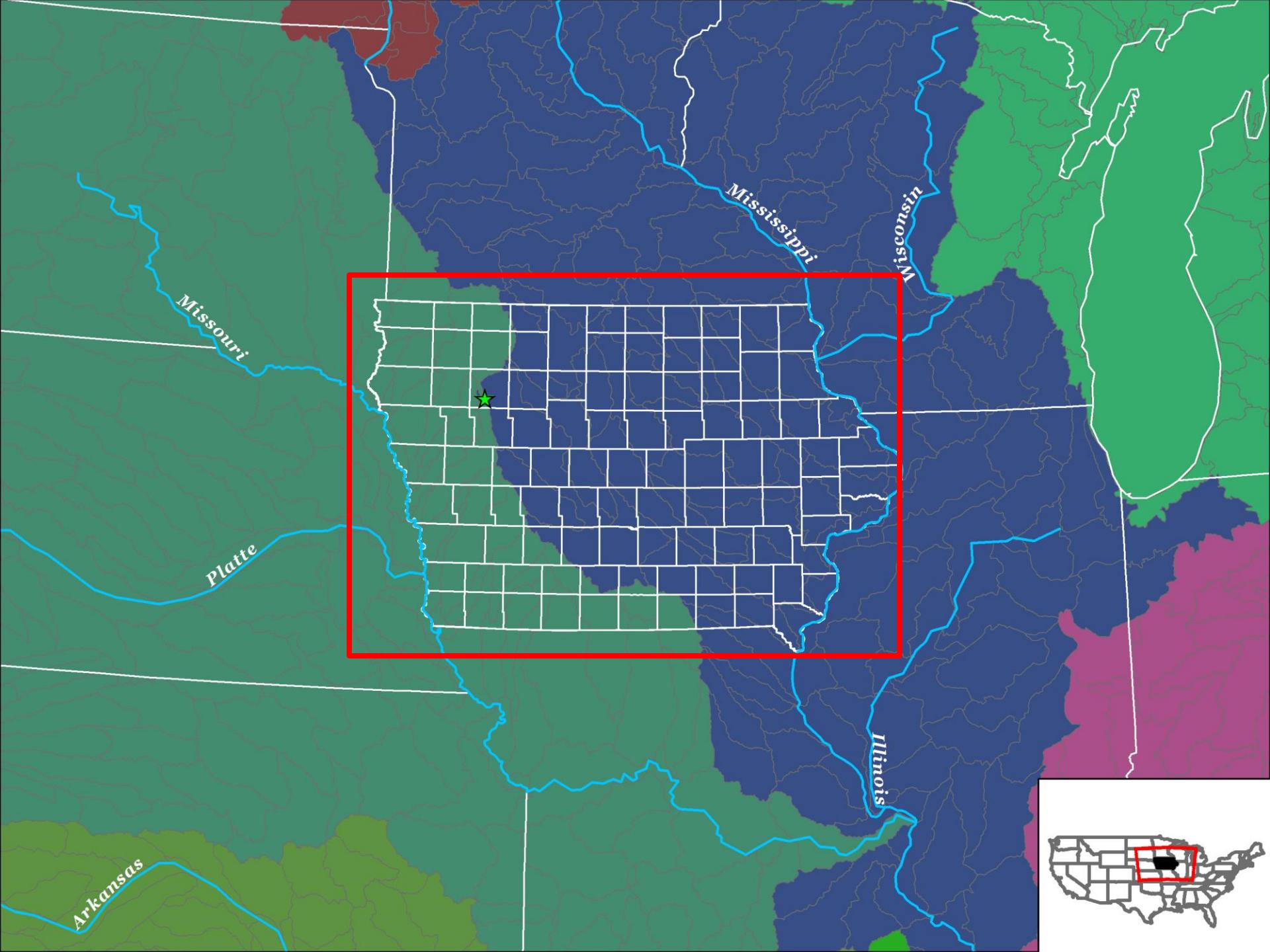
- Filtering (vegetation removal)
- Interpolation (hydrocorrection)
- Estimation (bathymetry)

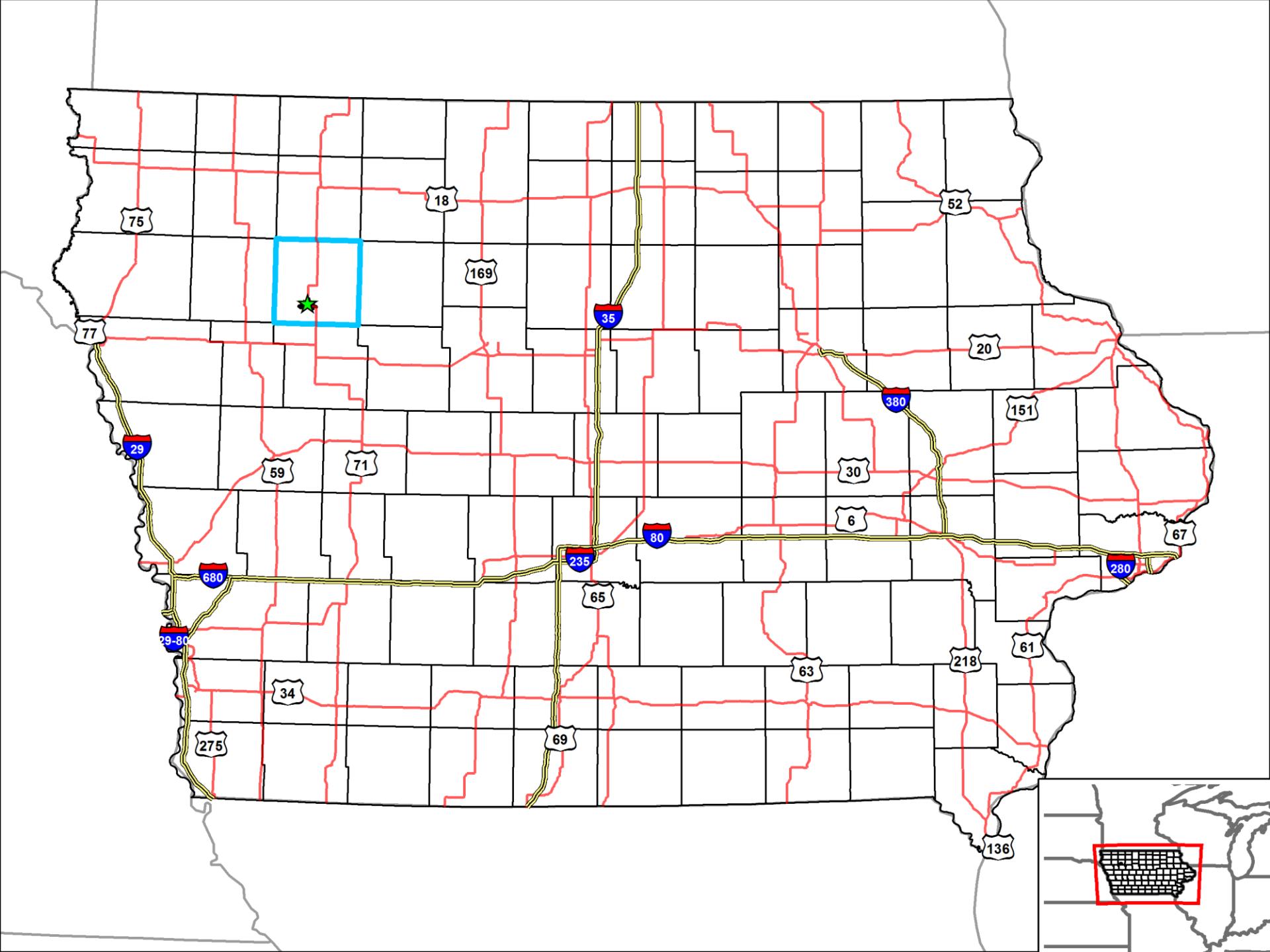
Traditional surveying

2D Hydrologic & Hydraulic Modeling

Source: Gilles et al. (Water 2012, 4(1), 85-106)









Storm Lake City Limits

Obrien	Clay
Buena Vista	

Ida Sac



Poor Farm Creek
Storm Lake City Limits
Drainage District Infrastructure

Obrien	Clay
Buena Vista	
Ida	Sac



Poor Farm Creek
Storm Lake City Limits
• Storm Sewer Junctions
— Storm Sewer Pipes
- - - Drainage District Infrastructure

Obrien	Clay
Buena Vista	
Ida	Sac

1. Flooding locations?

- No substantial documentation
- Anecdotal evidence
- Use DEM to infer

2. Status of infrastructure?

- Out-dated GIS database
- Missing & empty attributes
- Discrepancies with field observations
- City staff turnover – lost institutional knowledge
- No existing city-wide model

3. Relevant recent projects?

- Various storm water projects
- Various road projects
- Various earthworks

“Unique” storm sewer system



“Unique” storm sewer system



“Unique” storm sewer system

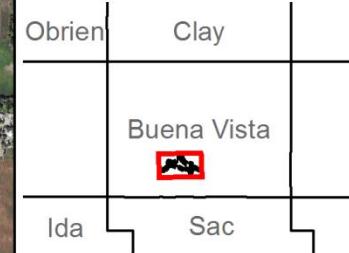
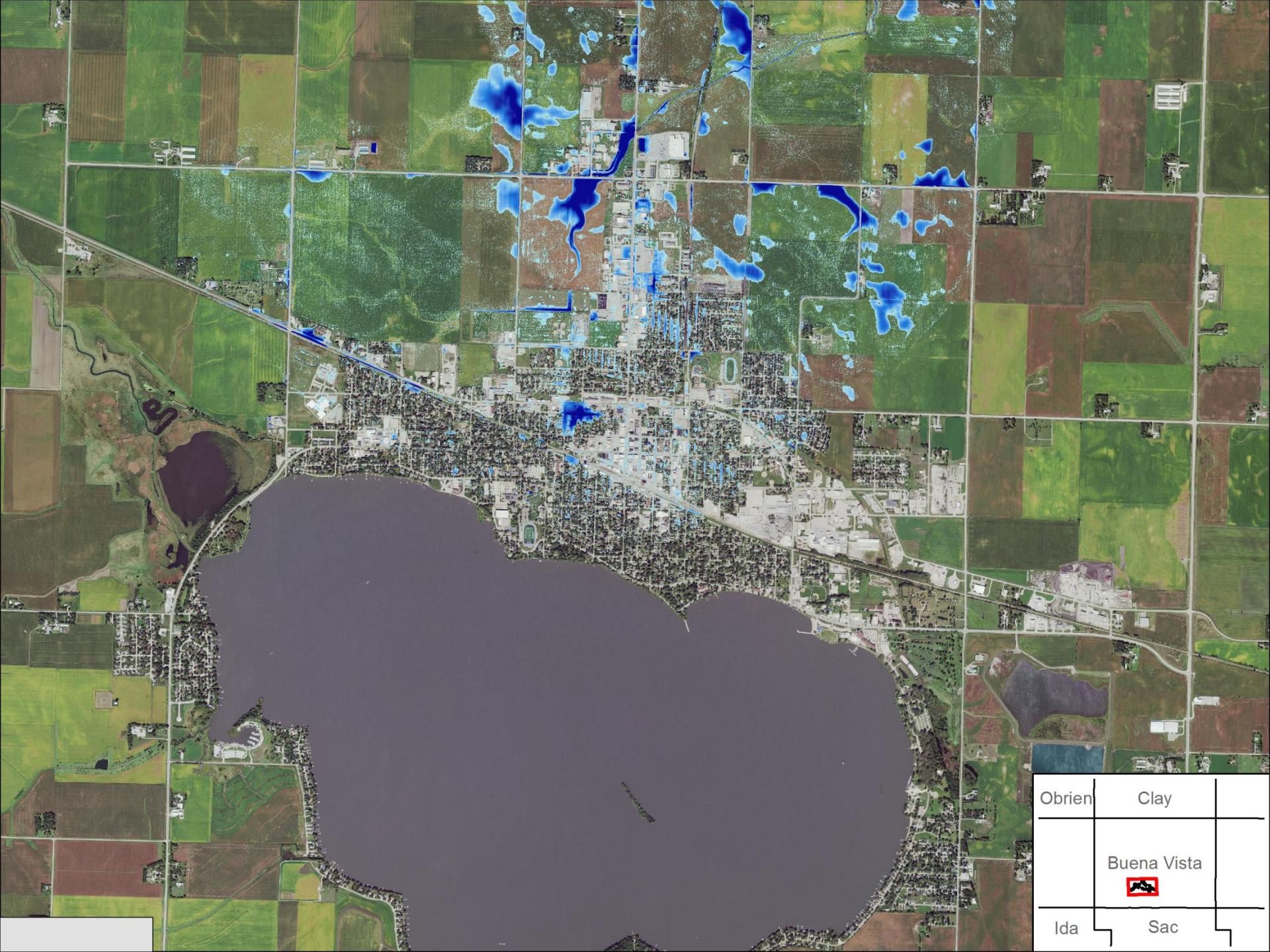




- Poor Farm Creek
- Storm Lake City Limits
- Storm Sewer Junctions
- Storm Sewer Pipes
- Drainage District Infrastructure

Obrien Clay
Buena Vista

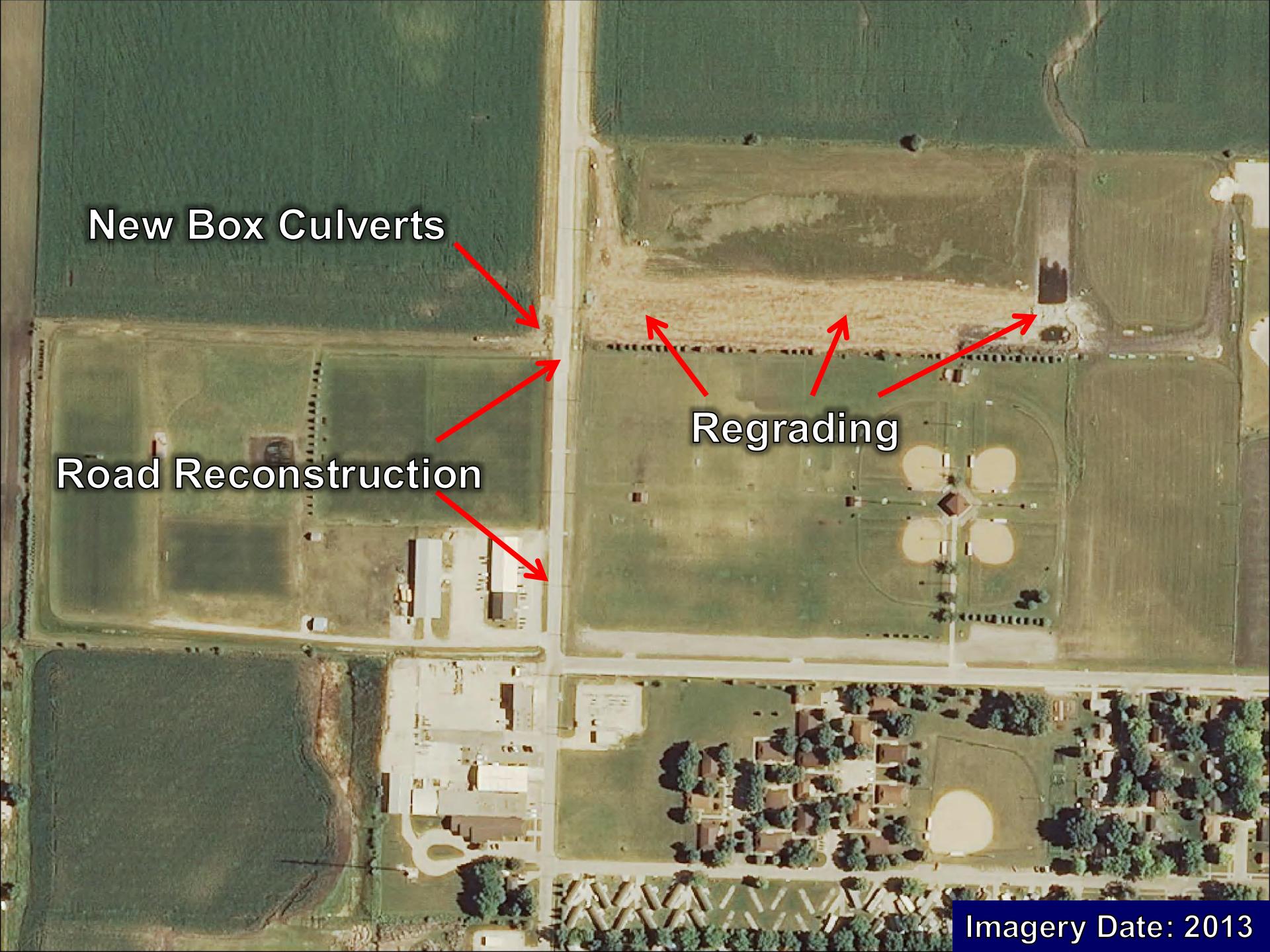
Ida Sac







Imagery Date: 2009



New Box Culverts

Road Reconstruction

Regrading

Imagery Date: 2013



Aerial photograph showing a residential neighborhood with houses, streets, and green spaces. In the upper right, there is a large, undeveloped field labeled "Development". A red arrow points from the word "Development" to a specific area within the field. The surrounding area includes several baseball diamonds and a cluster of buildings.

Development

Imagery Date: 2015

1. Collect the right survey data

- Precision (i.e. equipment)
- Data structure
- Targeted locations

2. Use breaklines

- Hard – curbs, road centerlines, retaining walls
- Soft – slope breaks, channel centerlines

3. Use the lidar point cloud

- Bare earth (.xyz)
- Better accuracy
- Easier & faster to manipulate

4. Targeted correction

- Compare survey with lidar
- Err on the side higher point density

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Lesson 1: Collect the right data



Lesson 1: Collect the right data



6637	3703082	4464044	1433.887	TBC +
6638	3703078	4464038	1433.79	TBC
6639	3703067	4464033	1433.396	TBC
6640	3703040	4464032	1433.623	TBC
6641	3703014	4464031	1433.752	TBC
6642	3703004	4464035	1434.165	TBC
6643	3702998	4464042	1434.508	TBC -
6644	3702972	4464041	1434.838	TBC +
6645	3702968	4464034	1434.584	TBC
6646	3702959	4464030	1434.095	TBC
6647	3702927	4464029	1434.348	TBC
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6650	3702911	4464021	1434.579	TBC
6651	3702909	4464021	1434.591	TBC
6652	3702906	4464023	1434.454	TBC -
6653	3702903	4464023	1434.436	TBC +
6654	3702900	4464021	1434.533	TBC
6655	3702898	4464021	1434.495	TBC -
6656	3702904	4464024	1433.97	TURRET
6657	3702914	4464035	1435.039	CBC
6658	3702910	4463984	1433.569	CBC
6659	3702899	4463992	1434.503	TBC +
6660	3702901	4463993	1434.408	TBC
6661	3702903	4463991	1434.465	TBC -
6662	3702905	4463989	1433.915	TURRET
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6664	3702901	4463993	1434.085	FL
6665	3702903	4463991	1433.927	FL -

• Survey Points

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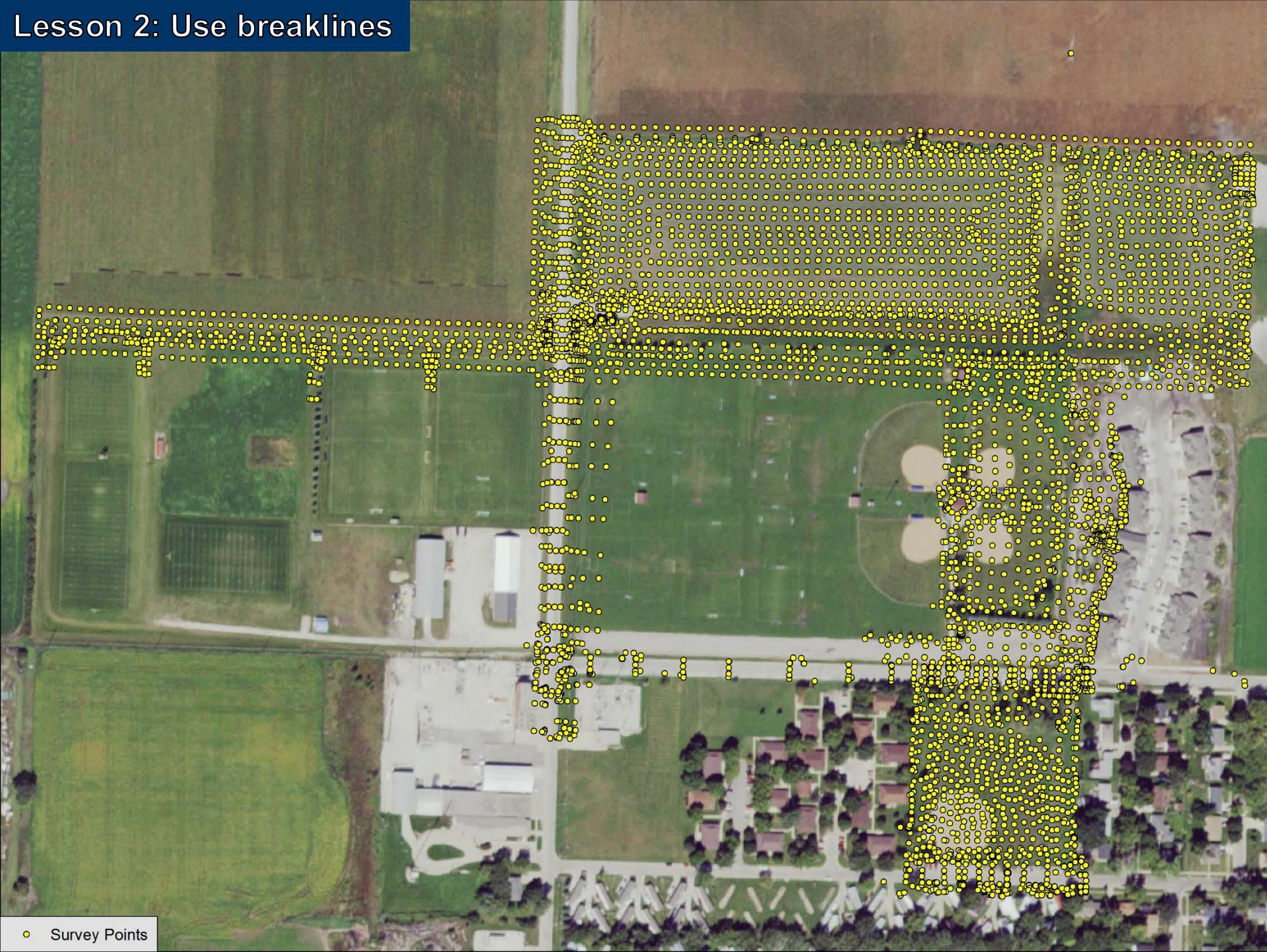
4. Targeted correction

- Compare survey with lidar
- Err on the side of higher point density

Lesson 2: Use breaklines

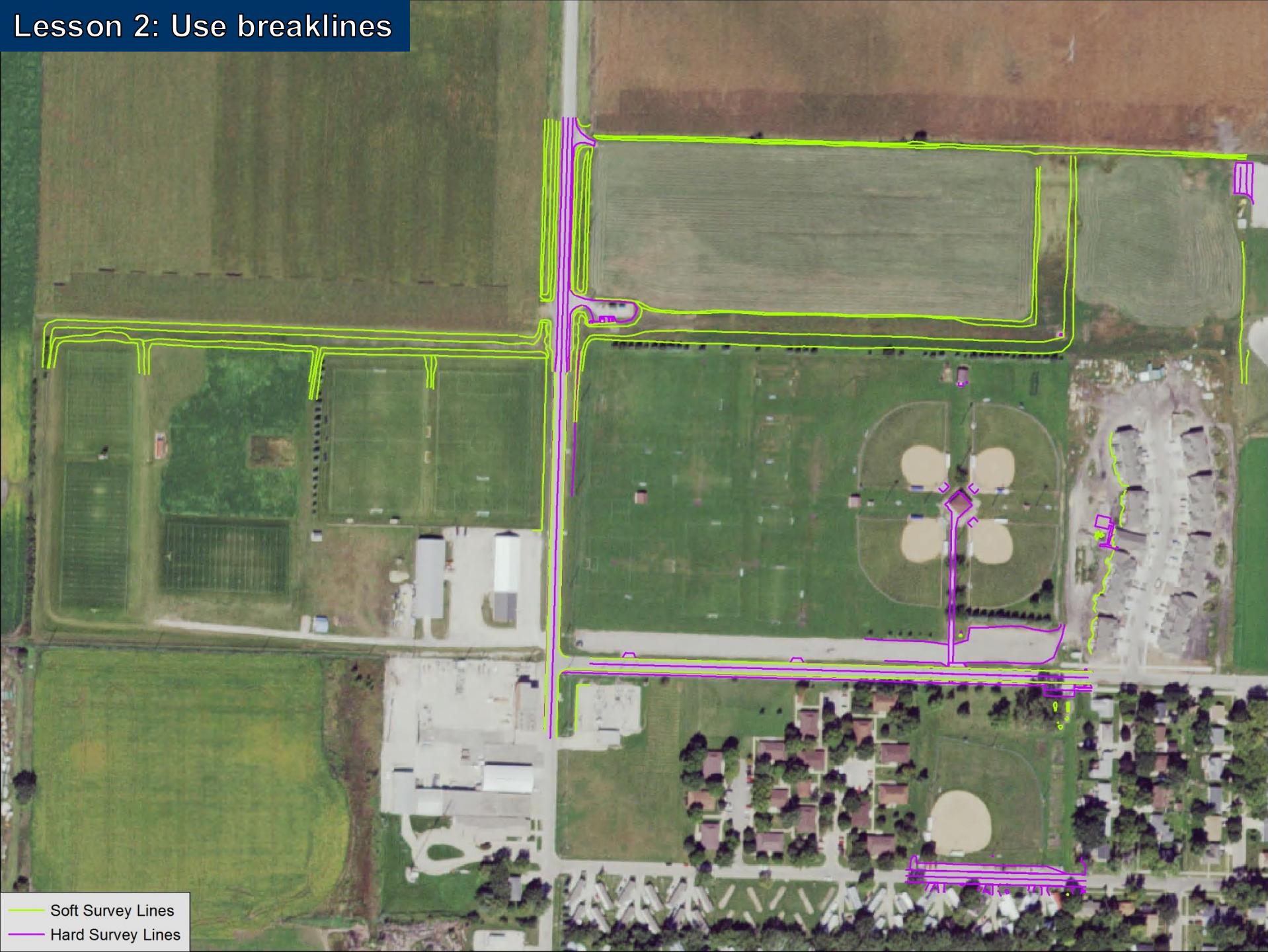


Lesson 2: Use breaklines



Survey Points

Lesson 2: Use breaklines



Soft Survey Lines
Hard Survey Lines

Lesson 2: Use breaklines



Lesson 2: Use breaklines



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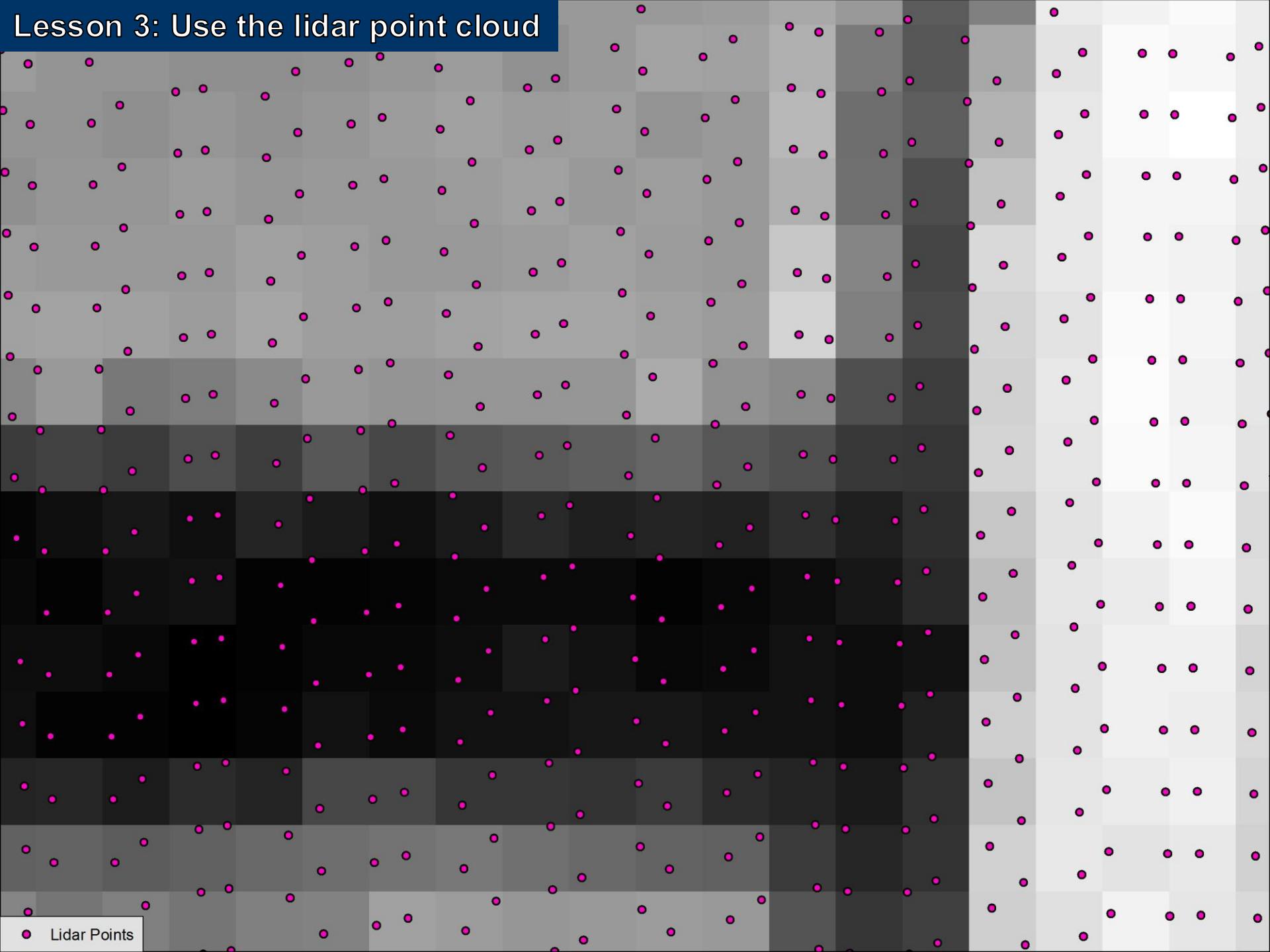
3. Use the lidar point cloud

- Bare earth (.xyz)
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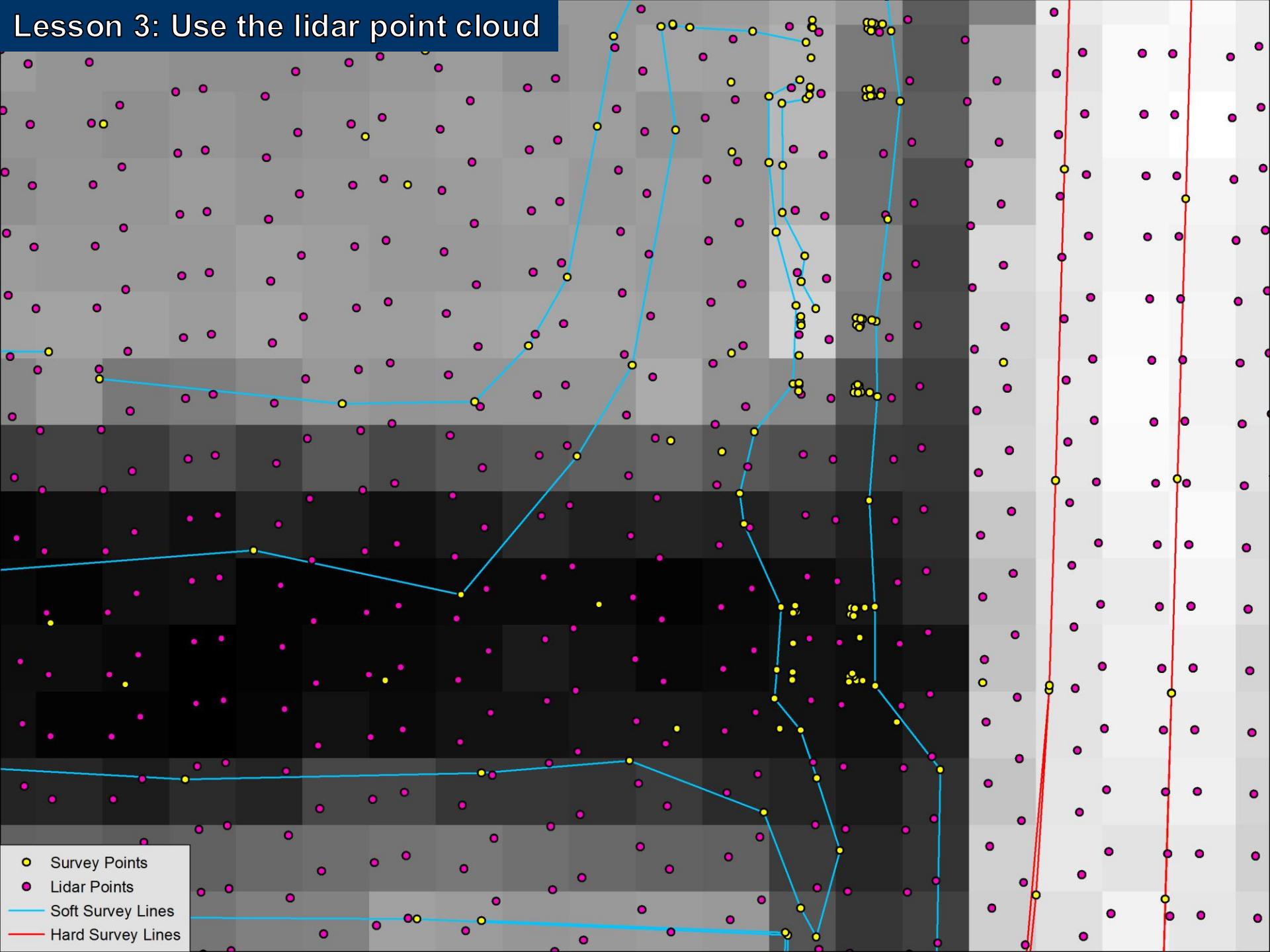
4. Targeted correction

- Compare survey with lidar
- Err on the side of higher point density

Lesson 3: Use the lidar point cloud

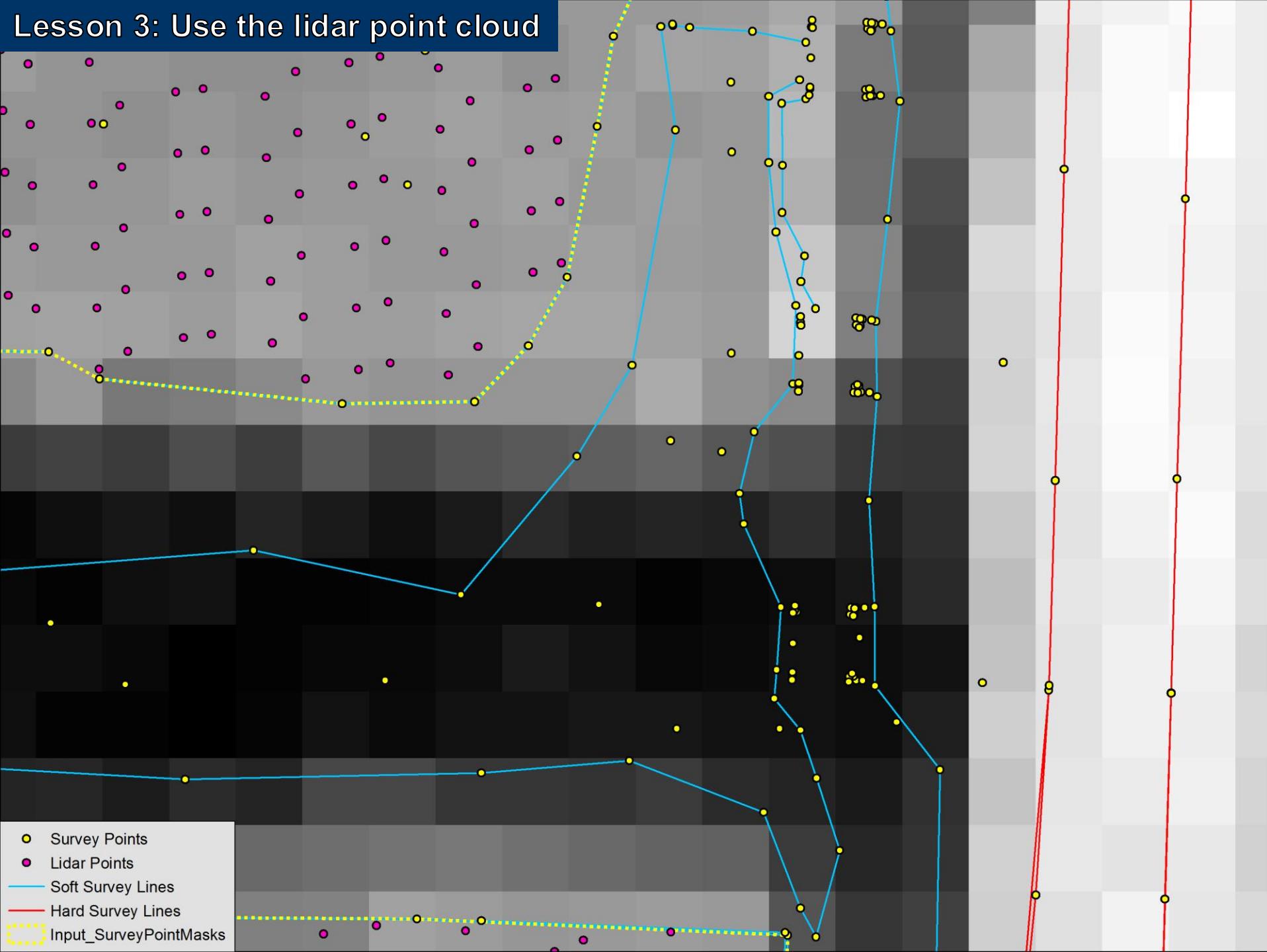


Lesson 3: Use the lidar point cloud



- Survey Points
- Lidar Points
- Soft Survey Lines
- Hard Survey Lines

Lesson 3: Use the lidar point cloud



- Survey Points
- Lidar Points
- Soft Survey Lines
- Hard Survey Lines
- Input_SurveyPointMasks

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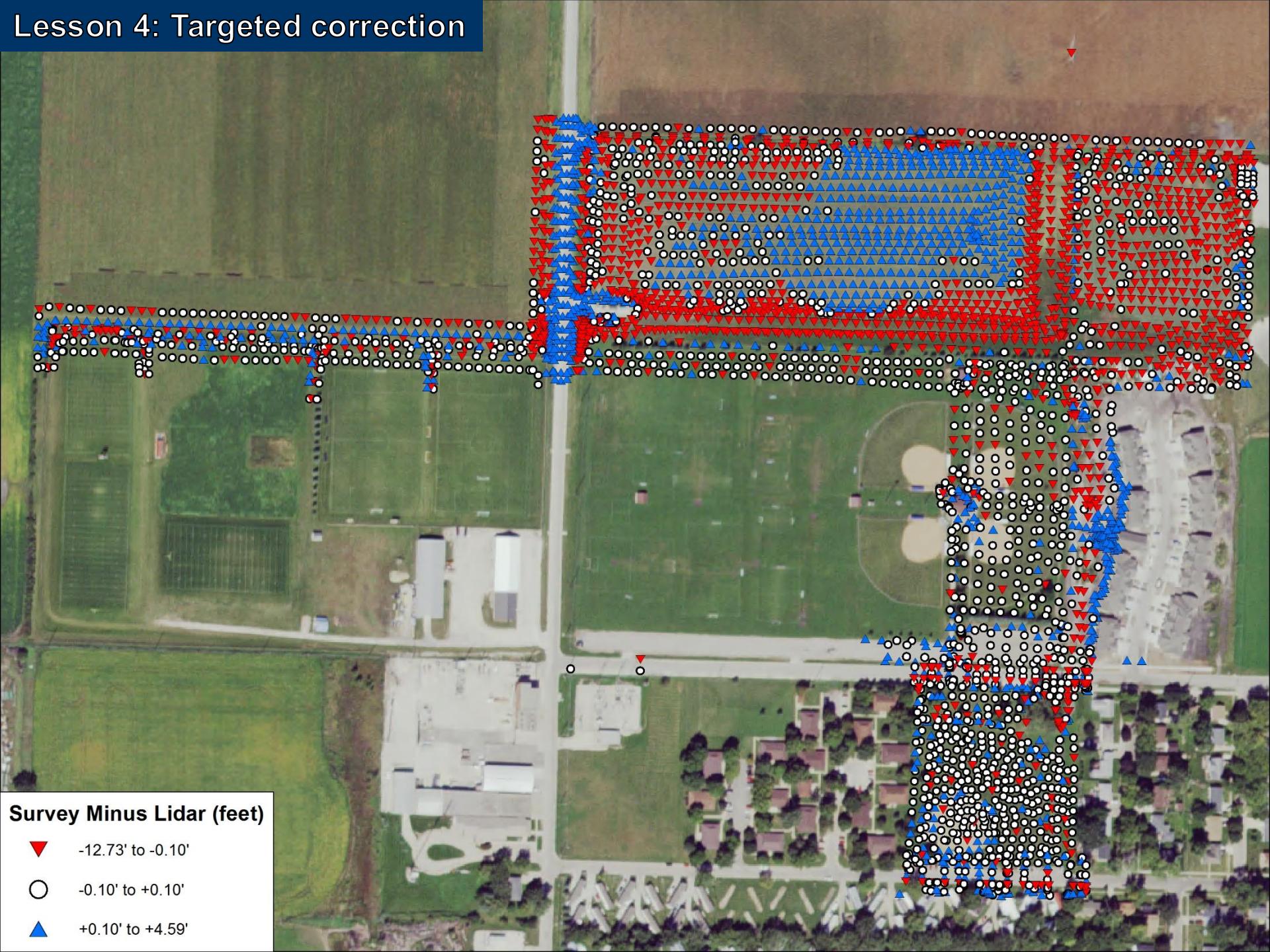
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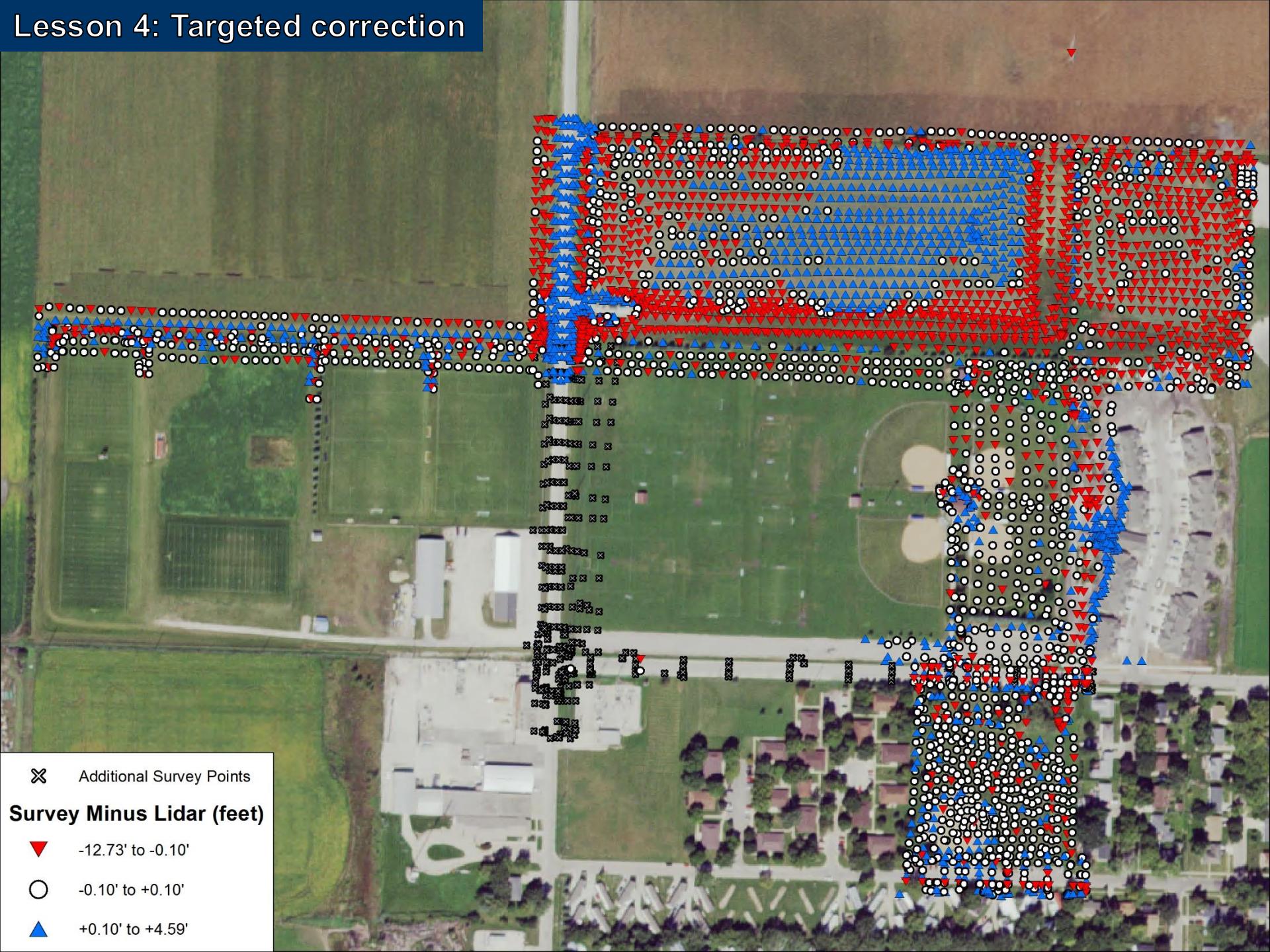
4. Targeted correction

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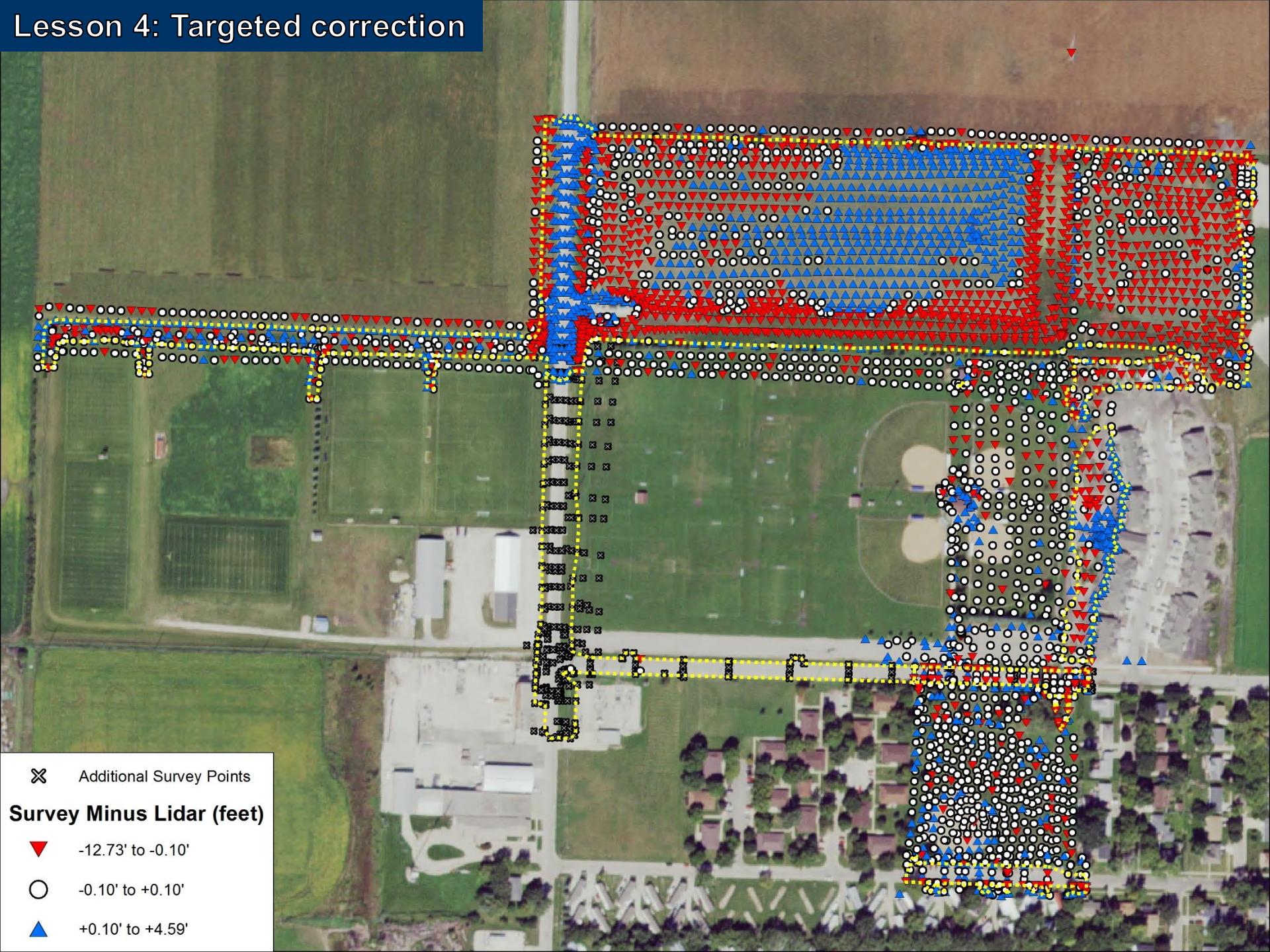
Lesson 4: Targeted correction



Lesson 4: Targeted correction



Lesson 4: Targeted correction



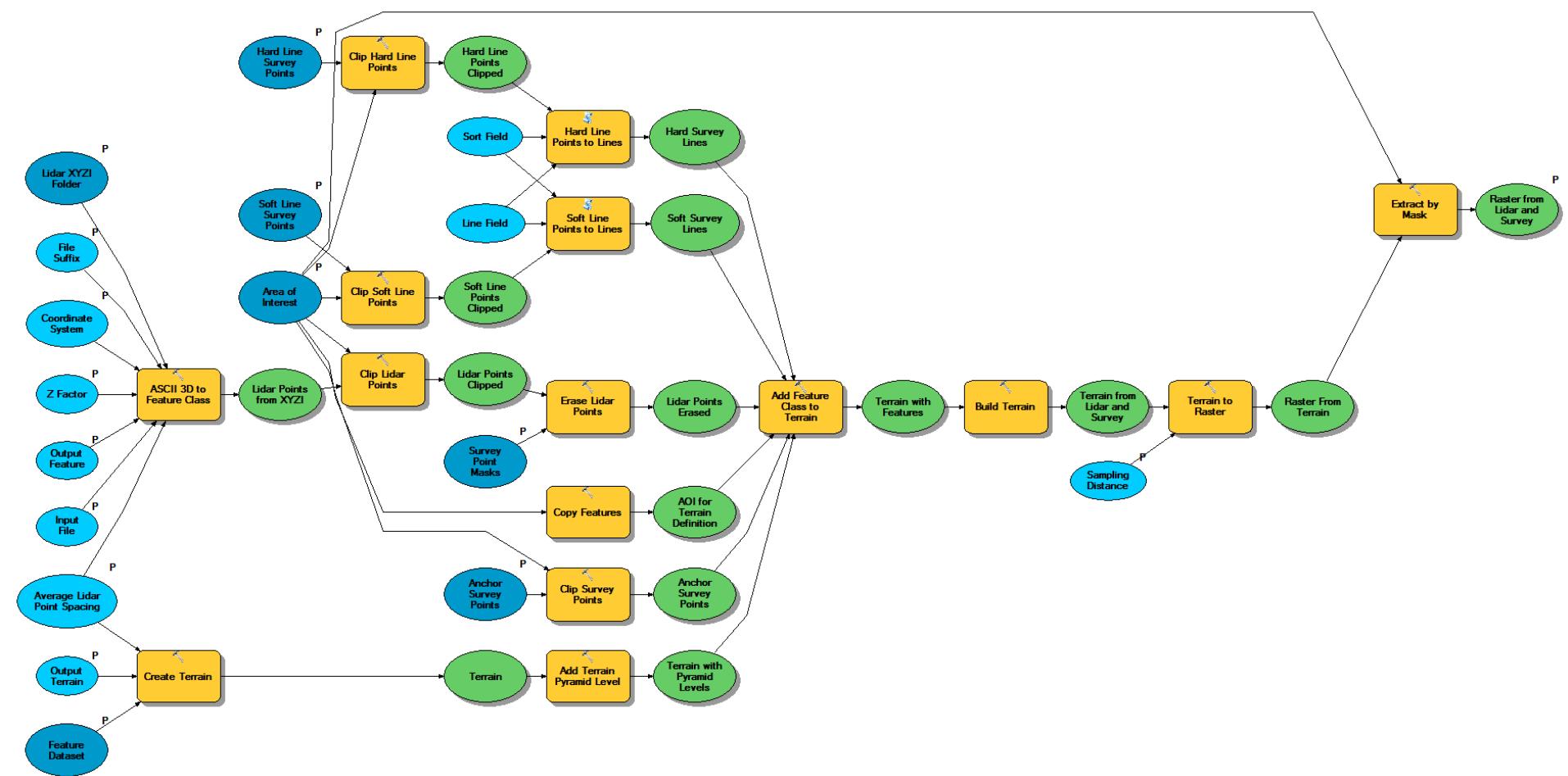
✖ Additional Survey Points

Survey Minus Lidar (feet)

▼ -12.73' to -0.10'

○ -0.10' to +0.10'

▲ +0.10' to +4.59'



Input Terrain

Terrain with Pyramid Levels

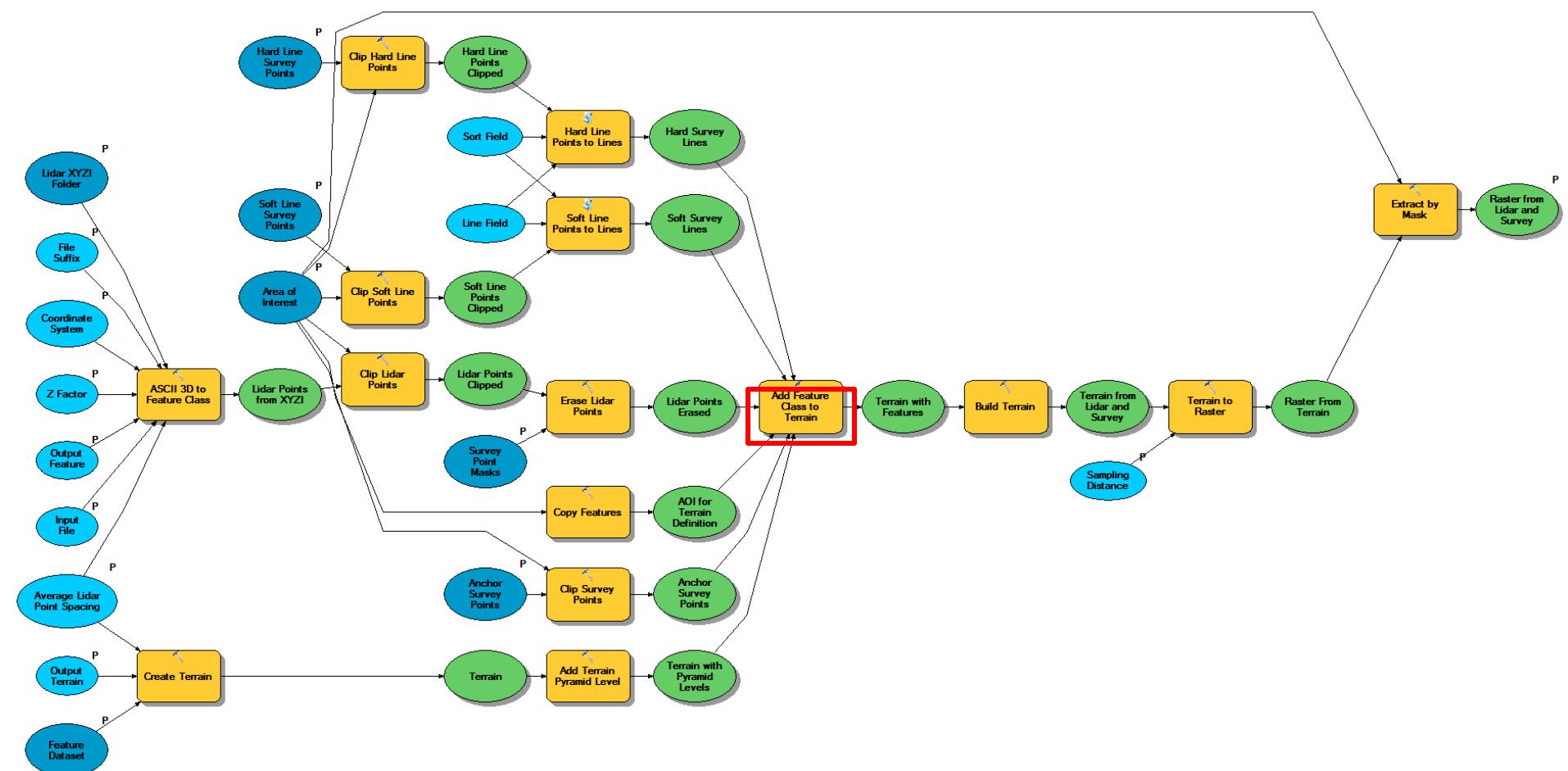


Input Feature Class



Input Features	Height Field	SF Type	Group	Min Resolution	Max Resolution	Overview	Embed	Anchor
Soft Survey Lines	Shape	Soft_Line	2	0	20	true	false	false
Hard Survey Lines	Shape	Hard_Line	3	0	20	true	false	false
Lidar Points Erased	Shape	Mass_Points	4	0	20	true	false	false
Anchor Survey Points Clipped	Shape	Mass_Points	5	0	20	true	false	true
AOI for Terrain Definition	<None>	Soft_Clip	1	0	20	true	false	false



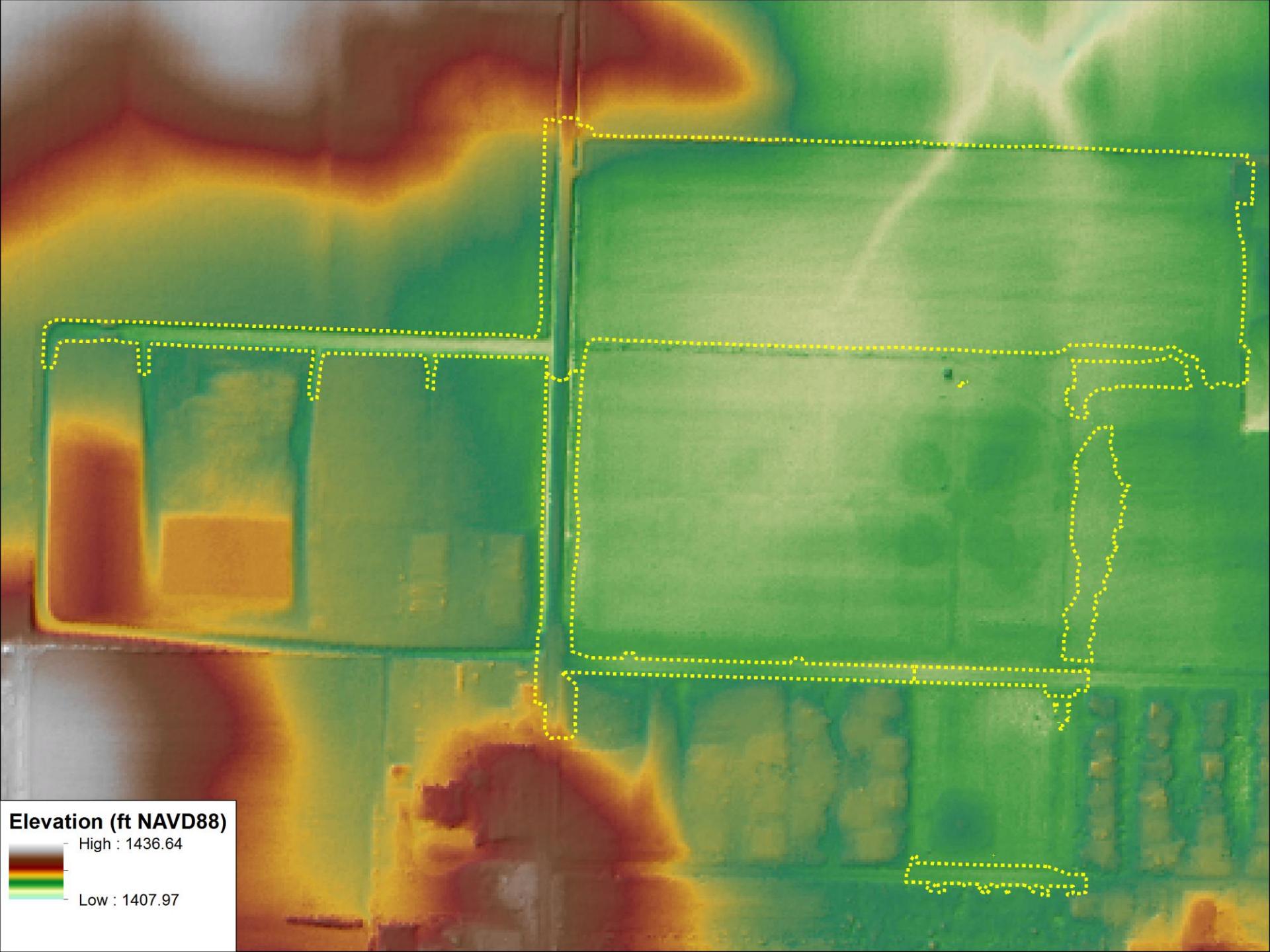


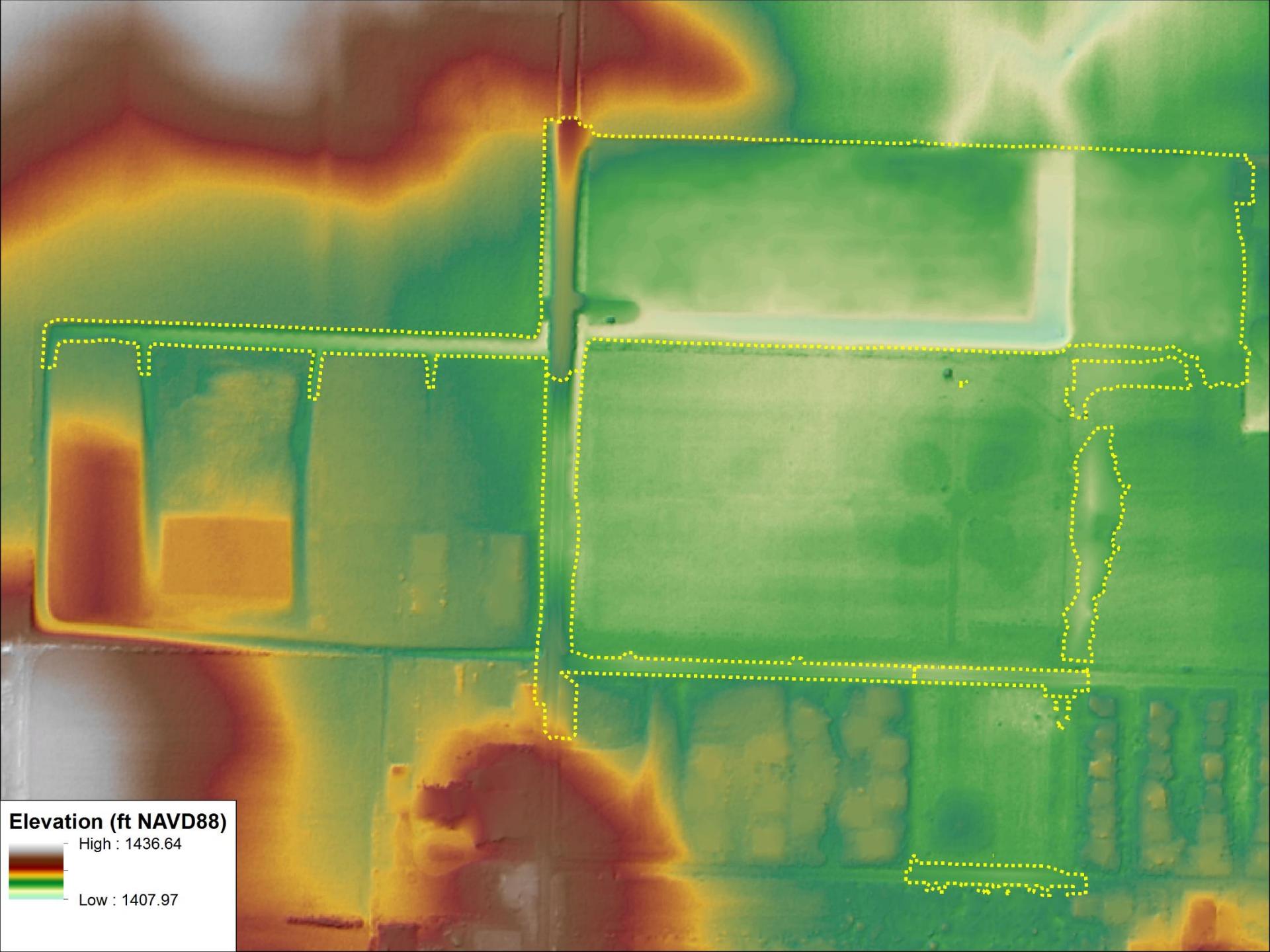
Input Terrain

Terrain with Pyramid Levels

Input Feature Class

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Lidar Points Erased	Shape	Mass_Points	4	0	20	true	false	false
Anchor Survey Points Clipped	Shape	Mass_Points	5	0	20	true	false	true
AOI for Terrain Definition	<None>	Soft_Clip	1	0	20	true	false	false







Key Takeaways

1. What is "out-of-date" or "inadequate" lidar?

- Changes have taken place (natural or anthropogenic)
- Can be very old or very recent lidar
- Could be due to interest in fine-scale features

2. How can we address it?

- Survey-grade handheld GPS (think urban)
 - Structures, linear features needing high accuracy
- Survey-grade ATV/vehicle-mounted GPS (think agriculture)
 - Large, open, dry areas needing high accuracy
- Micro UAV photogrammetry (think construction)
 - Open areas, large features without dense vegetation
- Aerial (e.g. UAV) lidar acquisition (think hydrology)
 - Large areas with or without vegetation
- Terrestrial (i.e. ground-based) lidar (think geomorphology)
 - Small areas or large features need extremely high accuracy

Thank you



A large, abstract background image at the top of the slide shows a bird's-eye view of a river or coastal area. The image is dominated by warm, golden-yellow tones, suggesting sunlight reflecting off water or sand. The waterways are depicted as dark, winding lines, while the surrounding land is shown in various shades of yellow and orange. The overall texture is slightly grainy and has a painterly quality.

Mike Talbot, EIT, CFM

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