Airborne Topographic Lidar Report

Wisconsin WROC – 3DEP

Green Lake County Lidar 2018

Prime contractor: Ayres Associates
Airborne lidar acquisition completed by Quantum Spatial

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1.1. SUMMARY

This report contains a summary of the Wisconsin WROC – 3DEP 2018 Green Lake County lidar acquisition task order, issued by Green Lake County, Wisconsin. The task order yielded a project area covering 386 square miles over Green Lake 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	1800 m	40°	30%	≤ 10 cm

1.3. COVERAGE

The project boundary covers 386 square miles and encompasses Green Lake County, 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 28, 2018, to April 30, 2018, in five total lifts. See “Section: 2.4. Time Period” for more details.

1.5. ISSUES

There were no major issues to report for this project.

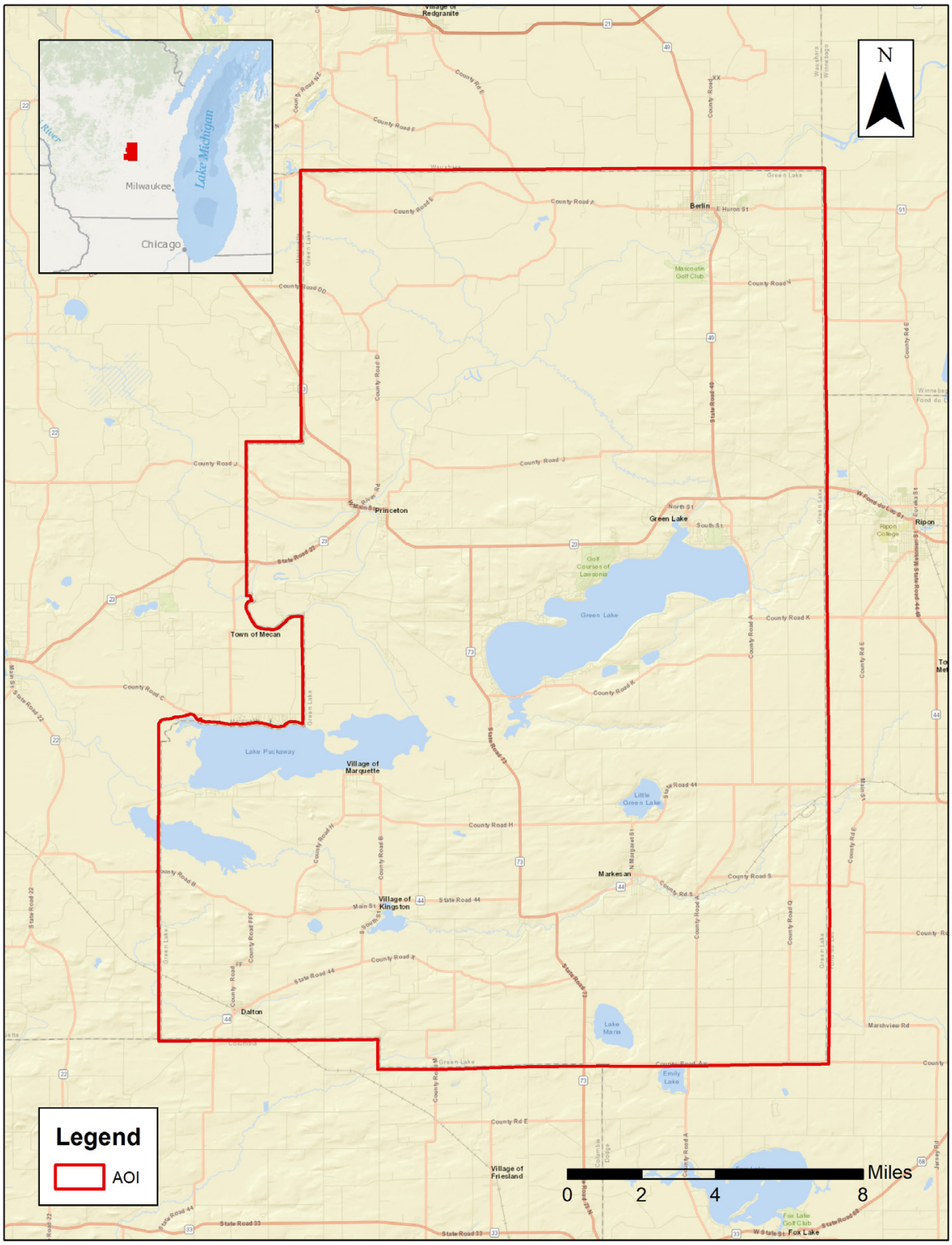
1.6. DELIVERABLES

The following products were produced and delivered:

- Lidar point cloud data, tiled, in LAS 1.4 format
- Flight logs and GPS/IMU statistics in .PDF format

All geospatial deliverables were produced with a horizontal datum/projection of Green Lake County Coordinate System (WISCRS), 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 Leica MissionPro planning software. The entire target area was comprised of 39 planned flight lines (Figure 2).

2.2. LIDAR SENSOR

Quantum Spatial used a Leica ALS70 lidar sensor (Figure 3), serial number 7161, during the project. The Leica ALS 70 system is capable of collecting data at a maximum frequency of 500 kHz, which affords elevation data collection of up to 500,000 points per second. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor is also equipped with the ability to measure up to 4 returns per outgoing pulse from the laser and these come in the form of 1st, 2nd, 3rd and last returns. The intensity of the returns is also captured during aerial acquisition.

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

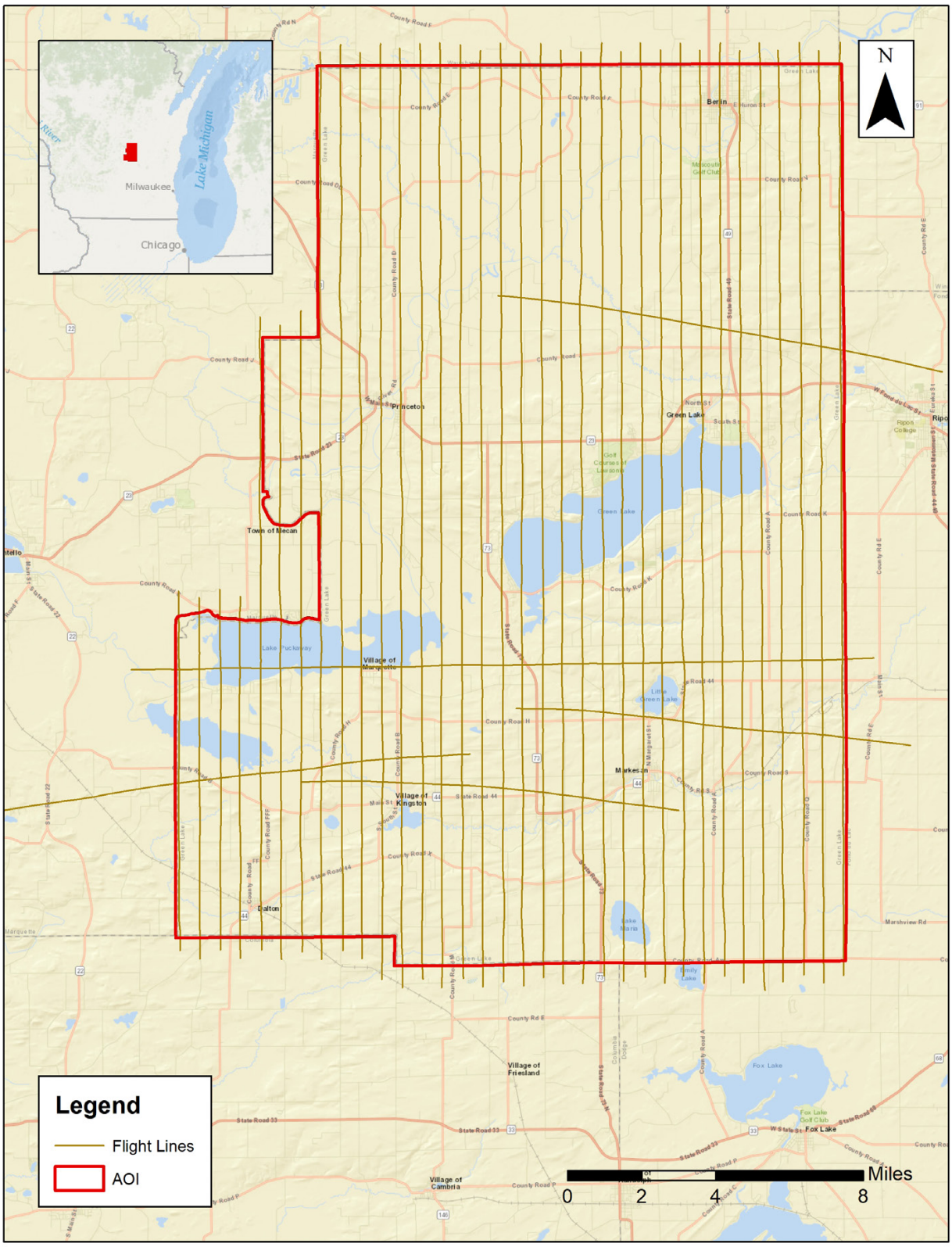


Table 2. Lidar System Specifications

Terrain and Aircraft Scanner	Flying Height	1800 m
	Recommended Ground Speed	150 kts
Scanner	Field of View	40°
	Scan Rate Setting Used	53.4 Hz
Laser	Laser Pulse Rate Used	302.6 kHz
	Multi Pulse in Air Mode	yes
Coverage	Full Swath Width	1310 m
	Line Spacing	917 m
Point Spacing and Density	Average Point Spacing	0.71 m
	Average Point Density	2 pts / m^2

Figure 3. Leica ALS 70 Lidar Sensor

2.3. AIRCRAFT

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

Lidar Collection Planes

- Piper Navajo (twin-piston) PA31, Tail Number: N262AS

This aircraft provided an ideal, stable aerial base for lidar acquisition. This aerial platform has a relatively fast cruise speed, which is beneficial for project mobilization / demobilization while maintaining relatively slow stall speeds – which proved ideal for collection of high-density, consistent data posting using a state-of-the-art Leica ALS70 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 over one month. Five aircraft lifts were completed. Accomplished lifts are listed below.

- April 28, 2018-A (N262AS, SN7161)
- April 28, 2018-B (N262AS, SN7161)
- April 29, 2018-A (N262AS, SN7161)
- April 29, 2018-B (N262AS, SN7161)
- April 30, 2018-A (N262AS, SN7161)

3. Processing Summary

3.1. LIDAR PROCESSING

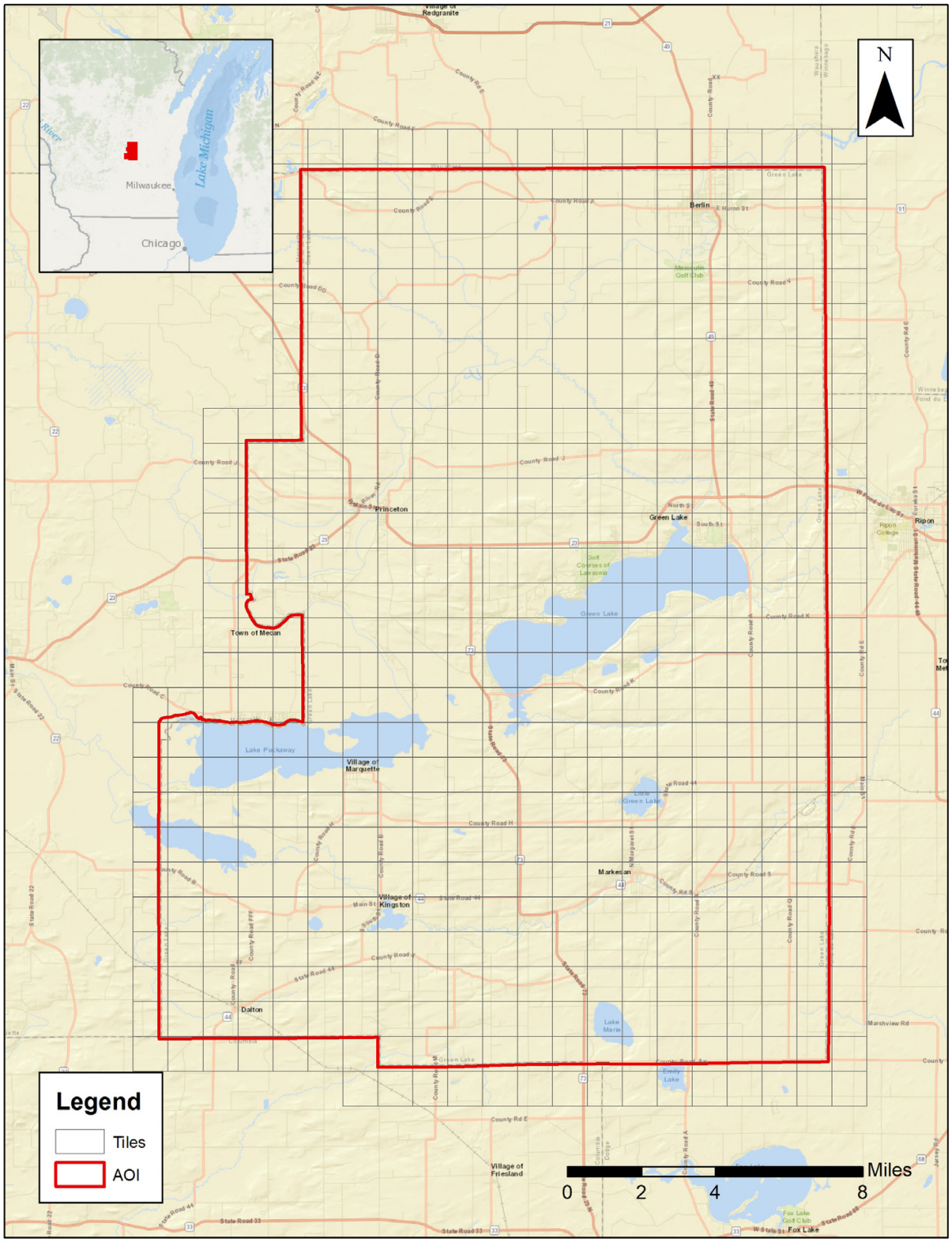
Inertial Explorer software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the lidar sensor during all flights. Inertial Explorer combines aircraft raw trajectory data with stationary GPS base station data yielding a "Smoothed 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 Inertial Explorer 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 Leica CloudPro 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.

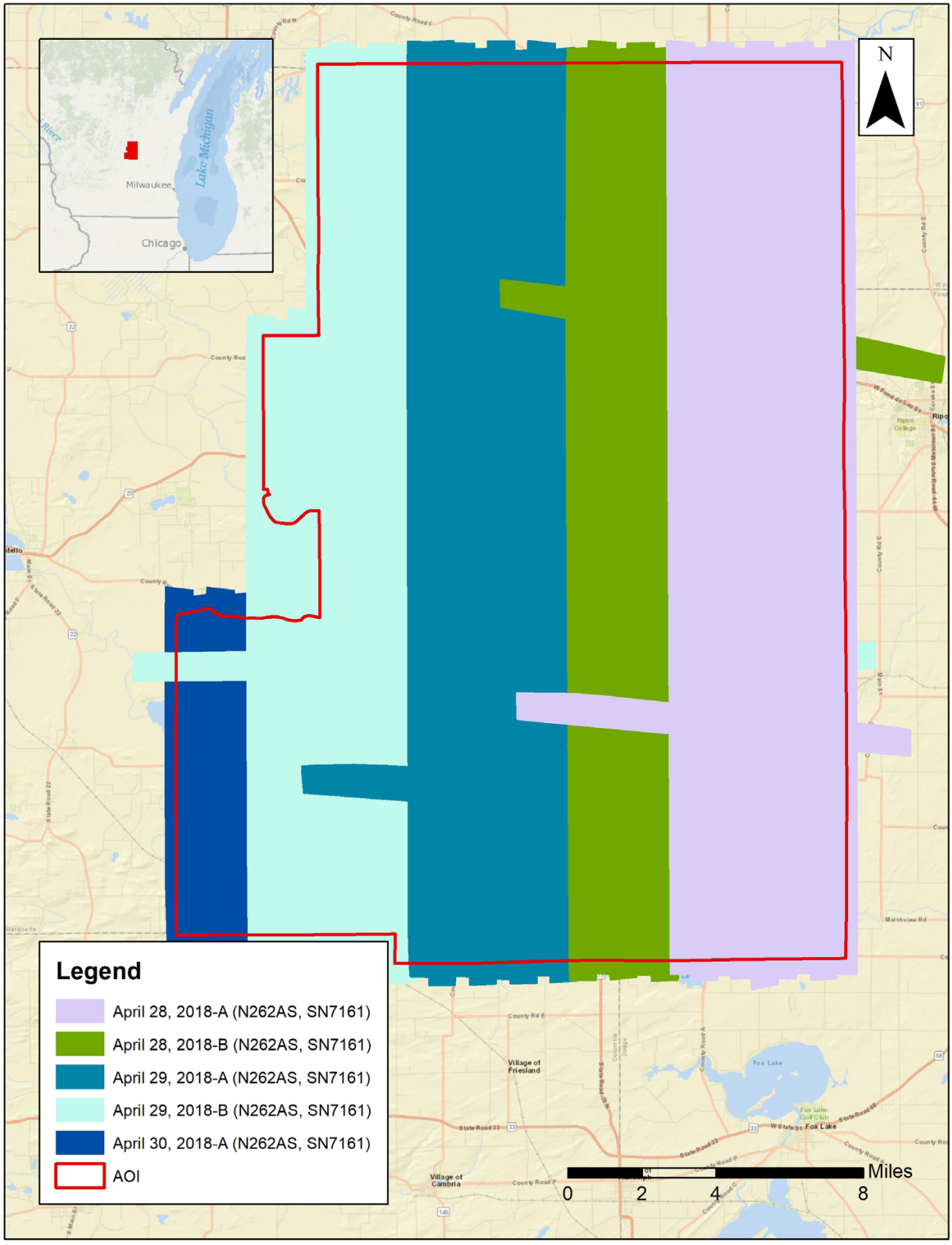
Figure 5. Lidar Tile Layout



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 10 ground control (calibration) points collected by Ayres Associates, Inc. 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

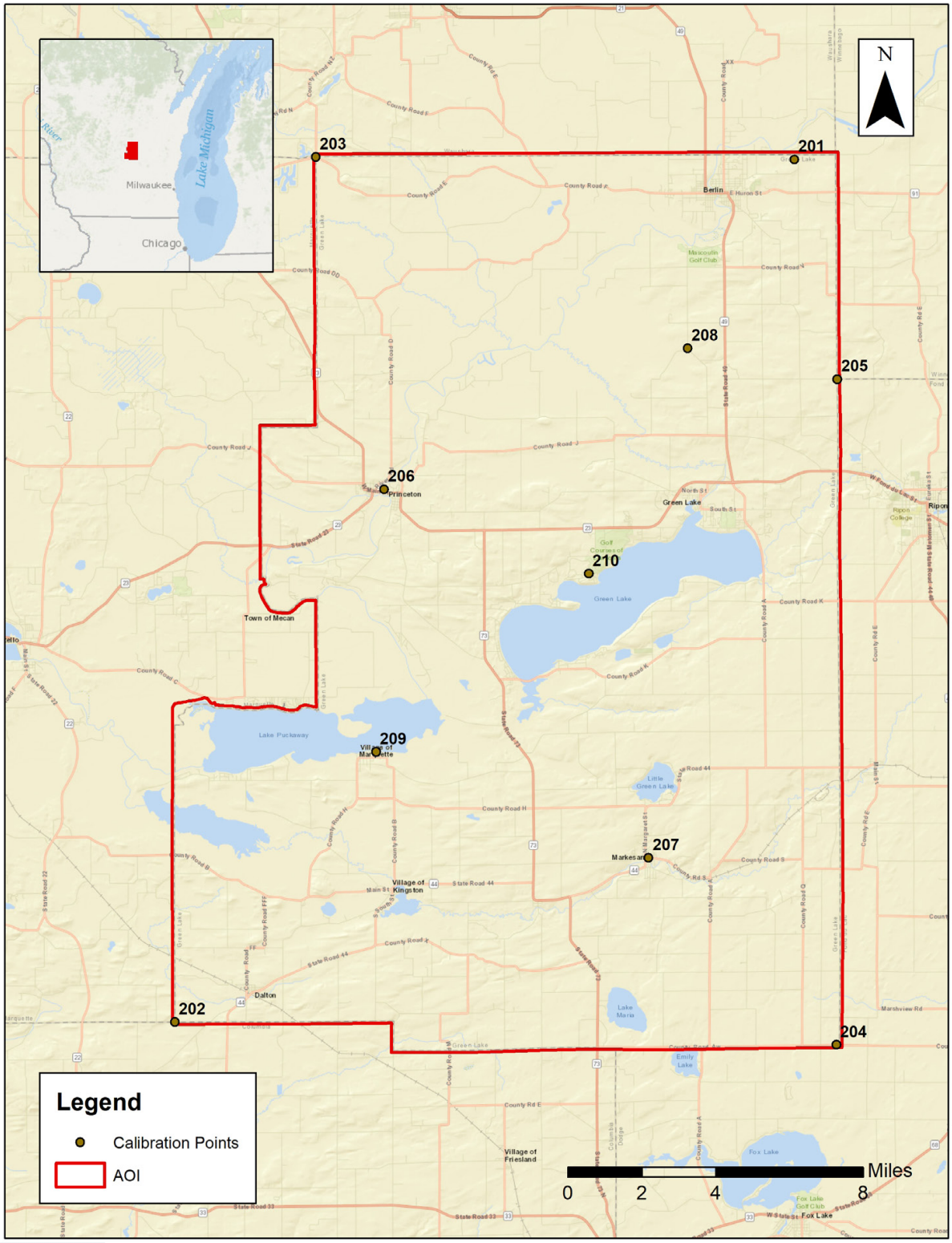


Table 3. Calibration Control Point Report
Units = US survey feet

Number	Easting	Northing	Known Z	Laser Z	Dz
209	522833.910	238647.088	770.322	770.520	+0.198
207	561843.681	223503.091	855.433	855.540	+0.107
206	523984.185	276251.961	766.734	766.840	+0.106
210	553257.096	264175.953	841.520	841.570	+0.050
208	567409.802	296447.012	807.009	807.050	+0.041
201	582700.416	323470.357	796.712	796.740	+0.028
204	588689.148	196710.096	961.470	961.430	-0.040
202	494041.494	199992.995	850.923	850.850	-0.073
205	588849.308	292024.277	975.923	975.810	-0.113
203	514224.740	323833.908	804.391	804.130	-0.261

Average Dz	+0.004
Minimum Dz	-0.261
Maximum Dz	+0.198
Root Mean Square	0.124
Std Deviation	0.131