Airborne Topographic Lidar Report

Wisconsin WROC - 3DEP
Jefferson County Lidar 2019

Prime Contractor: Ayres

Airborne Lidar Acquisition: Quantum Spatial

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1. Summary / Scope

1.1 Summary

This report contains a summary of the WROC 2019 Jefferson County lidar acquisition task order, issued by Jefferson County, Wisconsin. The intent of this document is only to provide specific validation information for the data acquisition/collection, processing, and production of deliverables completed as specified in the task order.

1.2 Scope

Aerial topographic lidar was acquired using state-of-the-art technology, along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

Table 1. Originally Planned Lidar Specifications

AVERAGE POINT DENSITY	FLIGHT ALTITUDE (AGL)	FIELD OF VIEW	MINIMUM SIDE OVERLAP	RMSEz
2 pts / m^2	2195 m	58.5°	20%	≤10 cm

1.3 Coverage

The project boundary covers 589 square miles over Wisconsin. A buffer of 100 meters was created to meet task order specifications. Project extents are shown in Figure 1.

1.4 Duration

Lidar data was acquired from April 20, 2019, to April 21, 2019, in 2 total lifts. See "Section: 2.4. Time Period" for more details.

1.5 Issues

There were no major issues to report for this project.

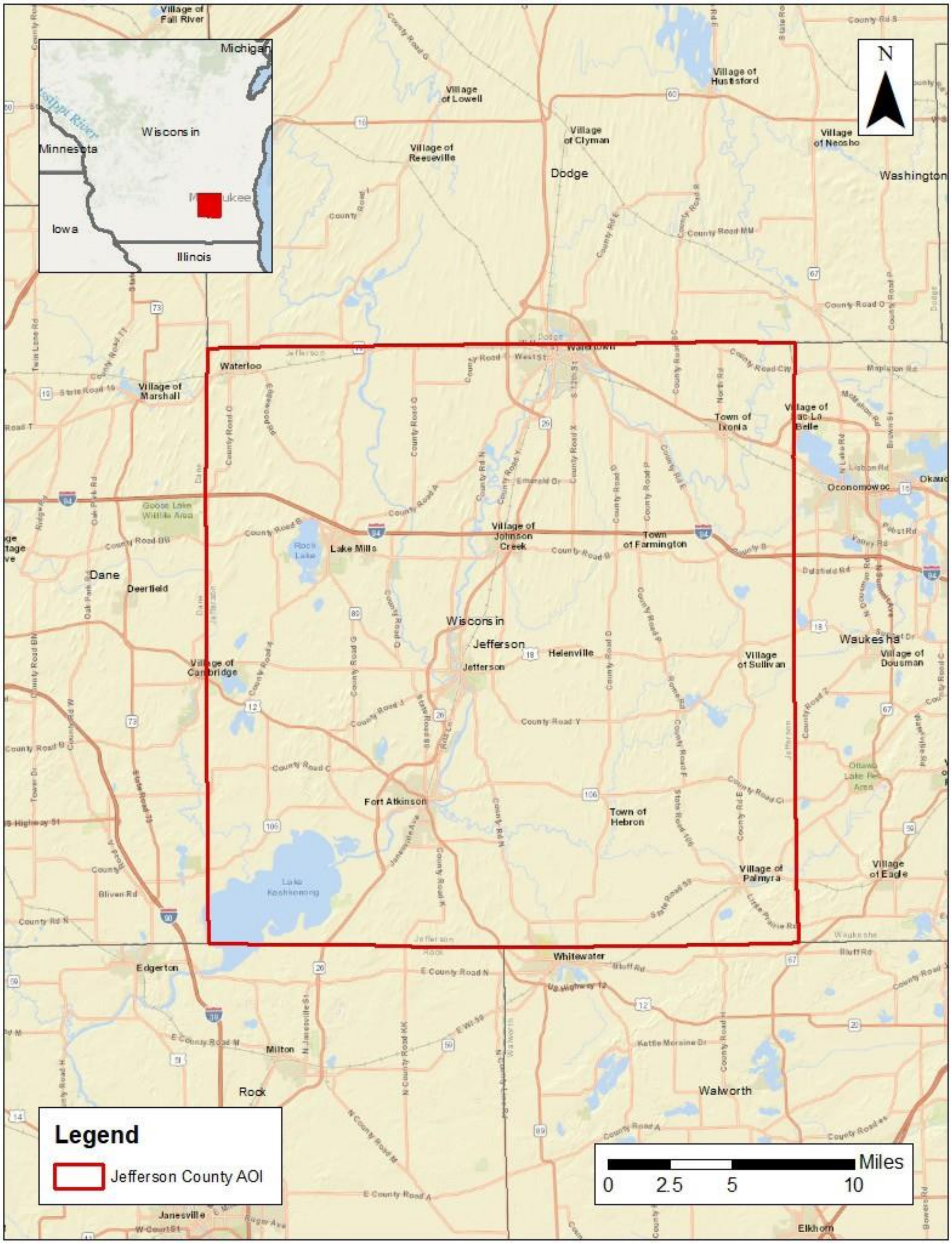
1.6 Deliverables

The following products were produced and delivered:

- Flight Collection Report in .PDF and .DOC format
- One copy of lidar tiled point cloud data in LAS format on external hard drive
- All flight mission parameters appropriate for inclusion in FGDC/USGS compliant metadata

All geospatial deliverables were produced with a horizontal datum/projection of Wisconsin State Plane South, NAD83 (2011) and a vertical datum/projection of NAVD88 (Geoid 12B), US Survey Feet. All tiled deliverables have a tile size of 4,500-ft x 4,500-ft.

Figure 1. Project Boundary



2. Planning / Equipment

2.1 Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount/type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project using RiPARAMETER planning software. The entire target area was comprised of 25 planned flight lines (Figure 2).

2.2 Lidar Sensor

Quantum Spatial used a Riegl VQ 1560i lidar sensor (Figure 3), serial numbers 546 and 061, during the project.

The Riegl 1560i system has a laser pulse repetition rate of up to 2 MHz resulting in more than 1.3 million measurements per second. The system uses a Multi-Pulse in the Air option (MPIA). The sensor is also equipped with the ability to measure up to an unlimited number of targets per pulse from the laser.

A brief summary of the aerial acquisition parameters for the project are shown in the Lidar System Specifications in Table 2.

Figure 2. Planned Flight Lines

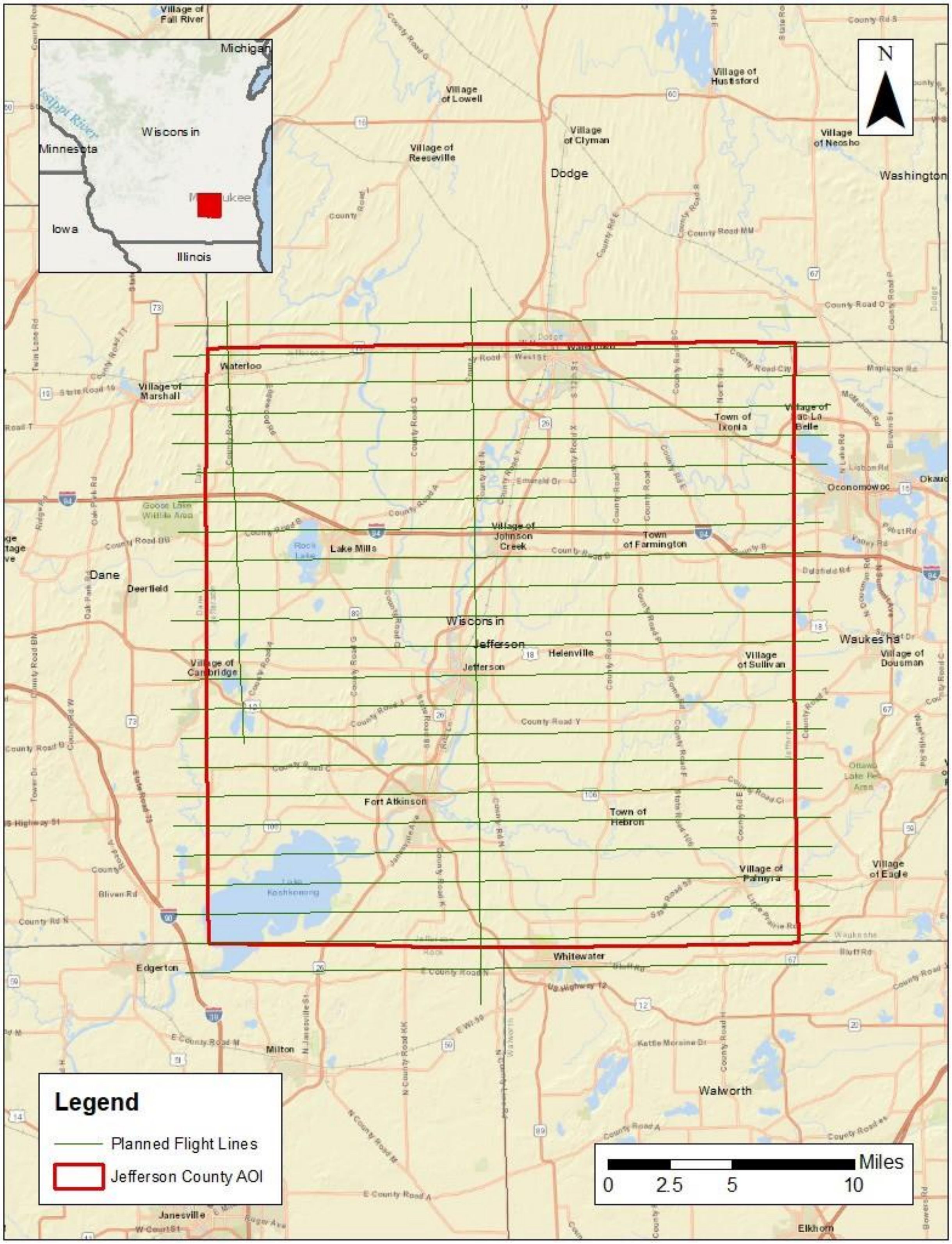


Table 2. Lidar System Specifications

Terrain and Aircraft Scanner	Flying Height	2195 m
	Recommended Ground Speed	145 kts
Scanner	Field of View	58.5°
	Scan Rate Setting Used	73.9 Hz
Laser	Laser Pulse Rate Used	350 kHz
	Multi Pulse in Air Mode	yes
Coverage	Full Swath Width	2380 m
	Line Spacing	1904 m
Point Spacing and Density	Average Point Spacing	0.71 m
	Average Point Density	2 pts / m^2

Figure 3. Riegl VQ 1560i Lidar Sensor

2.3 Aircraft

All flights for the project were accomplished through the use of customized planes. Plane type and tail numbers are listed below.

Lidar Collection Planes

- Piper Navajo, Tail Number(s): N73TM
- Cessna Caravan, Tail Number(s): N840JA

These aircraft provided an ideal, stable aerial base for lidar acquisition. These aerial platforms have relatively fast cruise speeds, which are beneficial for project mobilization/demobilization while maintaining relatively slow stall speeds, proving ideal for collection of high-density, consistent data posting using a state-of-the-art Riegl VQ 1560i lidar system. Some of Quantum Spatial's operating aircraft can be seen in Figure 4 below.

Figure 4. Some of Quantum Spatial's Planes

2.4 Time Period

Project-specific flights were conducted between April 20, 2019 and April 21, 2019. Two aircraft lifts were completed. Accomplished lifts are listed below.

- 20190420B (SN 061, N73TM)
- 20190421A (SN 546, N840JA)

3. Processing Summary

3.1 Lidar Processing

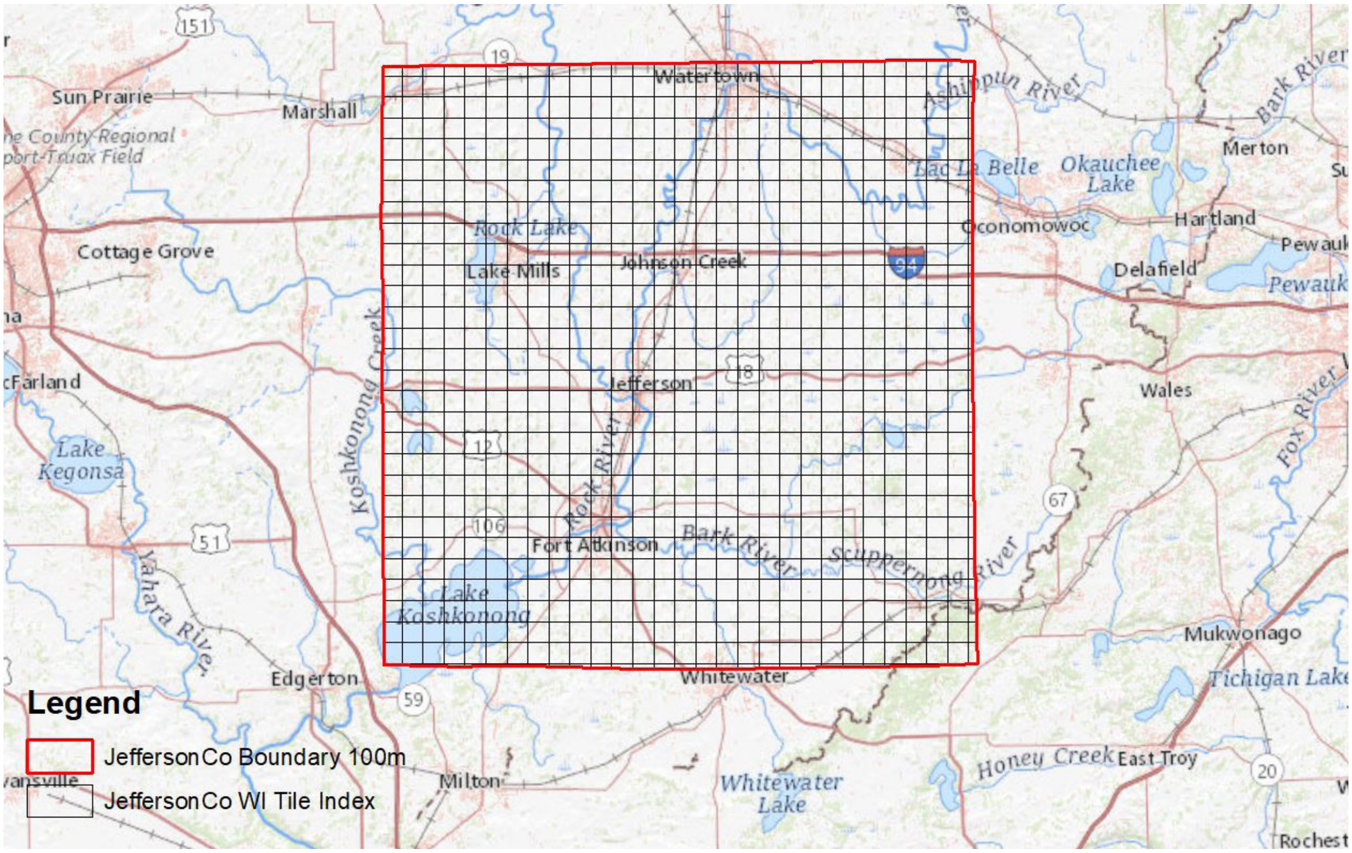
Applanix + POSPac Mobile Mapping Suite software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the lidar sensor during all flights. Applanix POSPac combines aircraft raw trajectory data with stationary GPS base station data yielding a "Smoothed Best Estimate Trajectory" (SBET) necessary for additional post processing software to develop the resulting geo-referenced point cloud from the lidar missions.

During the sensor trajectory processing (combining GPS & IMU datasets) certain statistical graphs and tables are generated within the Applanix POSPac processing environment which are commonly used as indicators of processing stability and accuracy. This data for analysis include: Max horizontal/vertical GPS variance, separation plot, altitude plot, PDOP plot, base station baseline length, processing mode, number of satellite vehicles, and mission trajectory.

The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. Laser point data are imported into TerraScan and a manual calibration is performed to assess the system offsets for pitch, roll, heading and scale. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above-ground features are removed from the data set. Point clouds were created using the RiPROCESS software. GeoCue distributive processing software was used in the creation of some files needed in downstream processing, as well as in the tiling of the dataset into more manageable file sizes. TerraScan and TerraModeler software packages were then used for the automated data classification, manual cleanup, and bare earth generation. Project-specific macros were developed to classify the ground and remove side overlap between parallel flight lines.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper was used as a final check of the bare earth dataset. GeoCue was used to create the deliverable industry-standard LAS files for both the All Point Cloud Data and the Bare Earth. In-house software was then used to perform final statistical analysis of the classes in the LAS files.

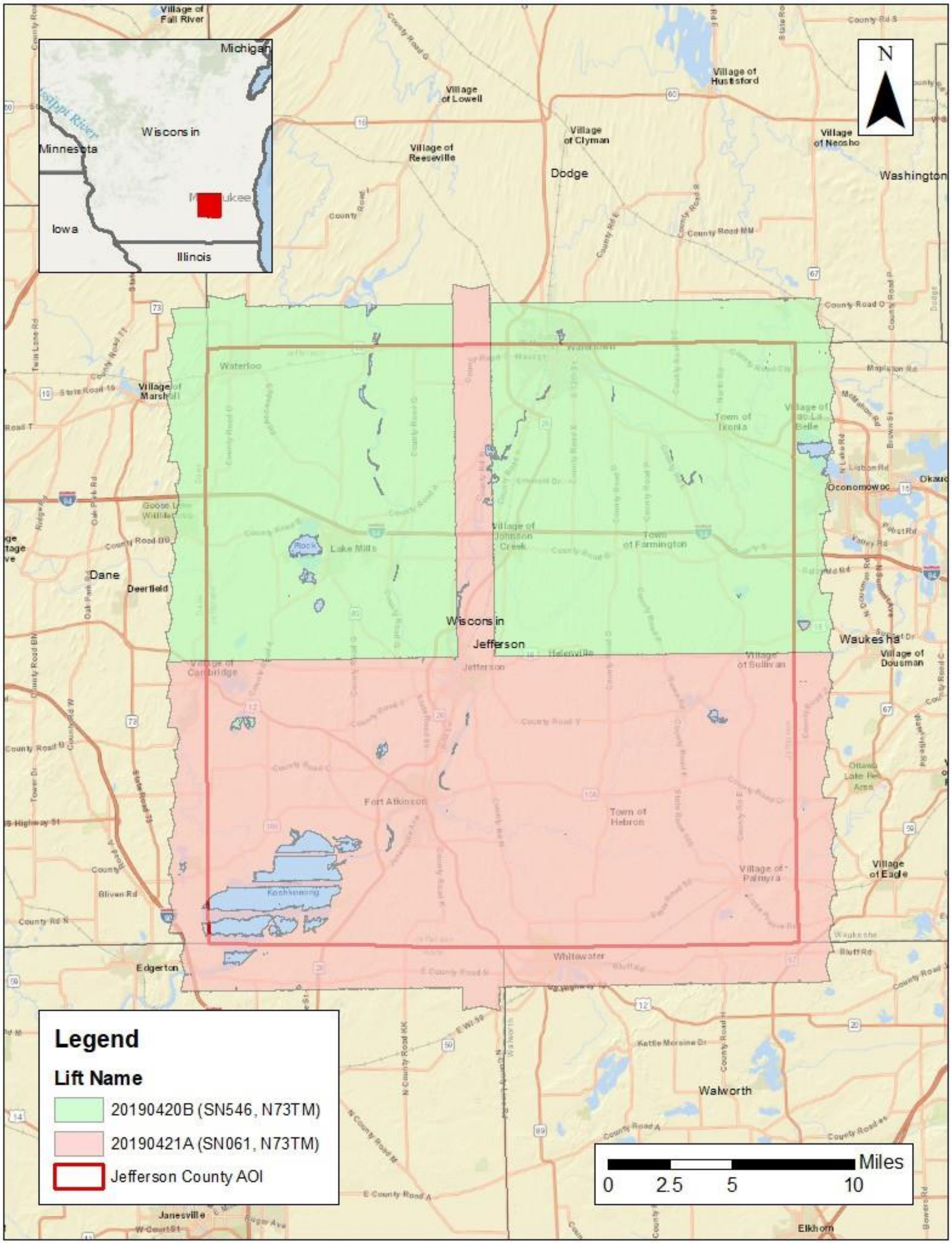
Figure 5. Lidar Tile Layout



4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 6.

Figure 6. Lidar Flightline Coverage



5. Ground Control and Check Point Collection

Quantum Spatial used 17 ground control (calibration) points collected by Ayres as an independent test of the accuracy of this project.

5.1 Calibration Control Point Testing

Figure 7 shows the location of each bare earth calibration point for the project area. Table 3 depicts the Control Report for the lidar bare earth calibration points, as computed in TerraScan as a quality assurance check. Note that these results of the surface calibration are not an independent assessment of the accuracy of these project deliverables, but the statistical results do provide additional feedback as to the overall quality of the elevation surface.

Figure 7. Calibration Control Point Locations

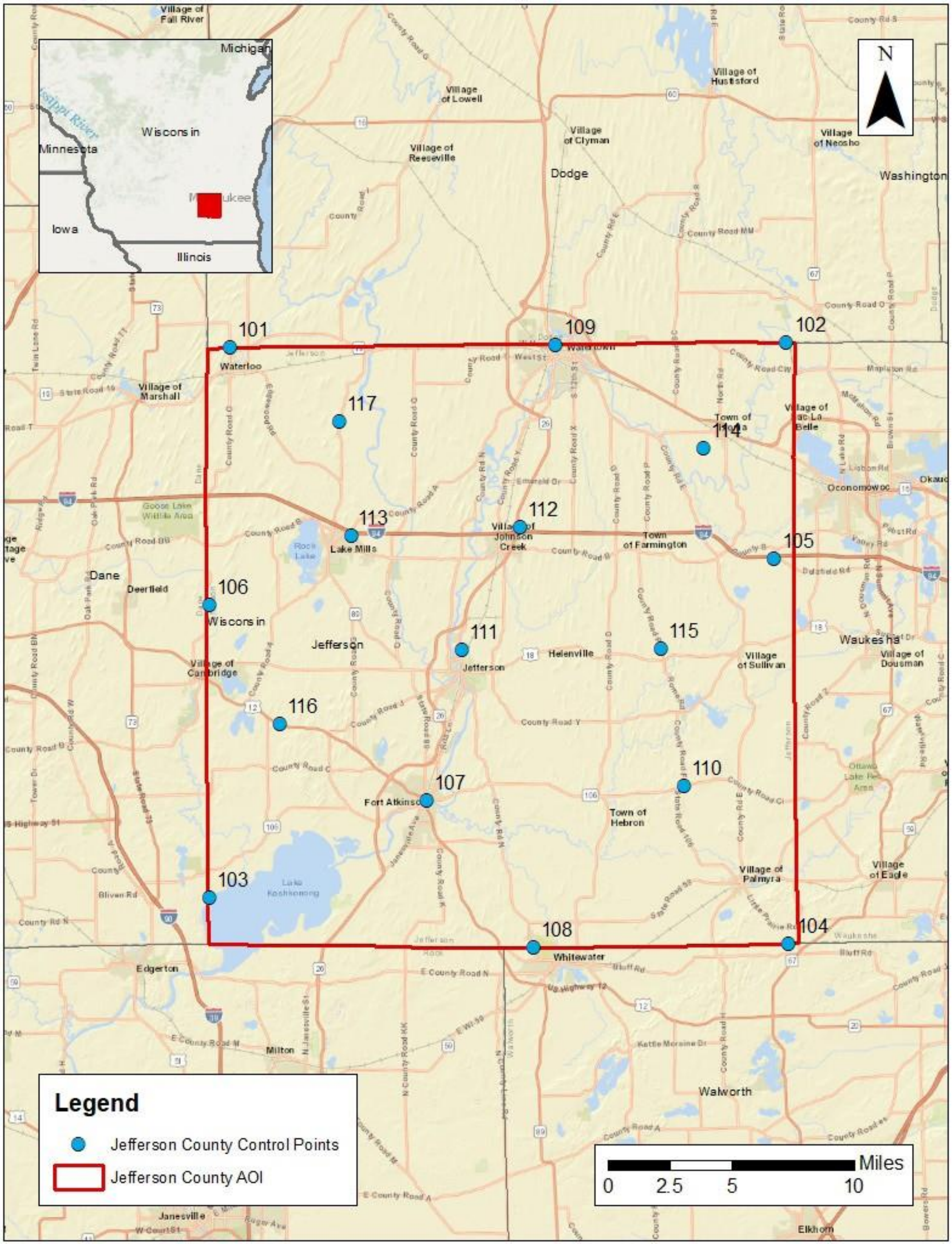


Table 3. Calibration Control Point Report
Units = US survey feet

NUMBER	EASTING	NORTHING	KNOWN Z	LASER Z	DZ
101	2237717.436	438155.400	899.958	900.000	0.042
102	2357104.231	439364.794	851.955	851.950	-0.005
103	2233397.683	320451.369	807.359	807.400	0.041
104	2357619.709	310580.683	963.669	963.700	0.031
105	2354505.404	393055.407	850.144	850.040	-0.104
106	2233367.854	383147.437	867.069	867.060	-0.009
107	2280009.712	341117.014	791.078	791.120	0.042
108	2302904.167	309764.431	864.001	864.180	0.179
109	2307631.296	438797.777	844.148	844.120	-0.028
110	2335126.666	344230.298	845.930	846.030	0.100
111	2287567.768	373502.378	819.865	819.820	-0.045
112	2300081.550	399708.529	861.781	861.750	-0.031
113	2263726.829	397955.650	829.208	829.200	-0.008
114	2339381.174	416639.975	853.326	853.510	0.184
115	2330330.547	373702.569	871.832	871.66	-0.172
116	2248571.689	357594.446	874.482	874.4	-0.082
117	2261302.467	422490.602	806.080	806.070	-0.010

Average Dz	+0.007 ft
Minimum Dz	-0.172 ft
Maximum Dz	+0.184 ft
Average Magnitude	0.065 ft
Root Mean Square	0.089 ft
Std Deviation	0.091 ft