Dewberry®

Connecticut's Lidar and Orthoimagery Revisited

December 11, 2025

Agenda

- Introductions
- Remote Sensing
- Project Scope and Schedule
- Acquisition
- Lidar Workflow
- Imagery Workflow
- Delivery and Beyond

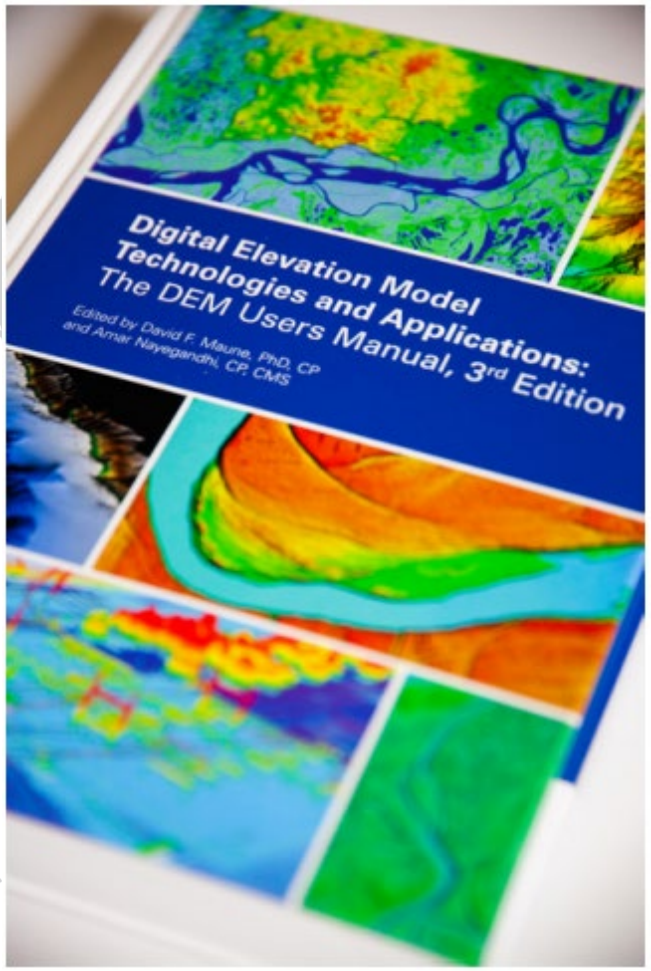
New Haven Green

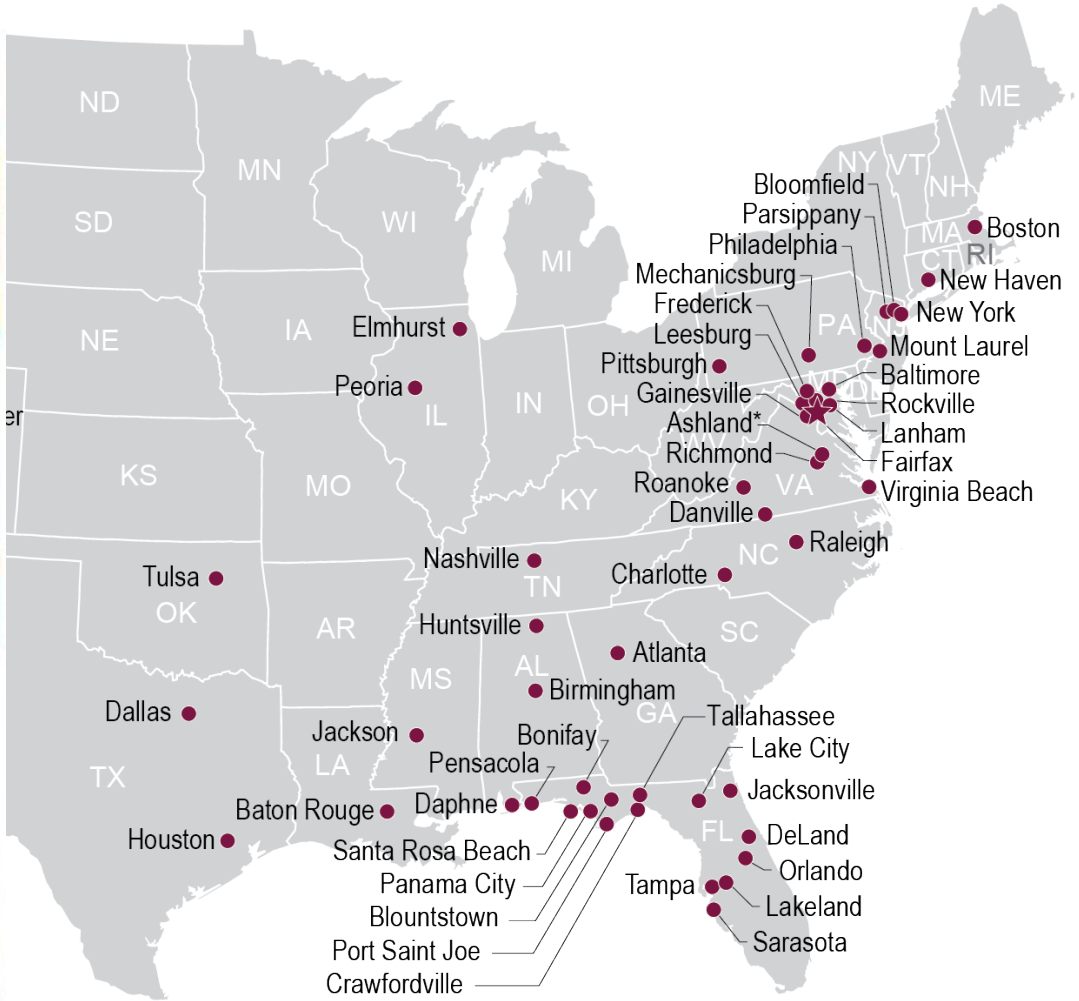
Contribution, Individualism, Perseverance, Honesty, Passion

2,500+ EMPLOYEES

60 LOCATIONS nationwide

65+ YEARS helping clients build and shape communities





Strong culture that focuses on core values and behaviors

HONESTY

Personal integrity. Our first value.

Intellectual honesty. Be honest about what you know and don't know.

Direct communication. Clear, direct with respect works best.

Have fun. If you are not having fun something is wrong. Make it right.

PASSION

Be the best. It is not about being the biggest company; it is about being the best every time.

Compete. Be driven to compete and yes, winning absolutely matters.

Deliver quality. You have succeeded when it is done right and delivered when promised.

CONTRIBUTION

Put the client first. Promote their broader interests.

Financial responsibility. Profits are the lifeblood needed to support growth, re-investment, and our independence.

Build strong relationships. Make building relationships with clients, the community, and others at Dewberry a priority.

Teamwork. Support one another. Share credit at every opportunity. We are one company.

INDIVIDUALISM

Think for yourself. Creativity, innovation and risk-taking starts with the individual.

Self reliance. We are in this together, but you are responsible for your own growth, success, and happiness.

Own It. Take individual responsibility for what gets done.

Follow your instincts. Listen first and last to your own inner voice.

PERSEVERANCE

Think big. Keep your feet on the ground but reach for the stars.

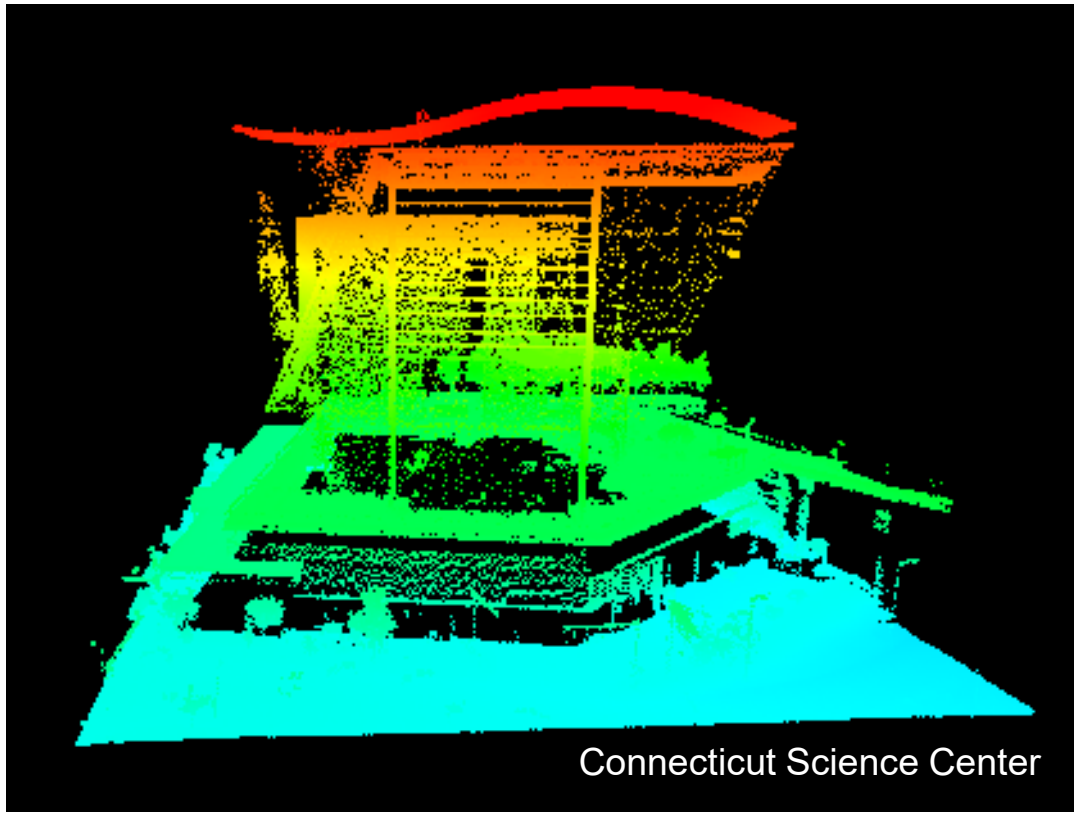
Conserve resources. No one can predict what tomorrow will bring.

Focus on the long haul. Real and meaningful success comes through sustained efforts.

Stay flexible. Keep our options open.

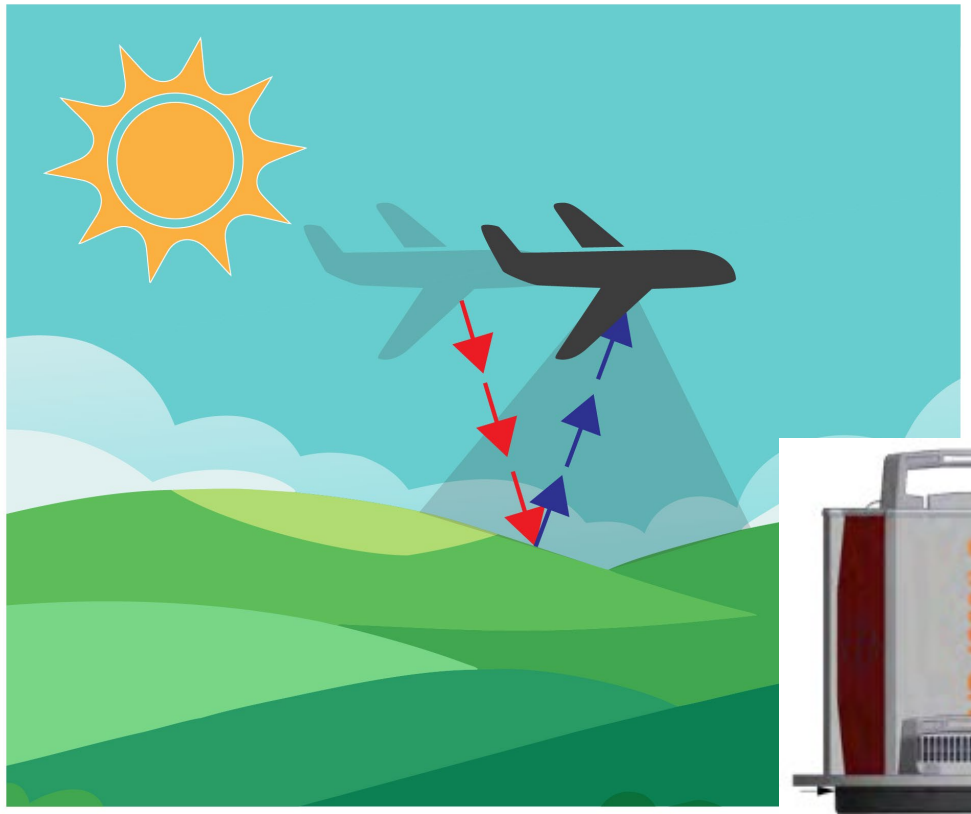
Introductions

- Andrew Peters
  - Project Management
  - Lidar Production Manager
- Dan Bubser
  - Orthoimagery and Feature Mapping Manager
- Catherine Bohn
  - Client Liaison
- Alfredo Herrera – OPM
- Emily Wilson – CLEAR


Connecticut Science Center

Remote Sensing 101

Lidar is an Active Sensor



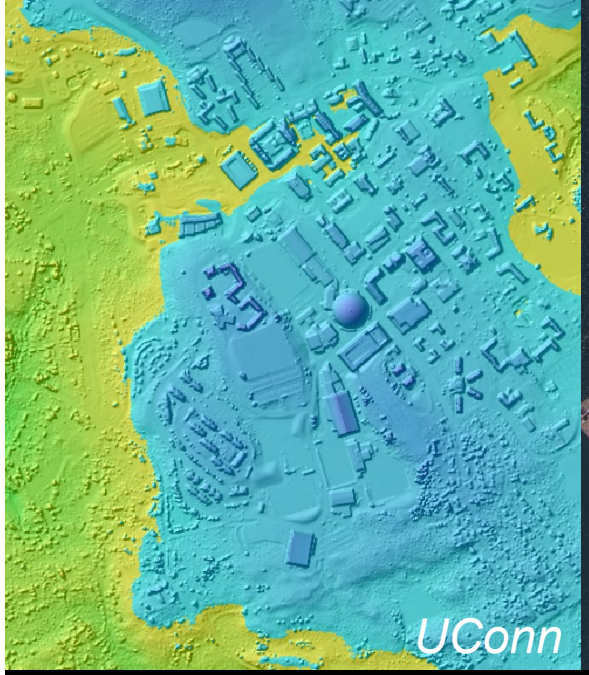
- Pulse of light emitted from the sensor, hits an object, and returns
- Pulses return and sensor attributes with a specific x, y, z, intensity and other information

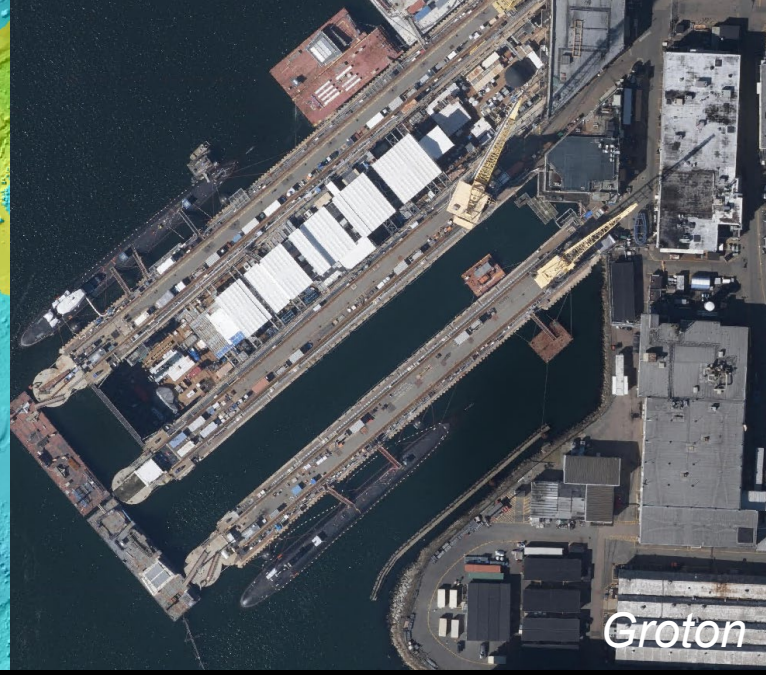
A Camera* is Passive Sensor

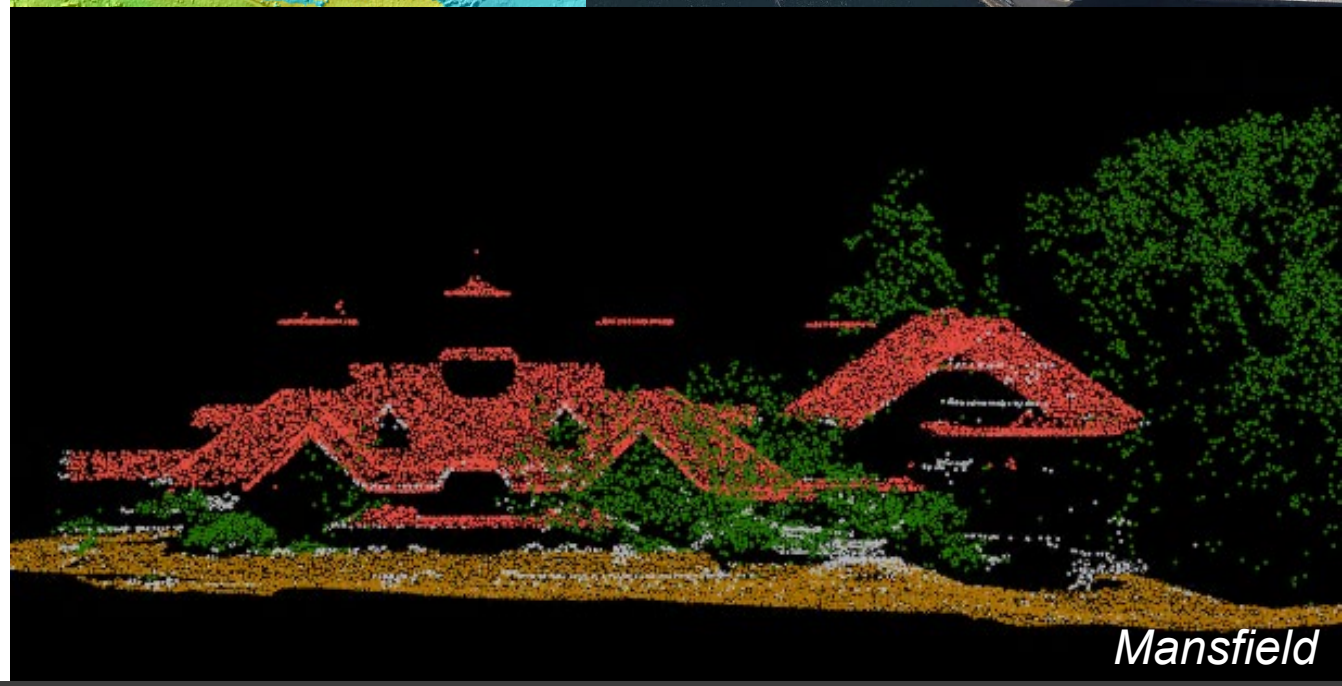
- In orthoimagery's case the sun emits light, and the camera collects the returned information
- The imagery collected for this project will have four bands (Red, Green, Blue, and Near Infrared)

Scope of Services

- Project Area:
  - Statewide with 500 ft buffer.
- Task:
  - Acquire high resolution aerial imagery and QL1 lidar data.
  - Develop derivative products.
- Specifications:
  - Lidar and imagery over coastal zones shall be collected during low tide period.
  - Lidar collected at no less than 14 ppsm (USGS QL1) over the inland and 20 ppsm over the defined coastal zones.
  - Imagery: 3-inch 4 band (RGBI) digital orthoimagery with a minimum 35° the sun angle.

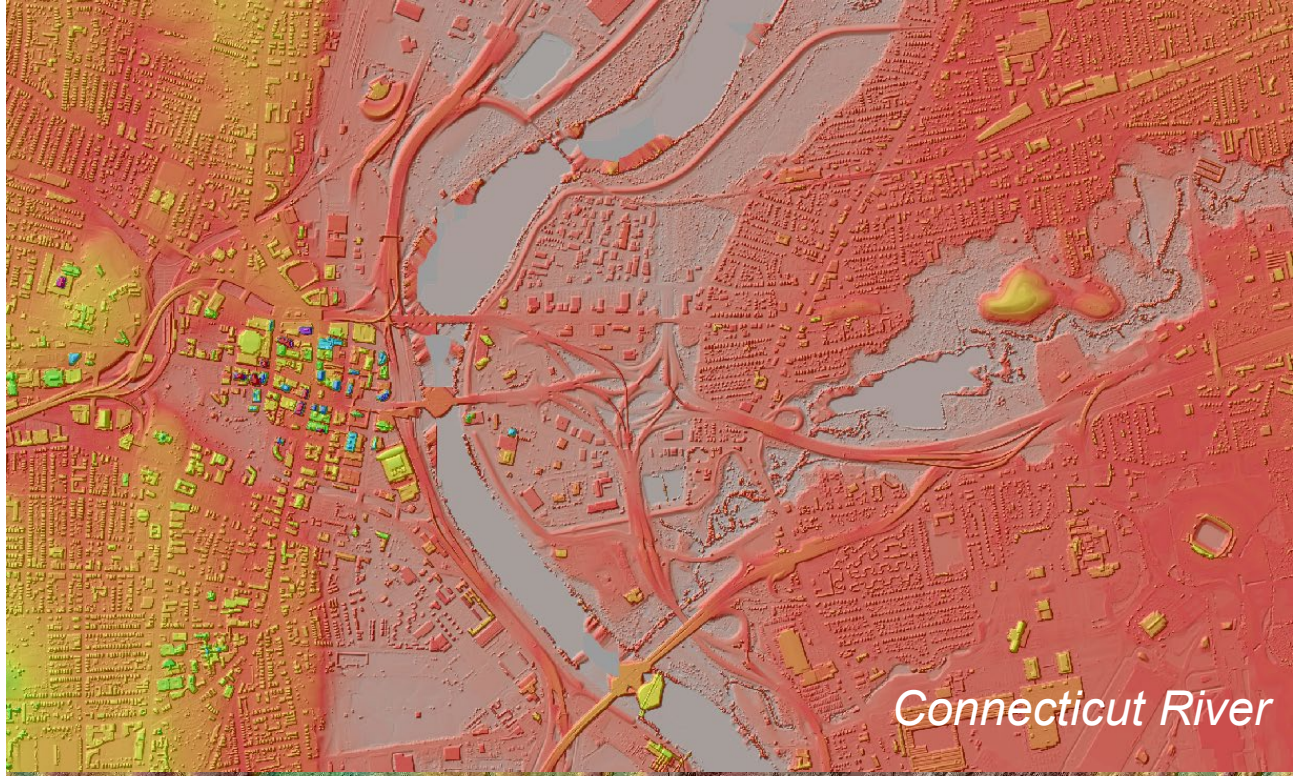


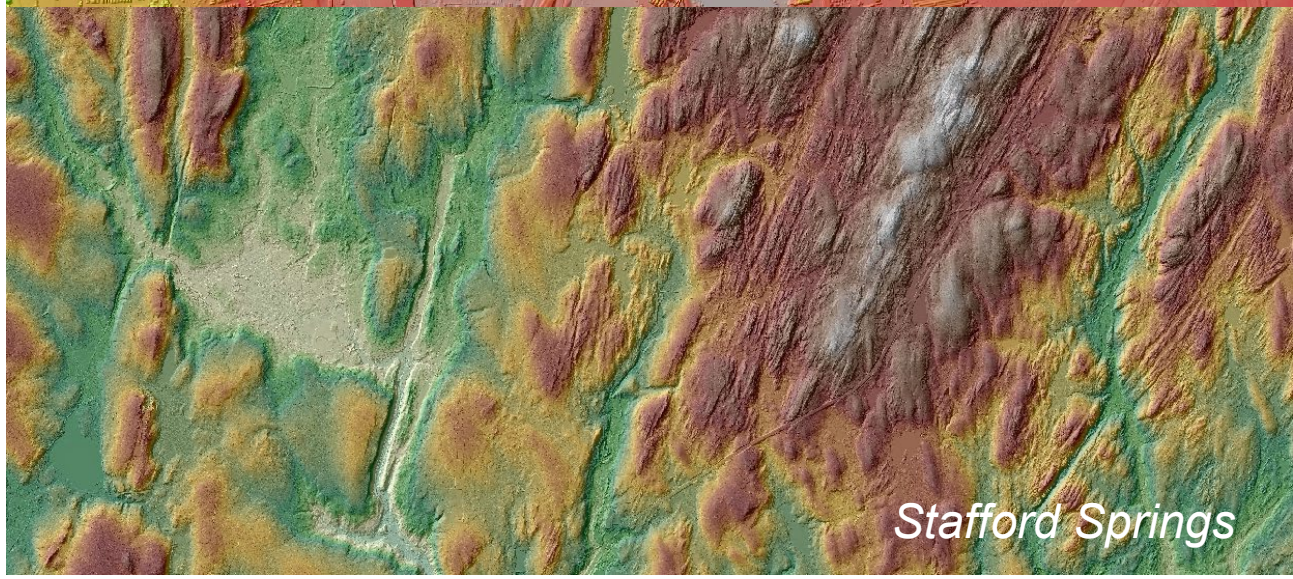




Tips for Success

- Specialization
  - Splitting large swaths
  - Vegetation classification by IR Band
  - Building footprint analysis
  - 3D Building workflows
  - Enhanced breakline conflation methods
- Advantages
  - 2023 DEM for orthorectification
  - Using 2023 Lidar as a reference for classification
  - Vegetation classification methods
  - Temporal changes identification
- Acquisition Parameters
  - Planned densities 16ppsm and 22ppsm
  - Shorter flight lines; lower altitude



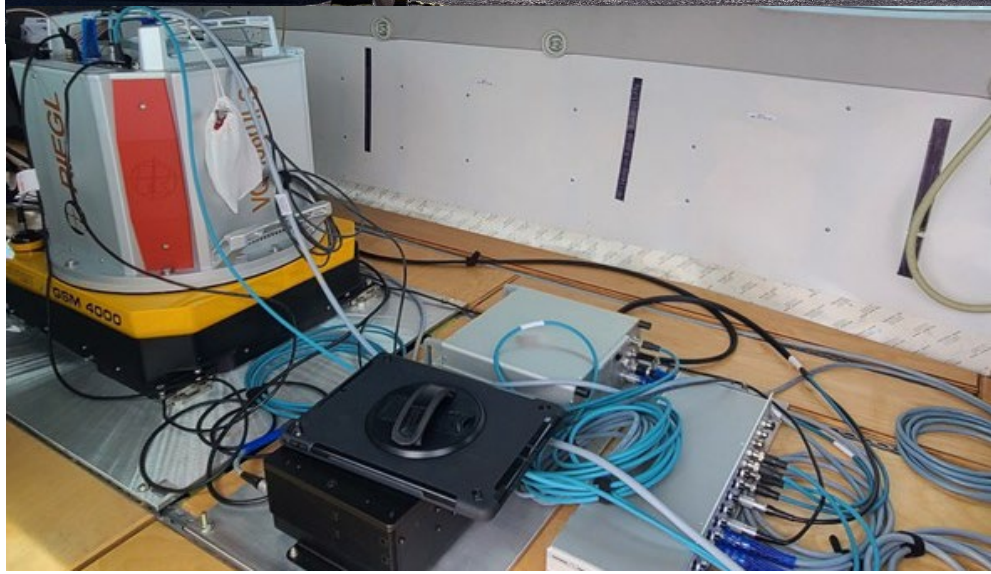


Schedule for 2026

Milestone	Due Date
Monthly Meetings with CT	Ongoing
Acquisition of Lidar and Ortho	Spring 2026
Ground Control Survey	March 2026
Project Pilot Delivery	June 30, 2026
Progressive Block Deliveries	August – November 2026
Core Deliverables Delivered	December 31, 2026
Contract End Date	June 30, 2027

Lidar Acquisition

- Collection Area 5,241 sq. miles
- Aircraft and sensor mobilized to Robertson Airport, Plainville, CT
- Weather, ground conditions and tidal monitoring
- Aircraft and sensor preflight inspection
- Initial QC of data by flight operations team
- Flight log created for each flight
- Data shipped to home office for processing
- Primary sensor: Riegl VQ-1560 II-S (1)



Acquisition
Calibration
Data Prep/Initial Grounding
Lidar Editing
Breakline Collection
Product Development
Final Quality Review
Delivery

Field Survey

- Ground Control Points (GCP) or “calibration points” will be used to calibrate the acquired lidar and aerial triangulation (AT) of imagery
  - 40 for lidar calibration and 30 for AT
- Independent Checkpoints (CP) will be used for accuracy assessment of the Lidar and derivative products
  - 238 well distributed check points per ASPRS specifications for lidar and 193 check points for imagery.
  - Check points distributed among major land cover types in the project area.

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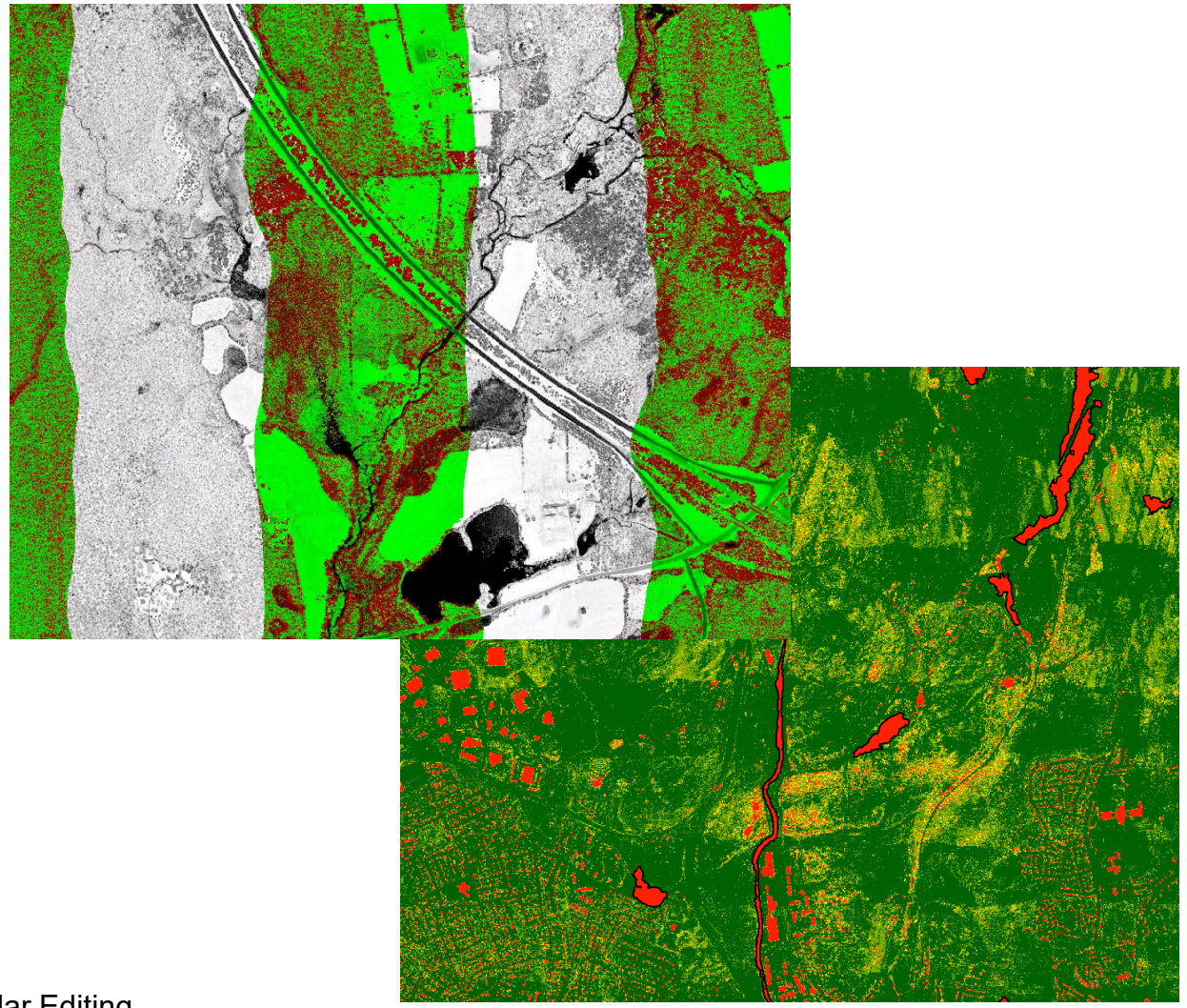
Calibration

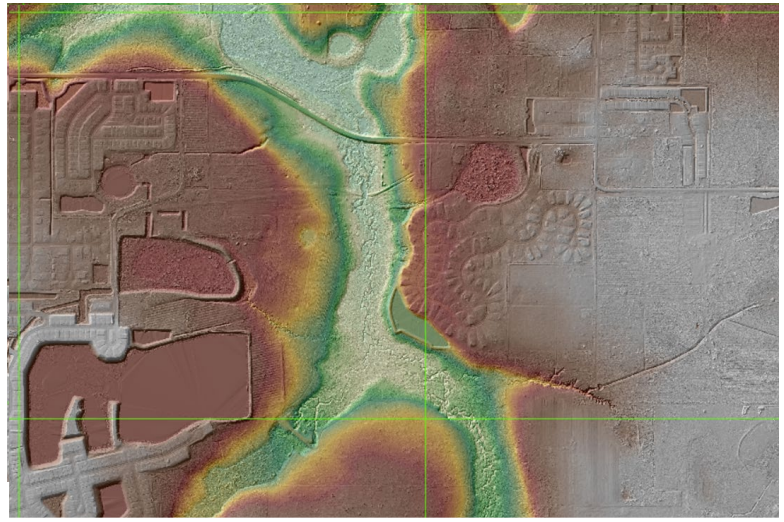
- GNSS/INS trajectory processing
- Initial checks for coverage and density validation
- Lidar data calibration using ground control
- QC Lidar data calibration checks

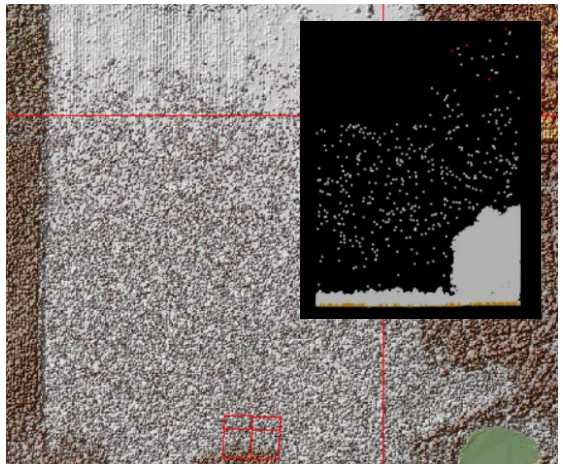


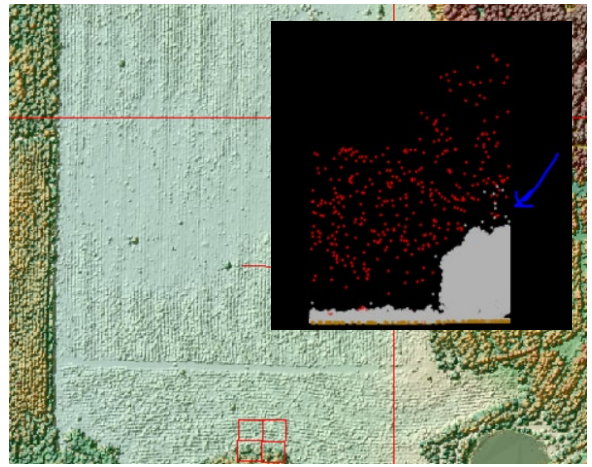
Acquisition | Calibration | Data Prep/Initial Grounding | Lidar Editing | Breakline Collection | Product Development | Final Quality Review | Delivery

Data Prep/Initial Grounding

- Swath data is tiled
- Initial accuracy assessments
- Initial classification of ground/non-ground
- Denoising of the data
- Classification of above ground features







Lidar Editing

Acquisition | Calibration | Data Prep/Initial Grounding | Breakline Collection | Product Development | Final Quality Review | Delivery

Lidar Editing

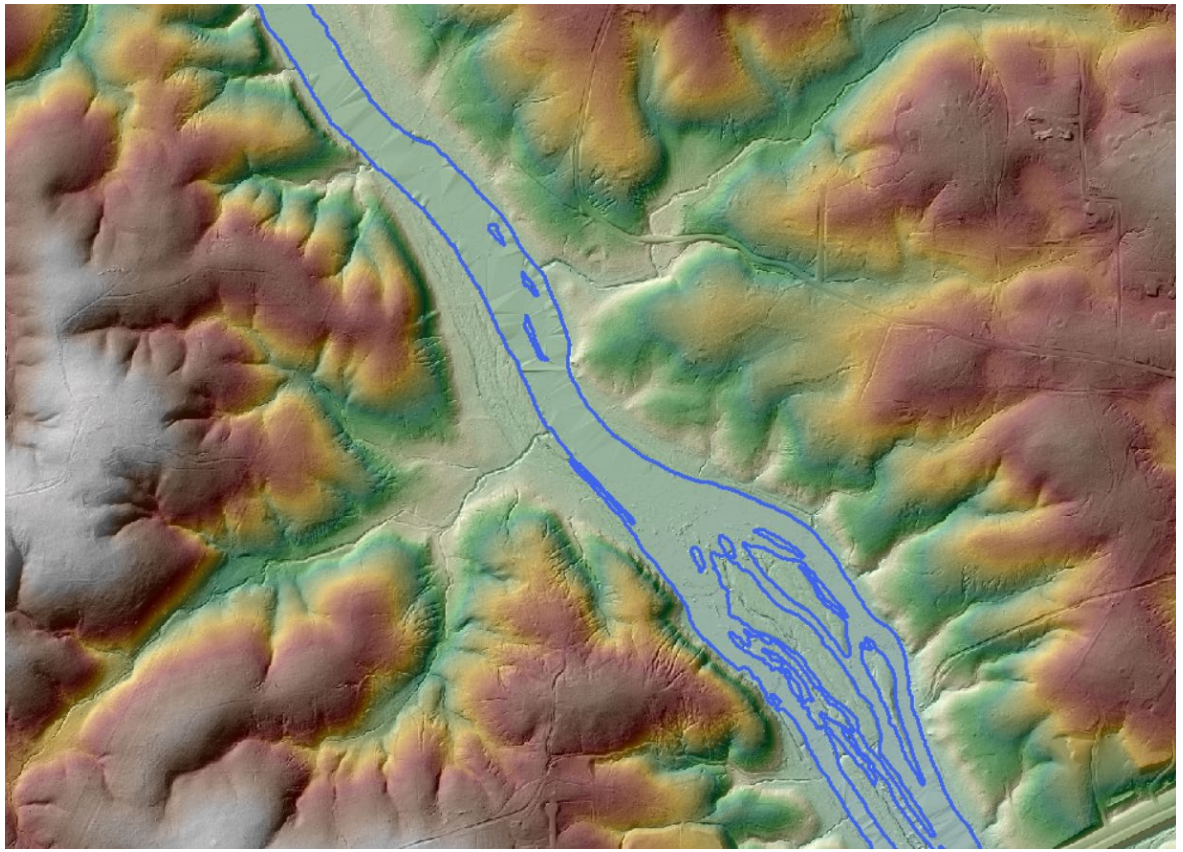
- Review of vector and raster representations of the point cloud
- Manually classification of bridges and over above ground features

Lidar Editing

Acquisition | Calibration | Data Prep/Initial Grounding | Breakline Collection | Product Development | Final Quality Review | Delivery

Breakline Collection

- Delineation of the land water interface using intensity images and initial ground model
- Elevations are assigned to the hydrographic features using interpolated values from the terrain

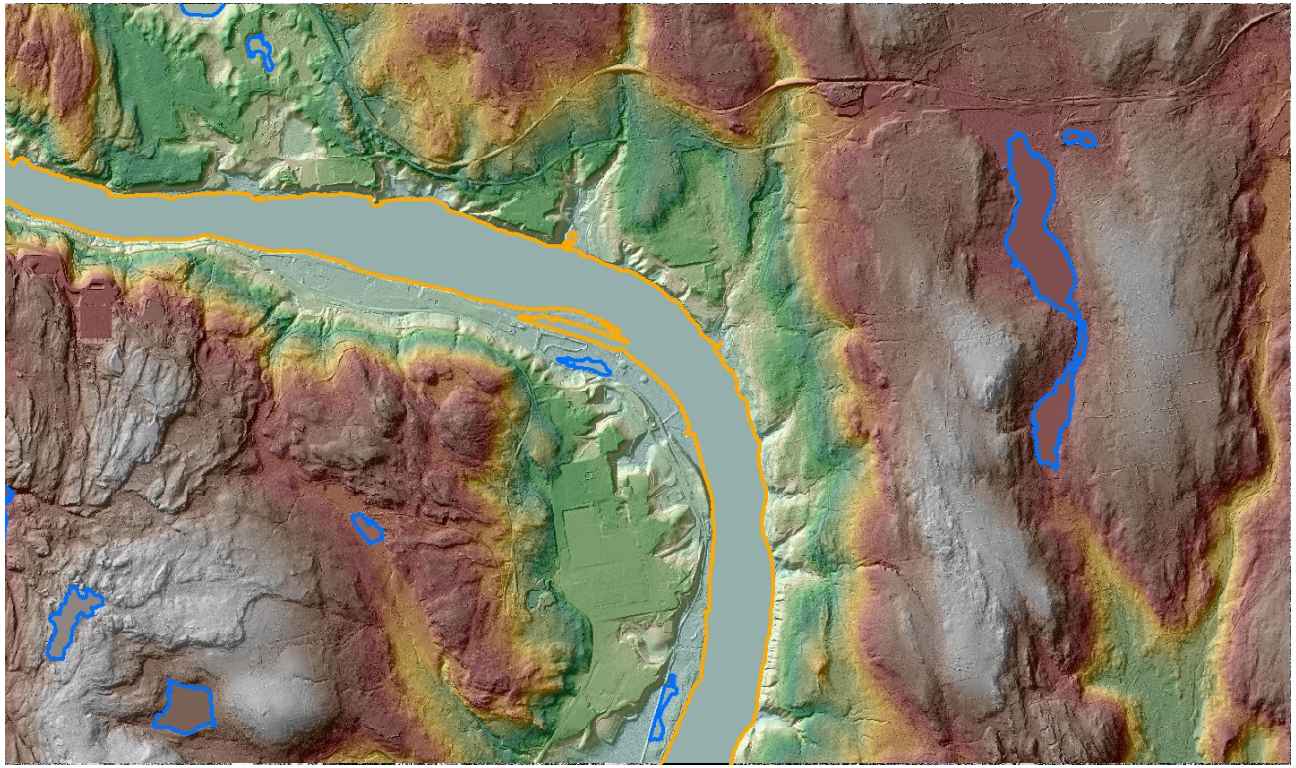


Lidar Editing

Acquisition | Calibration | Data Prep/Initial Grounding | Breakline Collection | Product Development | Final Quality Review | Delivery

Product Development

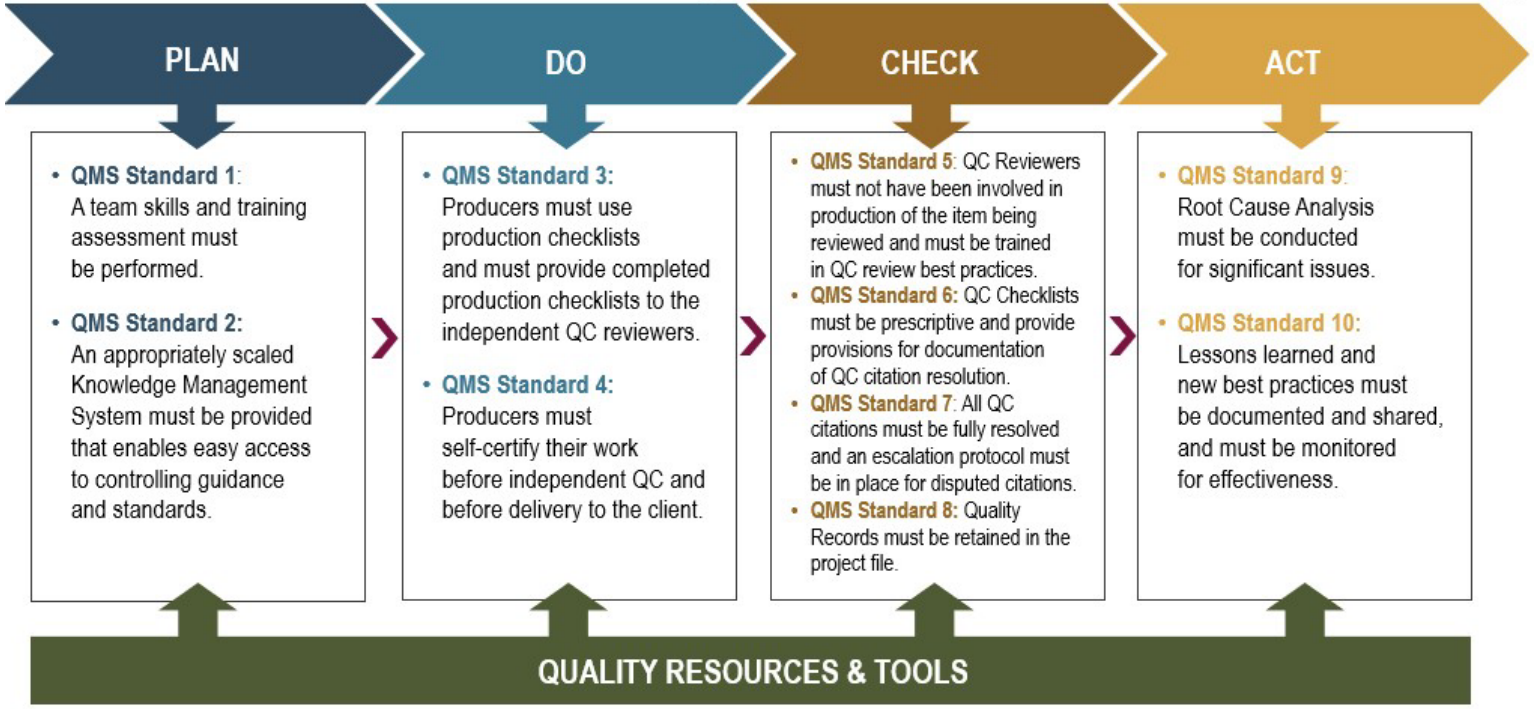
- Breakline features and manually classified Lidar are combined into Digital Elevation Models (DEM)
- Classified Lidar is used to create other raster and vector data
  - Building footprints
  - Maximum Surface Height Raster
  - Intensity images
  - Contour data
- Extrusion of 3D Buildings from Lidar and 2D footprints

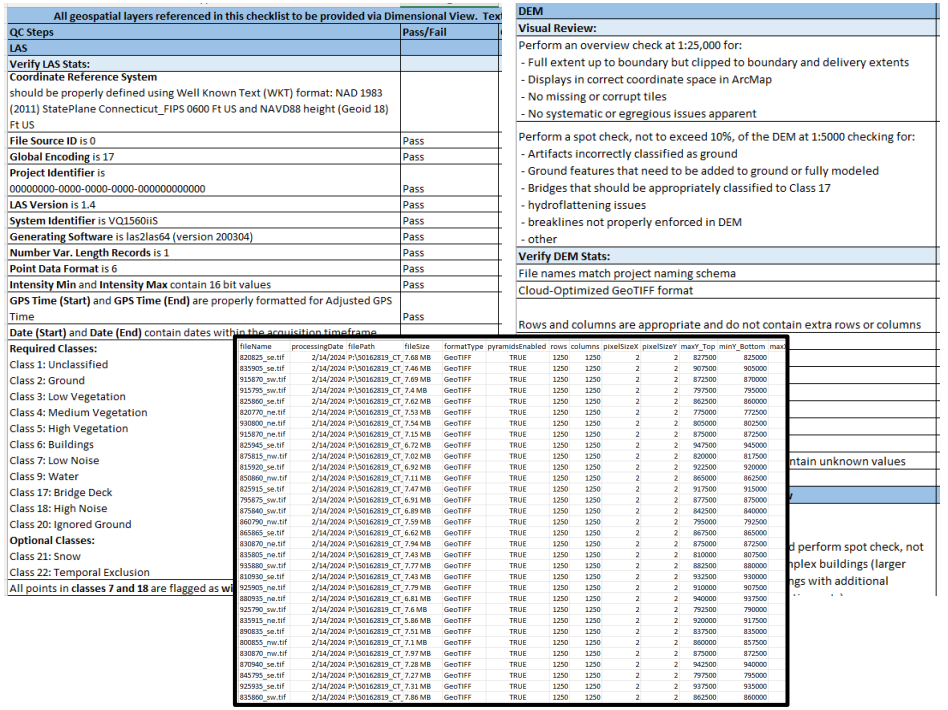


Lidar Editing

Acquisition | Calibration | Data Prep/Initial Grounding | Breakline Collection | Product Development | Final Quality Review | Delivery

Final Quality Review





All geospatial layers referenced in this checklist to be provided via Dimensional View. Tex

QC Steps	Pass/Fail
LAS	
Verify LAS Stats:	
Coordinate Reference System should be properly defined using Well Known Text (WKT) format: NAD 1983 (2011) StatePlane Connecticut_FIPS 0600 Ft US and NAVD88 height (Geoid 18) Ft US	
File Source ID is 0	Pass
Global Encoding is 17	Pass
Project Identifier is 00000000-0000-0000-0000-000000000000	Pass
LAS Version is 1.4	Pass
System Identifier is VQ1560iiS	Pass
Generating Software is las2las64 (version 200304)	Pass
Number Var. Length Records is 1	Pass
Point Data Format is 6	Pass
Intensity Min and **Intensity Max** contain 16 bit values	Pass
GPS Time (Start) and **GPS Time (End)** are properly formatted for Adjusted GPS Time	Pass
Date (Start) and **Date (End)** contain dates within the acquisition timeframe	
Required Classes:	
Class 1: Unclassified	
Class 2: Ground	
Class 3: Low Vegetation	
Class 4: Medium Vegetation	
Class 5: High Vegetation	
Class 6: Buildings	
Class 7: Low Noise	
Class 9: Water	
Class 17: Bridge Deck	
Class 18: High Noise	
Class 20: Ignored Ground	
Optional Classes:	
Class 21: Snow	
Class 22: Temporal Exclusion	
All points in **classes 7 and 18** are flagged as **wi**	

fileName	processingDate	filePath	fileSize	formatType	pyramidsEnabled	rows	columns	pixelSizeX	pixelSizeY	maxY_Top	minY_Bottom	max
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DEM
Visual Review:
Perform an overview check at 1:25,000 for: - Full extent up to boundary but clipped to boundary and delivery extents - Displays in correct coordinate space in ArcMap - No missing or corrupt tiles - No systematic or egregious issues apparent
Perform a spot check, not to exceed 10%, of the DEM at 1:5000 checking for: - Artifacts incorrectly classified as ground - Ground features that need to be added to ground or fully modeled - Bridges that should be appropriately classified to Class 17 - hydroflattening issues - breaklines not properly enforced in DEM - other
Verify DEM Stats:
File names match project naming schema
Cloud-Optimized GeoTIFF format
Rows and columns are appropriate and do not contain extra rows or columns
ntain unknown values
d perform spot check, not
nplex buildings (larger
ngs with additional

Lidar Editing

Acquisition | Calibration | Data Prep/Initial Grounding | Breakline Collection | Product Development | Final Quality Review | Delivery

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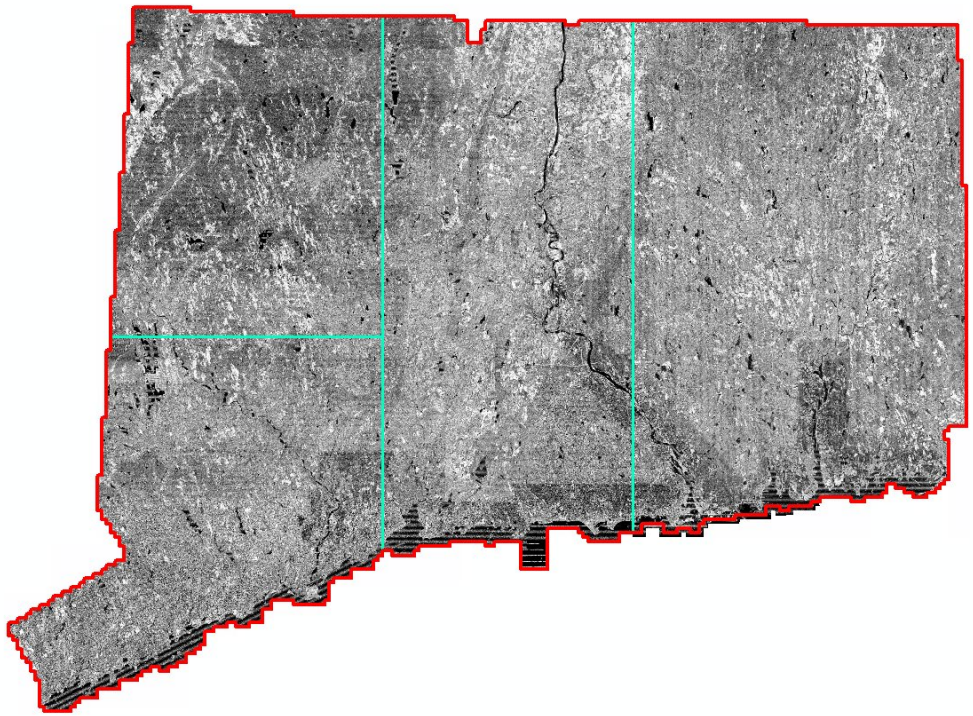
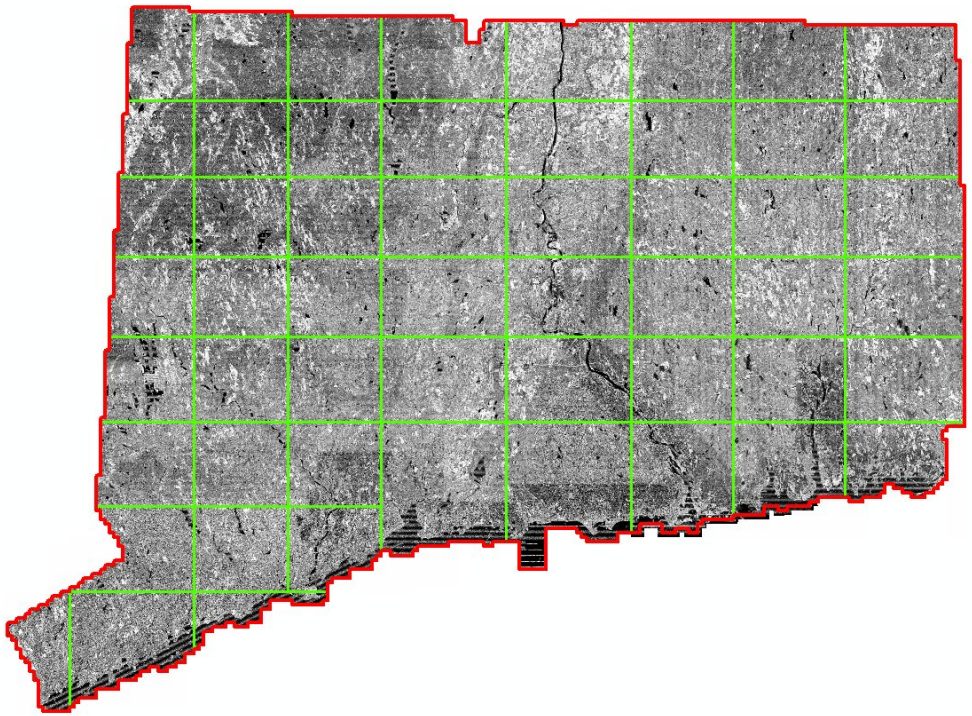
Delivery





Lidar Editing

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Aerial Imagery

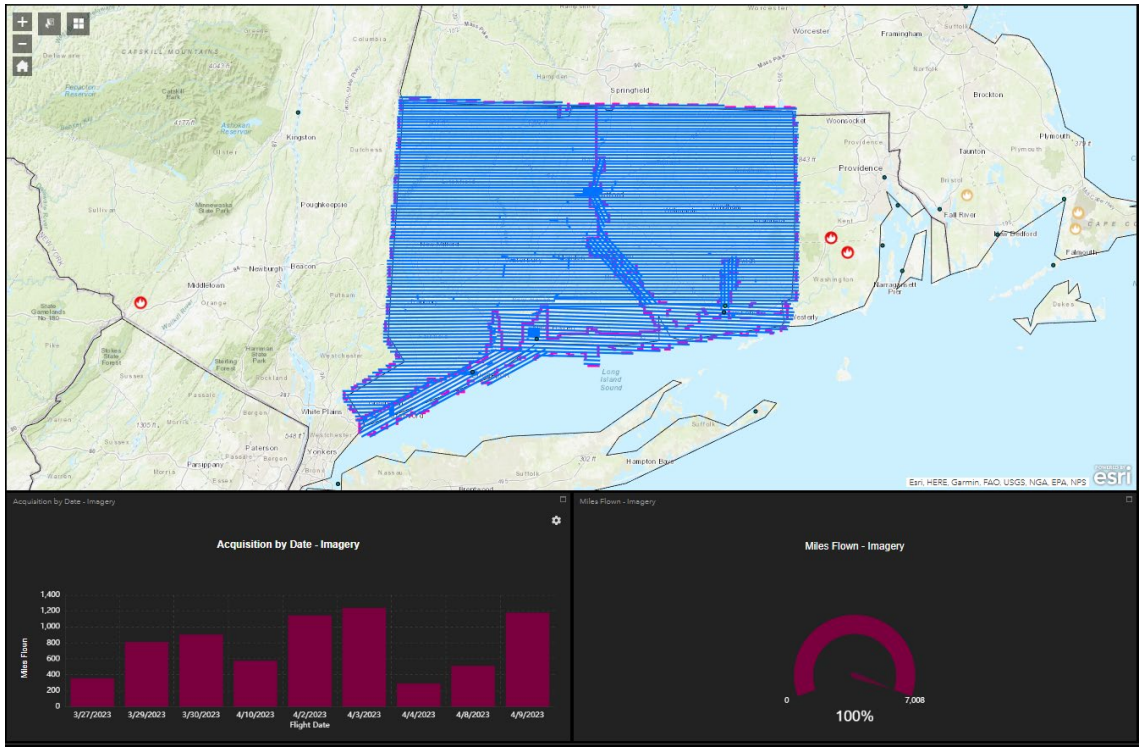
Aerial Imagery Acquisition

- Flight plan creation
- Weather, sun angle, and tidal monitoring
- Aircraft and sensor preflight inspection
- Data acquisition
- Initial QC of data by flight operations team
- Flight log created for each flight
- Data shipped to home office for processing
- Primary sensor: UltraCam Eagle Mark 3
- Two aircrafts were deployed

Acquisition | Aerial triangulation | Initial Ortho Photos | Mosaics | Final Quality Review | Delivery

Aerial Imagery Flight Planning

- UltraCam Eagle Mark 3
  - Flying at ~1900 m AGL
  - 7.5 cm (3”) imagery collection with large format high resolution digital aerial camera
  - 4 Band (Red, Green, Blue, NIR)
  - 60 / 30% overlap over entire project area
    - 145 flight lines
    - 27,116 digital images
- 80% overlap imagery over the true ortho locations
  - 62 flight lines
  - 835 digital images

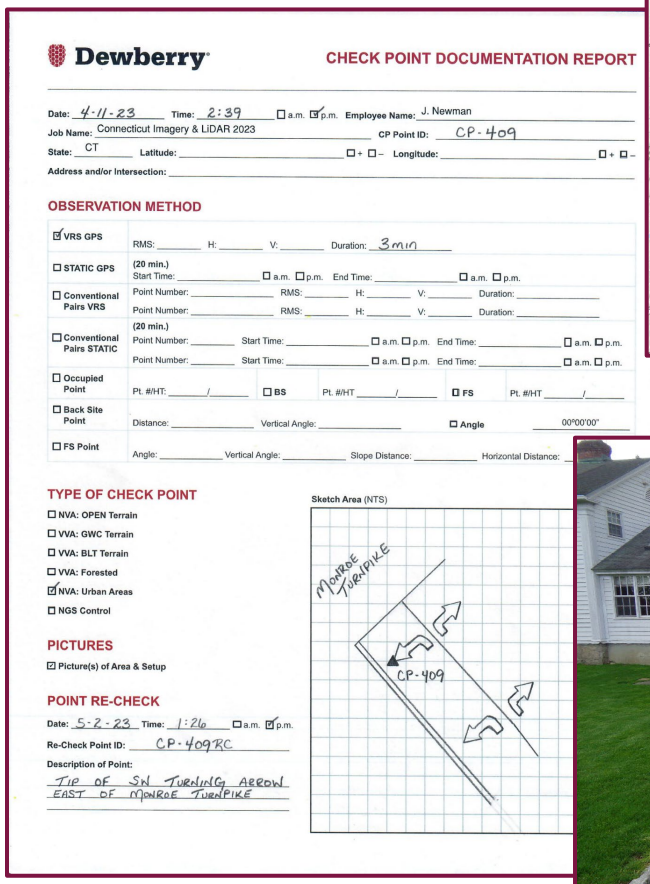


Acquisition | Aerial triangulation | Initial Ortho Photos | Mosaics | Final Quality Review | Delivery

Aerial Triangulation

- 30 ground control points
- Exterior orientation (EO) data
- Raw imagery
- Camera calibration

Point ID	Survey Checkpoint Coordinates Provided by Surveyor		Ortho Imagery Coordinates Measured by Dewberry		Ortho Imagery minus Surveyed Coordinates		Discrepancies Squared as Required for RMSE Calculations	
	NAD83(2011) CT SP Feet						Δx^2 (ft²)	Δy^2 (ft²)
	Easting X (ft)	Northing Y (ft)	Easting X (ft)	Northing Y (ft)	Δx (Easting)	Δy (Northing)		
CP-418	1241674.80	701527.81	1241674.45	701527.97	-0.34	0.16	0.12	0.03
CP-420	1093441.06	686386.14	1093441.37	686385.92	0.31	-0.22	0.10	0.05
CP-422	1148045.51	696741.07	1148045.90	696741.38	0.39	0.31	0.15	0.09
CP-424	1213850.87	768196.35	1213850.90	768196.47	0.03	0.12	0.00	0.01
CP-426	1075637.42	706349.24	1075637.77	706349.01	0.35	-0.23	0.12	0.05
CP-427	1182334.55	757089.99	1182334.80	757089.97	0.26	-0.01	0.07	0.00
CP-428	1192588.56	729166.52	1192588.30	729166.35	-0.26	-0.17	0.07	0.03
CP-429	1196561.90	743468.81	1196561.52	743468.94	-0.39	0.13	0.15	0.02
CP-430	1224312.85	756943.23	1224312.92	756943.34	0.07	0.11	0.00	0.01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CHECK POINT DOCUMENTATION REPORT

Date: 4-11-23 Time: 2:39 ☐ a.m. ☑ p.m. Employee Name: J. Newman

Job Name: Connecticut Imagery & LiDAR 2023 CP Point ID: CP-409

State: CT Latitude: ☐ + ☐ − Longitude: ☐ + ☐ −

Address and/or Intersection:

OBSERVATION METHOD

☑ VRS GPS — RMS: H: V: Duration: 3min

☐ STATIC GPS — (20 min.) Start Time: ☐ a.m. ☐ p.m. End Time: ☐ a.m. ☐ p.m.

☐ Conventional Pairs VRS — Point Number: RMS: H: V: Duration:

☐ Conventional Pairs STATIC — (20 min.) Point Number: Start Time: ☐ a.m. ☐ p.m. End Time: ☐ a.m. ☐ p.m.

☐ Occupied Point — Pt. #/HT: / ☐ BS Pt. #/HT / ☐ FS Pt. #/HT /

☐ Back Site Point — Distance: Vertical Angle: ☐ Angle 00°00'00"

☐ FS Point — Angle: Vertical Angle: Slope Distance: Horizontal Distance:

TYPE OF CHECK POINT

☐ NVA: OPEN Terrain
☐ VVA: GWC Terrain
☐ VVA: BLT Terrain
☐ VVA: Forested
☑ NVA: Urban Areas
☐ NGS Control

Sketch Area (NTS)

PICTURES

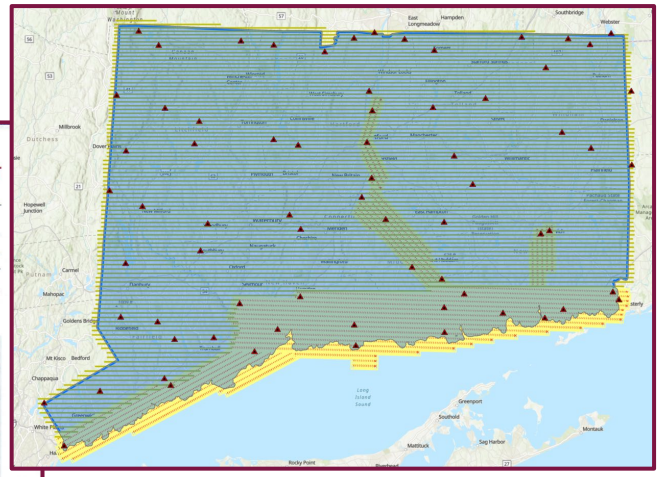
☑ Picture(s) of Area & Setup

POINT RE-CHECK

Date: 5-2-23 Time: 1:26 ☐ a.m. ☑ p.m.

Re-Check Point ID: CP-409RC

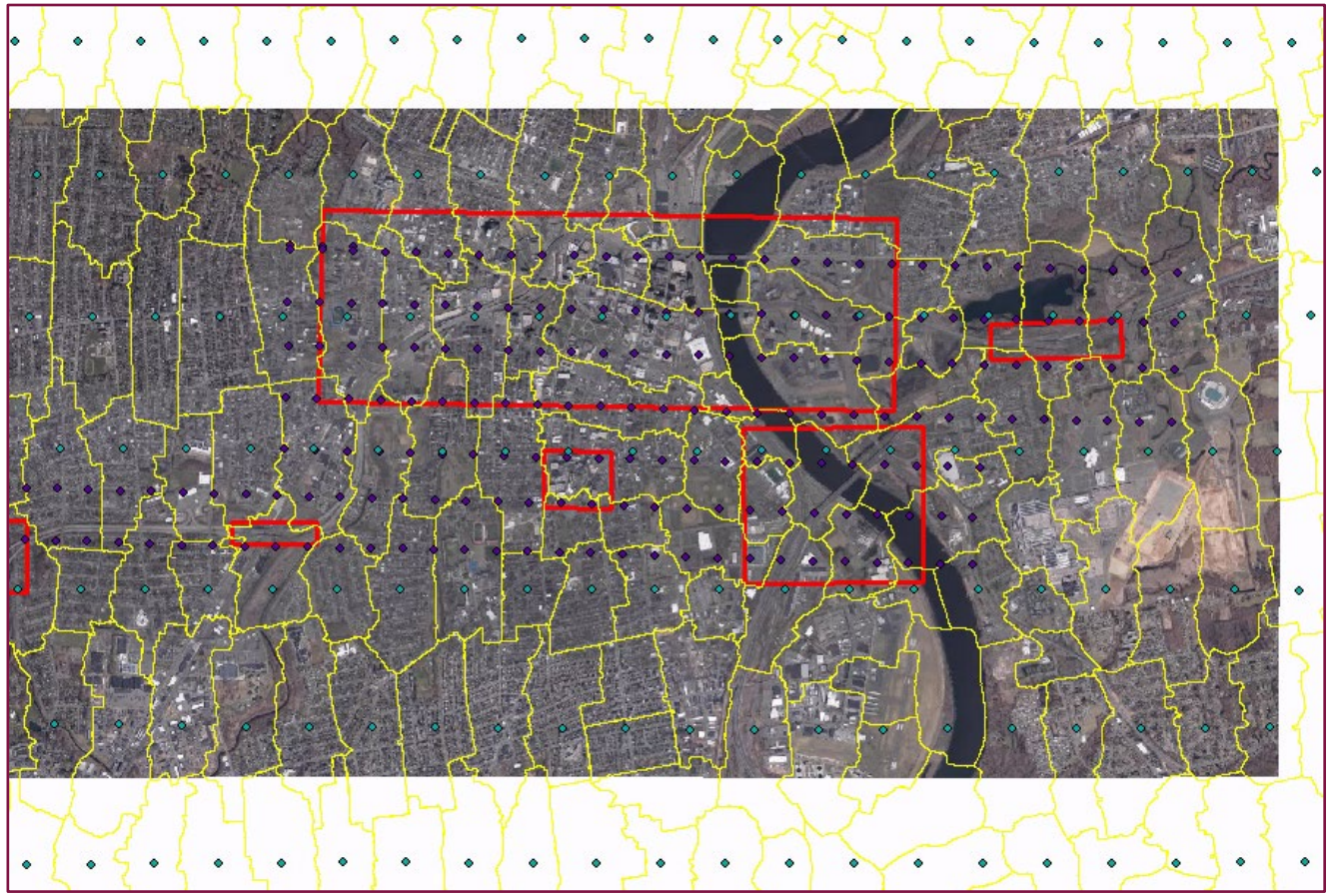
Description of Point: TIP OF SN TURNING ARROW EAST OF MONROE TURNPIKE



Acquisition | Aerial triangulation | Initial Ortho Photos | Mosaics | Final Quality Review | Delivery

Initial Ortho Photos

- Raw imagery + AT + DEM = Ortho frames
- Individual orthorectified frames are generated
- Smart seamlines are generated



Acquisition | Aerial triangulation | Initial Ortho Photos | Mosaics | Final Quality Review | Delivery

Mosaics

- Using the seamlines, multiple frames are mosaicked into a single tile
- Uniform tonal adjustments

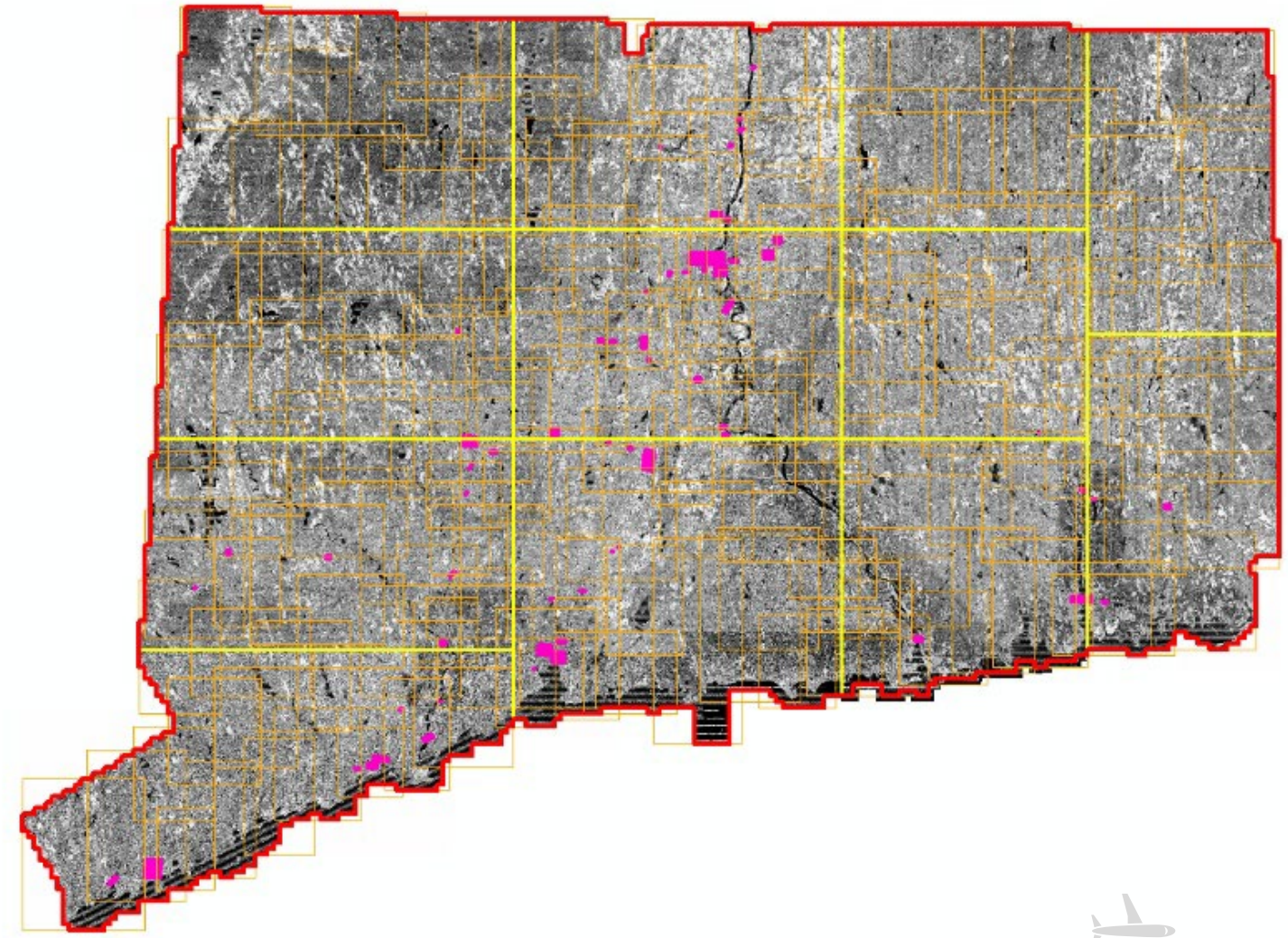
Acquisition | Aerial triangulation | Initial Ortho Photos | Mosaics | Final Quality Review | Delivery

Final Quality Review

- Validate final ortho mosaic for final revision
- Horizontal accuracy assessment
- The quality management team perform 100% review of the data
- Validation of pixel resolution on final deliverable

Acquisition | Aerial triangulation | Initial Ortho Photos | Mosaics | **Final Quality Review** | Delivery

Delivery



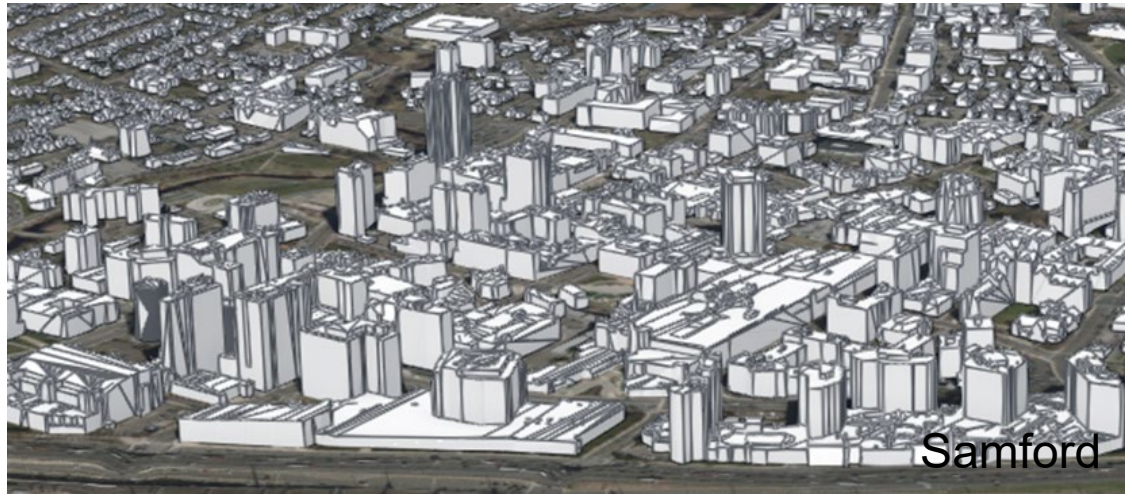
Acquisition | Aerial triangulation | Initial Ortho Photos | Mosaics | Final Quality Review | Delivery

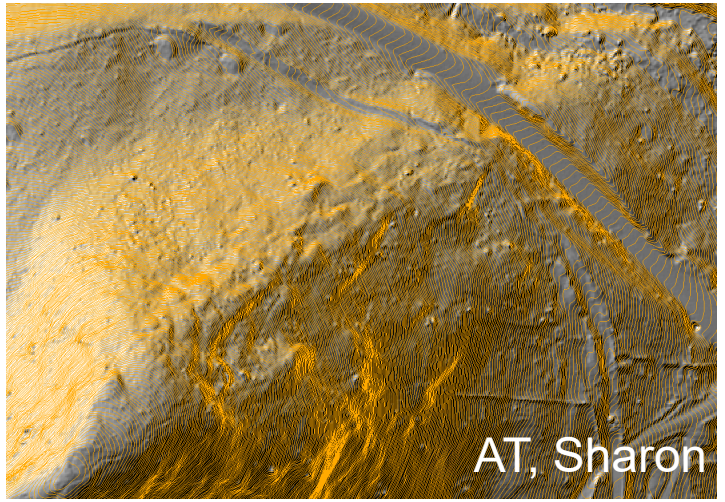
Deliverable Products

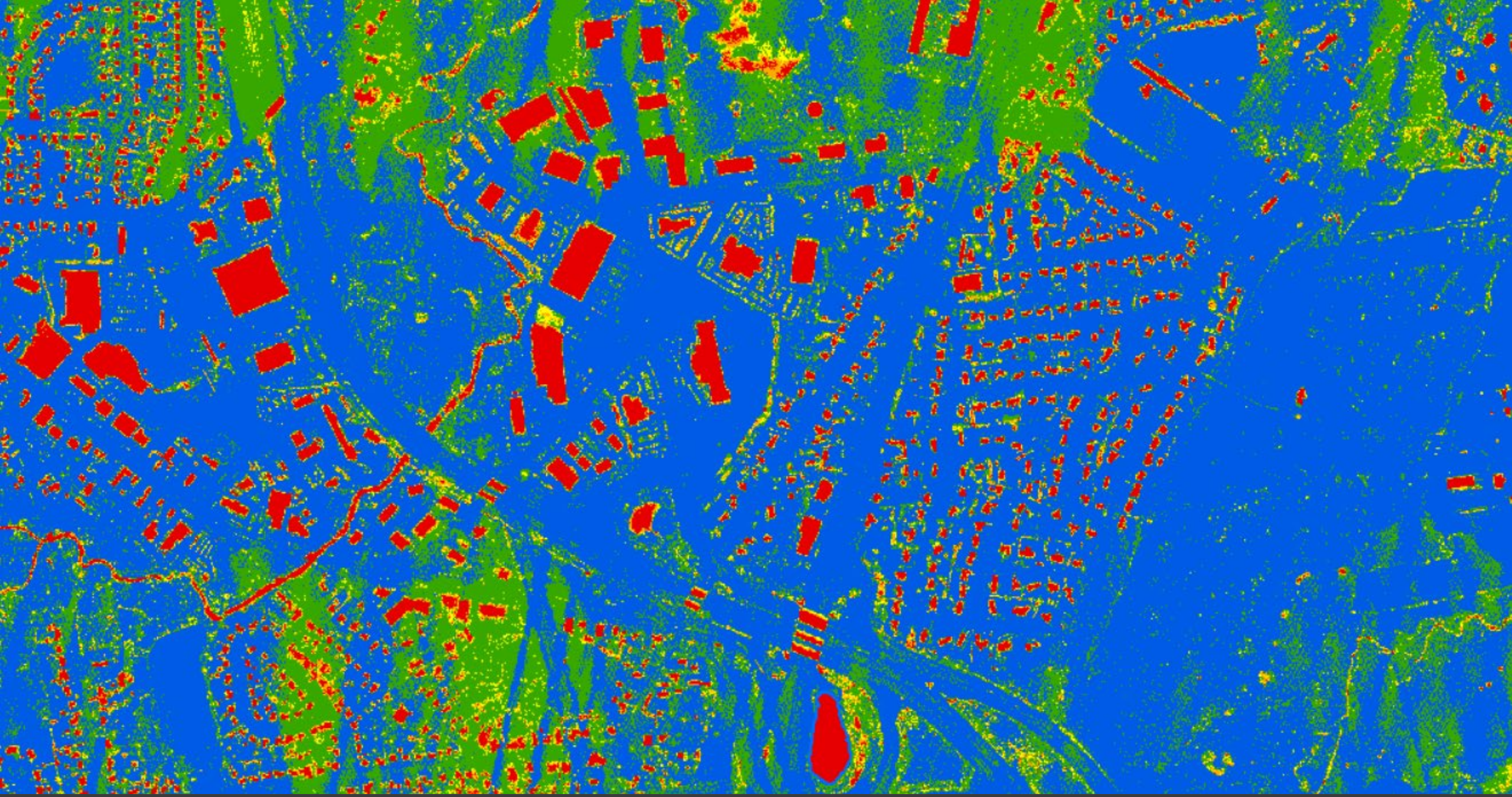
- Pilot Project
- ★ Aerial 4-Band Digital Orthoimagery
- True Ortho
- ★ Elevation Data Captured Using Lidar
- Bare Earth Digital Elevation Model
- Lidar-Derived 1-Foot Contours
- Lidar-Derived Building Footprints
- 3D Buildings
- Lidar Flight Index, Control, and Metadata

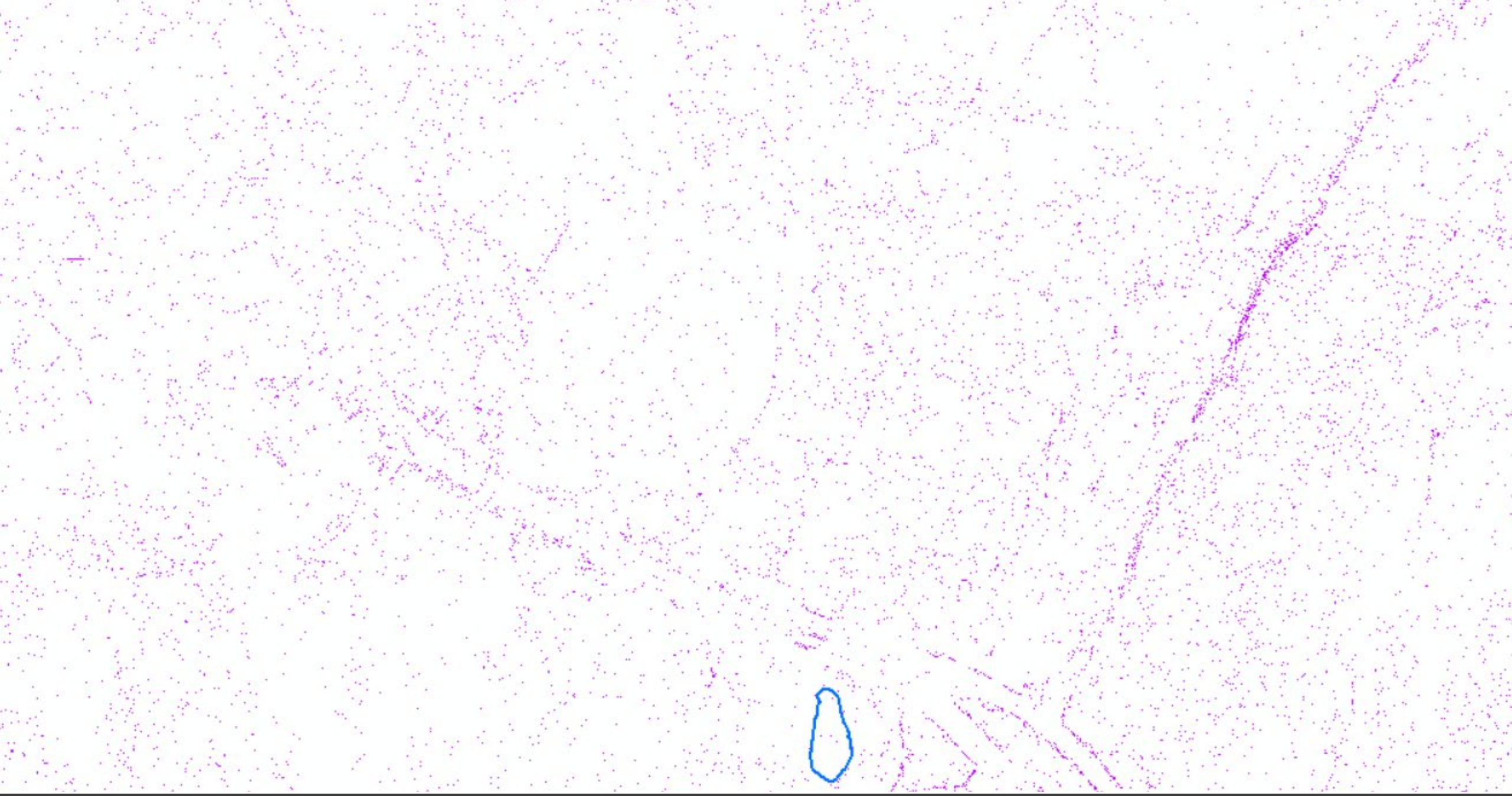
Shelton, Home of the Wiffle Ball

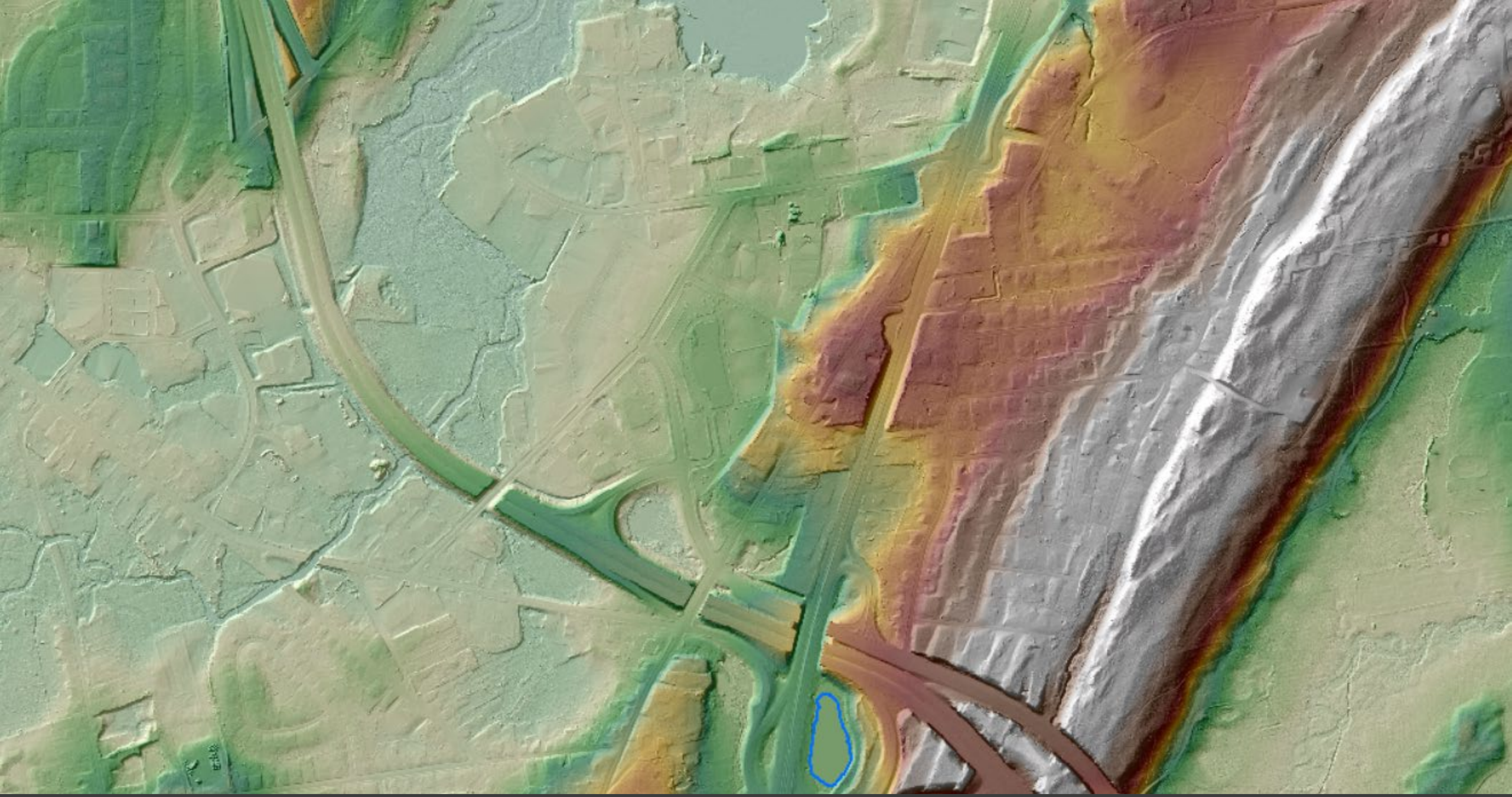

Manchester

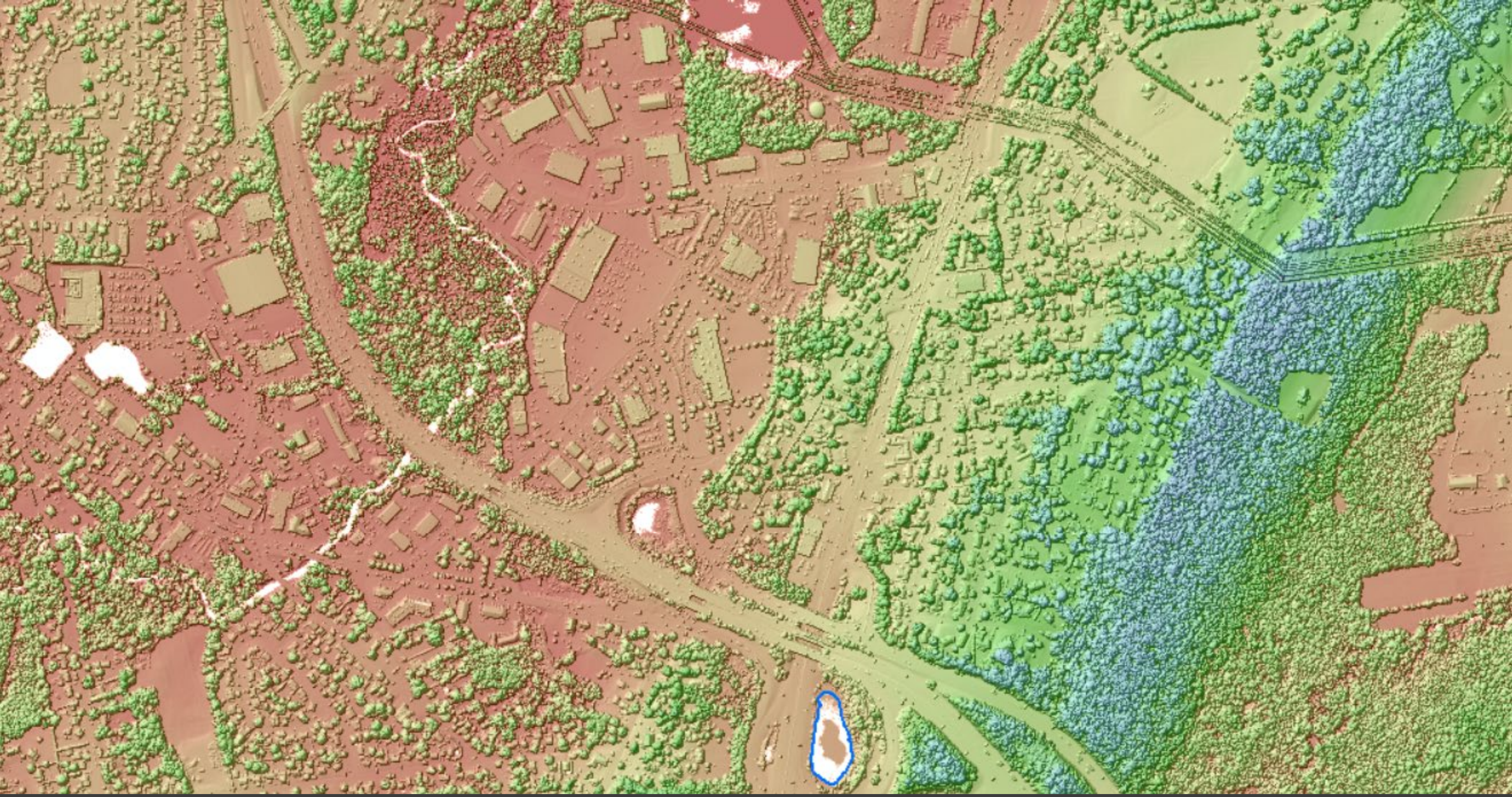

Samford

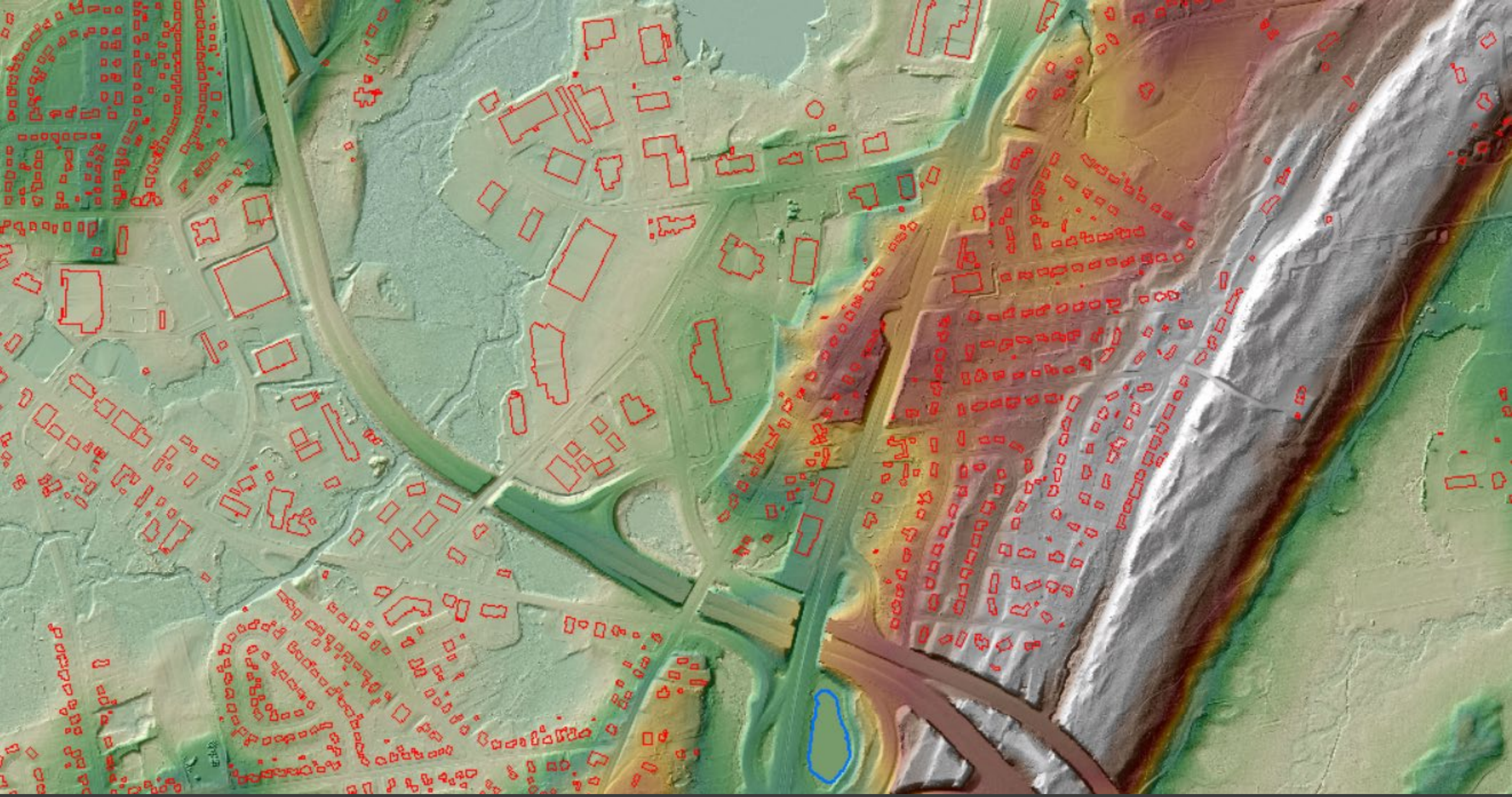

AT, Sharon

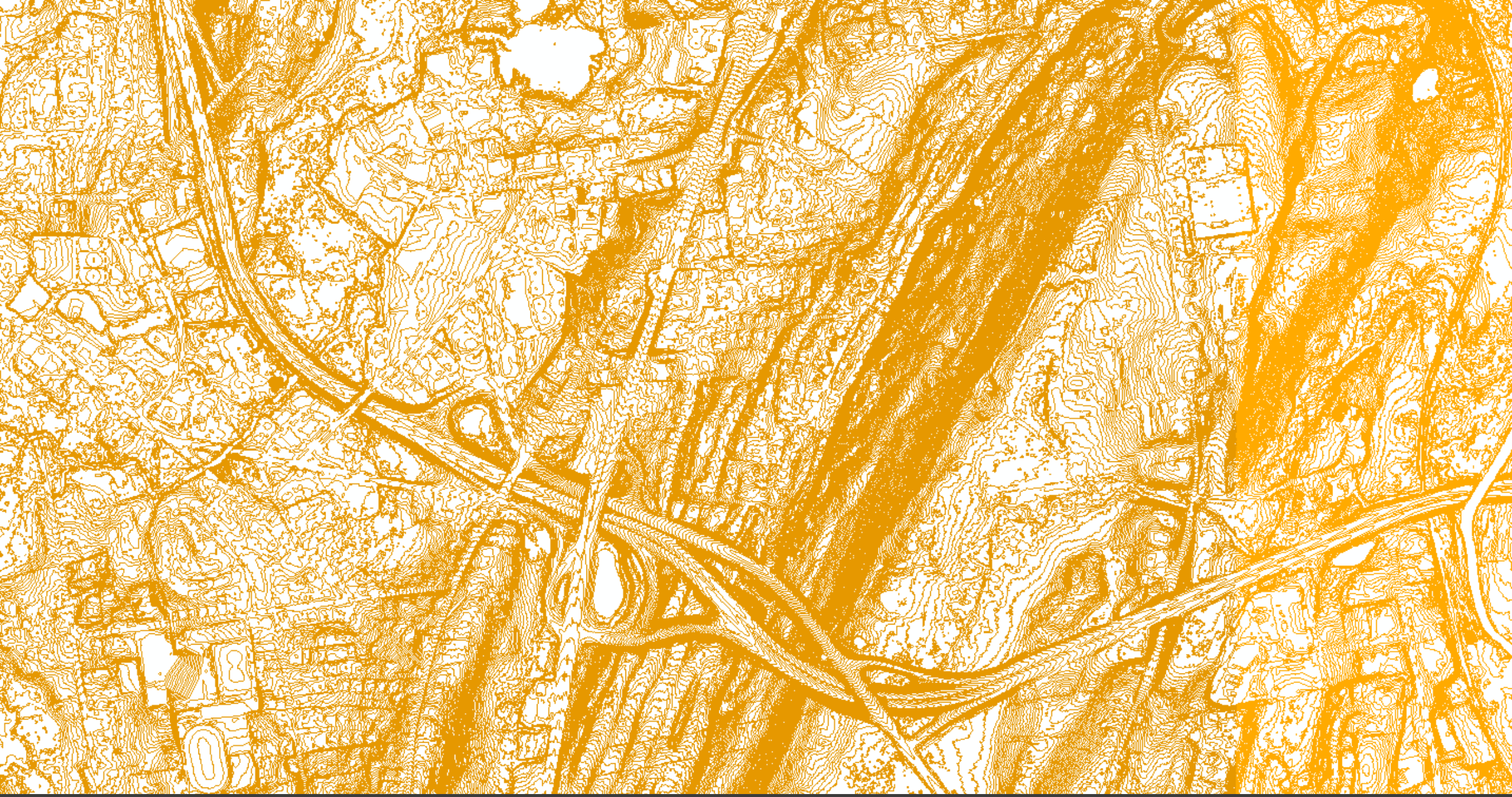




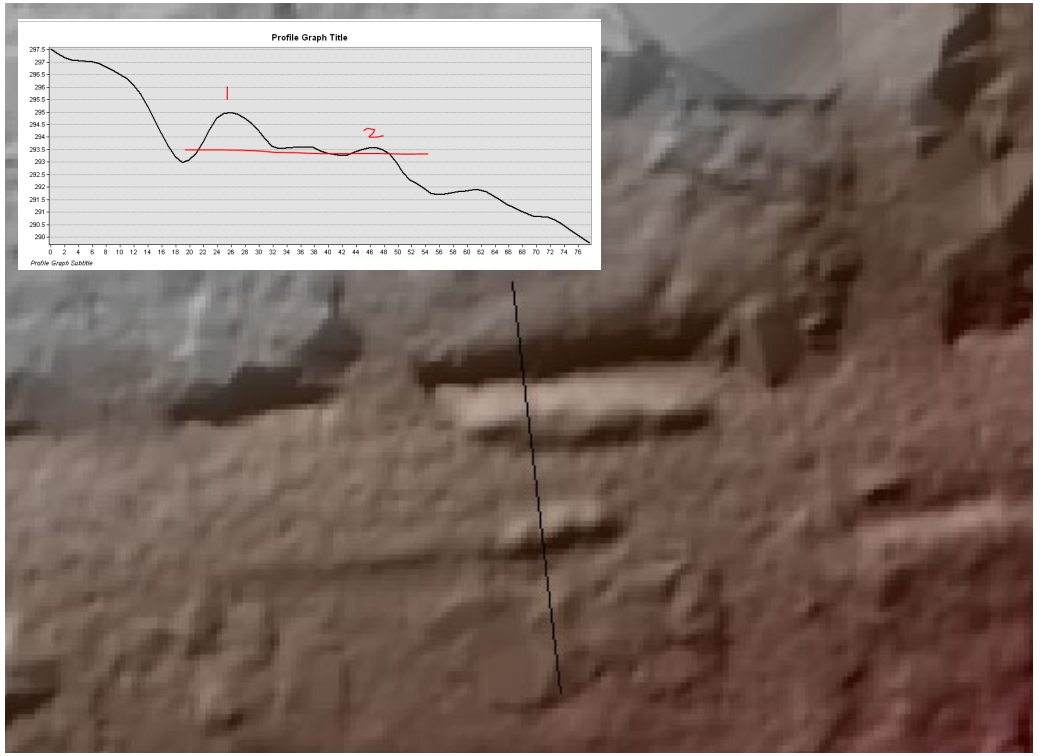


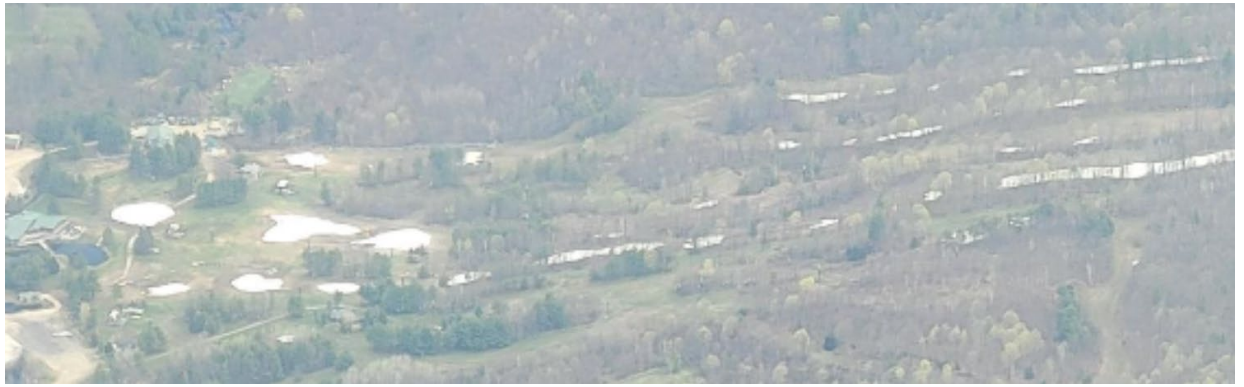




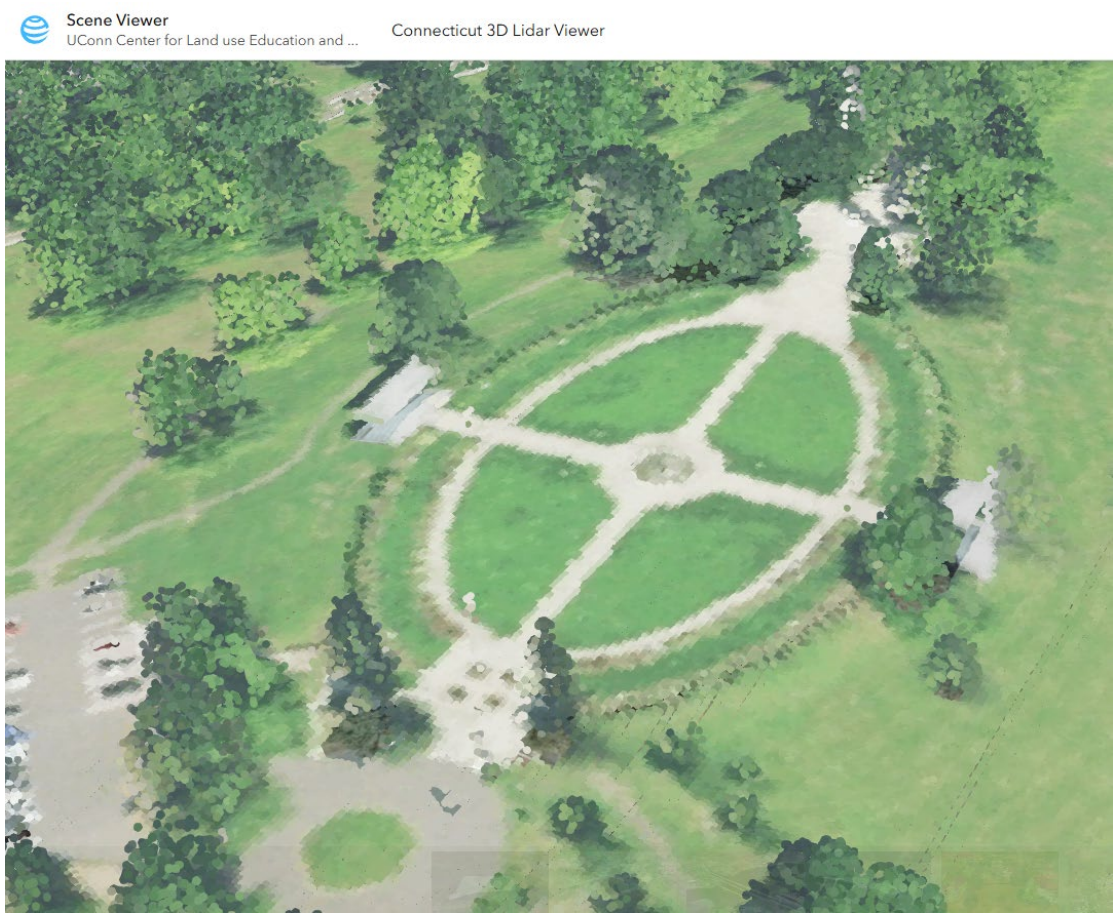


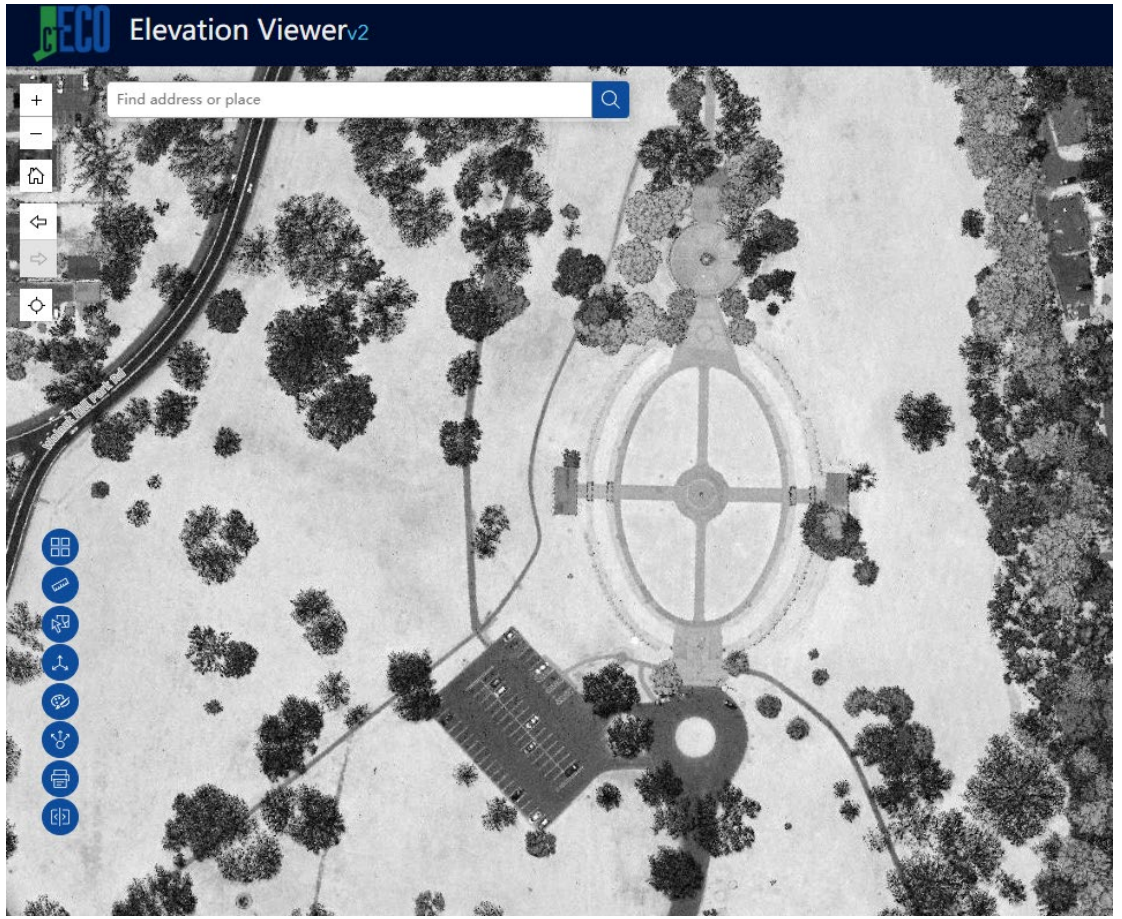
Call to Action – Weather Information





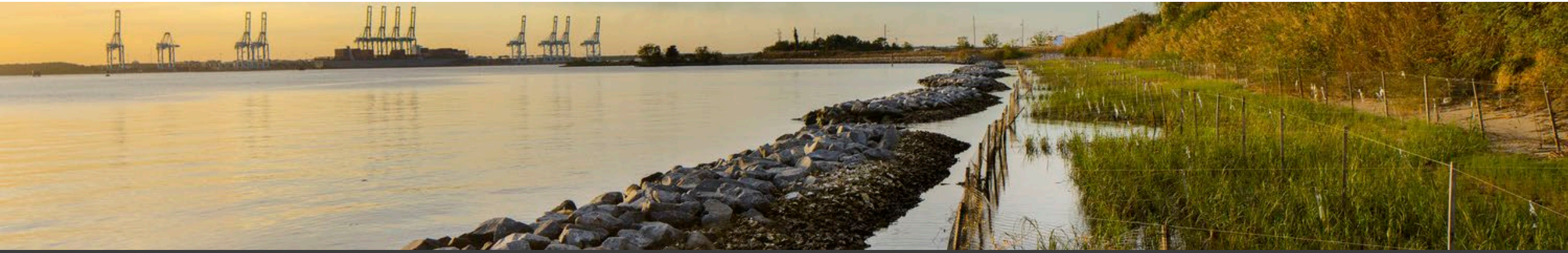
CT ECO UConn CLEAR Hosting





Data Possibilities

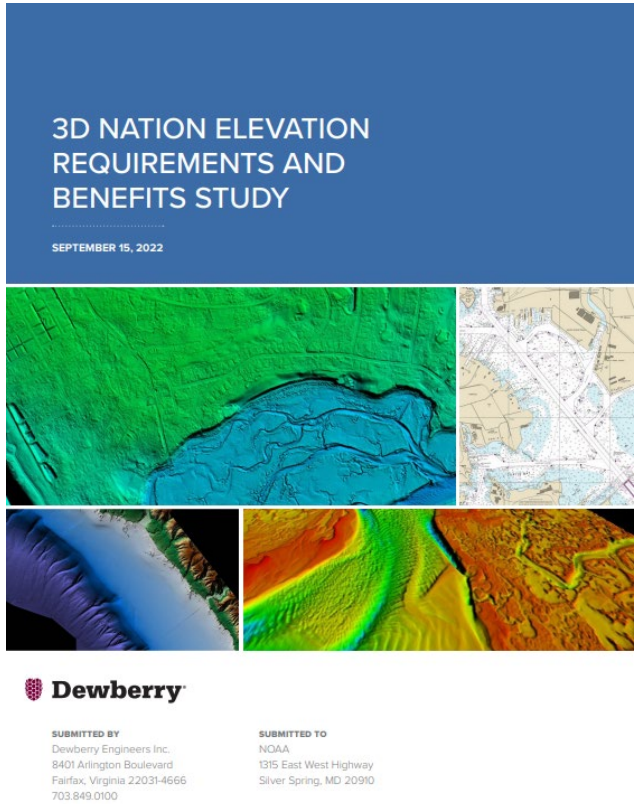
- Impervious Surface
- Topobathymetric Lidar
- Elevation-derived Hydrography (EDH)
- 3D Terrain Model
- Change Detection
- Additional Lidar Classification
- Enterprise GIS & Analytics



Lidar User Applications

$ Every dollar spent on lidar has a minimum of $5 in benefits

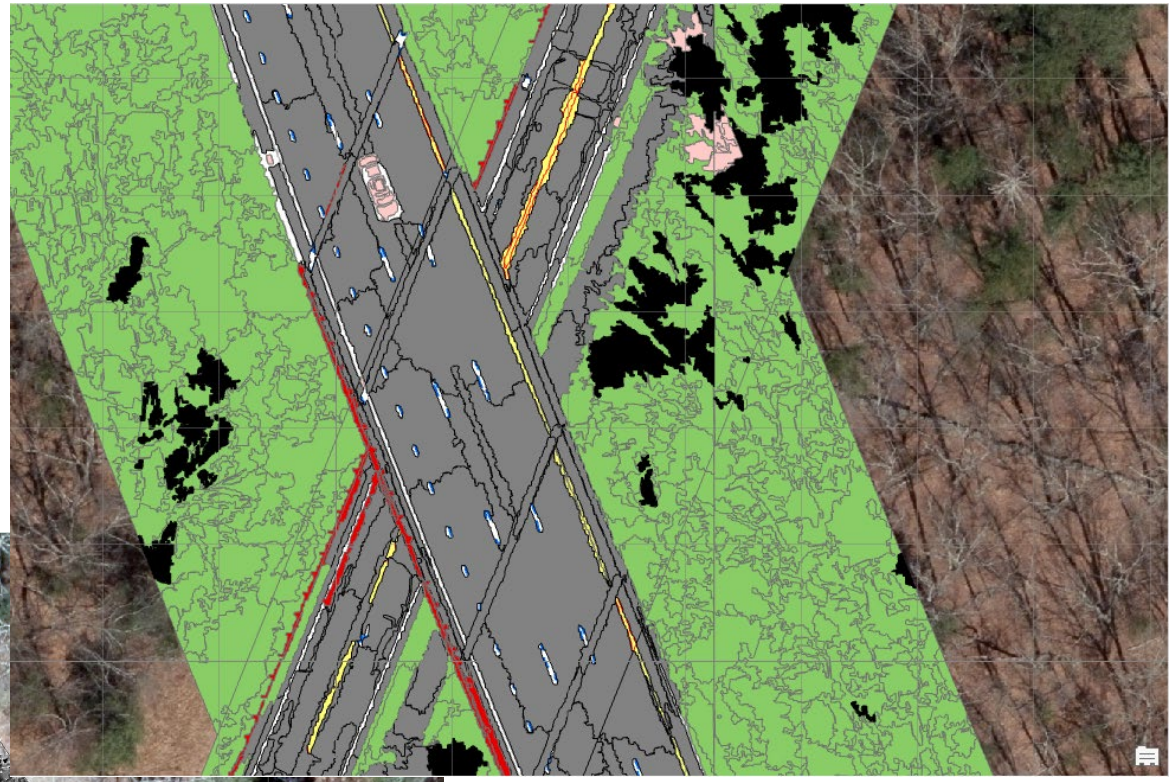
- Geologic Mapping
- Seismic Fault Detection
- Other Risk Analyses (Volcanoes and Landslides)
- Soils Mapping and Engineering
- Hydrologic & Hydraulic Modeling
- Flood Risk Management
- Sea Level Rise Mitigation
- Sewer & Storm Water Planning
- Post-Disaster Debris Estimation
- Electric Reliability
- Infrastructure Management
- 3D City Models
- Line-of-Sight Analysis
- Building Footprints
- Renewable Energy Potential
- Urban Planning
- Forest Management
- Change Detection
- Aviation Safety
- Route Planning
- Precision Farming

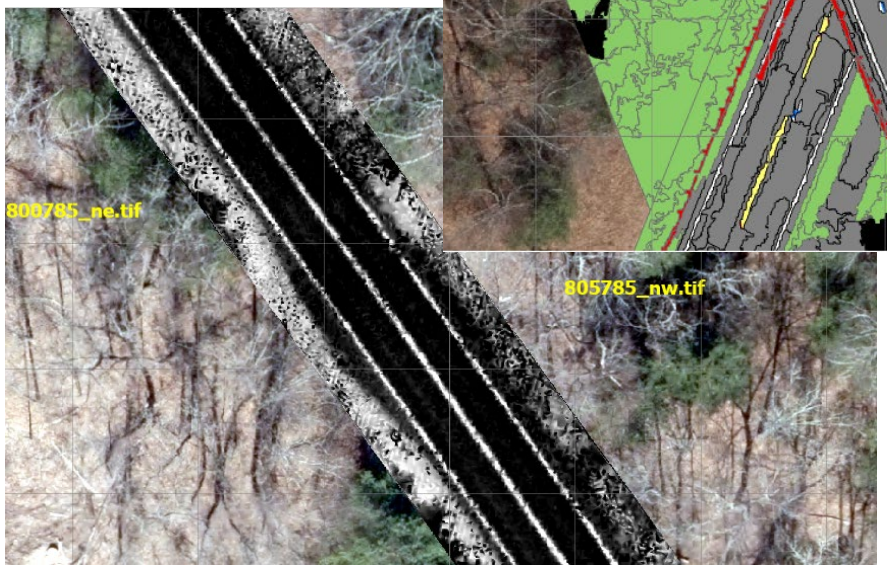


3D Nation Elevation Requirements and Benefits Study

Deriving Paint Stripes from Lidar

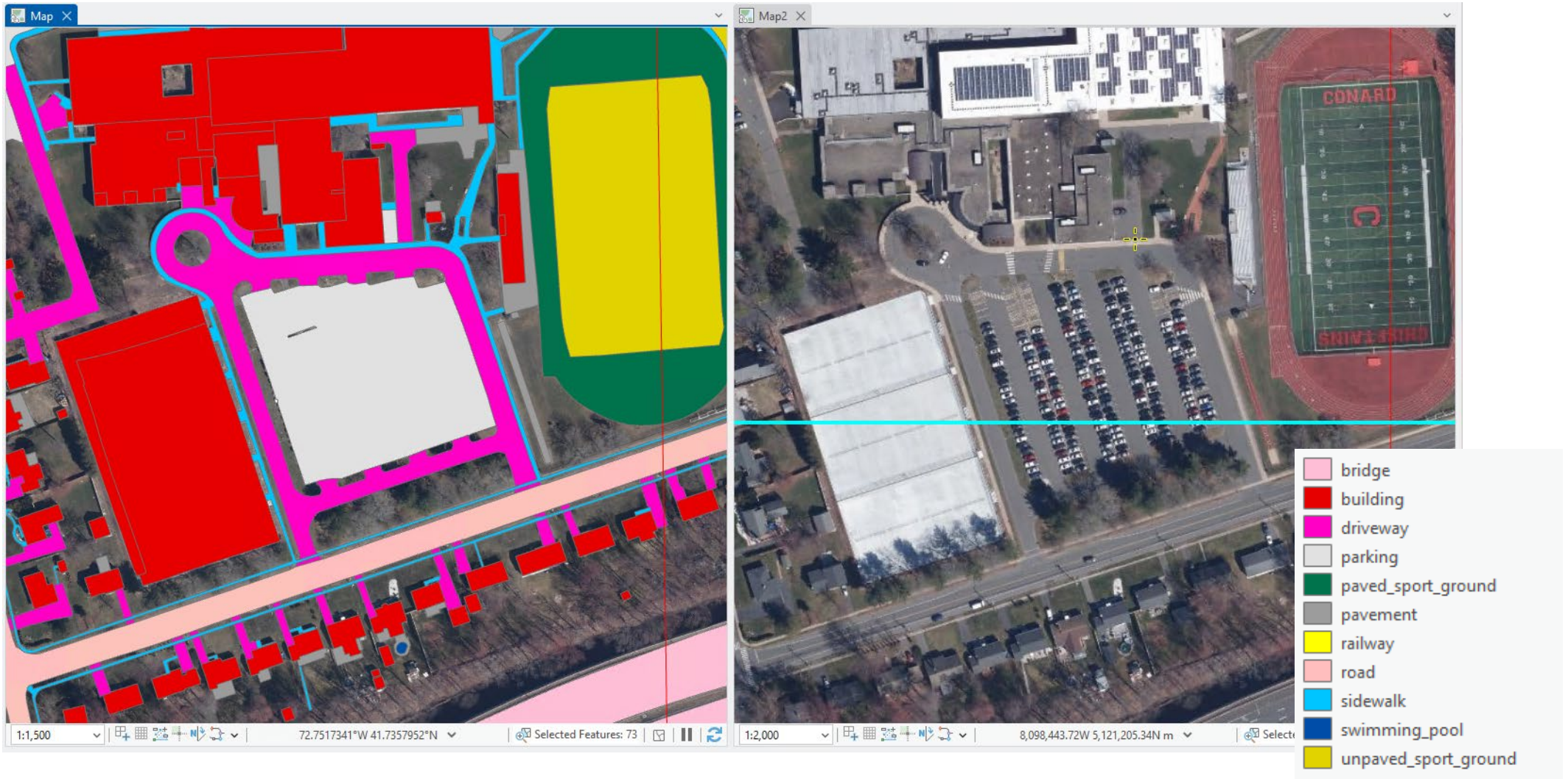
- Refining the Lidar Intensity output
- Comparing with Imagery
- Delineating Paint Stripes





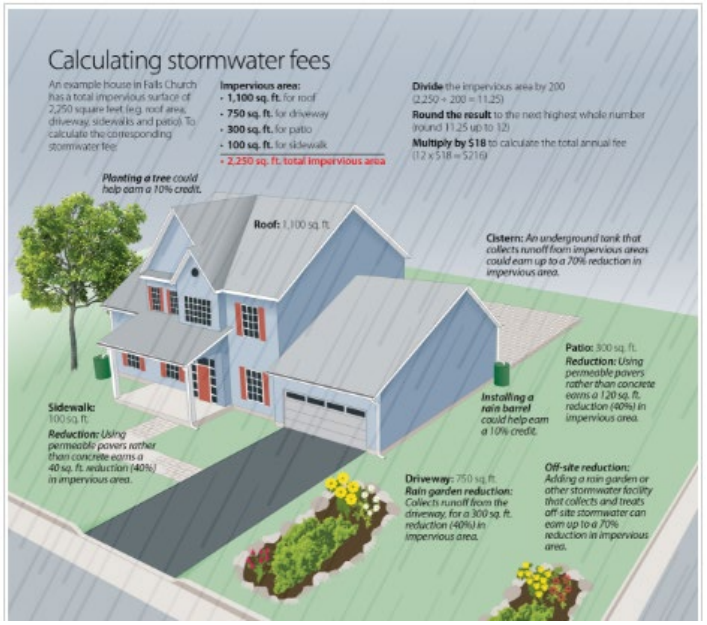
Moataz Kilany
Remote Sensing and
Feature Classification using LiDAR
1:20 PM

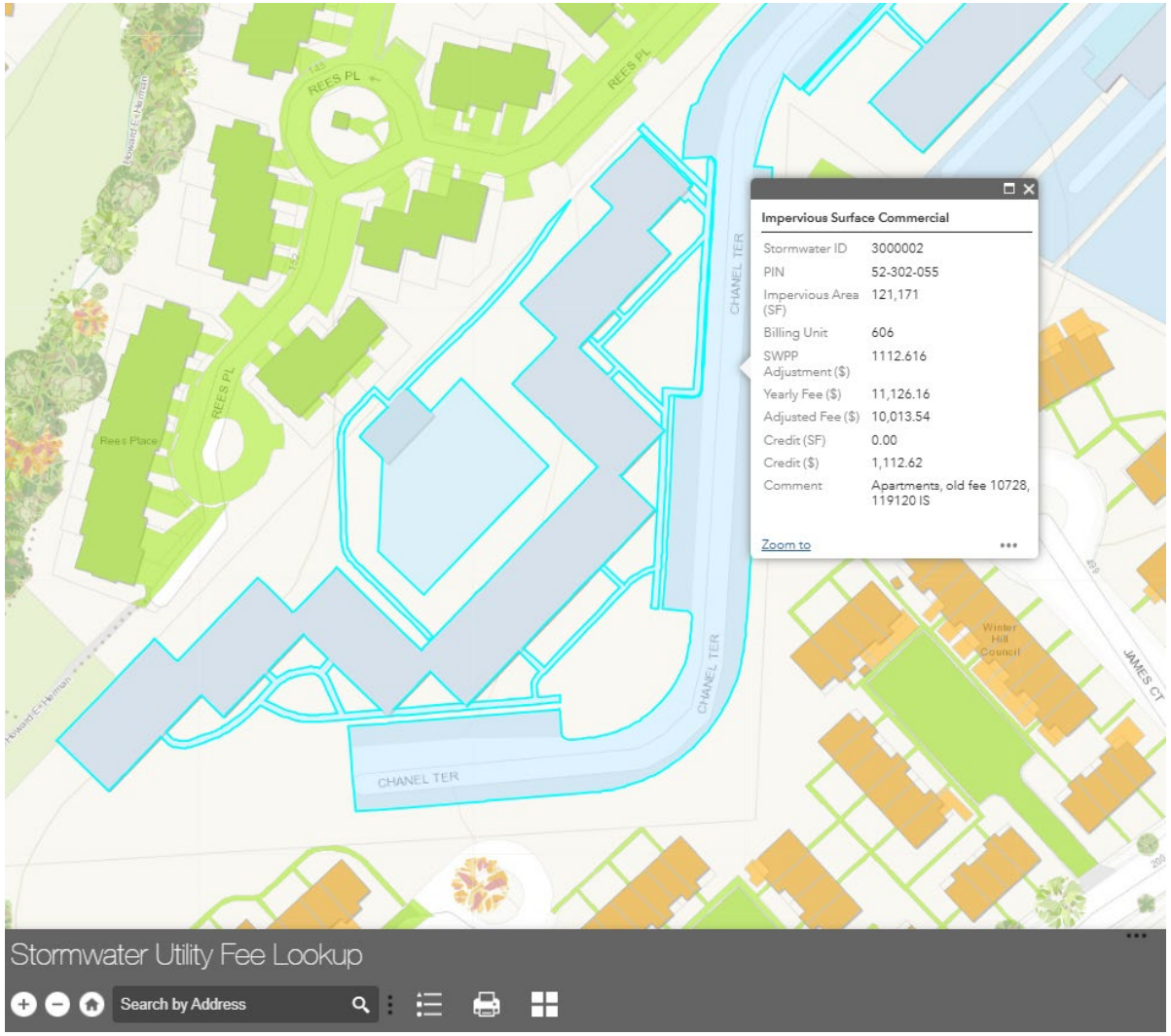
Impervious Surface



Impervious Surface: Stormwater Utility Fund

- Jurisdictions may adopt a new fee based on impervious coverage
- A two square mile locality in Northern Virginia collected $1.5 million dollars annually

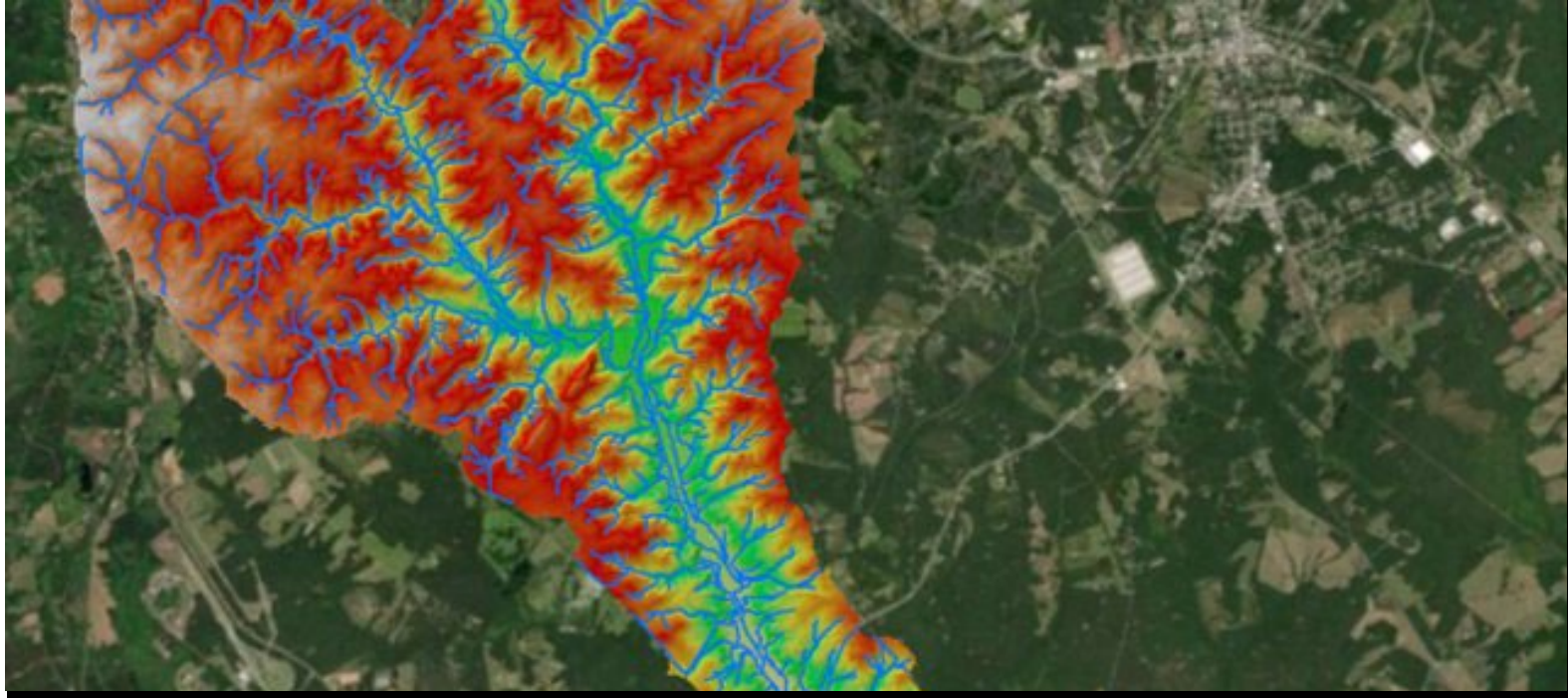


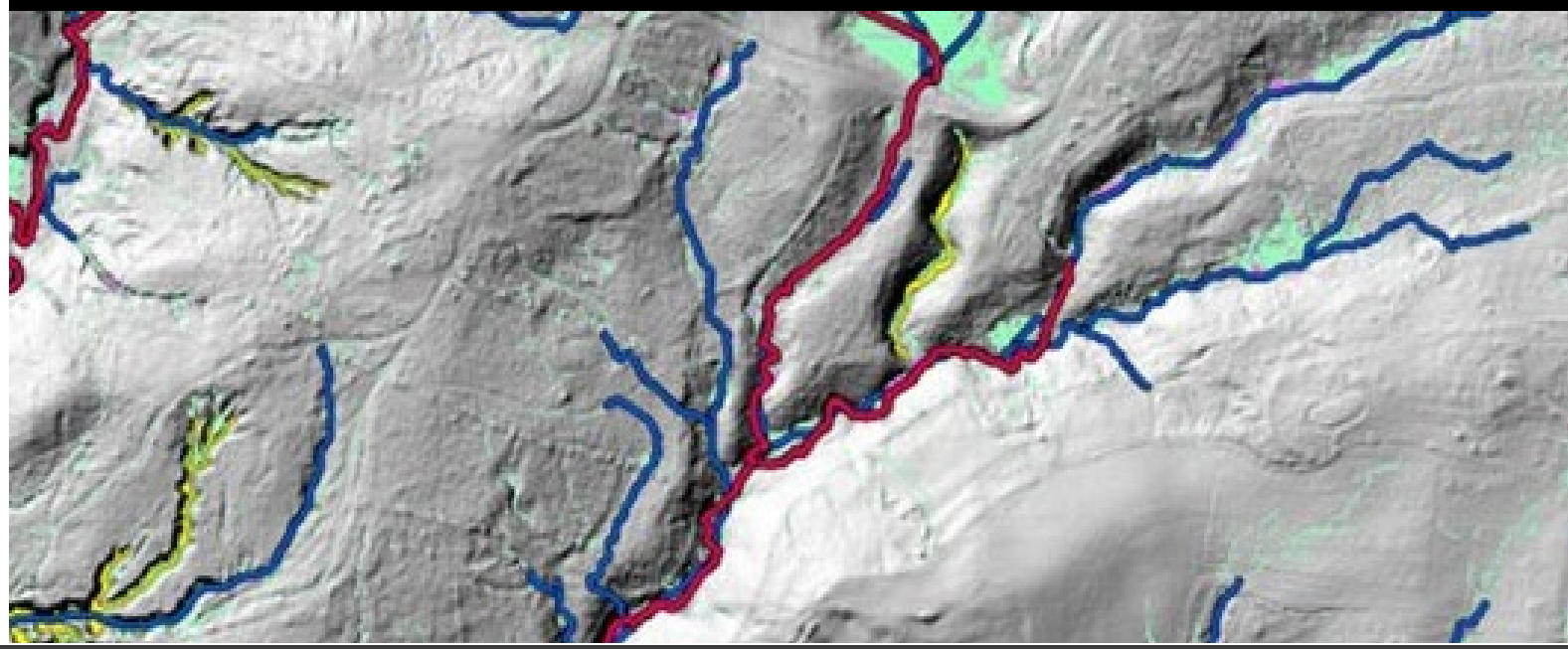


Dewberry

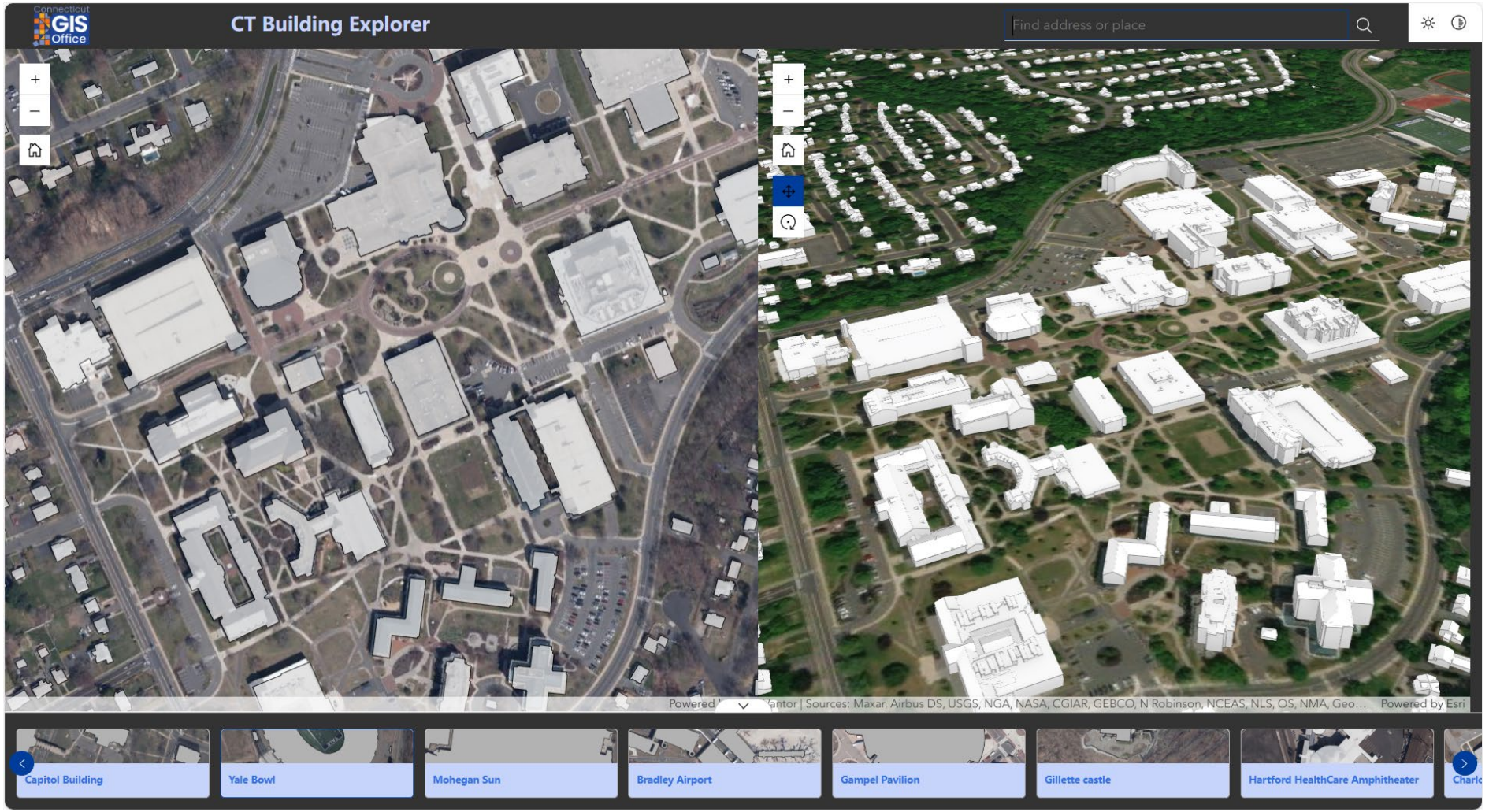
Elevation-derived Hydrography

- Collected multiple areas to meet USGS 3DHP Standards
- Focus on local needs for culvert detection
- Account for local needs related to existing NHD products



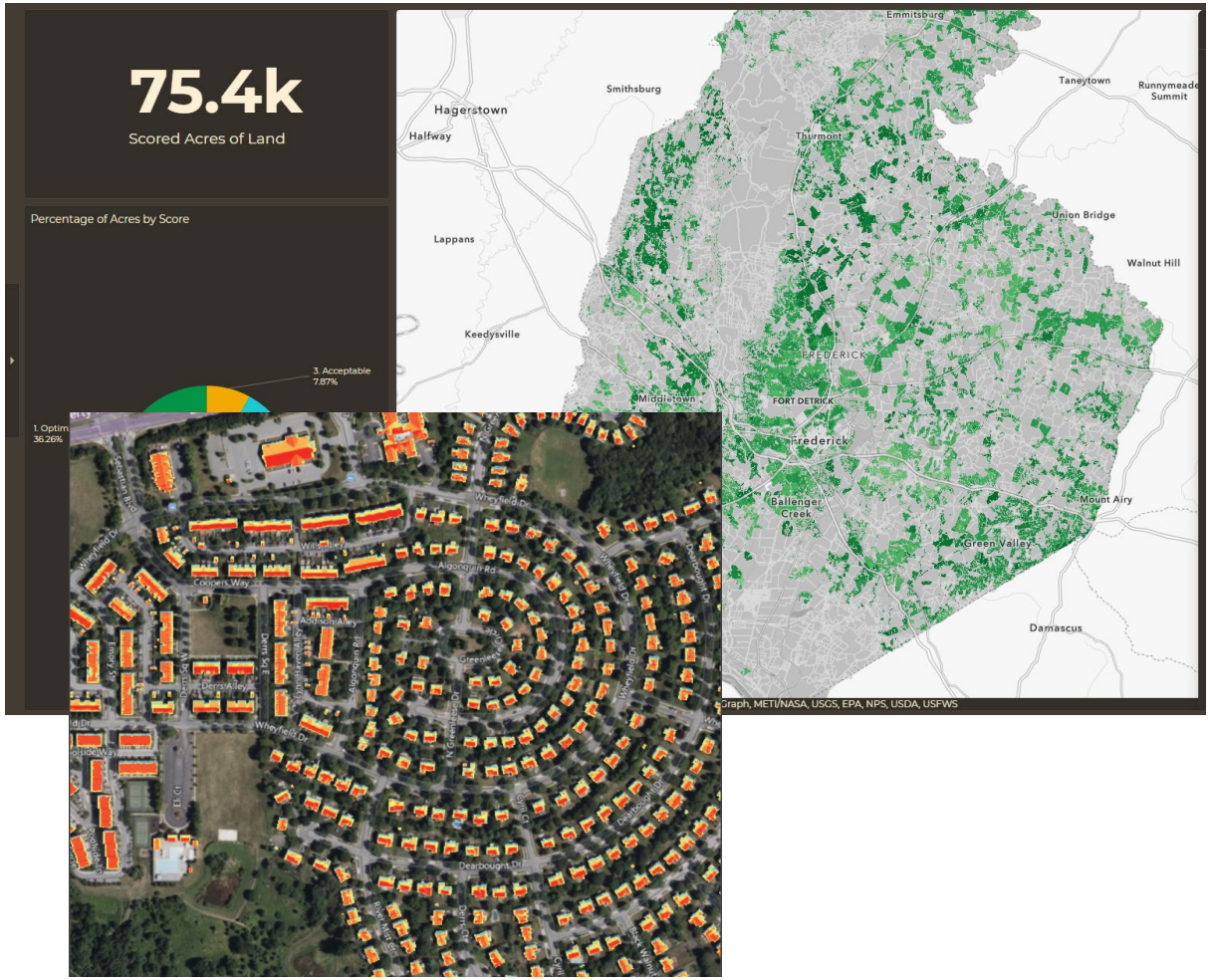


3D Terrain Modeling



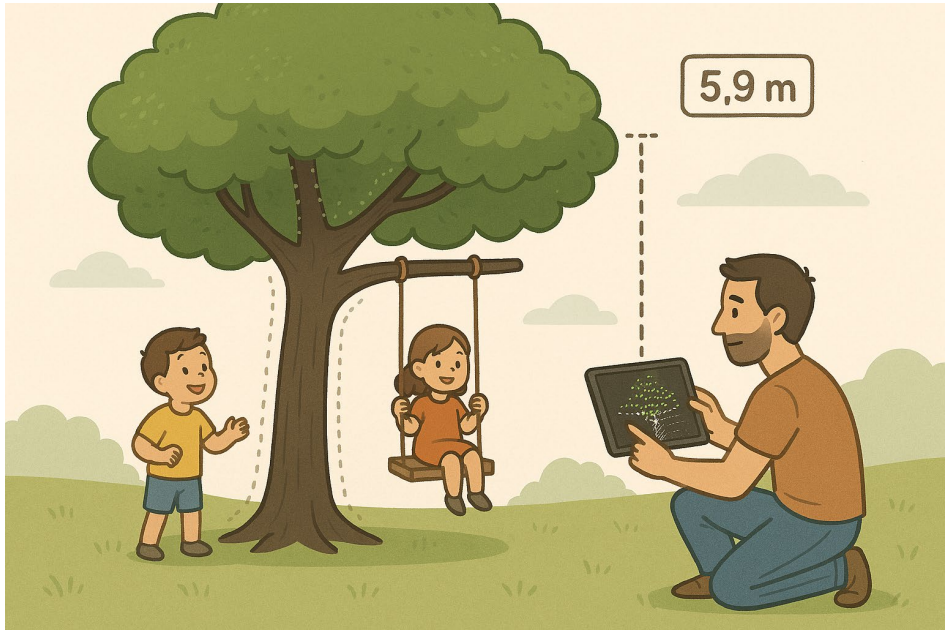
https://experience.arcgis.com/experience/67ef07f96af749daaa8ebd0db5386312

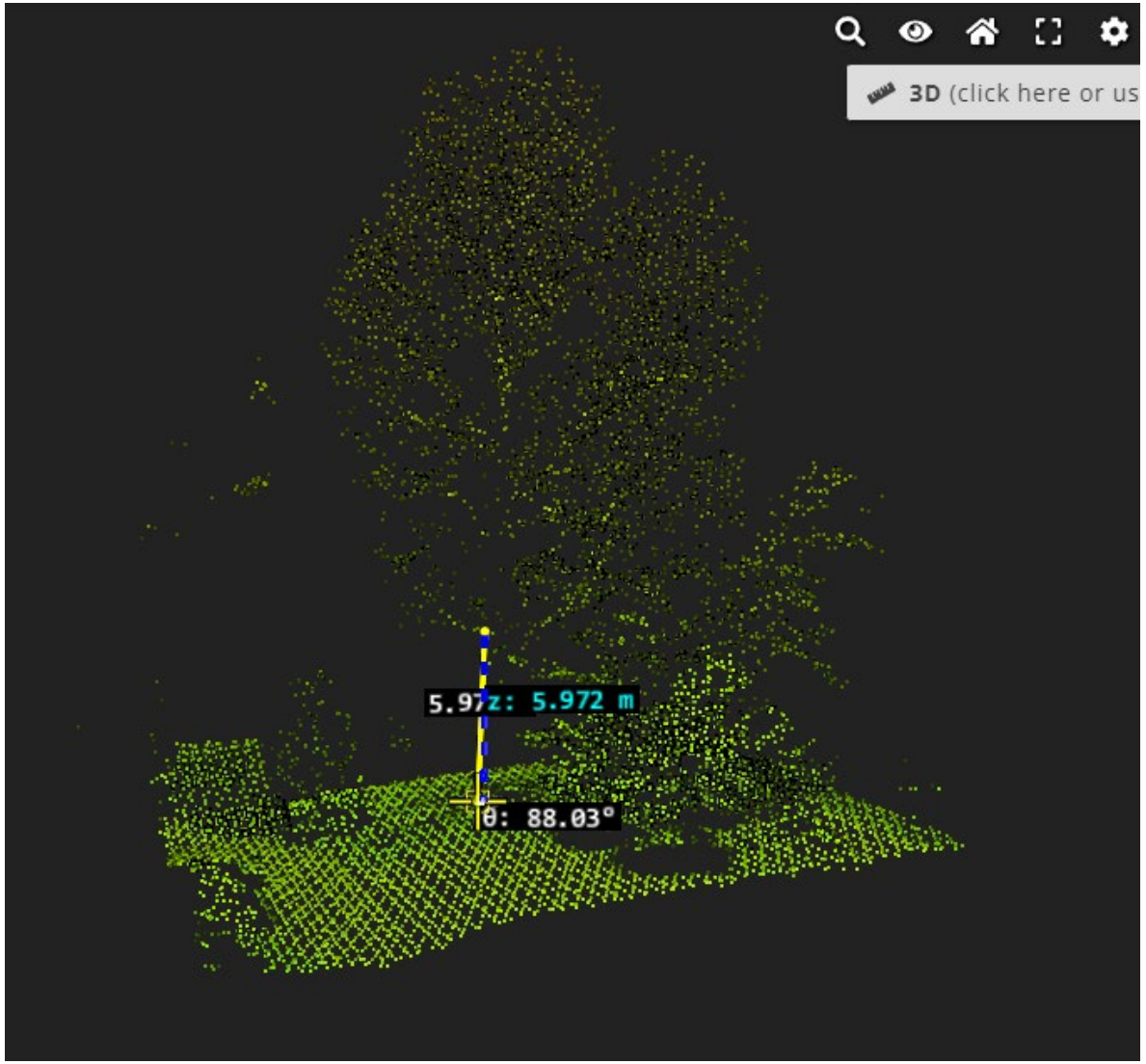
Renewable Energy, Solar Potential



- Frederick County Division of Energy and Environment
- Identify solar sites to meet county's goals for solar generation
- Filters out parcels where solar panels are not permitted or are physically unviable
- Score remaining parcels based on desirable/undesirable attributes associated with the parcel, like % forest, Slope, Distance to nearest high voltage power line, etc.

Solving Everyday Problems






Open Discussion