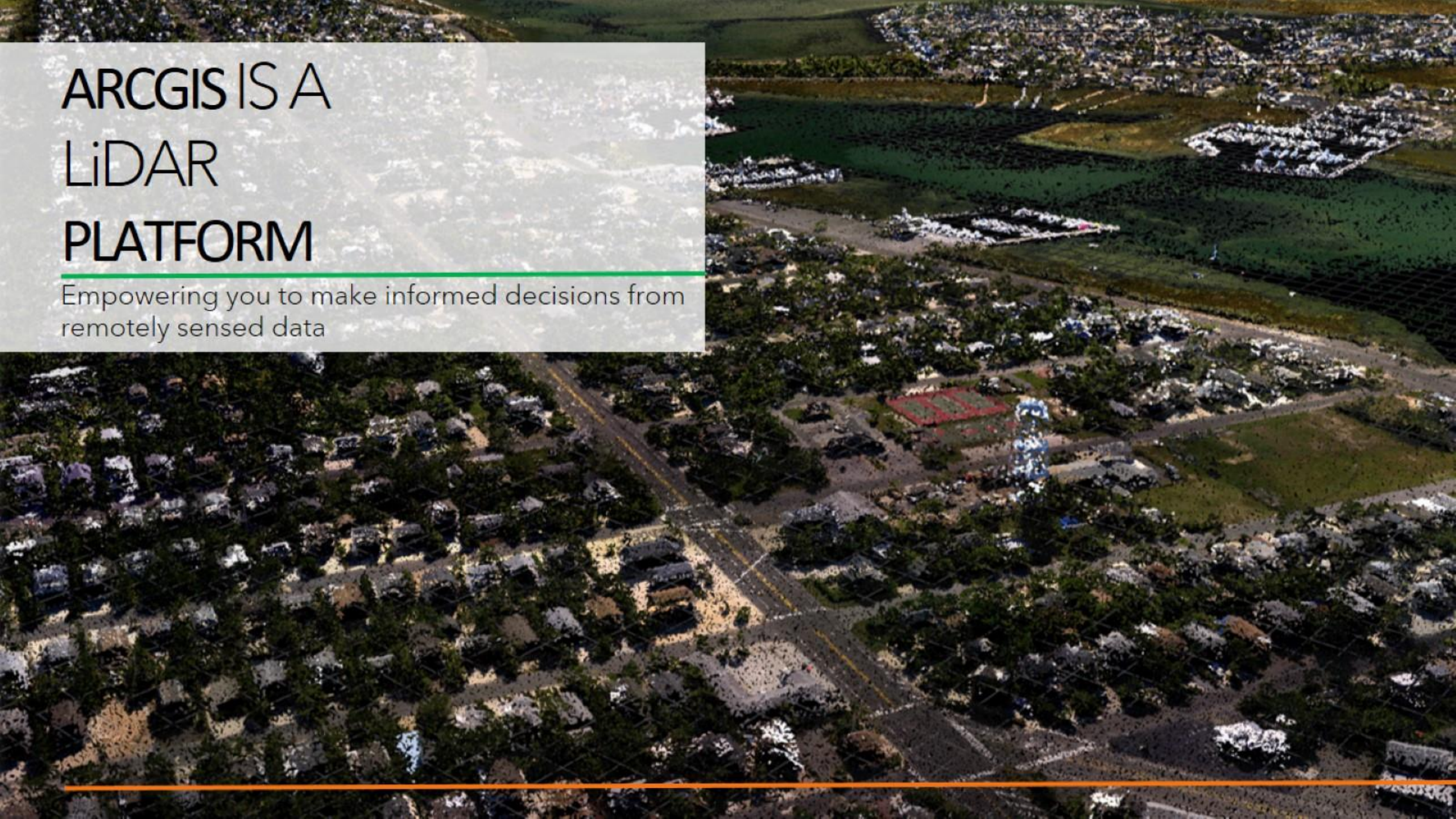
Lidar Analysis in ArcGIS: An Introduction

Lindsay Weitz

Arthur Crawford

ARCGIS IS A LiDAR PLATFORM

Empowering you to make informed decisions from remotely sensed data

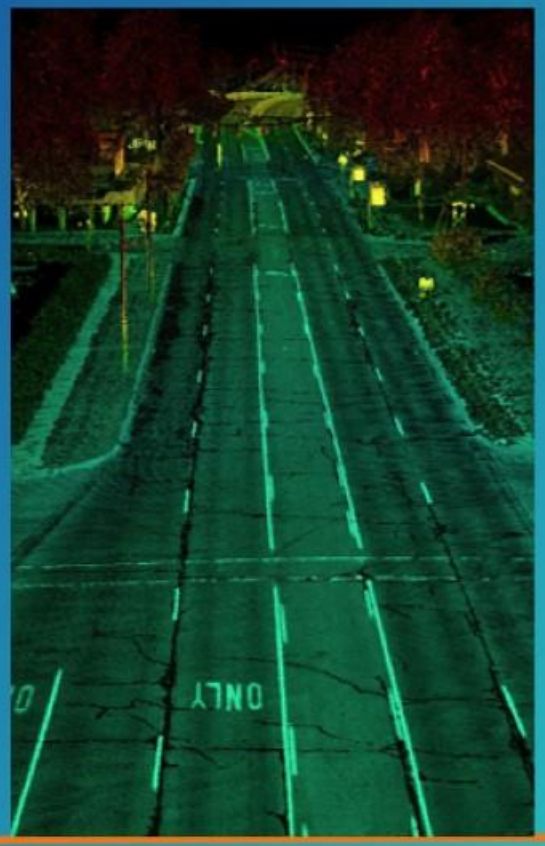


ArcGIS Supports

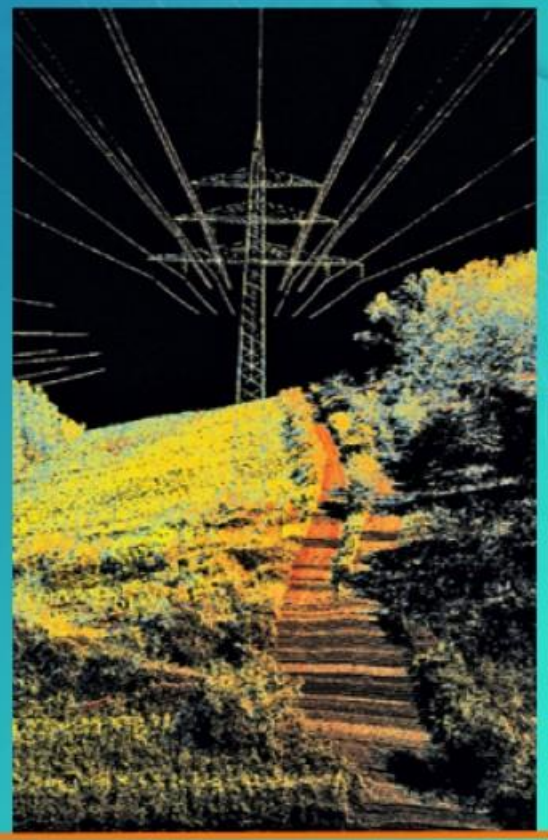
Airborne

Terrestrial

Mobile



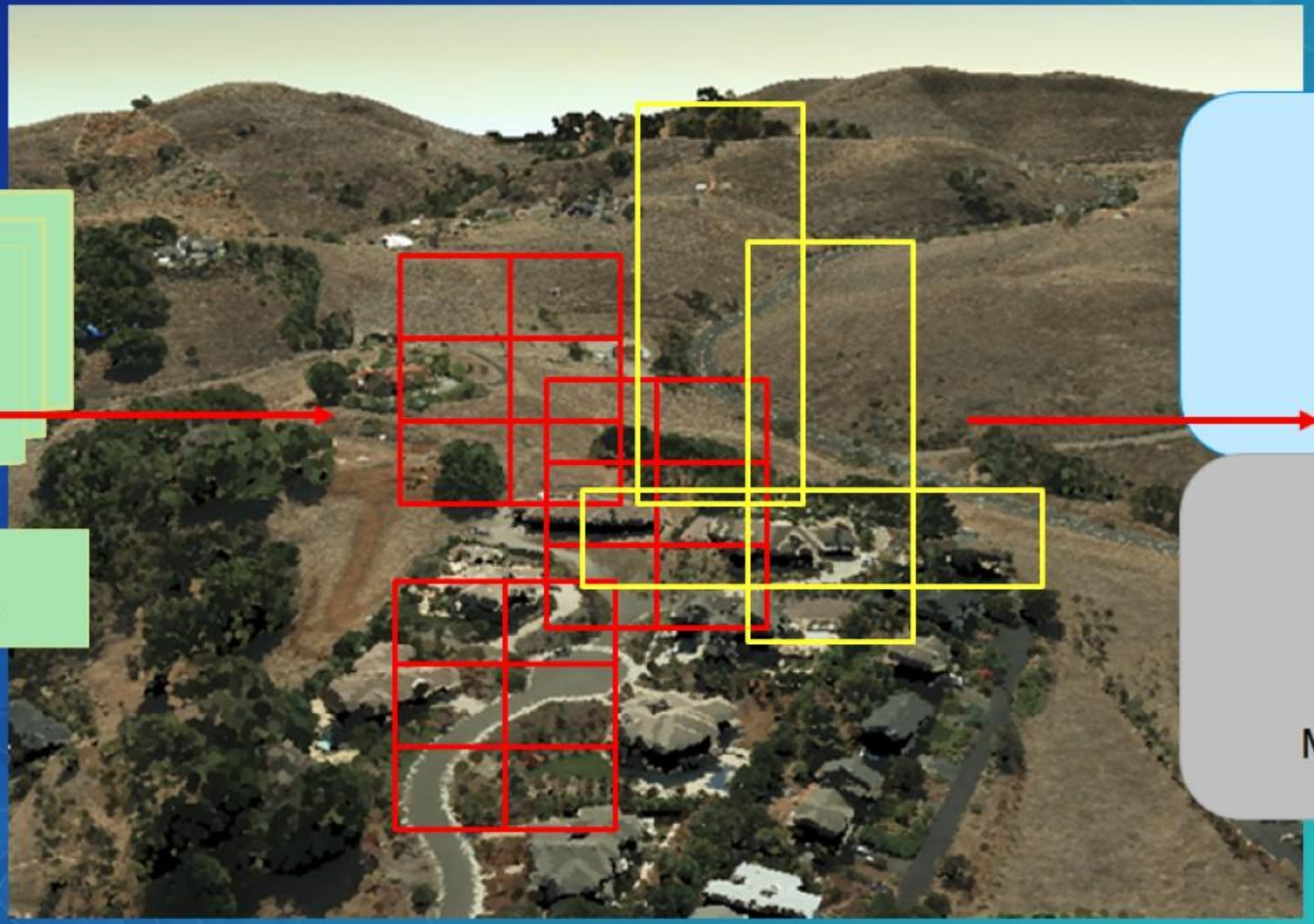
Drone/UAV



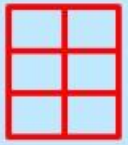
Data Structures for lidar support in ArcGIS

File01.las
File02.las
…
File99.las

Multiple files/folders

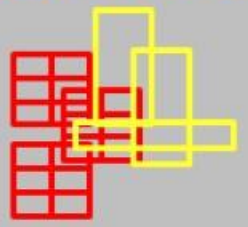


Analyze and update



LAS dataset / Terrain dataset

Manage, serve, share

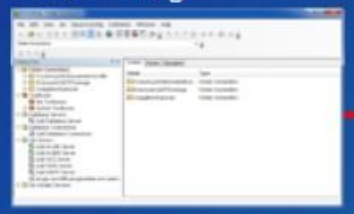


Mosaic dataset / point cloud scene layer

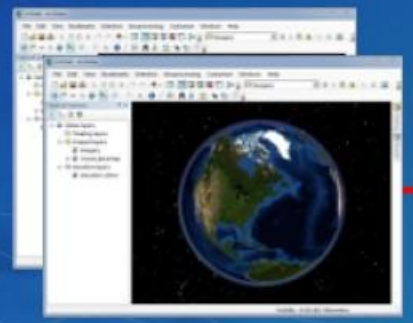
Application Fusion: ArcGIS Pro

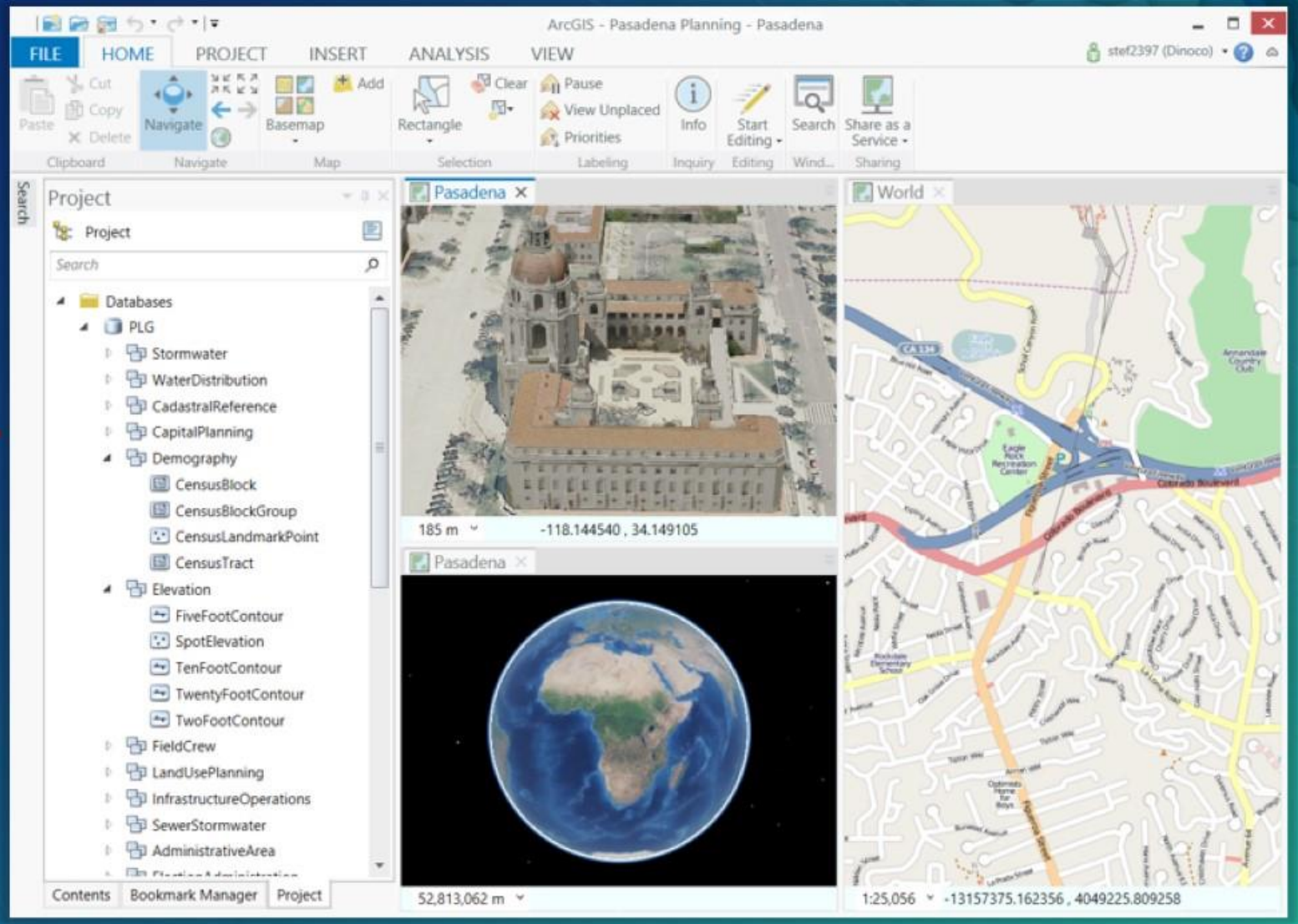
ArcMap

ArcCatalog



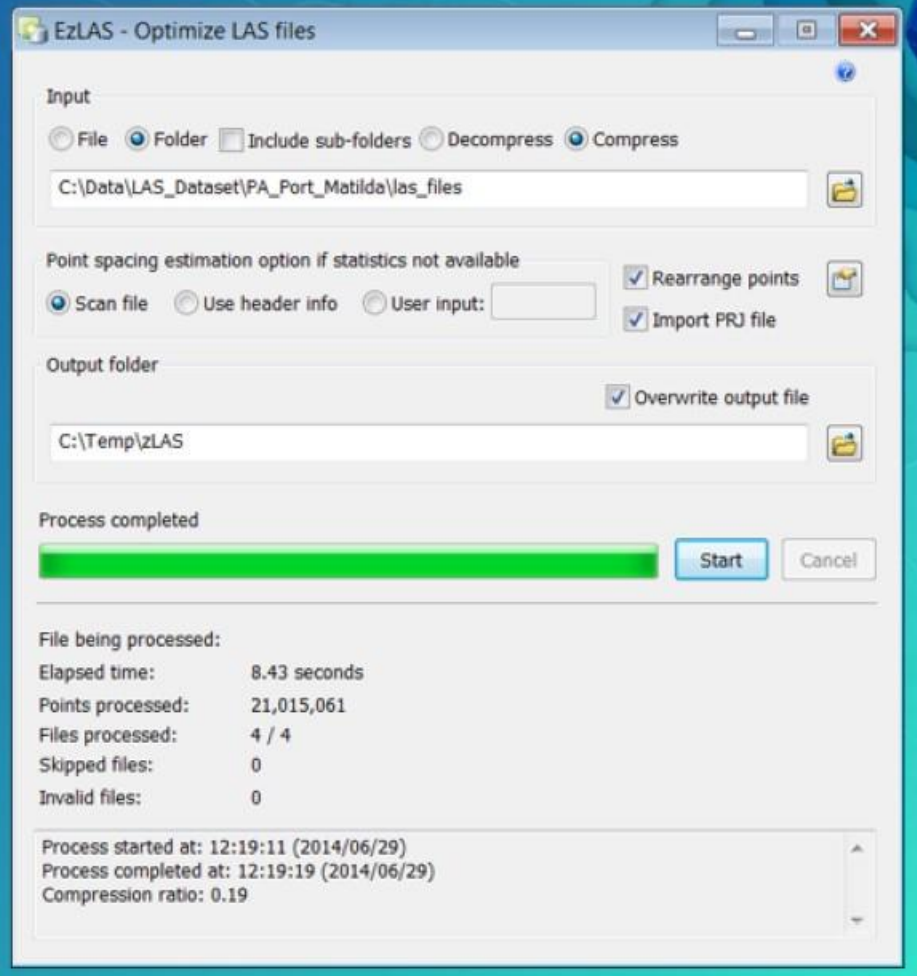
ArcGlobe / ArcScene





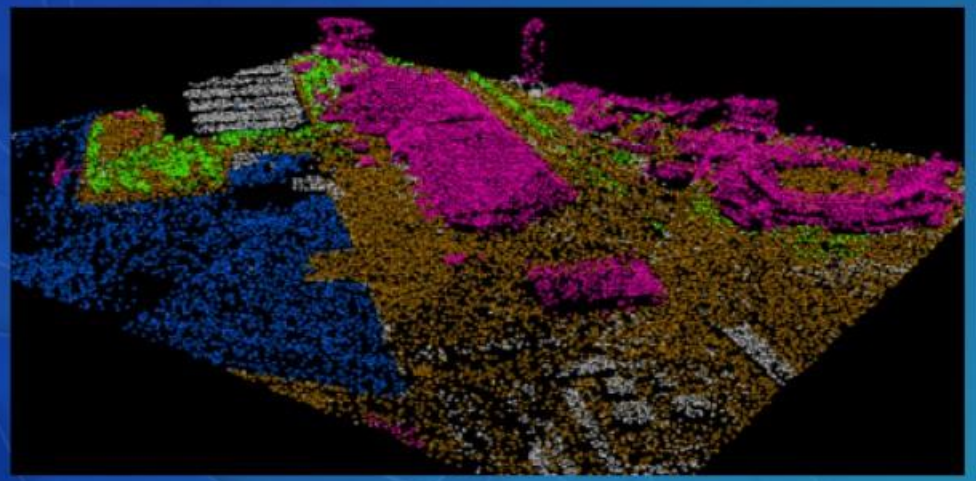
Lidar data storage – zLAS

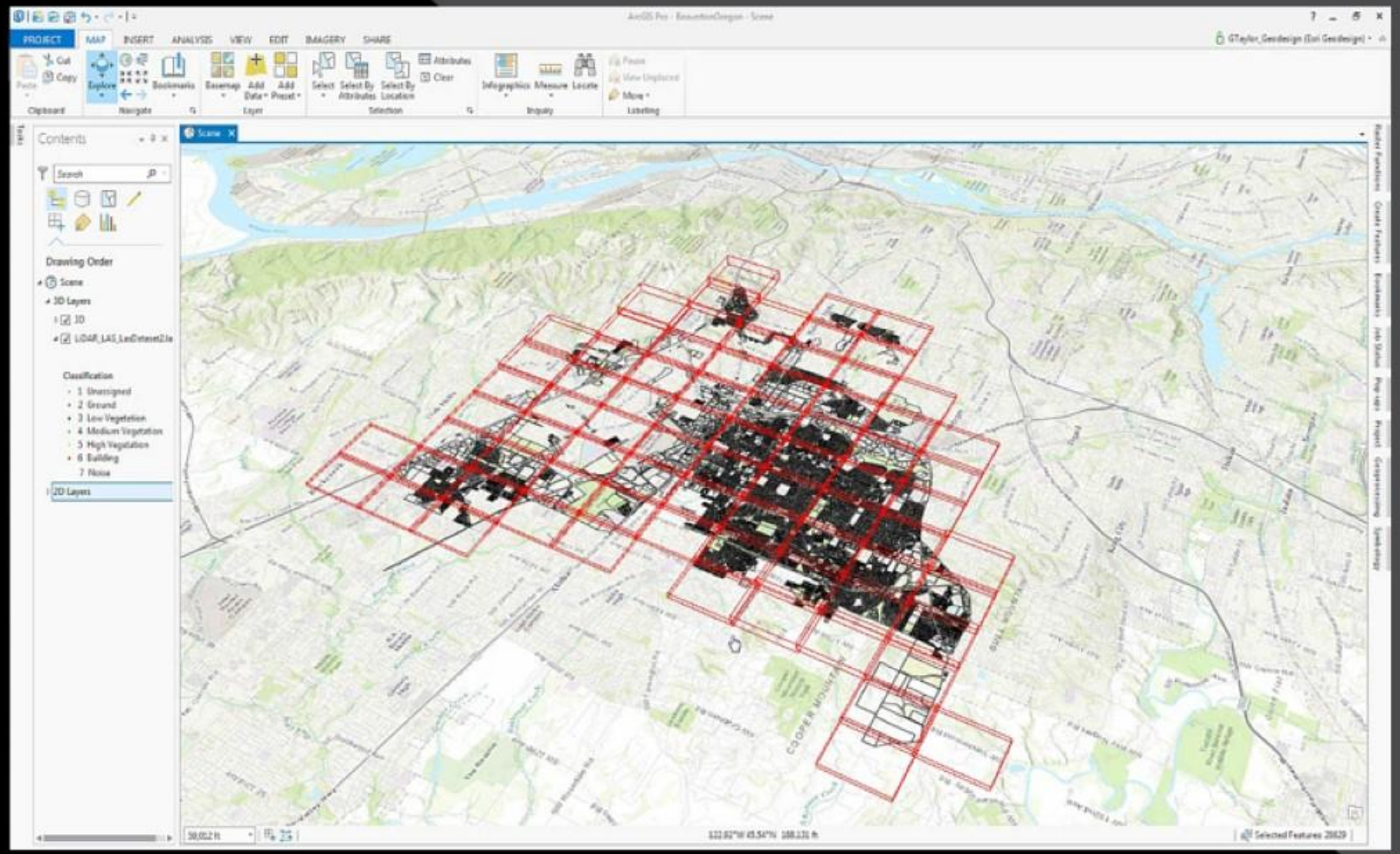
- Introduced January 2014
- Compression, sorting, and indexing
- Direct read
  - Parallel decompression added to ArcGIS apps in 10.3
- Features & Benefits
  - Re-sequence points w/ geospatial index
  - Optimized for random access
  - Lossless compression
  - Transparent integration with LAS dataset



Lidar data with a LAS dataset

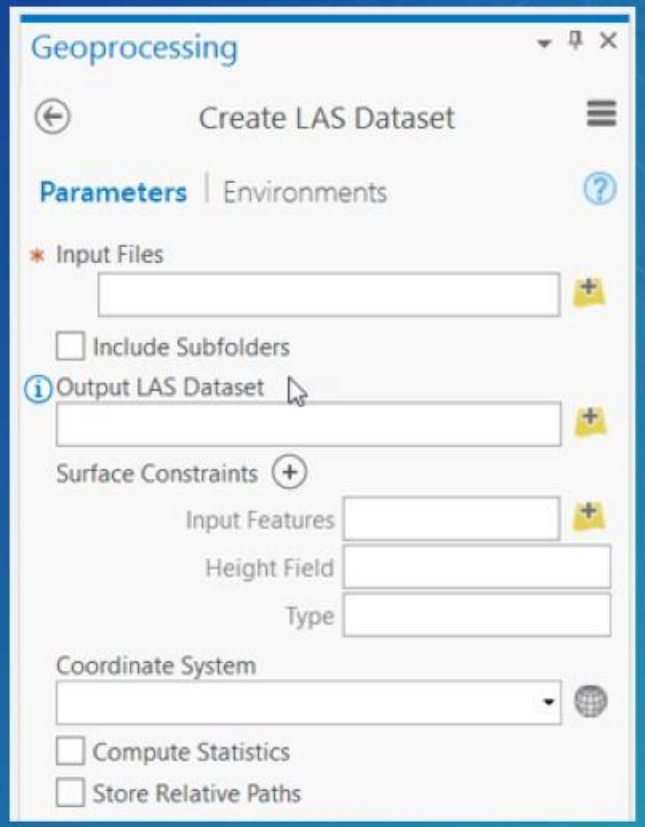
- Direct read of LAS or zLAS format lidar
- File based
- QA/QC tools
- Stores references to LAS/zLAS files on disk
- Optionally reference breakline and control point data
- Treats a collection of LAS/zLAS files as one logical dataset ("Project")

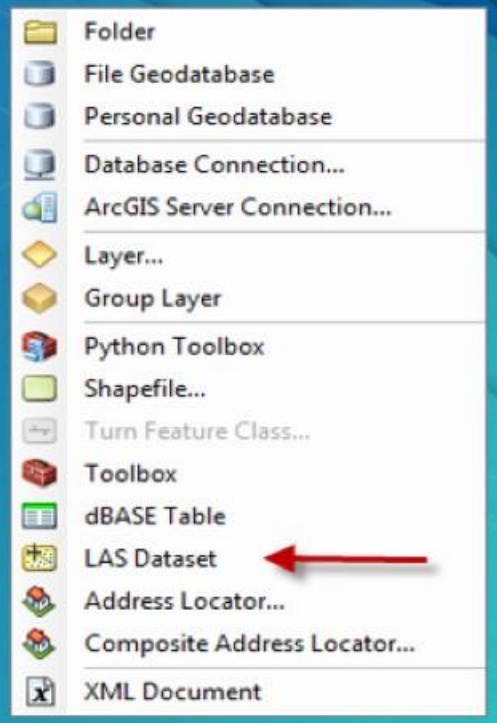


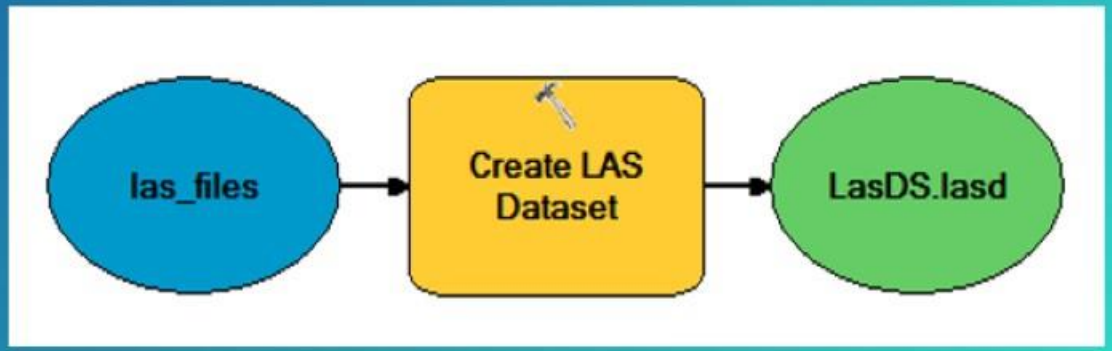

PROJECT
MAP
INSERT
ANALYSIS
VIEW
EDIT
IMAGERY
SHARE
Contents
Drawing Order
Scene
3D Layers
2D Layers
Classification
1 Unassigned
2 Ground
3 Low Vegetation
4 Medium Vegetation
5 High Vegetation
6 Building
7 Noise
COOPER MOUNTAIN

Create a LAS dataset

- Interactively through ArcCatalog
  - Use the file folder context menu
- Using scripts and models with geoprocessing tools

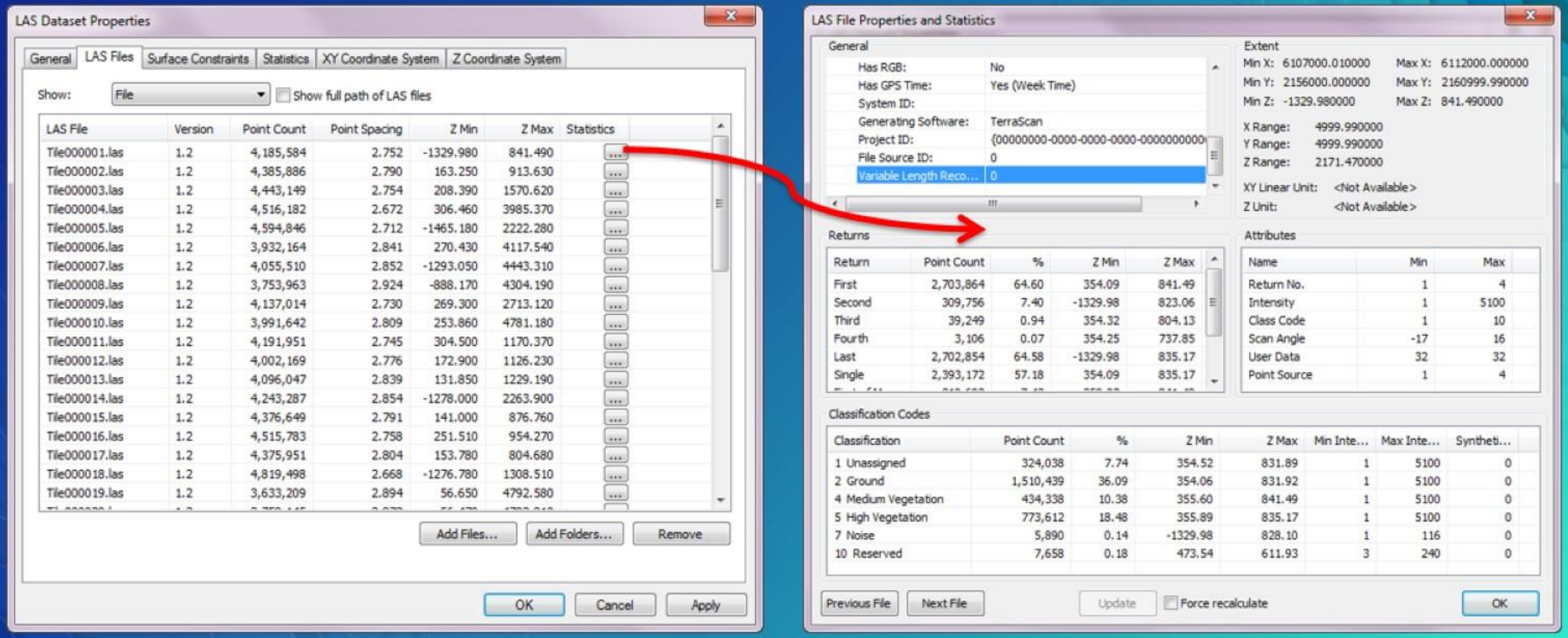






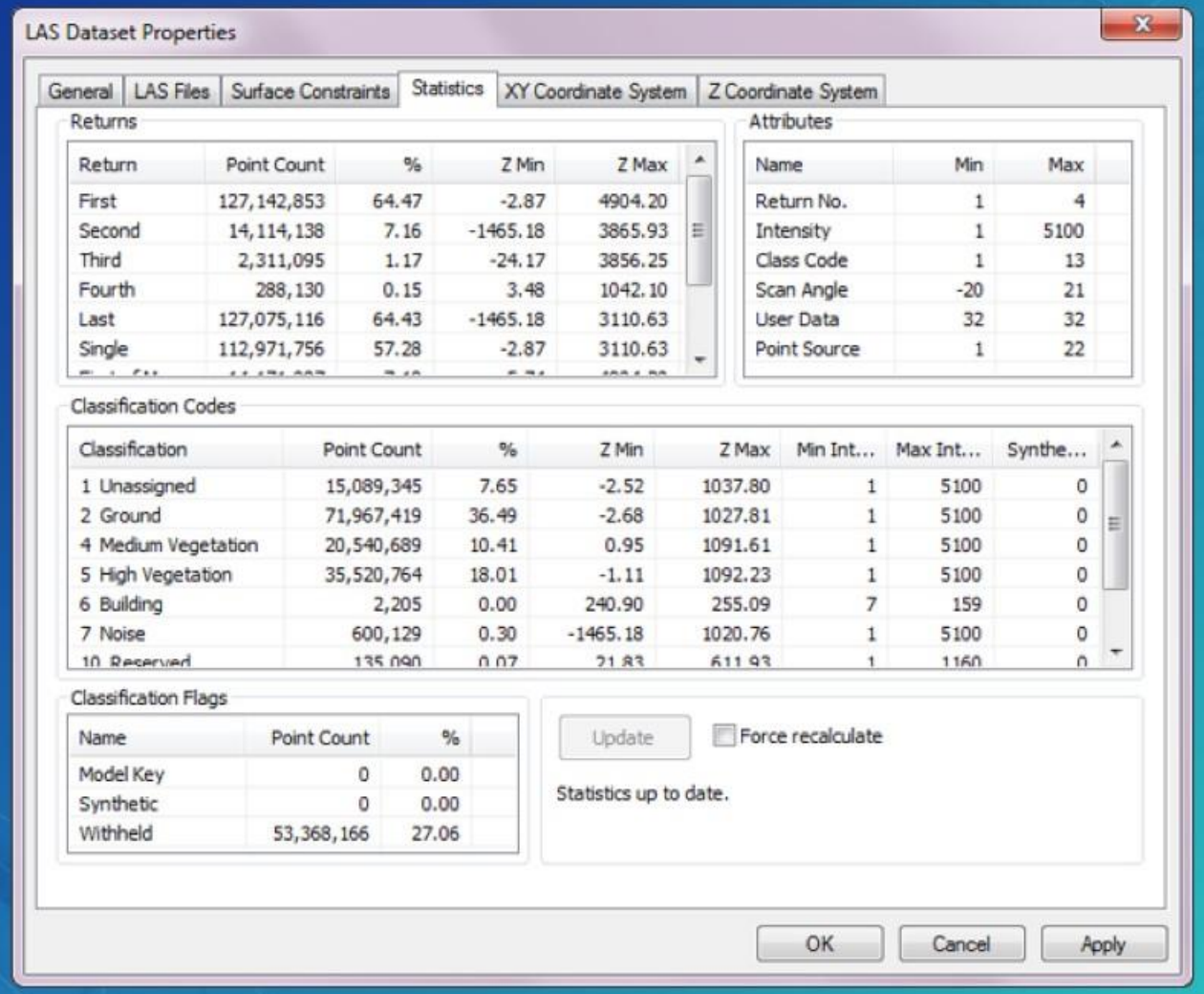
LAS file based statistics

- **LAS Dataset Properties: LAS File Statistics**



QA\QC: LAS dataset based statistics

- LAS Dataset **Properties**: LAS Dataset Statistics



Returns

Return	Point Count	%	Z Min	Z Max
First	127,142,853	64.47	-2.87	4904.20
Second	14,114,138	7.16	-1465.18	3865.93
Third	2,311,095	1.17	-24.17	3856.25
Fourth	288,130	0.15	3.48	1042.10
Last	127,075,116	64.43	-1465.18	3110.63
Single	112,971,756	57.28	-2.87	3110.63

Attributes

Name	Min	Max
Return No.	1	4
Intensity	1	5100
Class Code	1	13
Scan Angle	-20	21
User Data	32	32
Point Source	1	22

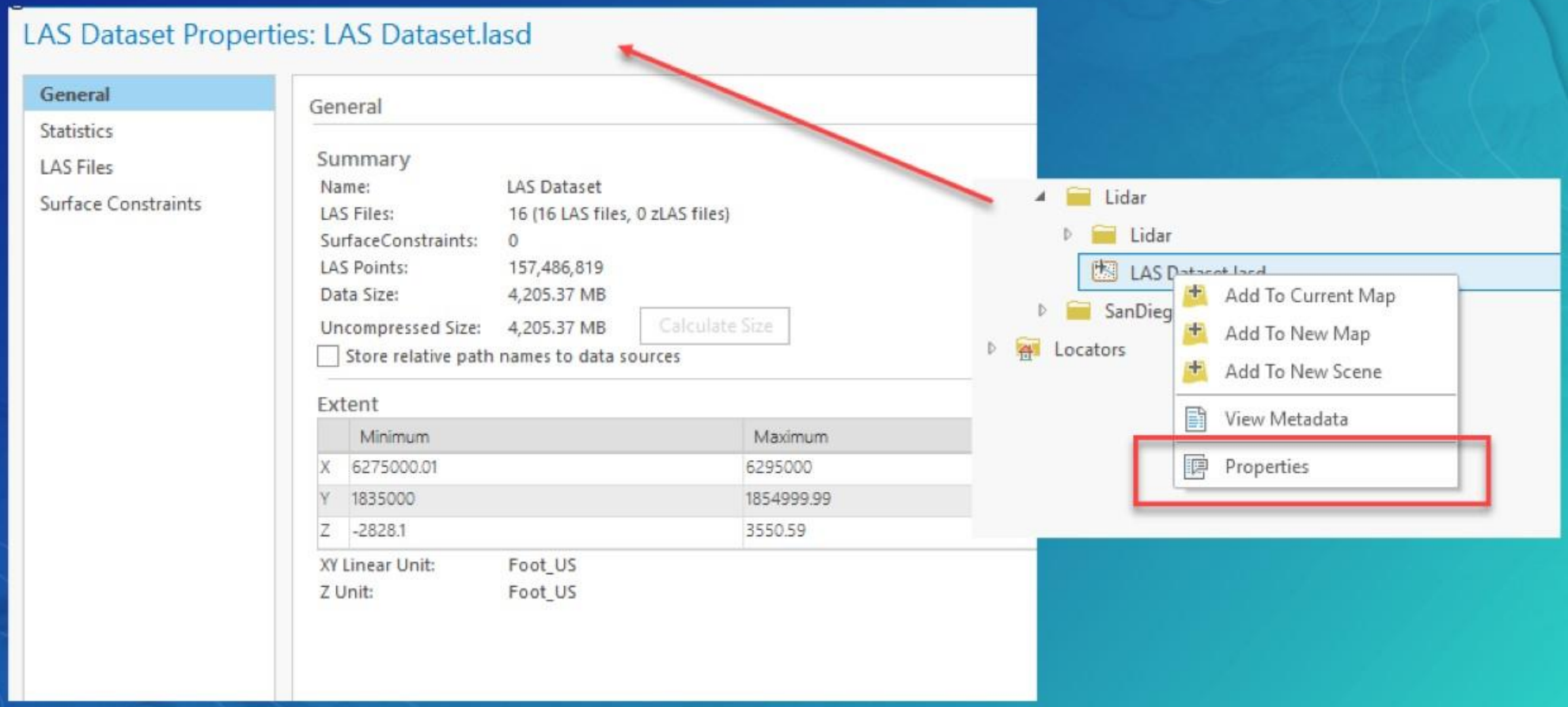
Classification Codes

Classification	Point Count	%	Z Min	Z Max	Min Int...	Max Int...	Synthe...
1 Unassigned	15,089,345	7.65	-2.52	1037.80	1	5100	0
2 Ground	71,967,419	36.49	-2.68	1027.81	1	5100	0
4 Medium Vegetation	20,540,689	10.41	0.95	1091.61	1	5100	0
5 High Vegetation	35,520,764	18.01	-1.11	1092.23	1	5100	0
6 Building	2,205	0.00	240.90	255.09	7	159	0
7 Noise	600,129	0.30	-1465.18	1020.76	1	5100	0
10 Reserved	135,090	0.07	21.83	611.93	1	1160	0

Classification Flags

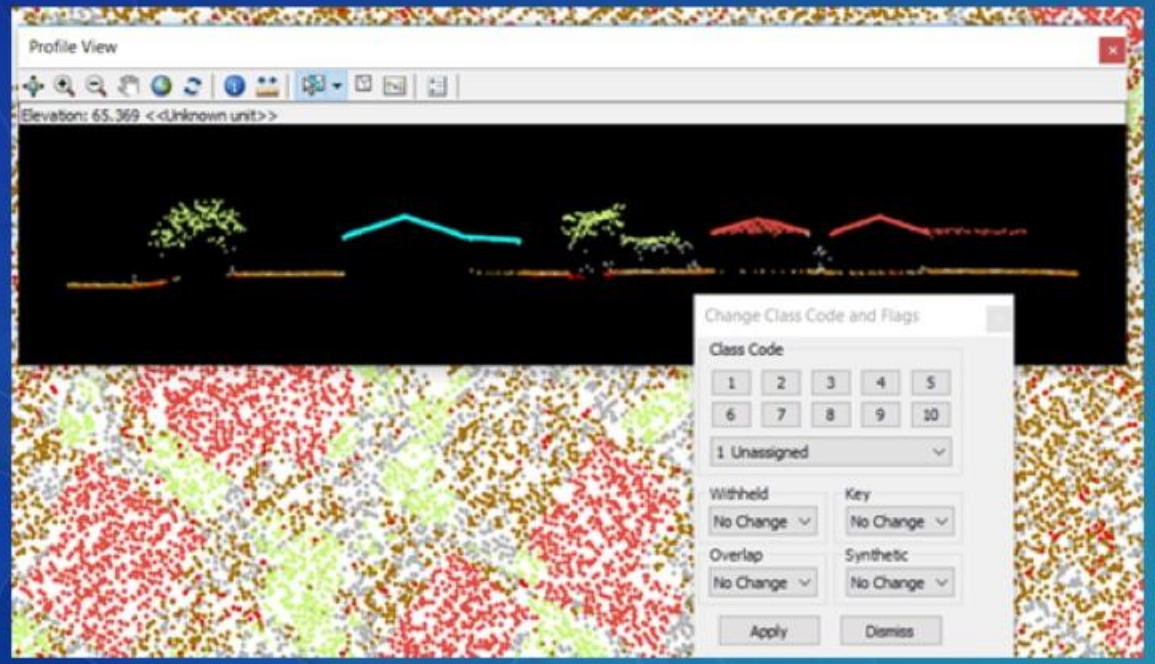
Name	Point Count	%
Model Key	0	0.00
Synthetic	0	0.00
Withheld	53,368,166	27.06

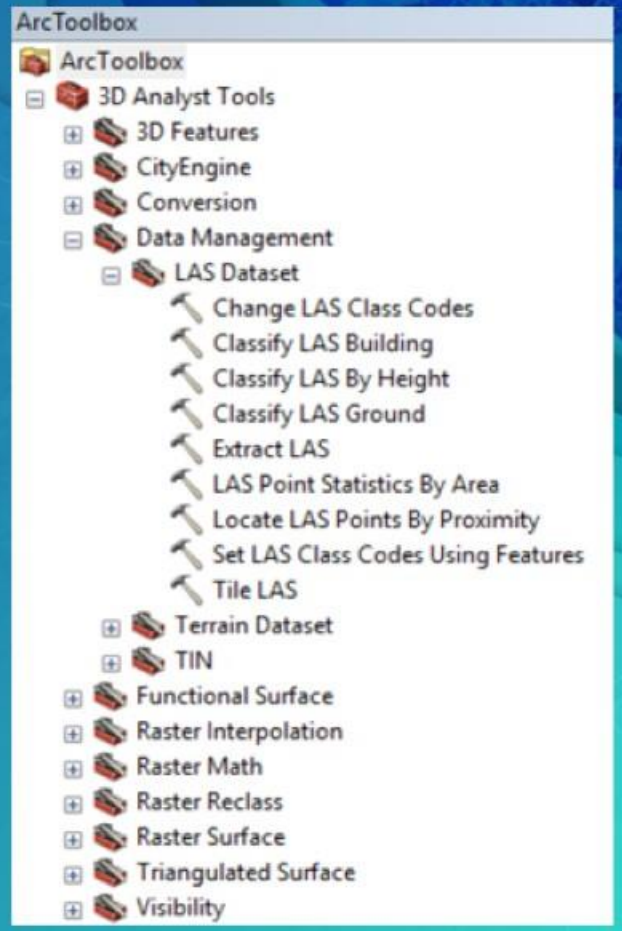
ArcGIS Pro: LAS Dataset Properties



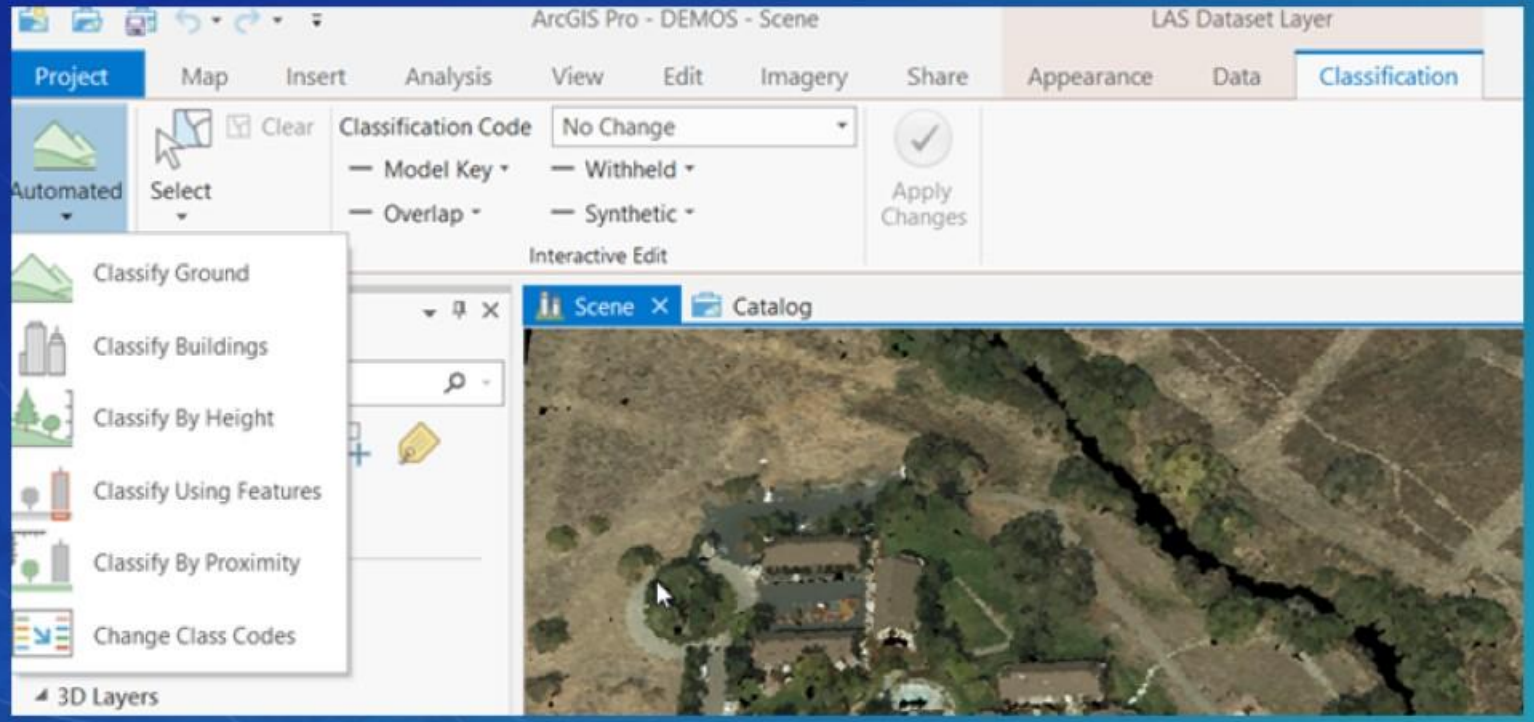
Edit classification codes: ArcMap

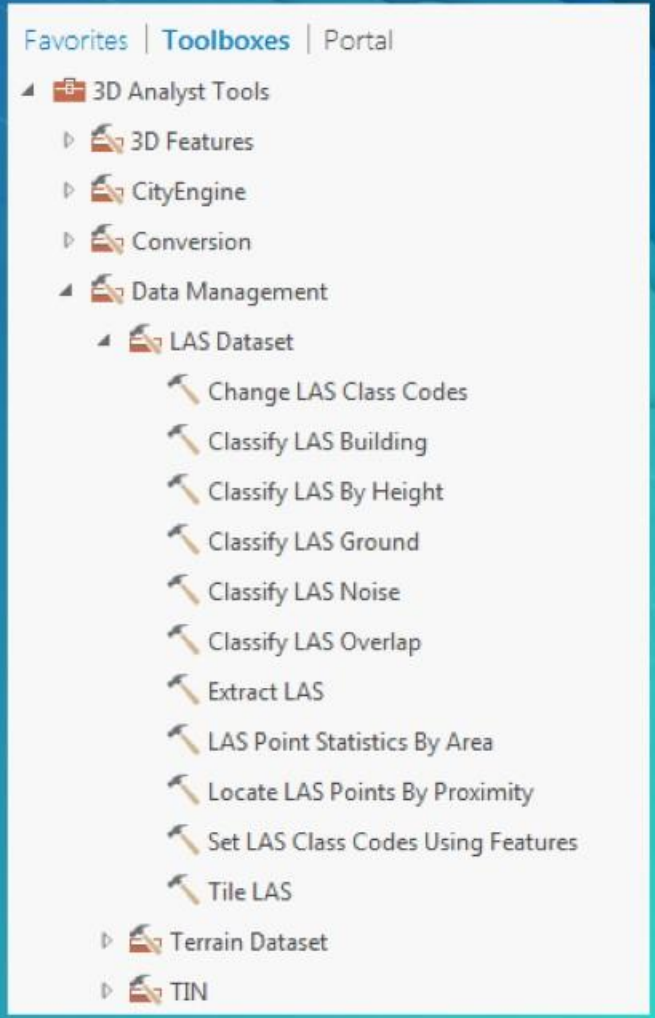
- Interactive
  - Fixing data anomalies and misclassifications via point profile window
- Automated (GP tools)
  - Classify relative to feature data
  - Reclassify to standard LAS specification





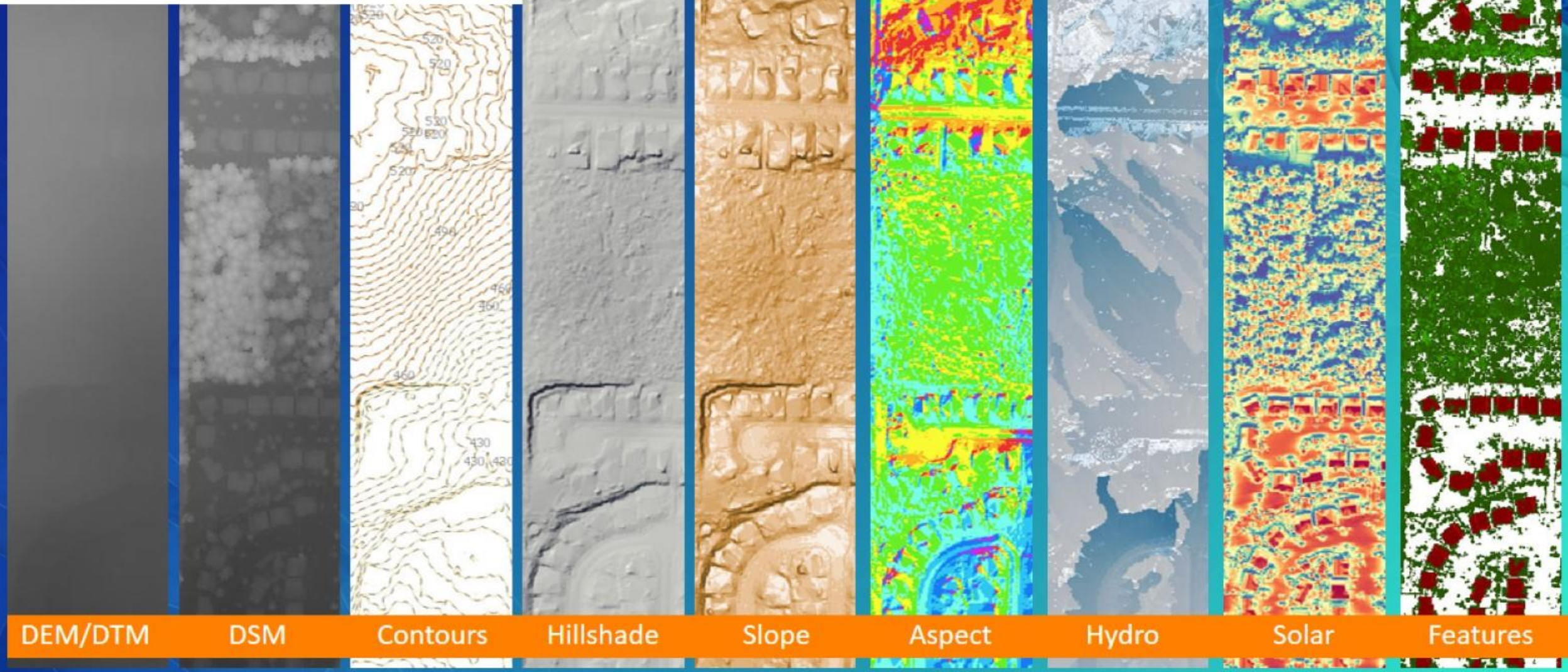
Edit classification codes: Pro





LiDAR Derivatives

Elevation & Analytical Raster Data

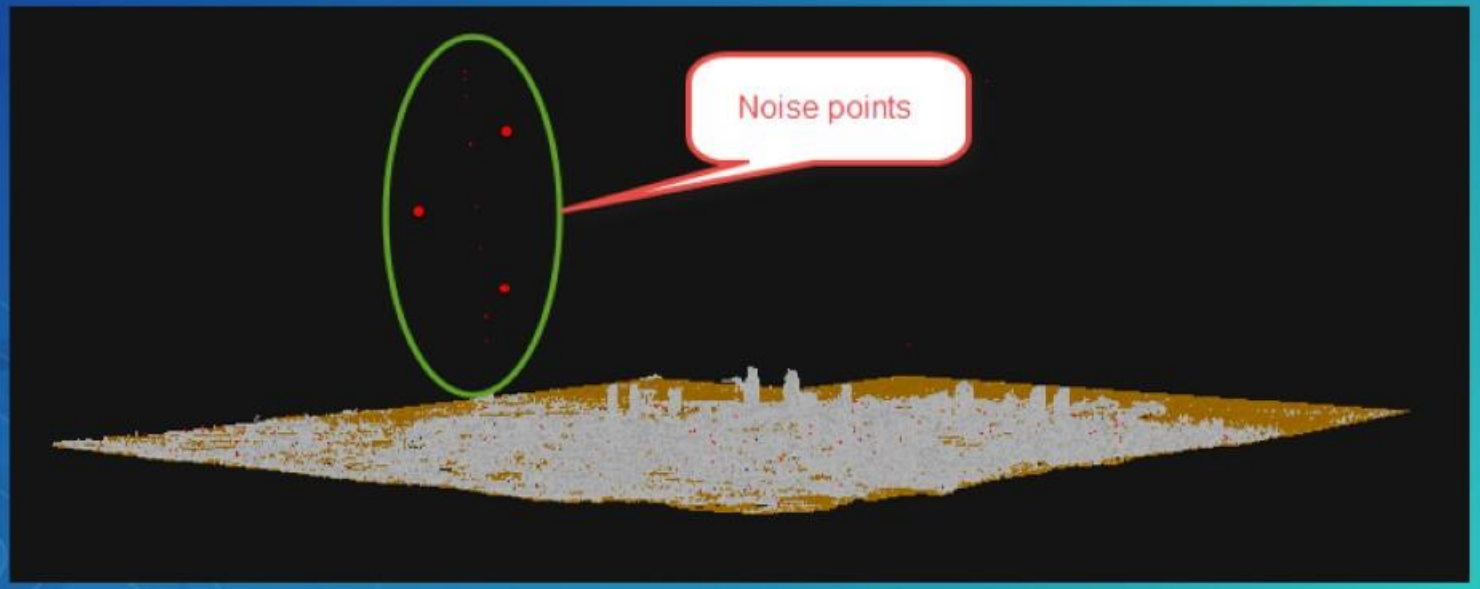


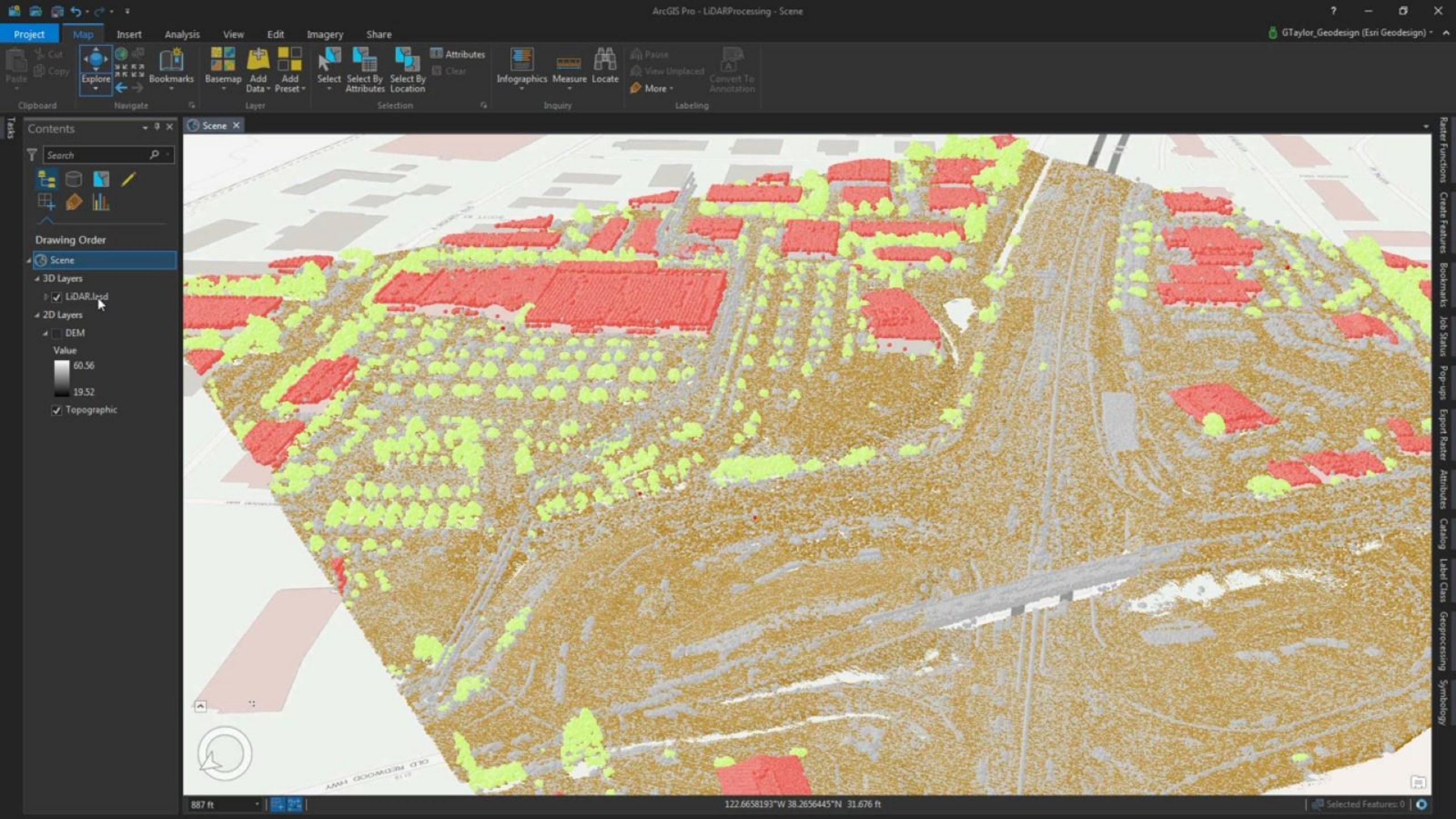
Polygon Volume

- Enhance existing geoprocessing tool to support LAS dataset as input surface. Current support limited to TINs and Terrains.
- Use of drones to collect photogrammetric point clouds to measure volumes for things like stockpiles is increasing rapidly.
- LAS dataset is a natural fit for this data so direct support in this tool improves productivity and usability.

Classify LAS Noise

- New GP tool to classify noise points in lidar.
- Erroneous points are caused by a variety of things such as haze, birds, and water.
- Present at least to some degree in all lidar collections.
- Noise interferes with display and processing of the data.
- This is a fundamental capability.

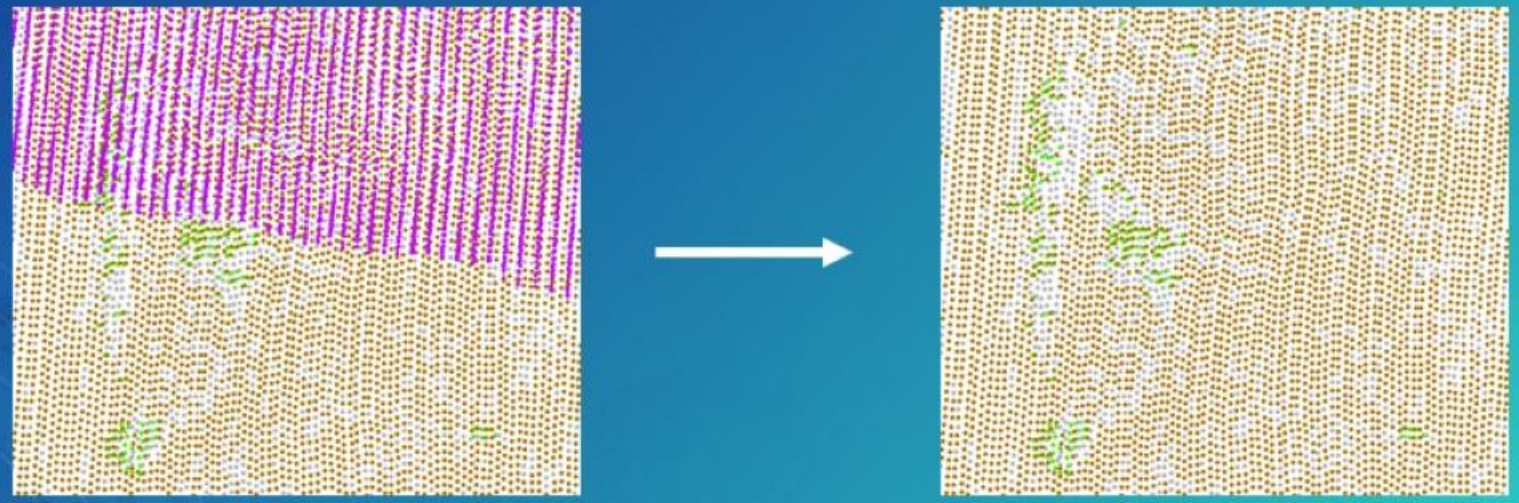


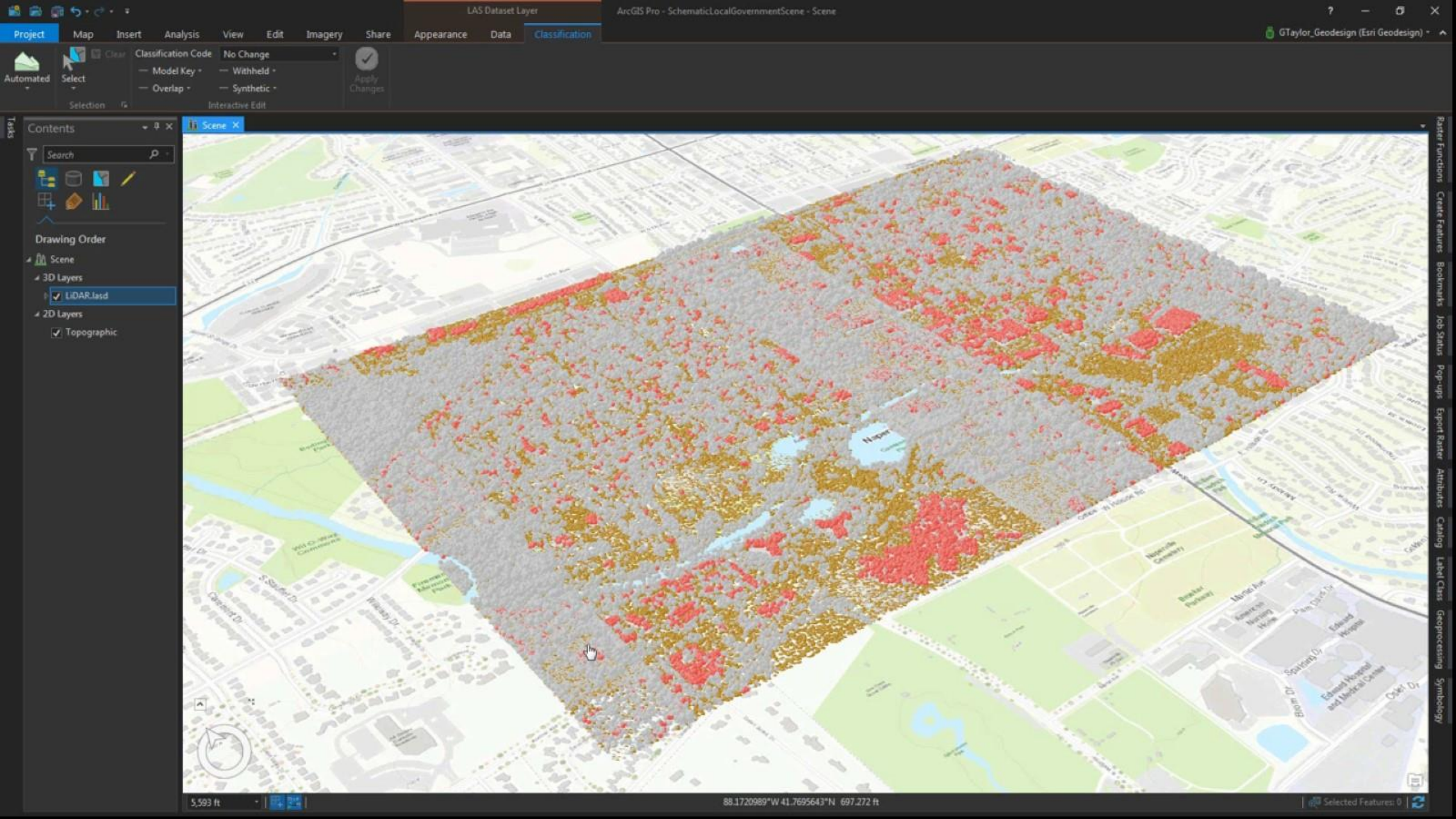

ArcGIS Pro - LiDARProcessing - Scene
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
GTaylor_Geodesign (Esri Geodesign)
Cut
Copy
Paste
Explore
Bookmarks
Basemap
Add Data
Add Preset
Select
Select By Attributes
Select By Location
Attributes
Clear
Infographics
Measure
Locate
Pause
View Unplaced
More
Convert To Annotation
Clipboard
Navigate
Layer
Selection
Inquiry
Labeling
Contents
Search
Drawing Order
Scene
3D Layers
LiDAR.lasd
2D Layers
DEM
Value
60.56
19.52
Topographic
Scene
887 ft
122.6658193°W 38.2656445°N 31.676 ft
Selected Features: 0

Classify LAS Overlap

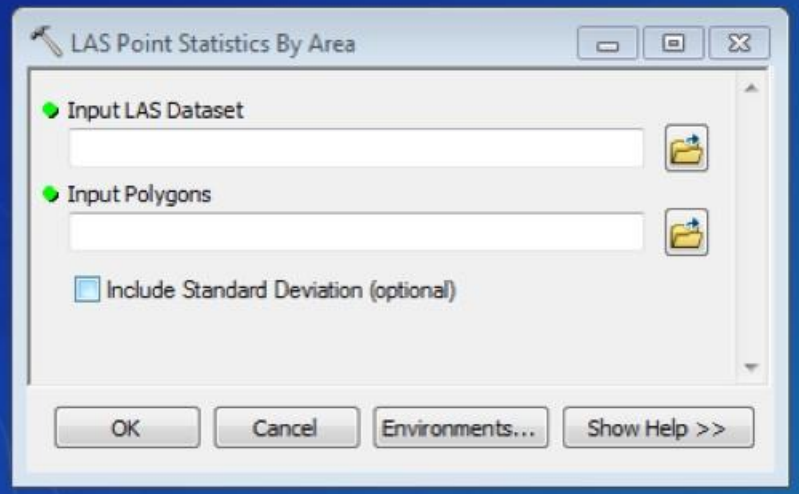
- New GP tool to assign the overlap flag/code to points in areas of overlap between flight lines.
- Area of overlap introduces high frequency noise to ground which interferes with creation of high quality DEMs. It's therefore desirable to exclude the overlap.
- Tool is needed to help improve quality of DEMs ArcGIS can produce,

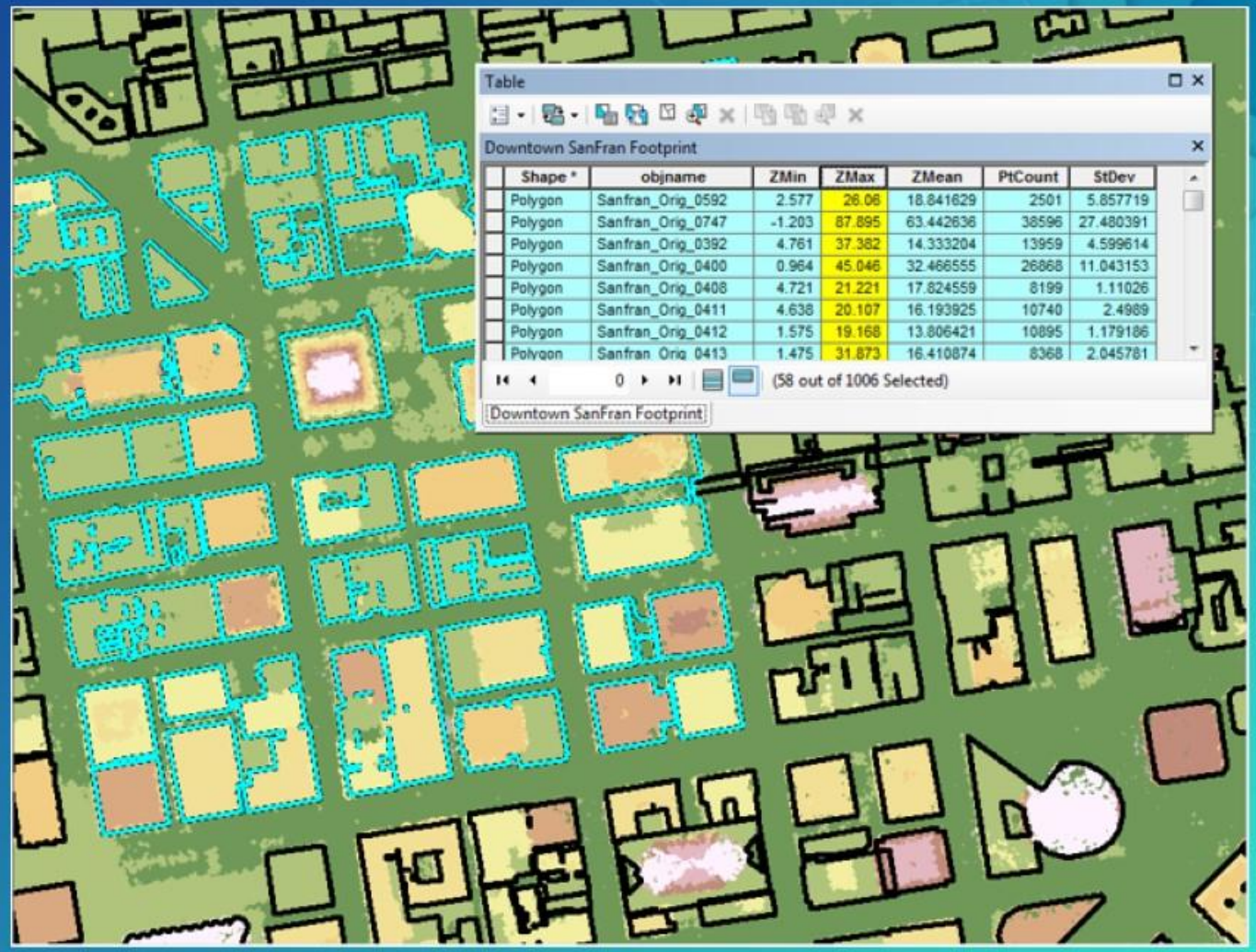
Overlap in purple




LAS Dataset Layer
ArcGIS Pro - SchematicLocalGovernmentScene - Scene
Project
Map
Insert
Analysis
View
Edit
Imagery
Share
Appearance
Data
Classification
GTaylor_Geodesign (Esri Geodesign)
Automated
Select
Clear
Selection
Classification Code
No Change
Model Key
Withheld
Overlap
Synthetic
Interactive Edit
Apply Changes
Contents
Search
Drawing Order
Scene
3D Layers
LiDAR.lasd
2D Layers
Topographic
Scene
Raster Functions
Create Features
Bookmarks
Job Status
Pop-ups
Export Raster
Attributes
Catalog
Label Class
Geoprocessing
Symbology
5,593 ft
88.1720989°W 41.7695643°N 697.272 ft
Selected Features: 0

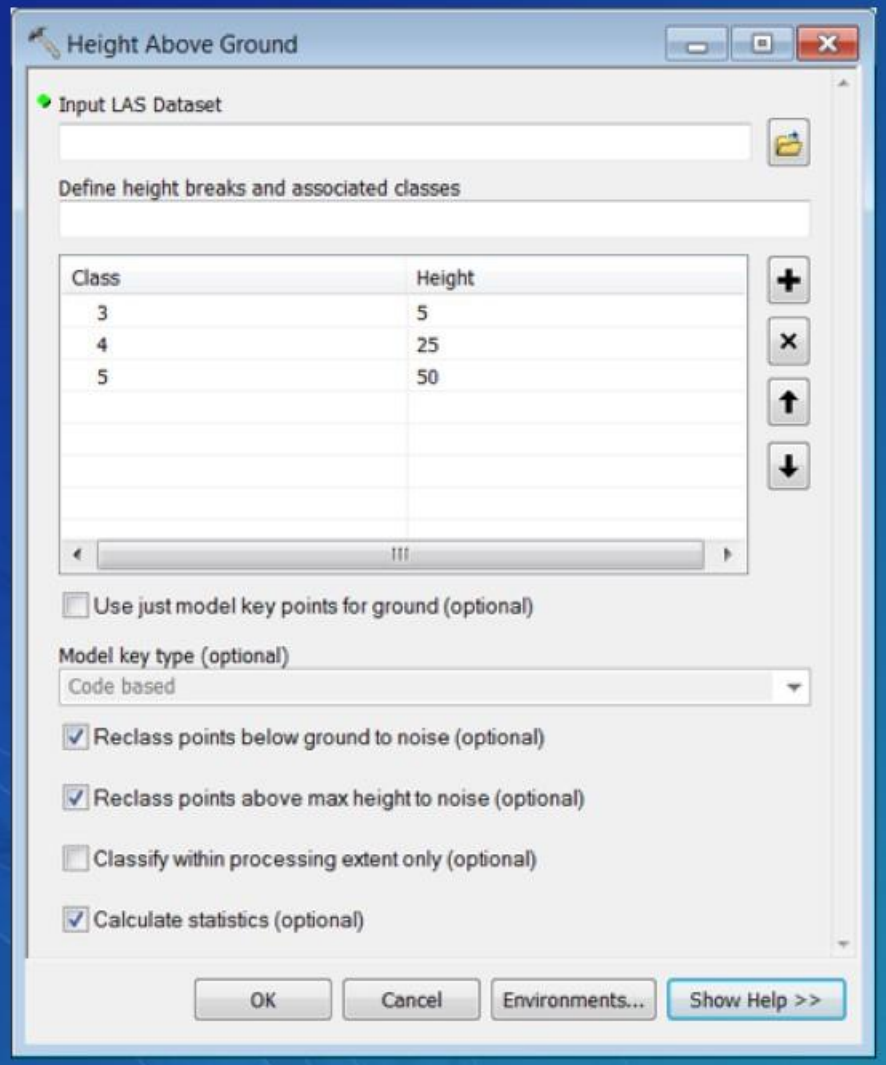
LAS Point Statistics By Area

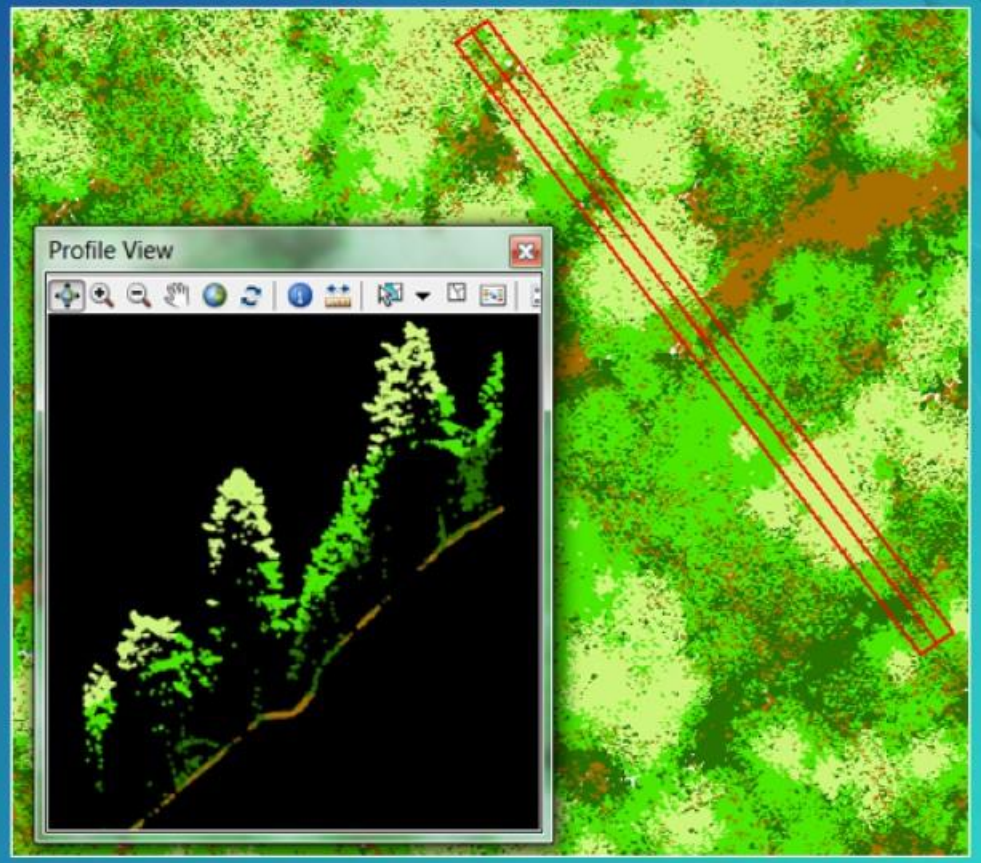




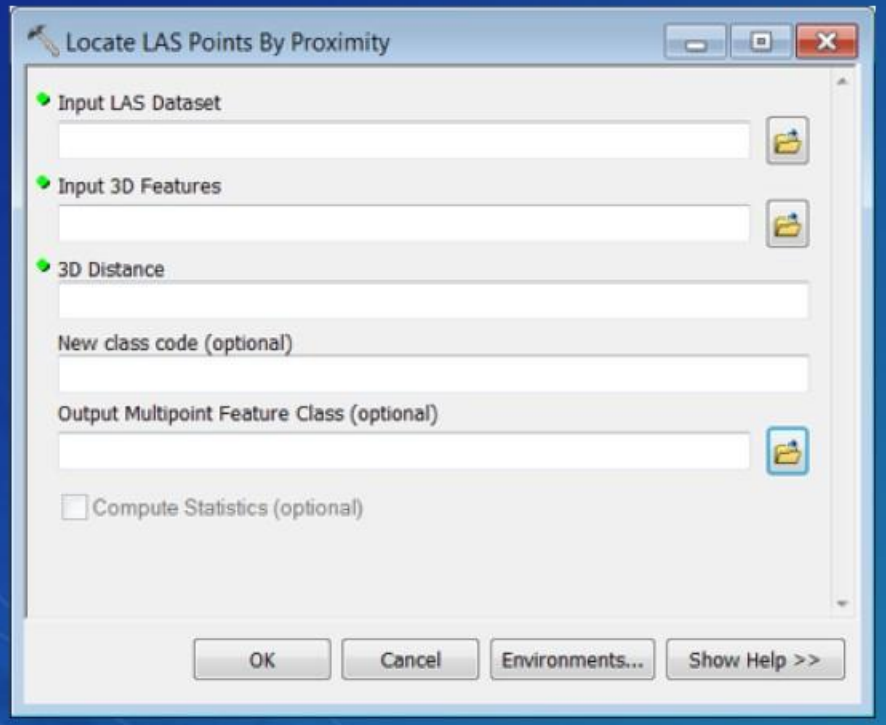
Shape *	objname	ZMin	ZMax	ZMean	PtCount	StDev
Polygon	Sanfran_Orig_0592	2.577	26.06	18.841629	2501	5.857719
Polygon	Sanfran_Orig_0747	-1.203	87.895	63.442636	38596	27.480391
Polygon	Sanfran_Orig_0392	4.761	37.382	14.333204	13959	4.599614
Polygon	Sanfran_Orig_0400	0.964	45.046	32.466555	26868	11.043153
Polygon	Sanfran_Orig_0408	4.721	21.221	17.824559	8199	1.11026
Polygon	Sanfran_Orig_0411	4.638	20.107	16.193925	10740	2.4989
Polygon	Sanfran_Orig_0412	1.575	19.168	13.806421	10895	1.179186
Polygon	Sanfran_Orig_0413	1.475	31.873	16.410874	8368	2.045781

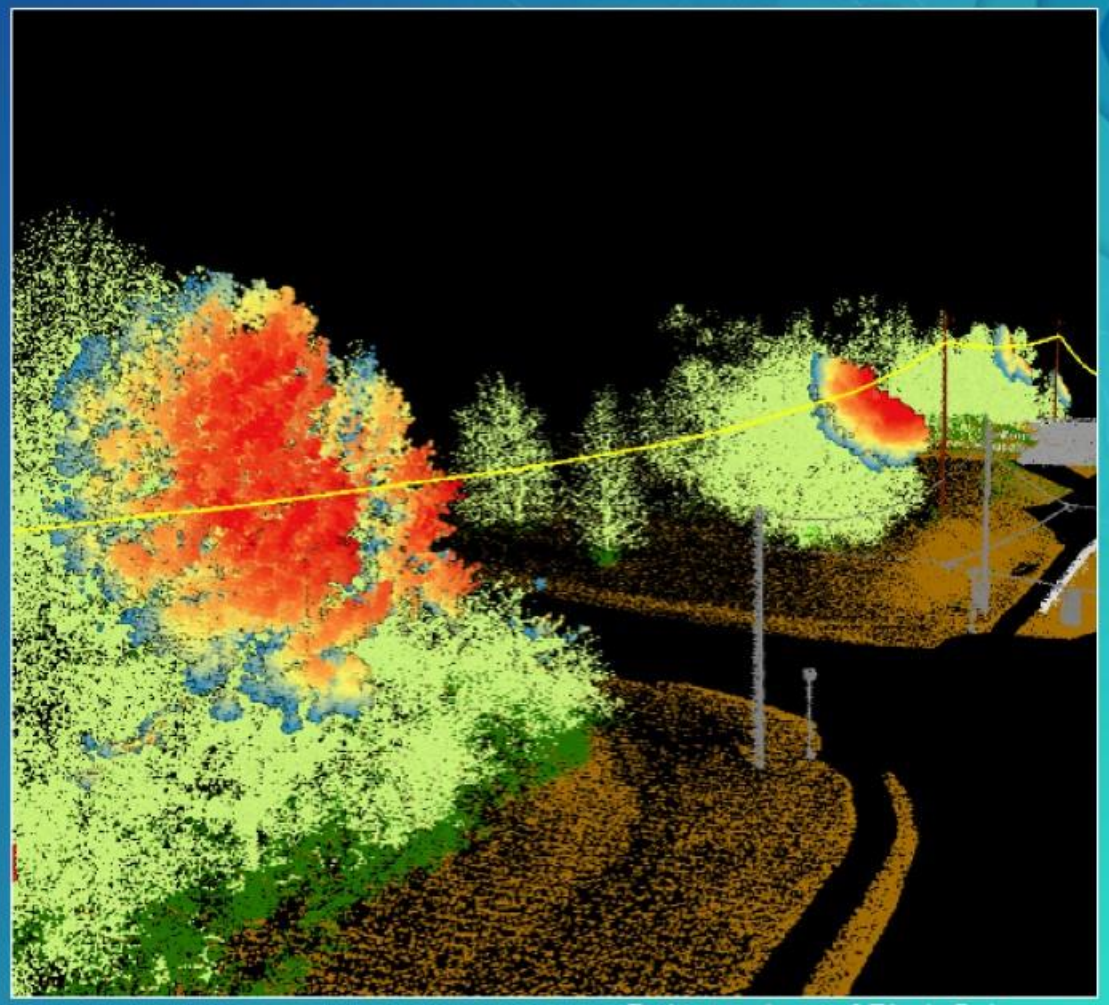
Classify LAS by Height





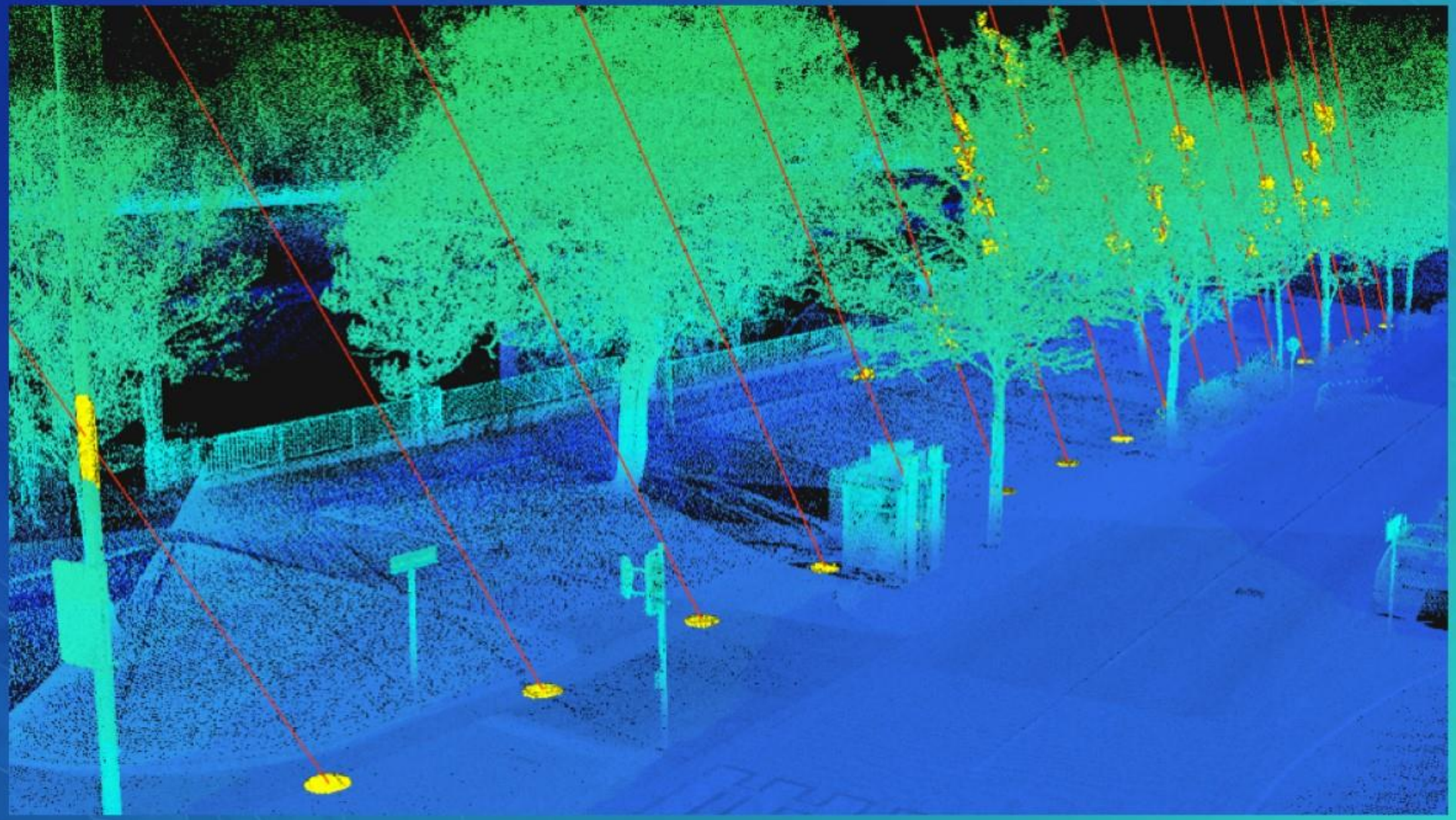
Locate LAS Points By Proximity



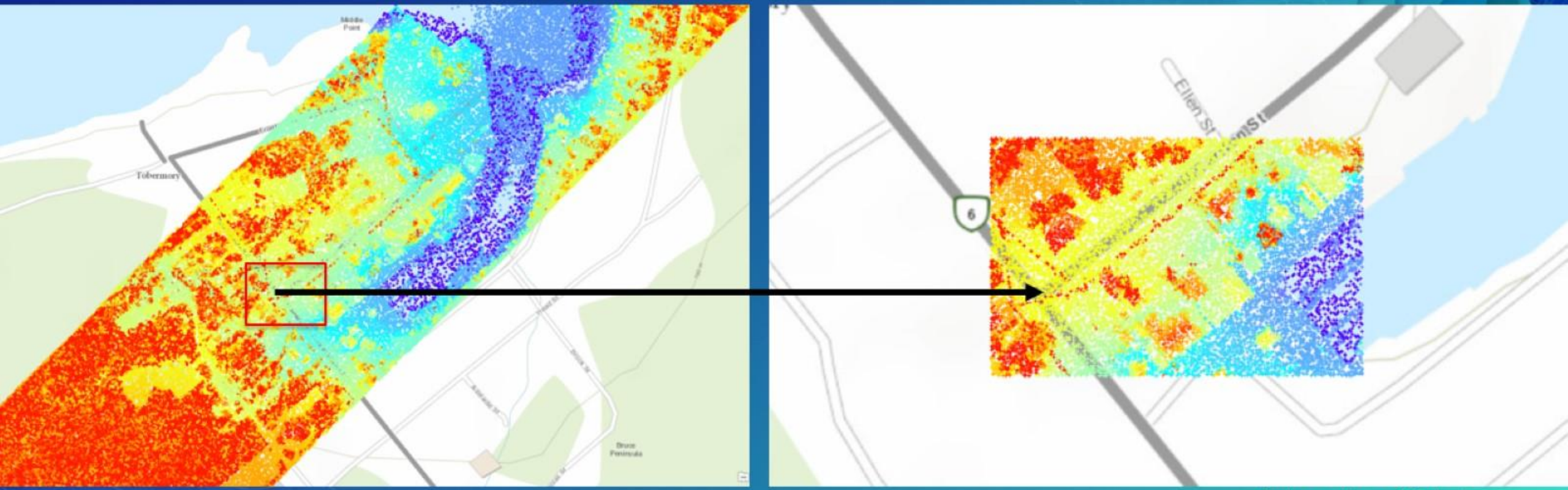


Data courtesy of PhotoScience

Locate LAS Points By Proximity



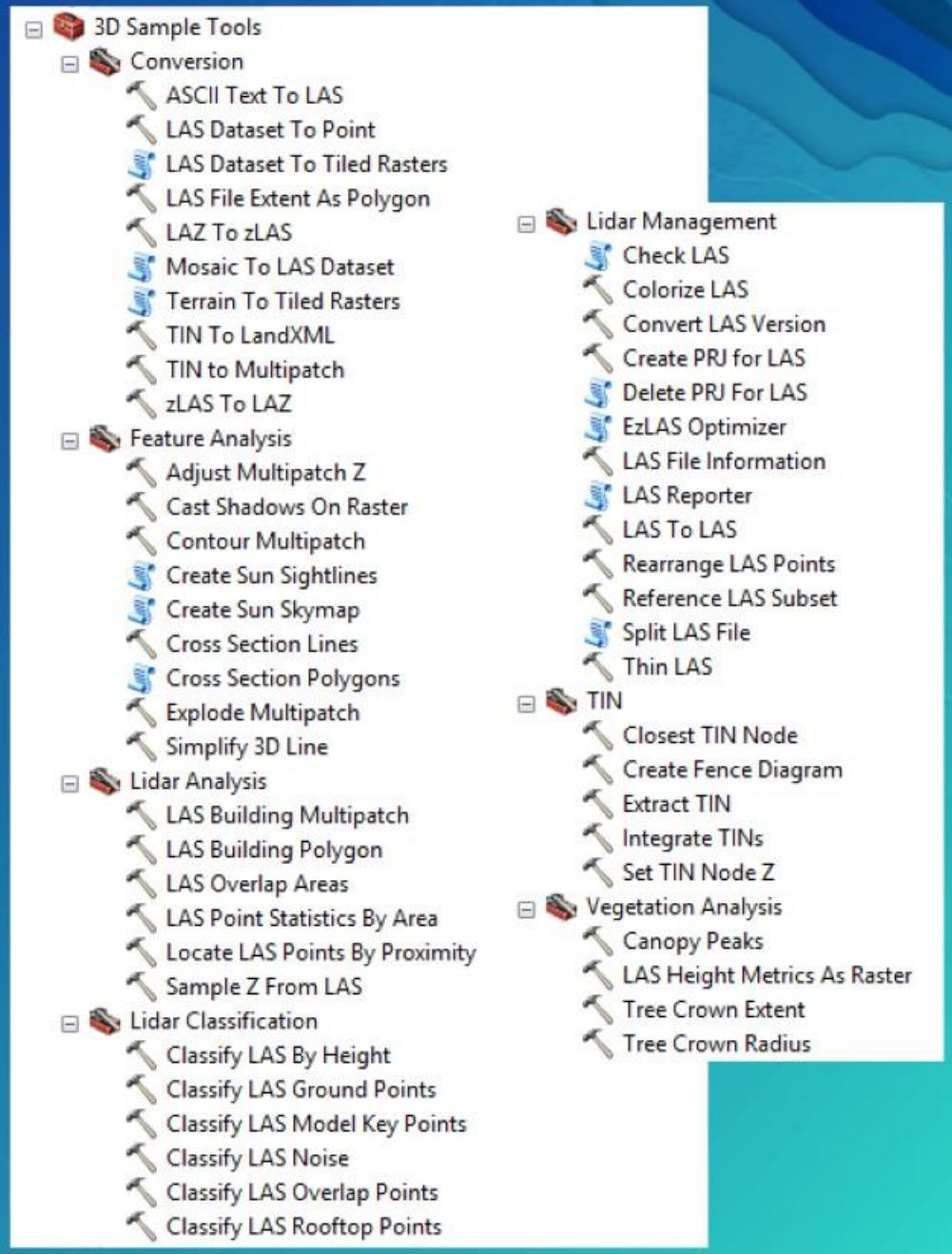
Extract LAS



Data courtesy of Optech

Lidar/3D Sample Tools

- Available in ArcGIS 10.2 – 10.5
- Sample geoprocessing tools
  - http://links.esri.com/3dSamples



Demo

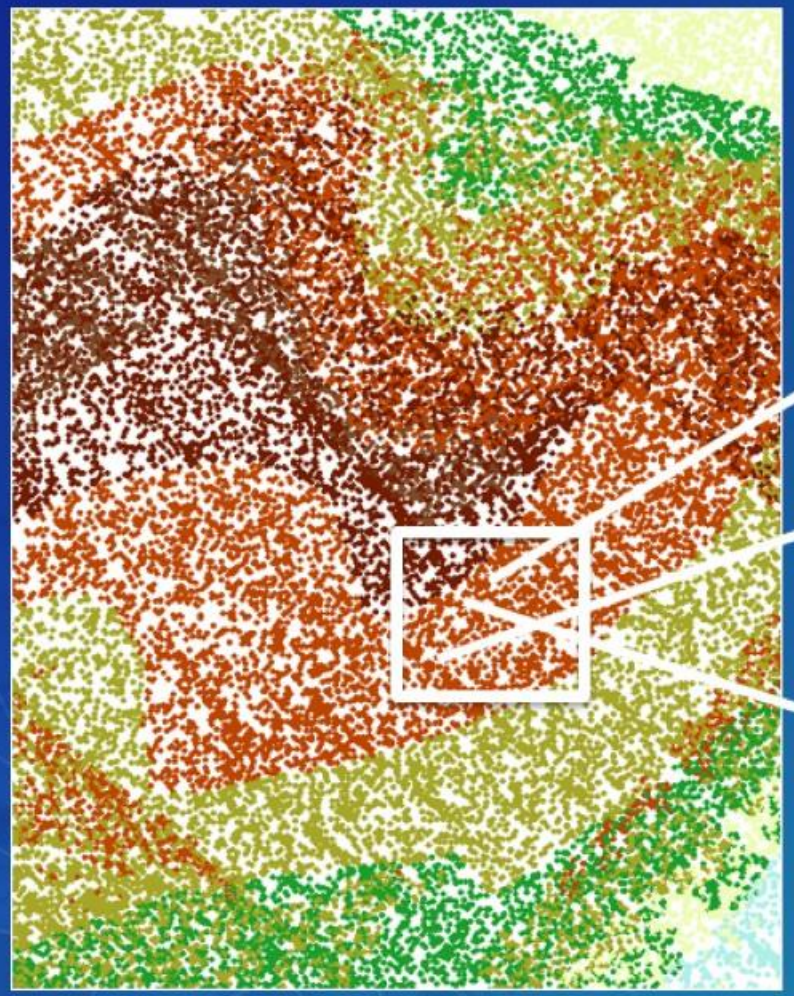
Lindsay Weitz

Best Practices

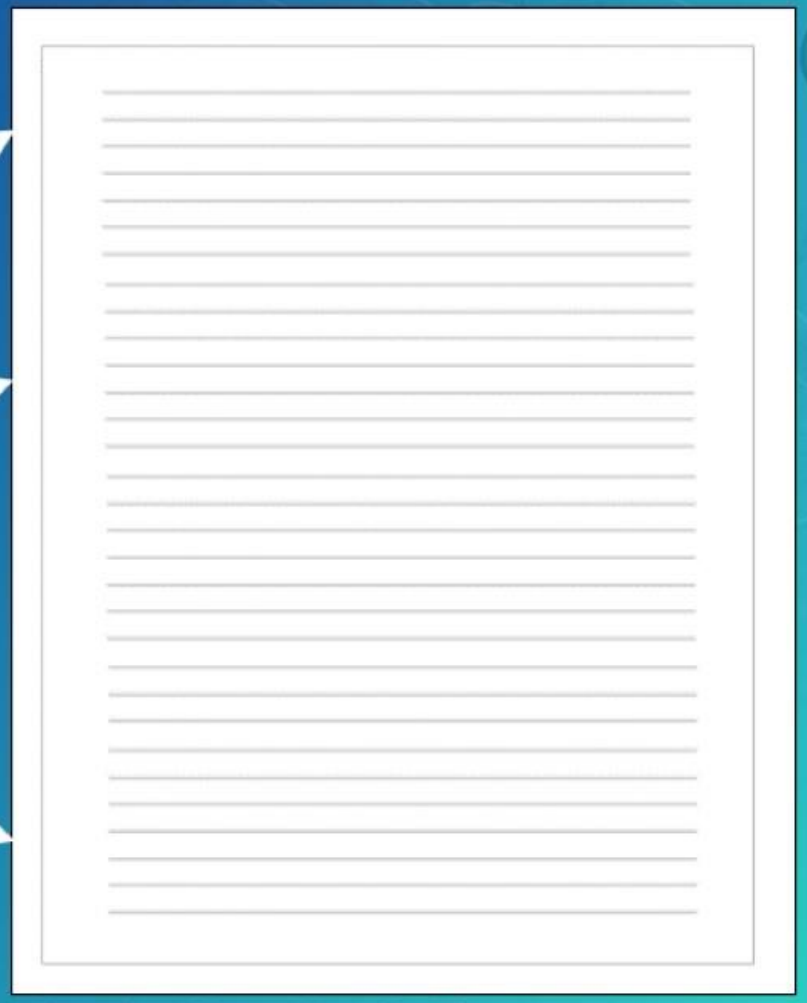
- Tiled LAS, v1.1 or higher
- Projected, rearranged, indexed
  - zLAS
- File size: 1 – 2 GB or less (<500 MB if not rearranged)
- Keep file I/O local, avoid network
- Study area boundary included as constraint
- Airborne lidar
  - Classified (bare earth, non-ground)
  - Breaklines for hydro enforcement
- Terrestrial lidar
  - RGB & intensity values, classified

* Also applies to photogrammetric point clouds

Rearranging Point Records

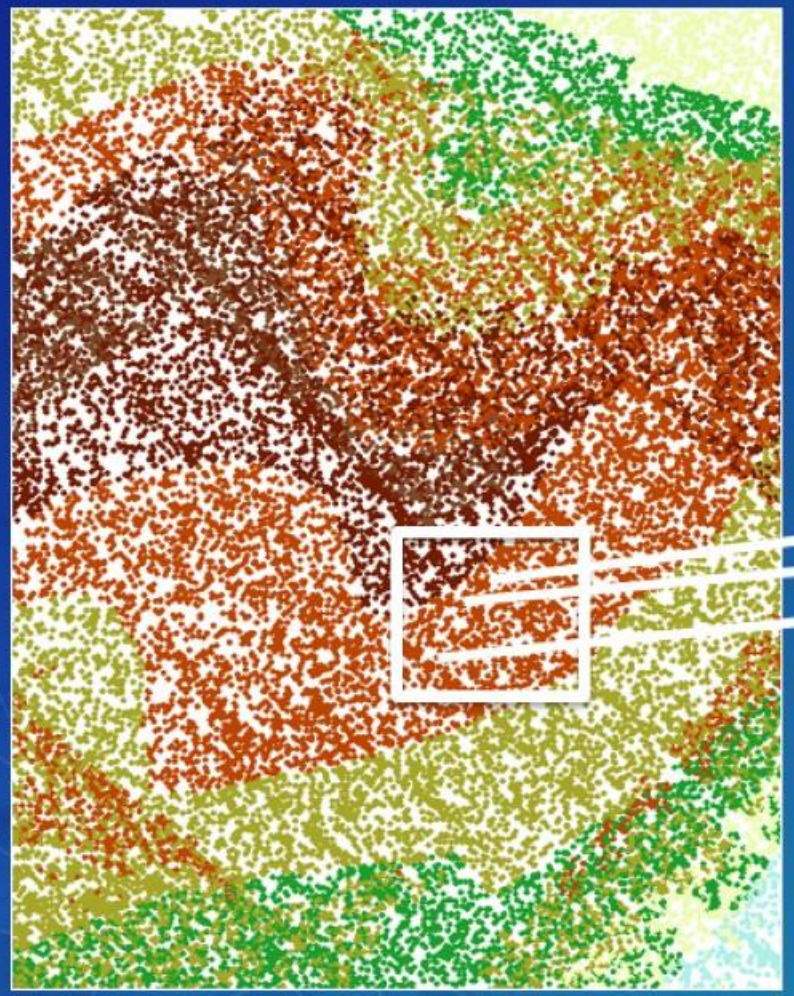


Spatial distribution of points



Physical location in file

Rearranging Point Records



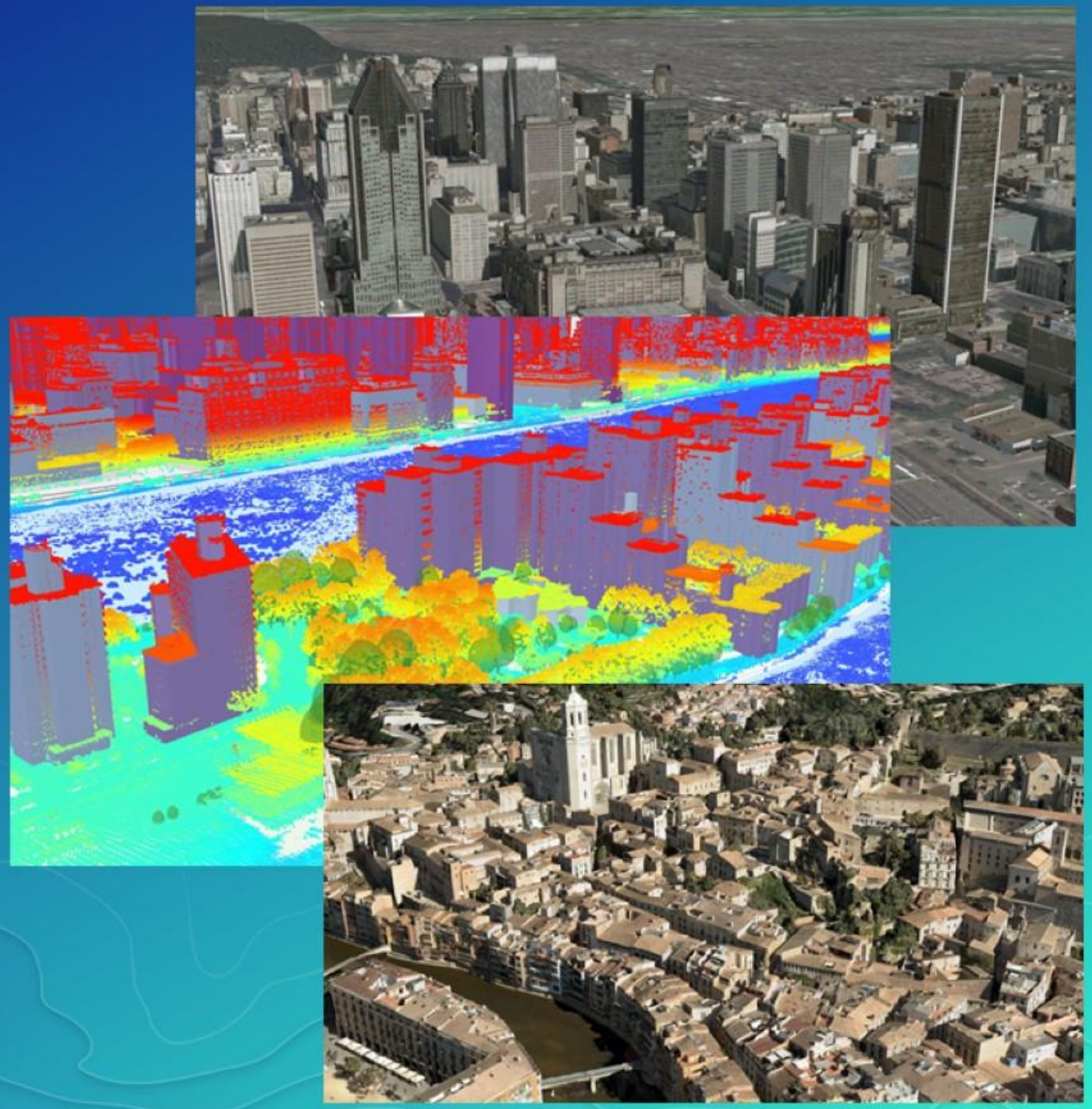
Spatial distribution of points

Physical location in file

Indexed 3d Scene Layer (I3S)

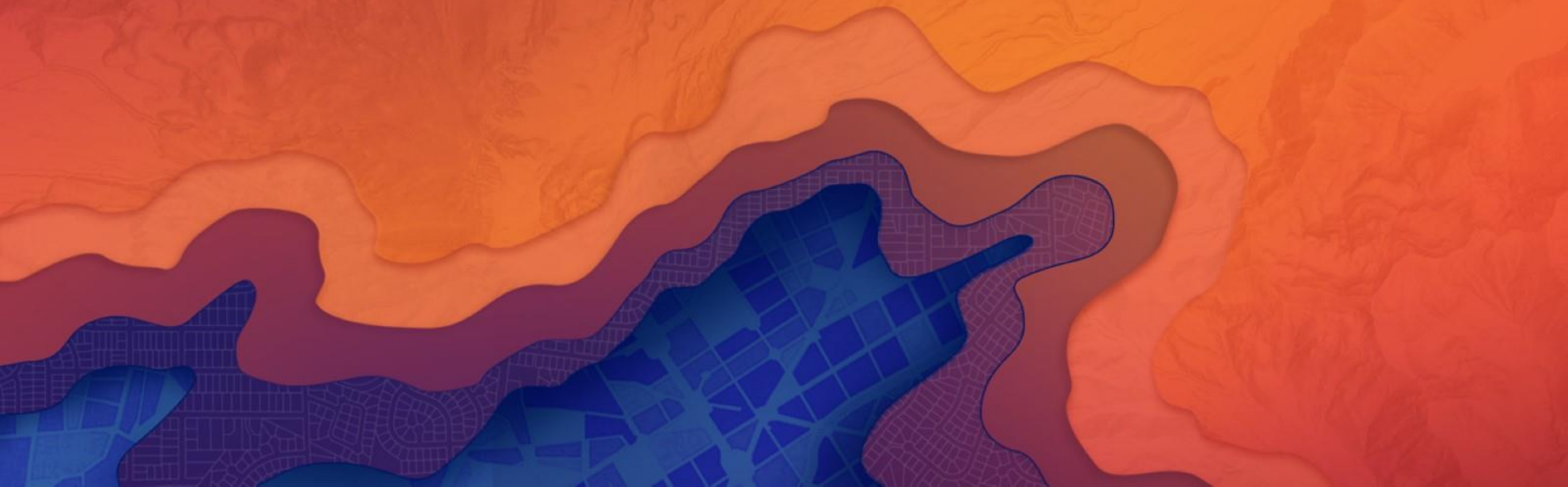
- Specification:
- https://github.com/Esri/i3s-spec

  - Point cloud scene layer – lidar data
  - Integrated Meshes – surface model
  - 3D objects – 3D models
  - Point features - schools, hospitals, signs



Lidar Building Footprint Extraction

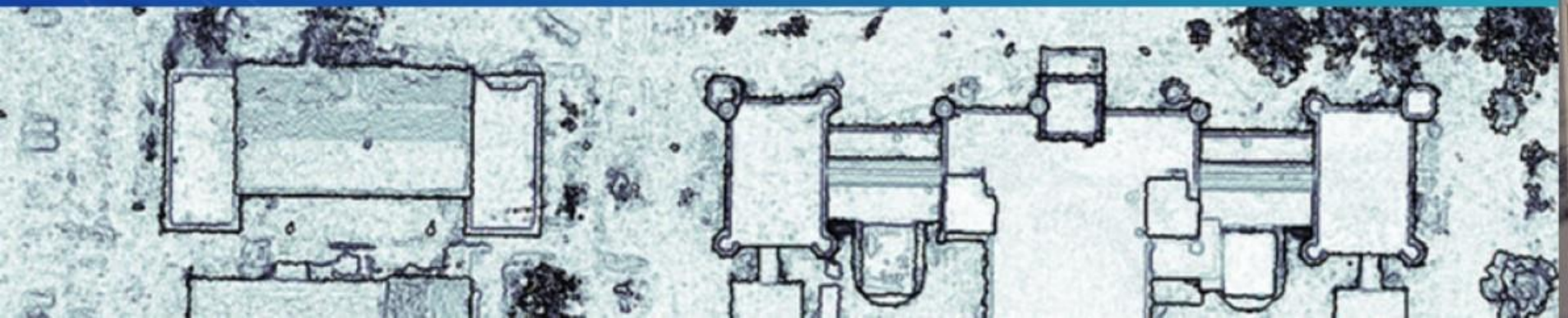
Arthur Crawford



Lidar Building Footprint Extraction

Collection Building Footprints for Content and tools to share with contributors

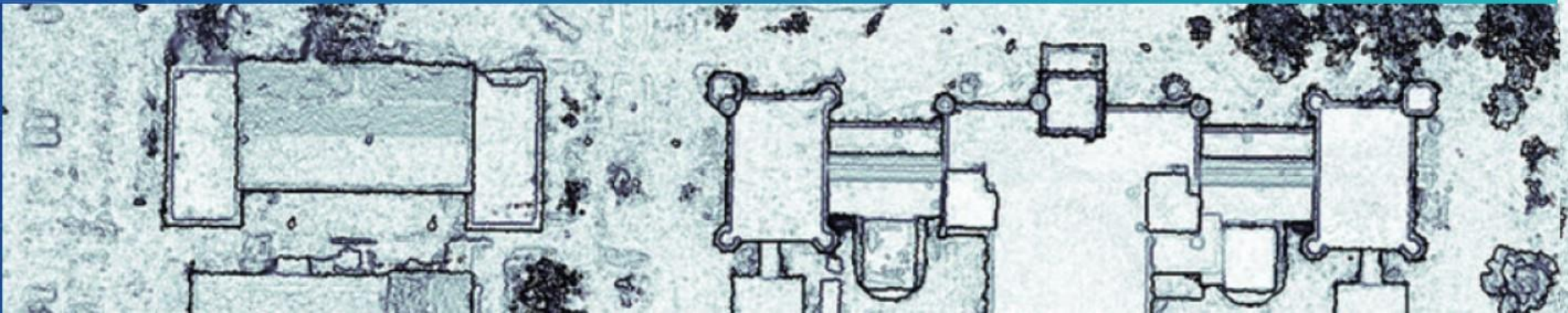
- Millions of buildings have been collected so far.
- Tools and processes developed were put into a toolset.
- Cleaning tools developed for Regularizing buildings
- Lidar Classified for Buildings (Code 6) Extraction
- Lidar Unclassified for Buildings Extraction
  - Uses Bone Map in background



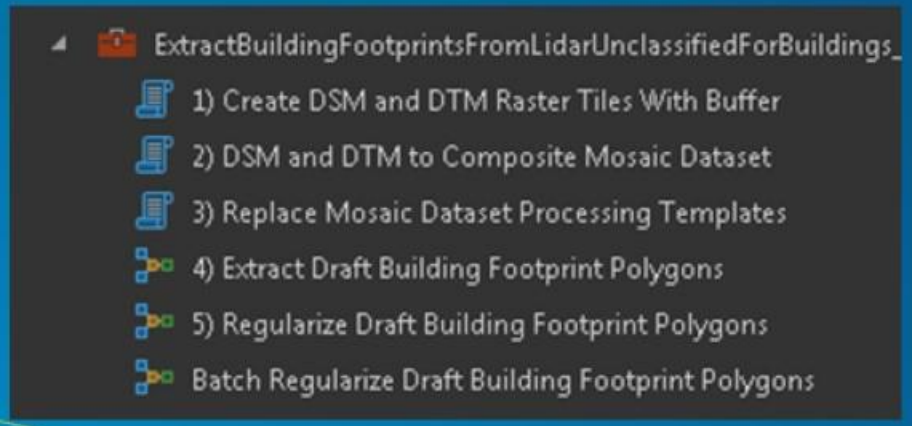
Bone Map

- Dr. Thomas Pingel (University of California, Santa Barbara) developed the Bone Map using a Shaded Slope.
- Instead, we use a multi-directional hillshade with a mask of areas below a height. Similar result.
- Fill in center of the building using a statistics minimum
- Remove trees with there texture (darkness) using remap

Images supplied by Dr. Pingel, below and to right.



Extract Building Footprints from LiDAR that is not classified for buildings



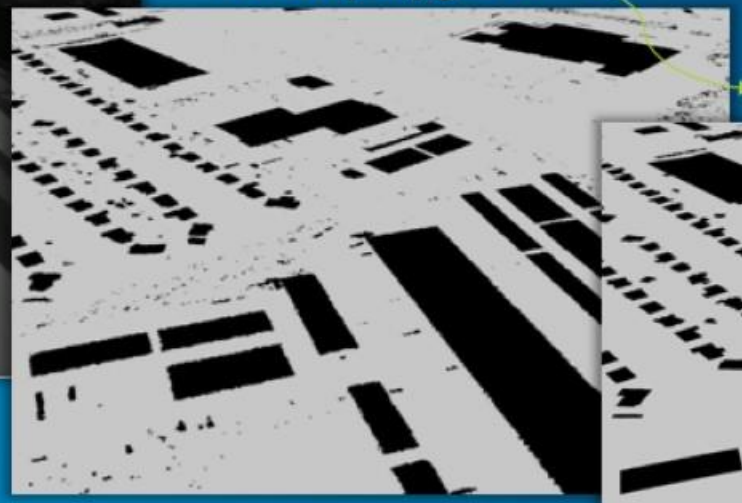
Tools that:

- Create a set of tiled surfaces from lidar
- Load tiled surfaces into a Mosaic Dataset
- Apply Raster Functions to analyze data
- Convert results to vector data
- Cleanup artifacts and perform generalization (regularization)

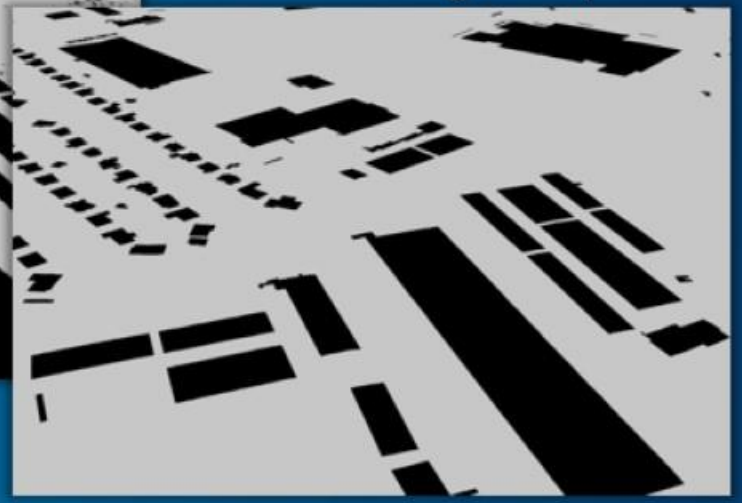
Raw LiDAR

DTM and DSM creation

Draft polygons

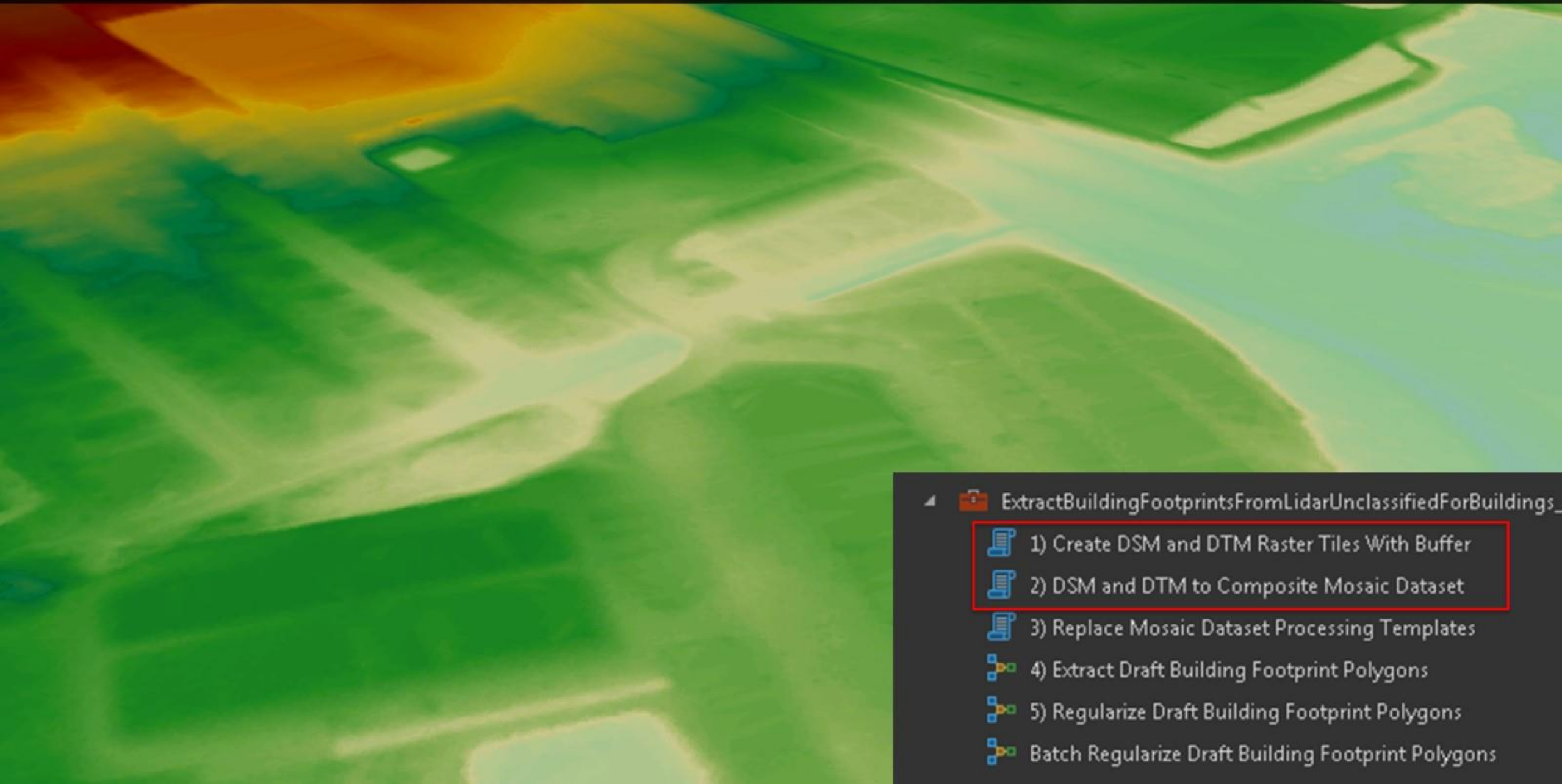


Final Building Footprints

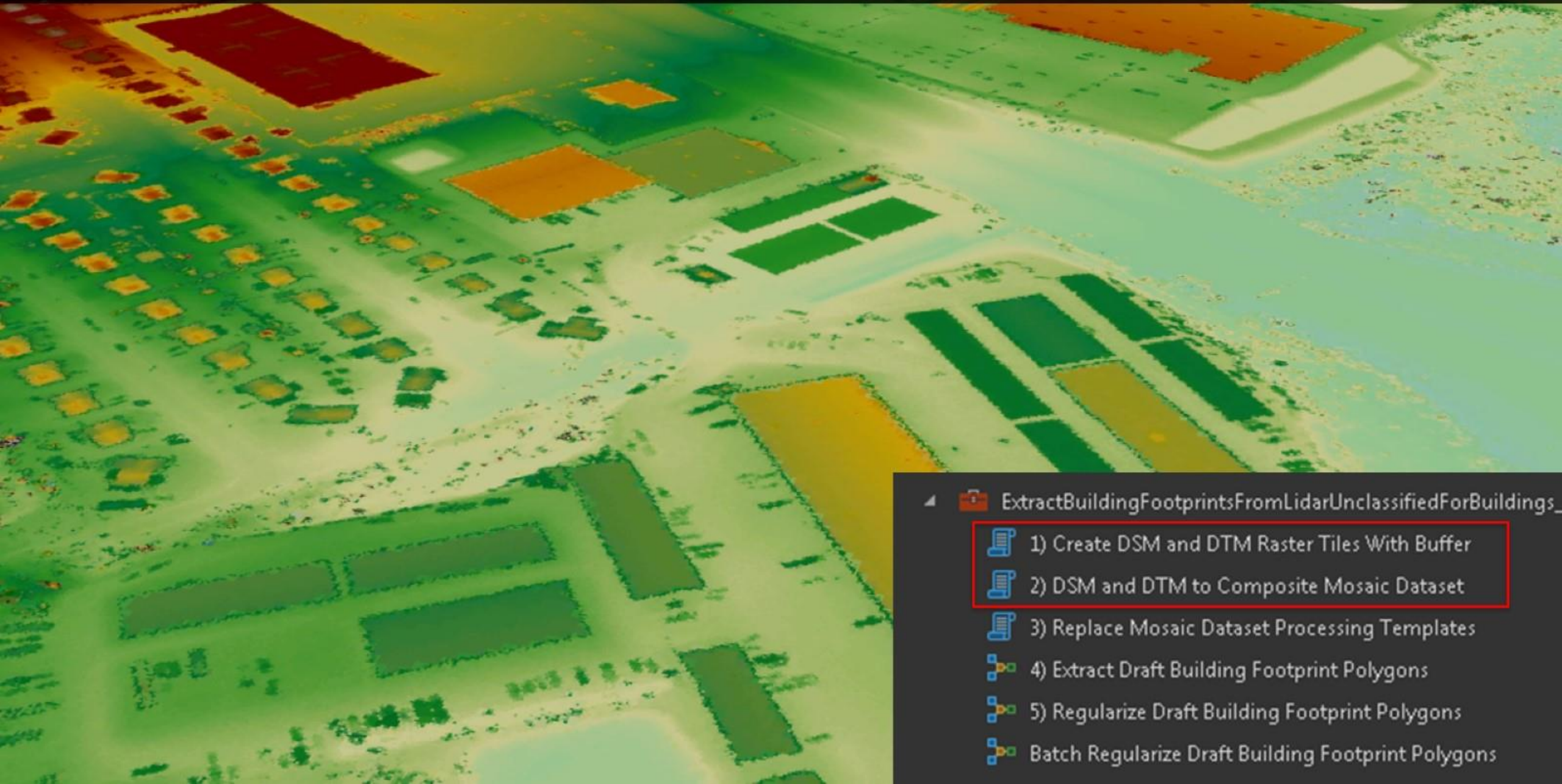


Lidar Point Cloud not classified for buildings

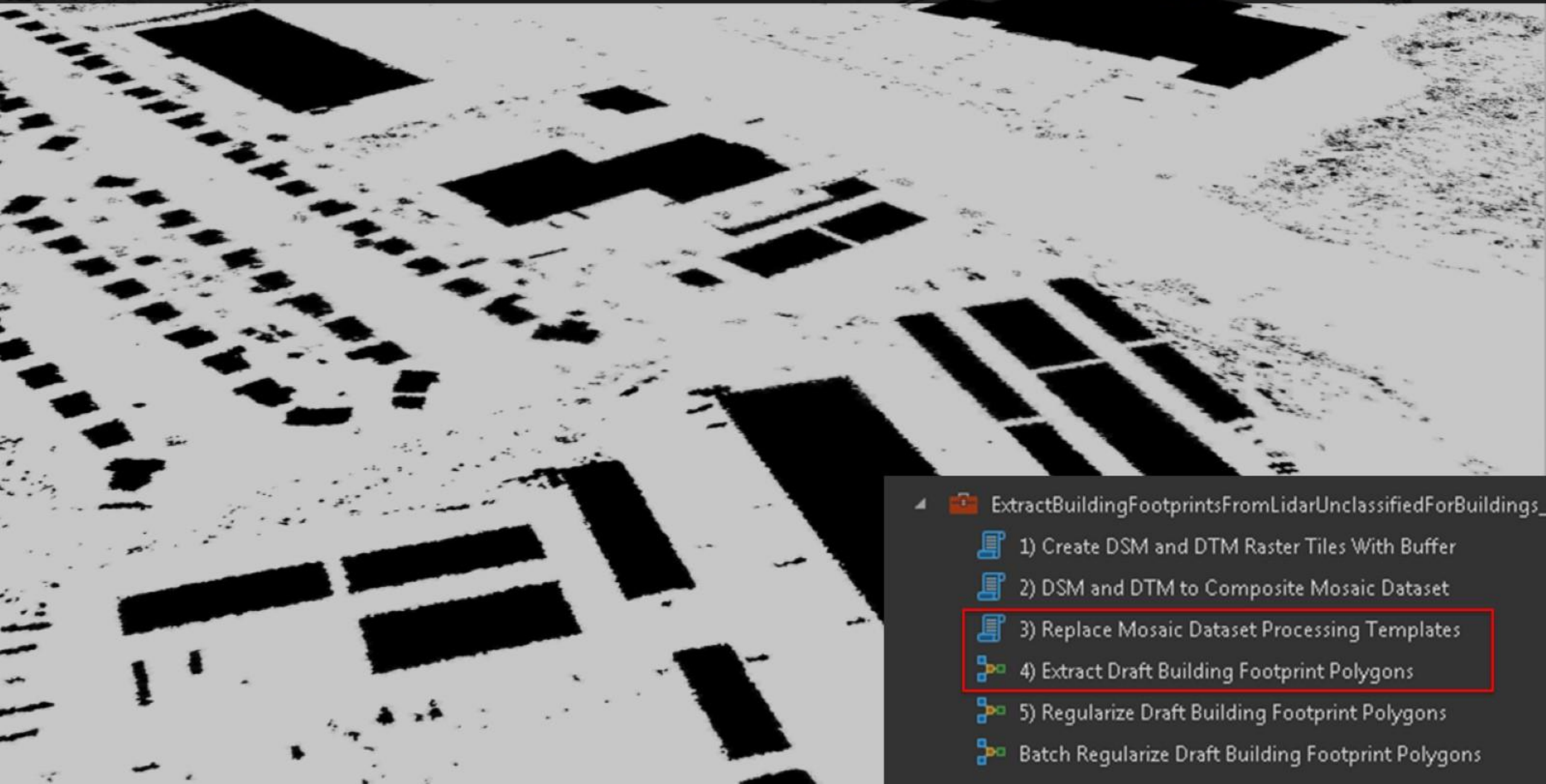
Lidar Raster Tile (DTM)



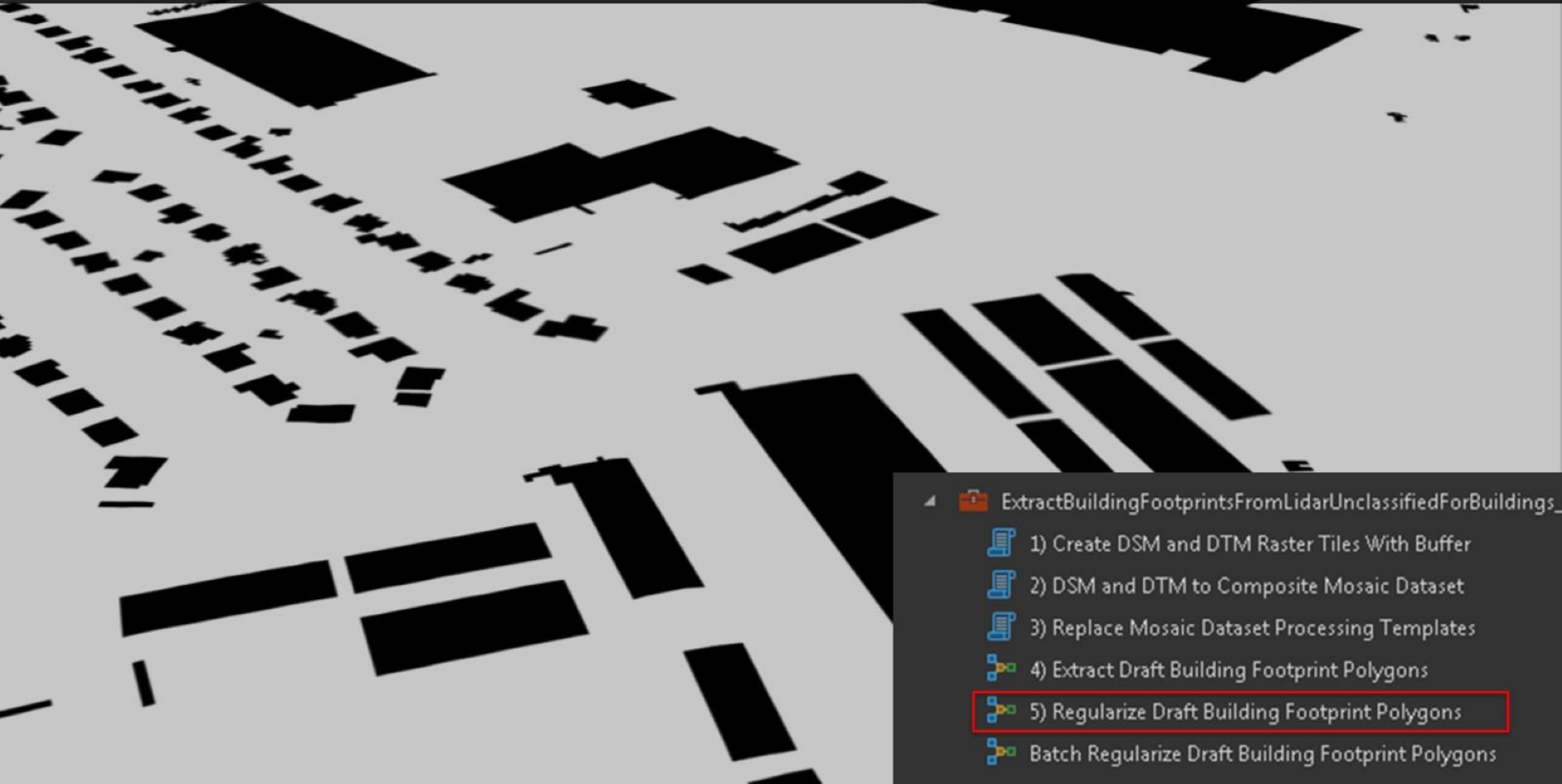
Lidar Raster Tile (DSM)



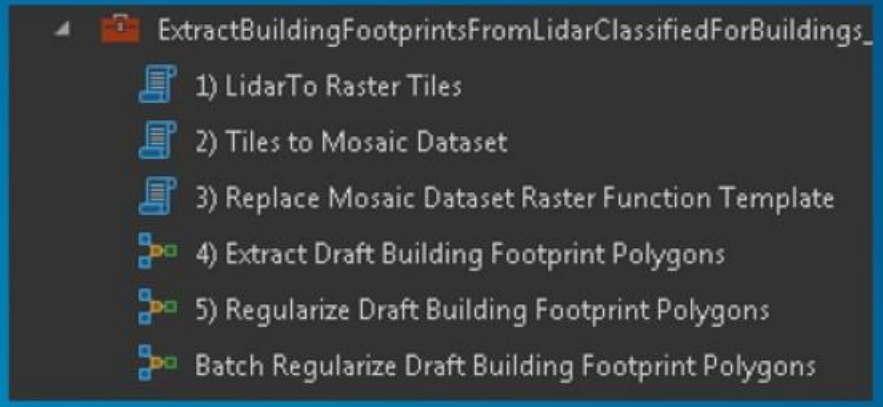
Raster Functions and then Draft Building Footprints



Final Building Footprints (Regularized)

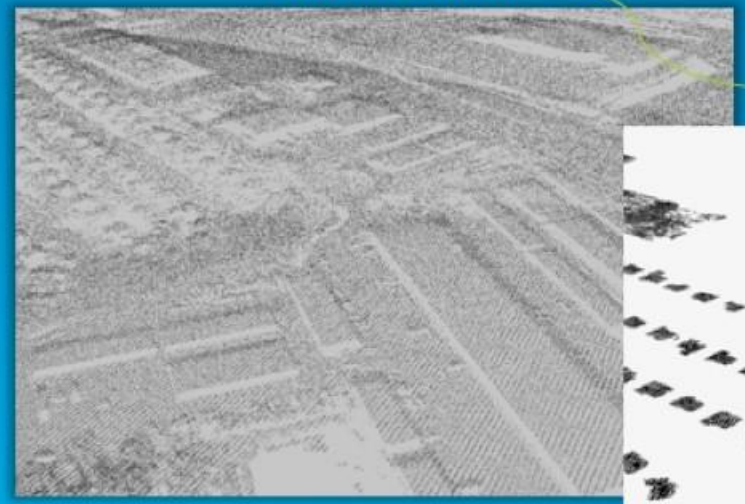


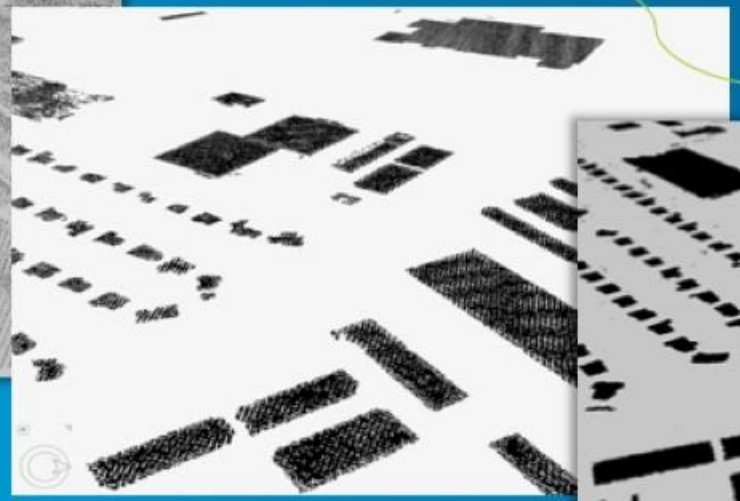
Extract Building Footprints from LiDAR that is classified for buildings

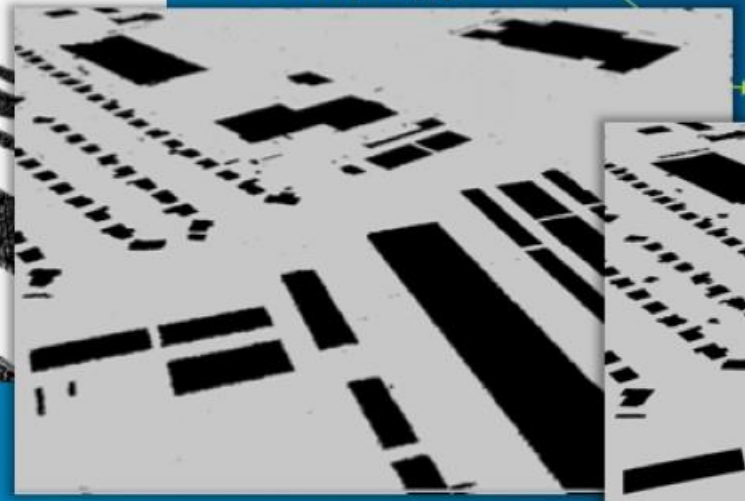


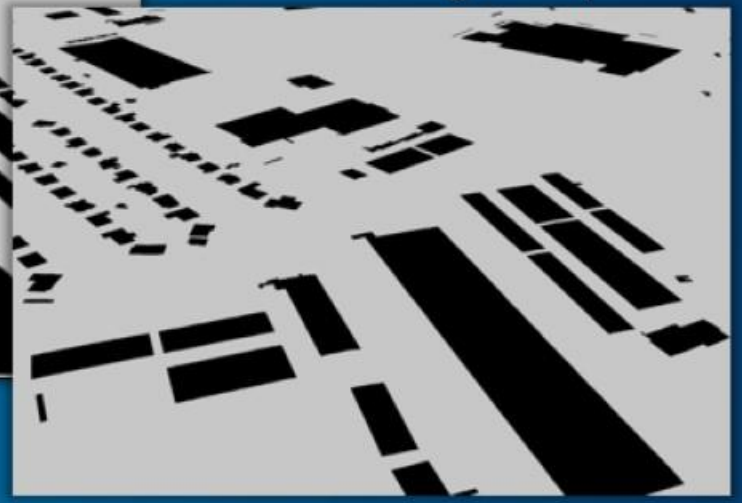
Python scripts and ArcGIS Models that:

- Convert LiDAR to LAS Dataset
- Create a set of tiled surfaces (DTM, DSM)
- Load tiled surfaces into a Mosaic Dataset
- Apply Raster Functions to analyze data
- Convert results to vector data
- Cleanup artifacts and perform generalization





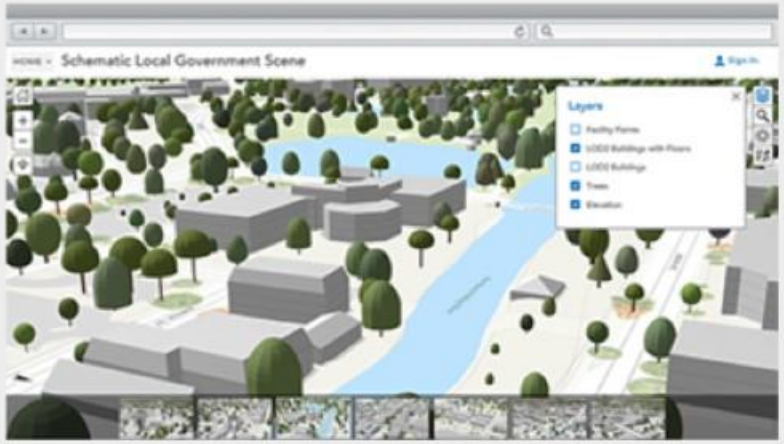




ArcGIS for Local Government SEARCH esri

Local Government 3D Basemaps

Overview



The Local Government 3D Basemaps is a set of ArcGIS Pro projects that can be used to author high-quality 3D scenes for your local government. These scenes are organized in different Levels of Detail (LOD) and derived from 2D operational data managed by a department or agency within a local government. Once authored, the 3D scenes are a foundation for 3D workflows and applications; and provide a consistent geographic context across local government departments and agencies.

REQUIREMENTS WHAT YOU GET WHAT'S NEW

DOWNLOAD VIEW SCENES

Demo

Arthur Crawford

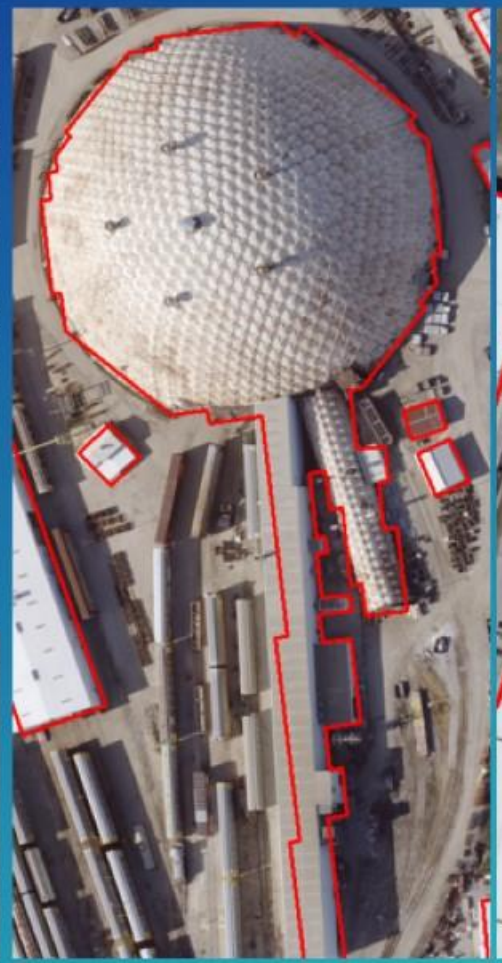
Future tools to improve the Process:

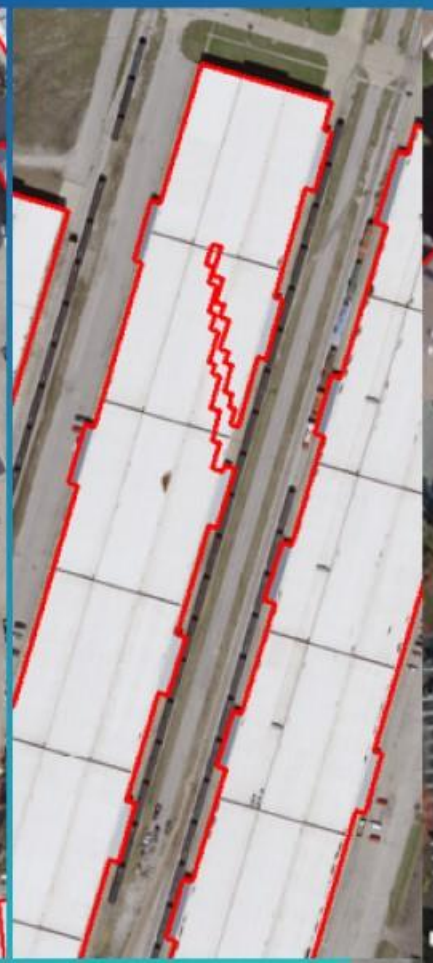
- After draft building collection, use Intersect with Parcel data
- Use NDVI with 4 band imagery and Zonal Statistics
- Use Texture of the DSM (TPI) and Zonal Statistics
- A tool to identify and possibly fix jagged edges at non 45 or 90 degree edges

Issues with Extraction – the Good, Bad and Ugly:

Bad: Individual Buildings that come out bad with extraction from classified lidar

Complex Industrial Areas





Homes

Ideas for Improving tools for better extracted buildings:

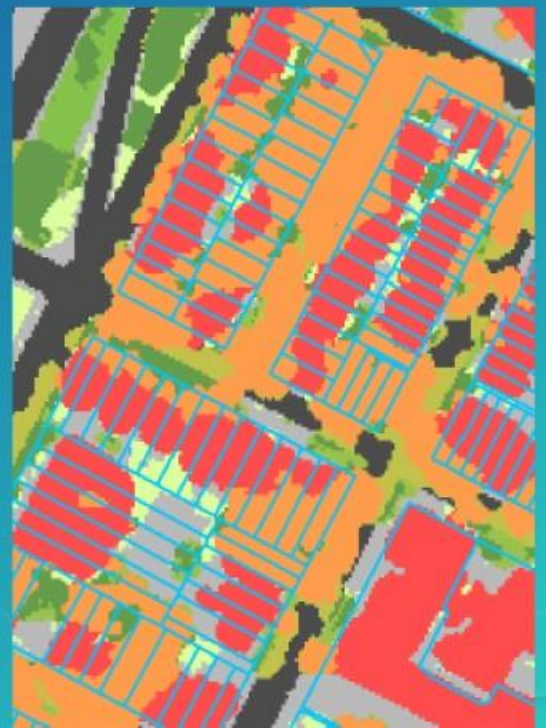
1. Create a Parcel Building Intersect Tool that will allow Intersect with buildings or clipping using buffered parcel lines.
2. Processes for automated clean up of non-building using NAIP NDVI and DSM Texture (TPI Roughness).
3. We need a tool that will align small buildings near to the road features. Fix issues with angle alignment.
4. Tools to identify features with stair stepping.

Regularize Draft Building Footprint Polygons tool works with High Resolution Land Cover

Example is from the open data Chesapeake Conservancy Land Cover with Delaware Parcel data used for Intersect with draft building polygons. (http://chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-cover-data-project/)

Rural

Urban



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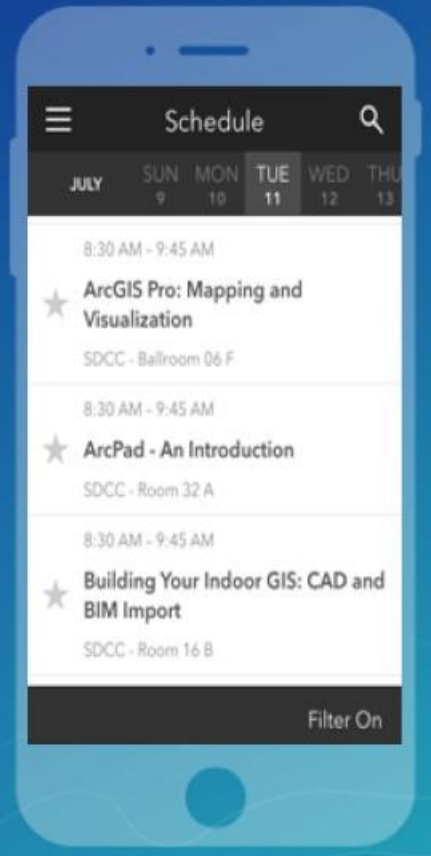
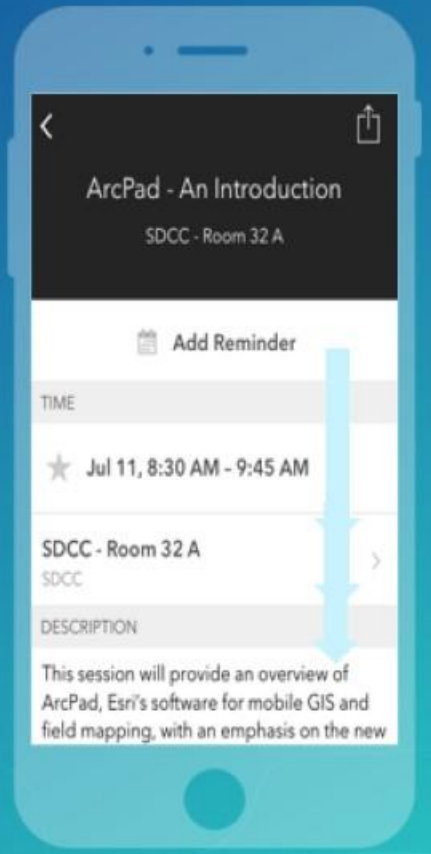


Scroll down to find the survey



Complete Answers and Select "Submit"

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