Airborne Topographic Lidar Report

Wisconsin WROC - 3DEP
Adams County Lidar 2019

Prime Contractor: Ayres

Airborne Lidar Acquisition: Quantum Spatial

AYRES

Ingenuity, Integrity, and Intelligence.

www.AyresAssociates.com

Table of Contents

1. Summary / Scope .... Page 1

1.1. Summary .... Page 1

1.2 Scope .... Page 1

1.3 Coverage .... Page 1

1.4 Duration .... Page 1

1.5 Issues .... Page 1

1.6 Deliverables .... Page 2

2. Planning / Equipment .... Page 4

2.1 Flight Planning .... Page 4

2.2 Lidar Sensor .... Page 4

2.3 Aircraft .... Page 7

2.4 Time Period .... Page 8

3. Processing Summary .... Page 9

3.1 Lidar Processing .... Page 9

4. Project Coverage Verification .... Page 11

5. Ground Control and Check Point Collection .... Page 13

5.1 Calibration Control Point Testing .... Page 13

List of Figures

Figure 1. Project Boundary .... Page 3

Figure 2. Planned Flight Lines .... Page 5

Figure 3. Leica ALS 80 Lidar Sensor .... Page 6

Figure 4. Some of Quantum Spatial's Planes .... Page 7

Figure 5. Lidar Tile Layout .... Page 10

Figure 6. Lidar Flightline Coverage .... Page 12

Figure 7. Calibration Control Point Locations .... Page 14

List of Tables

Table 1. Originally Planned Lidar Specifications .... Page 1

Table 2. Lidar System Specifications .... Page 6

Table 3. Calibration Control Point Report .... Page 15

1. Summary / Scope

1.1 Summary

This report contains a summary of the WROC 2019 Adams County lidar acquisition task order, issued by Adams 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 / m²	2346 m	40°	30%	≤ 10 cm

1.3 Coverage

The project boundary covers 696 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 21, 2019, to April 23, 2019, in 3 total lifts. See "Section: 2.4. Time Period" for more details.

1.5 Issues

There were no major issues to report for this project.

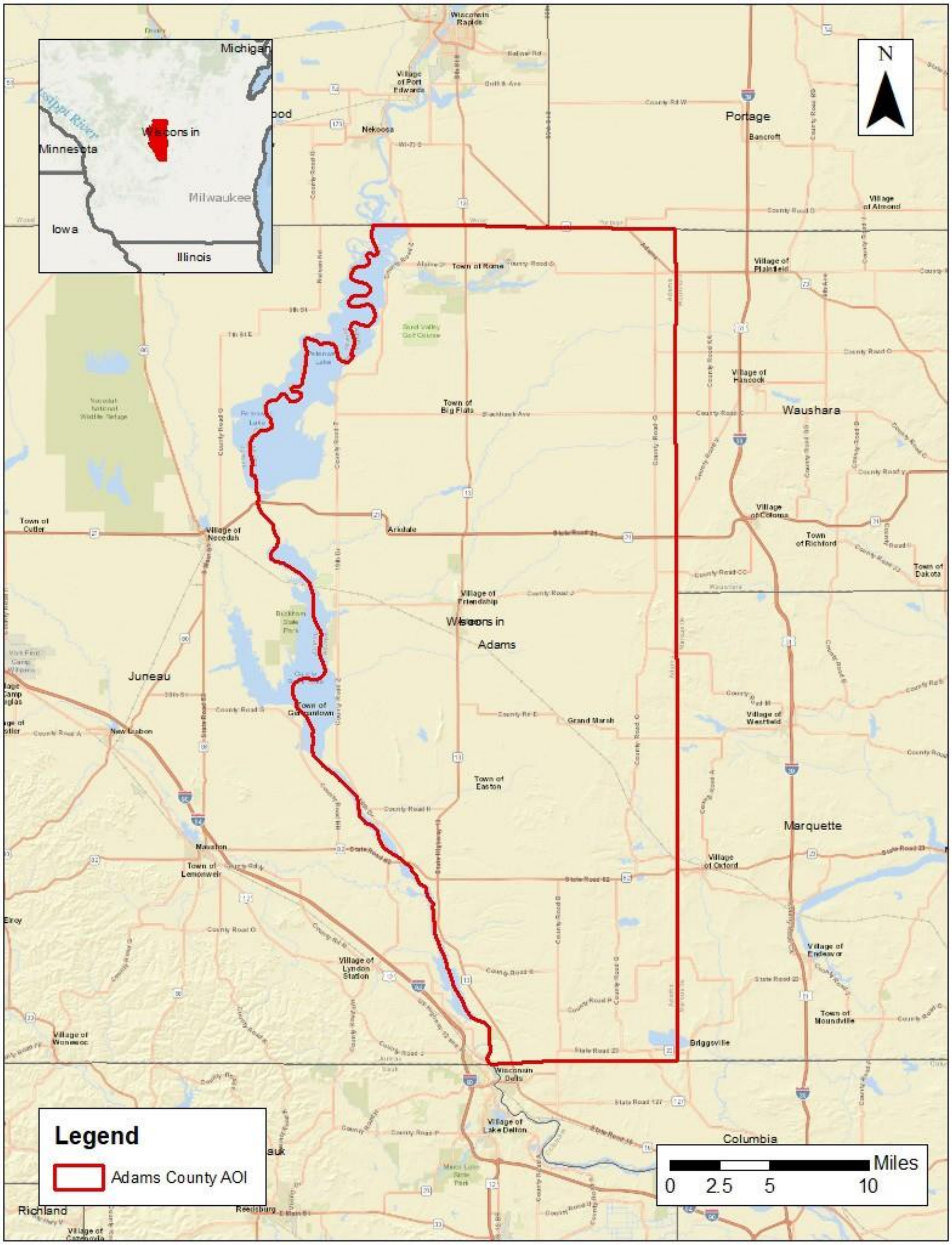
1.6 Deliverables

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 Adams 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 38 planned flight lines (Figure 2).

2.2 Lidar Sensor

Quantum Spatial used a Leica ALS 80 lidar sensor (Figure 3), serial number SN 8146, during the project.

The Leica ALS 80 system is capable of collecting data at a maximum frequency of 1,000 kHz. The system uses a Multi-Pulse in the Air option (MPIA). The sensor also has the capacity for unlimited range returns from each outbound pulse. 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

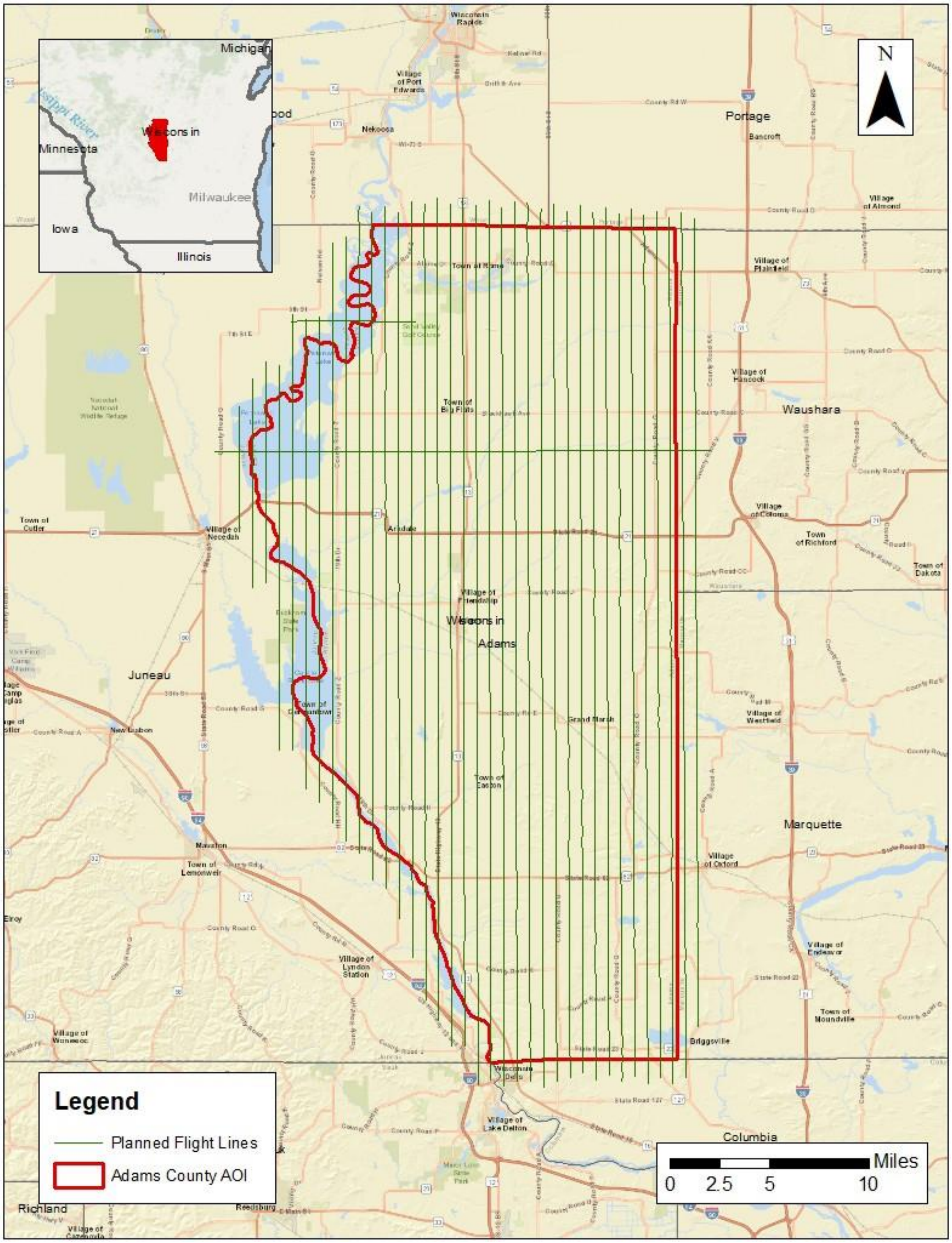


Table 2. Lidar System Specifications

Terrain and Aircraft Scanner	Flying Height	2346 m
	Recommended Ground Speed	160 kts
Scanner	Field of View	40°
	Scan Rate Setting Used	49 Hz
Laser	Laser Pulse Rate Used	381 kHz
	Multi Pulse in Air Mode	yes
Coverage	Full Swath Width	1560 m
	Line Spacing	1092 m
Point Spacing and Density	Average Point Spacing	0.71 m
	Average Point Density	2 pts / m^2

Figure 3. Leica ALS 80 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): N6GR

This aircraft provides an ideal, stable aerial base for lidar acquisition. This aerial platform has 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 Leica ALS 80 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 21, 2019 and April 23, 2019. Three aircraft lifts were completed. Accomplished lifts are listed below.

- 20190421A (SN8146, N6GR)
- 20190423A (SN8146, N6GR)
- 20190423B (SN8146, N6GR)

3. Processing Summary

3.1 Lidar Processing

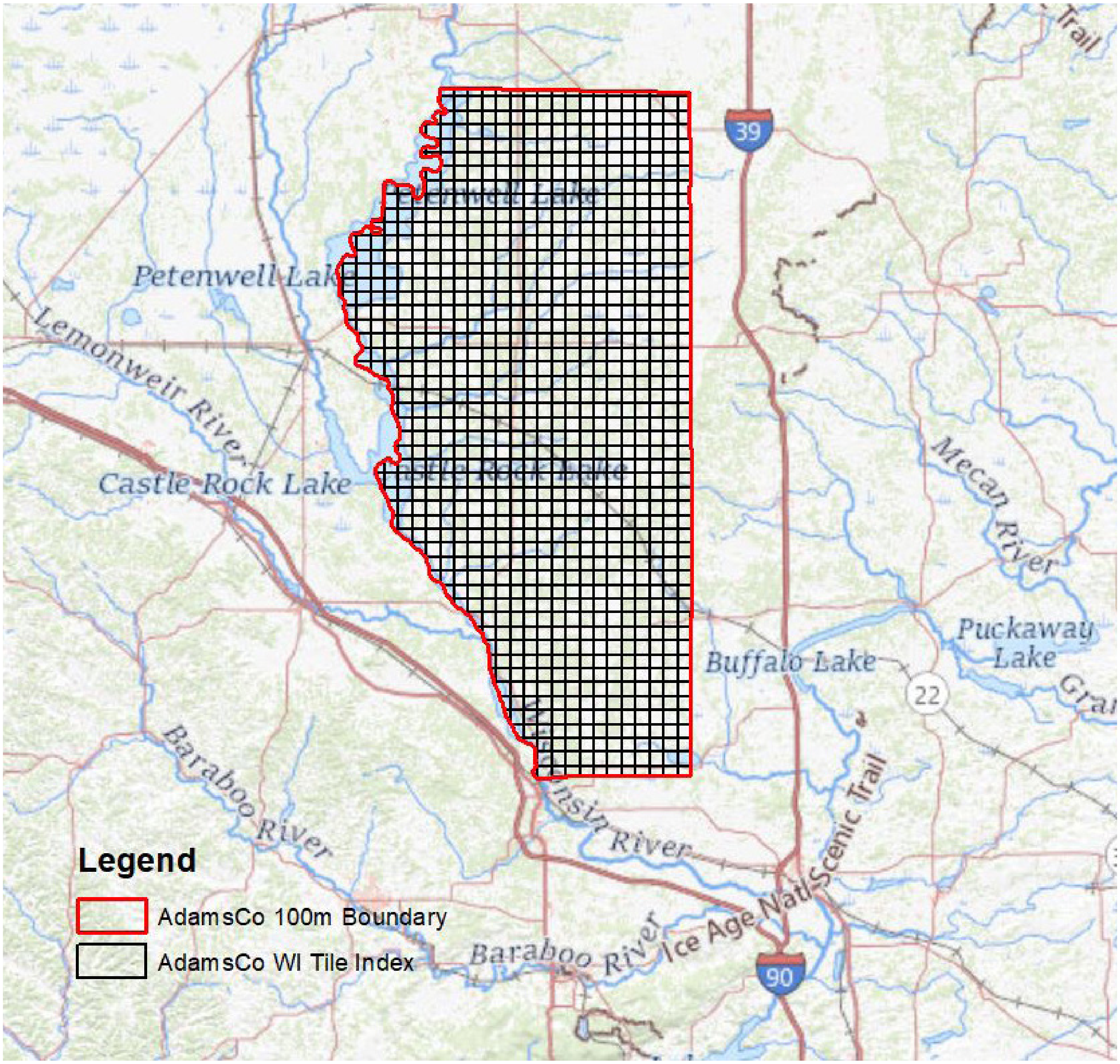
Inertial Explorer software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the lidar sensor during all flights. Inertial Explorer combines aircraft raw trajectory data with stationary GPS base station data yielding a "Smoothed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

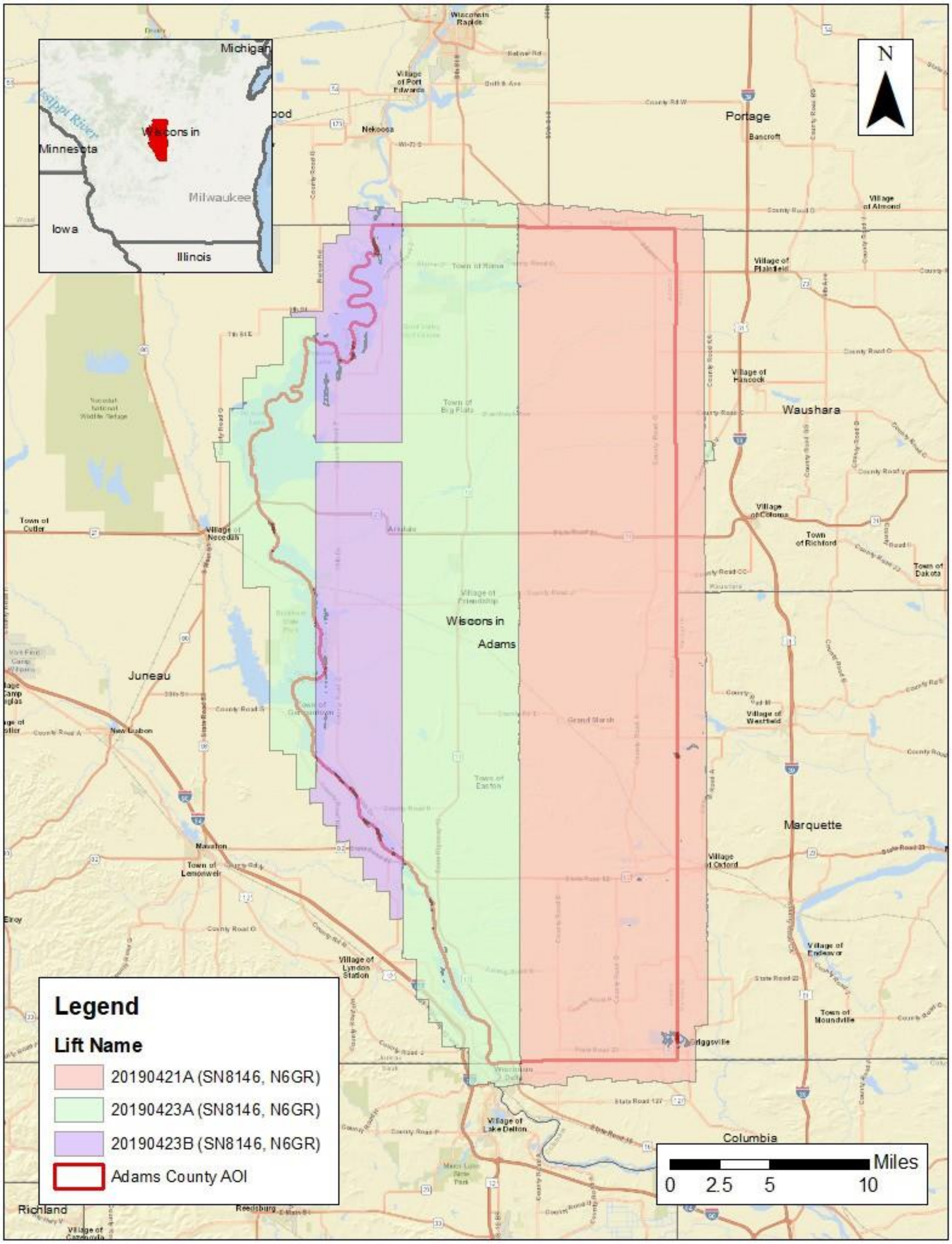
Figure 5. Lidar Tile Layout



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 14 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

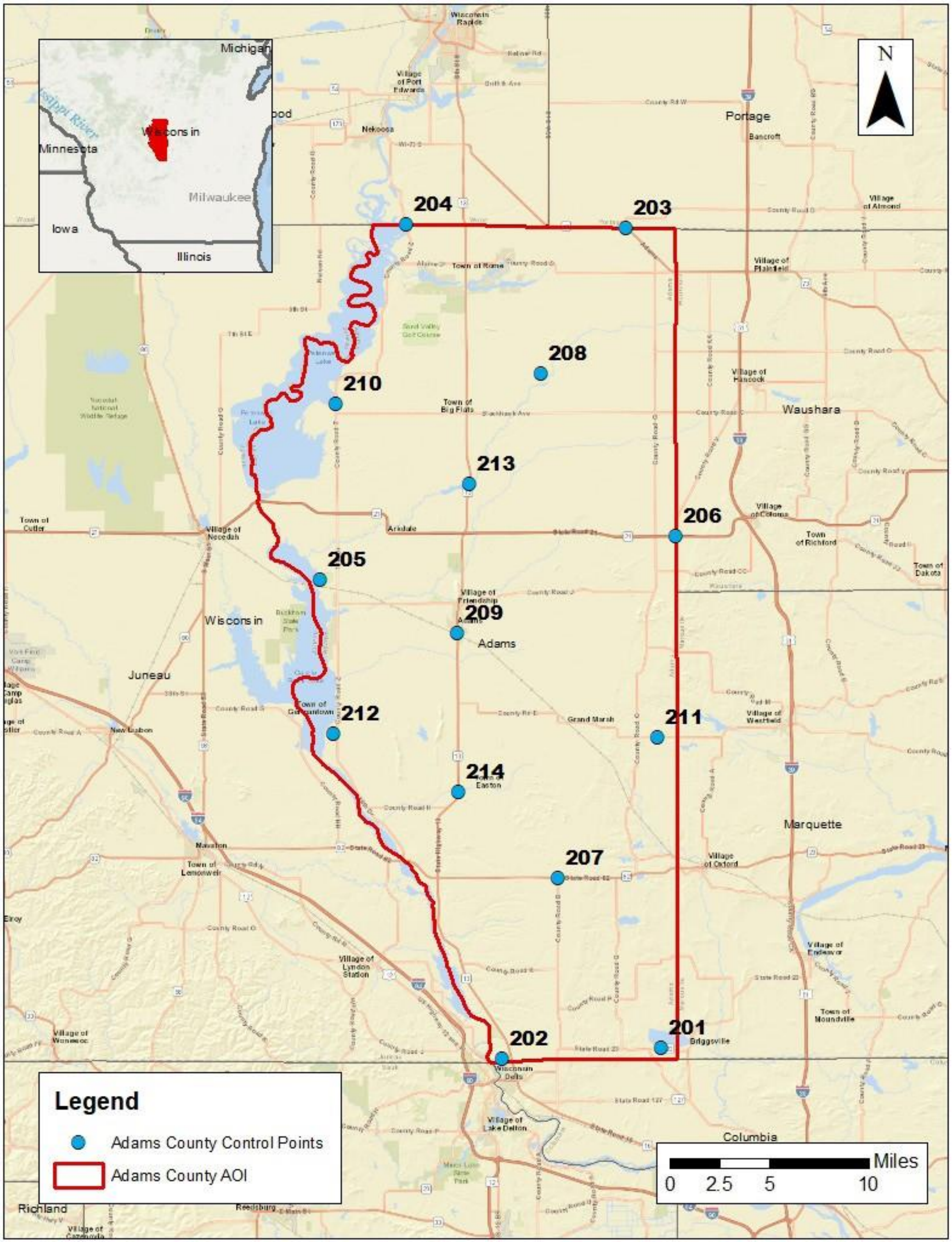


Table 3. Calibration Control Point Report
Units = US survey feet

NUMBER	EASTING	NORTHING	KNOWN Z	LASER Z	DZ
201	584949.159	103900.565	805.645	805.630	-0.015
202	542849.024	101031.018	962.418	962.400	-0.018
203	575564.279	320891.285	1056.843	1056.770	-0.073
204	517513.347	321853.879	928.222	928.400	0.178
205	494810.680	227716.899	917.242	917.270	0.028
206	588679.758	239214.532	1066.466	1066.550	0.084
207	557727.380	148760.434	1024.859	1024.760	-0.099
208	553100.007	282272.982	1017.611	1017.740	0.129
209	531104.732	213537.387	962.574	962.530	-0.044
210	498904.761	274244.474	932.244	932.270	0.026
211	583931.197	185956.553	980.710	980.700	-0.010
212	498271.120	186963.688	869.012	869.050	0.038
213	534183.922	253178.189	970.728	970.690	-0.038
214	531330.783	171445.274	908.550	908.490	-0.060

Average Dz	+0.009 ft
Minimum Dz	-0.099 ft
Maximum Dz	+0.178 ft
Average Magnitude	0.060 ft
Root Mean Square	0.076 ft
Std Deviation	0.078 ft