Airborne Topographic Lidar Report

Wisconsin WROC – 3DEP

Price County Lidar 2018

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

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1. SUMMARY / SCOPE

1.1. SUMMARY

This report contains a summary of the Wisconsin WROC – 3DEP 2018 Price County lidar acquisition task order, issued by Price County, Wisconsin. The task order yielded a project area covering 1,288 square miles over Price 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	2000 m	36°	30%	$\leq$ 10 cm

1.3. COVERAGE

The project boundary covers 1,288 square miles and encompasses Price 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 May 11, 2018, to May 17, 2018, in nine total lifts. See “Section: 2.4. Time Period” for more details.

1.5. ISSUES

There were no major issues to report for this project.

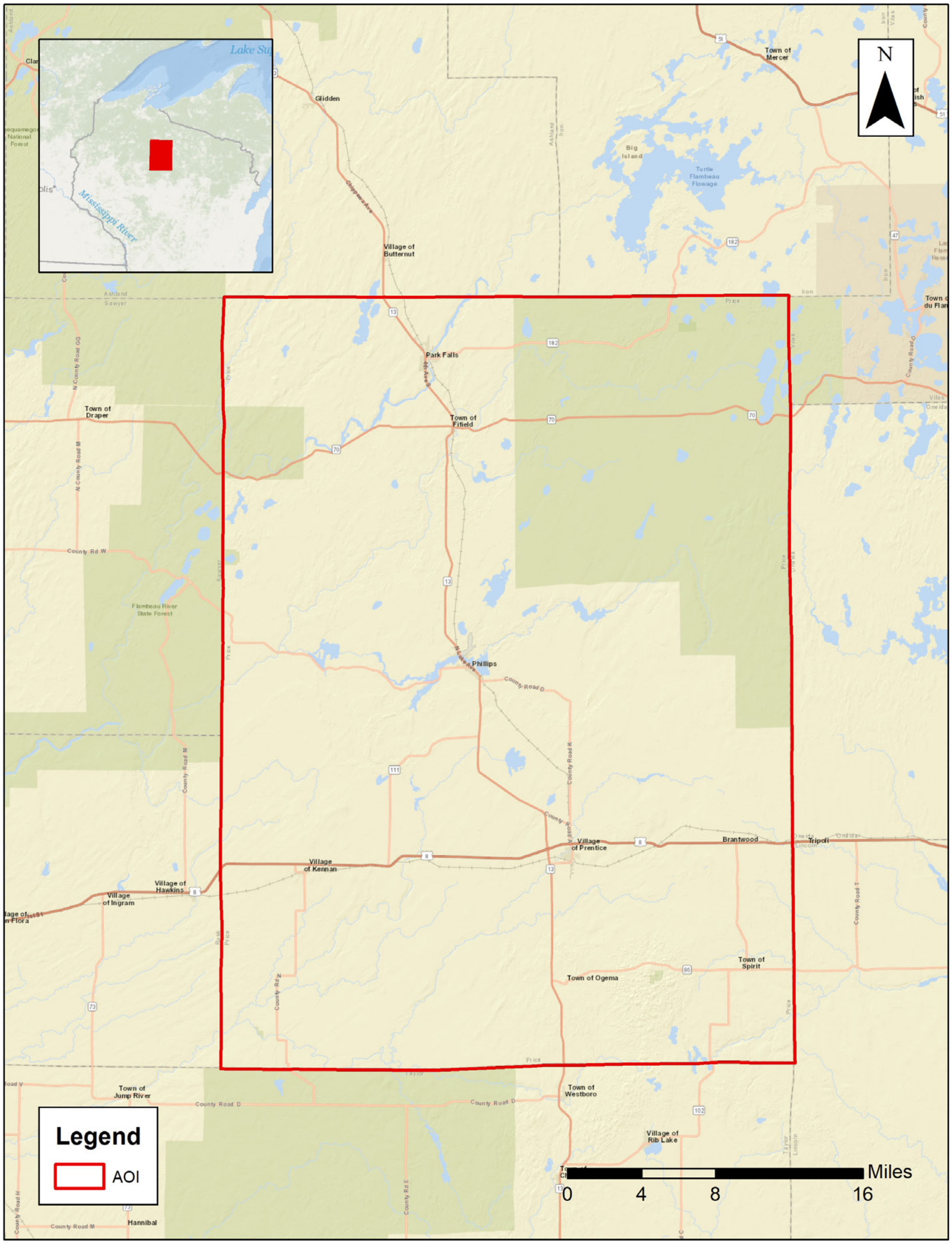
1.6. DELIVERABLES

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 Price 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 Optech FMS Planner planning software. The entire target area was comprised of 77 planned flight lines (Figure 2).

2.2. LIDAR SENSOR

Quantum Spatial used an Optech Orion H300 lidar sensor (Figure 3), serial number 329, during the project. These systems are capable of collecting data at a maximum frequency of 167 kHz, which affords elevation data collection of up to 167,000 points per second. These systems use a Multi-Pulse in the Air option (MPIA). These sensors are also equipped with the ability to measure up to 4 returns per outgoing pulse from the laser, and these come in the form of first, second, third, and last returns. The intensity of the first four 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

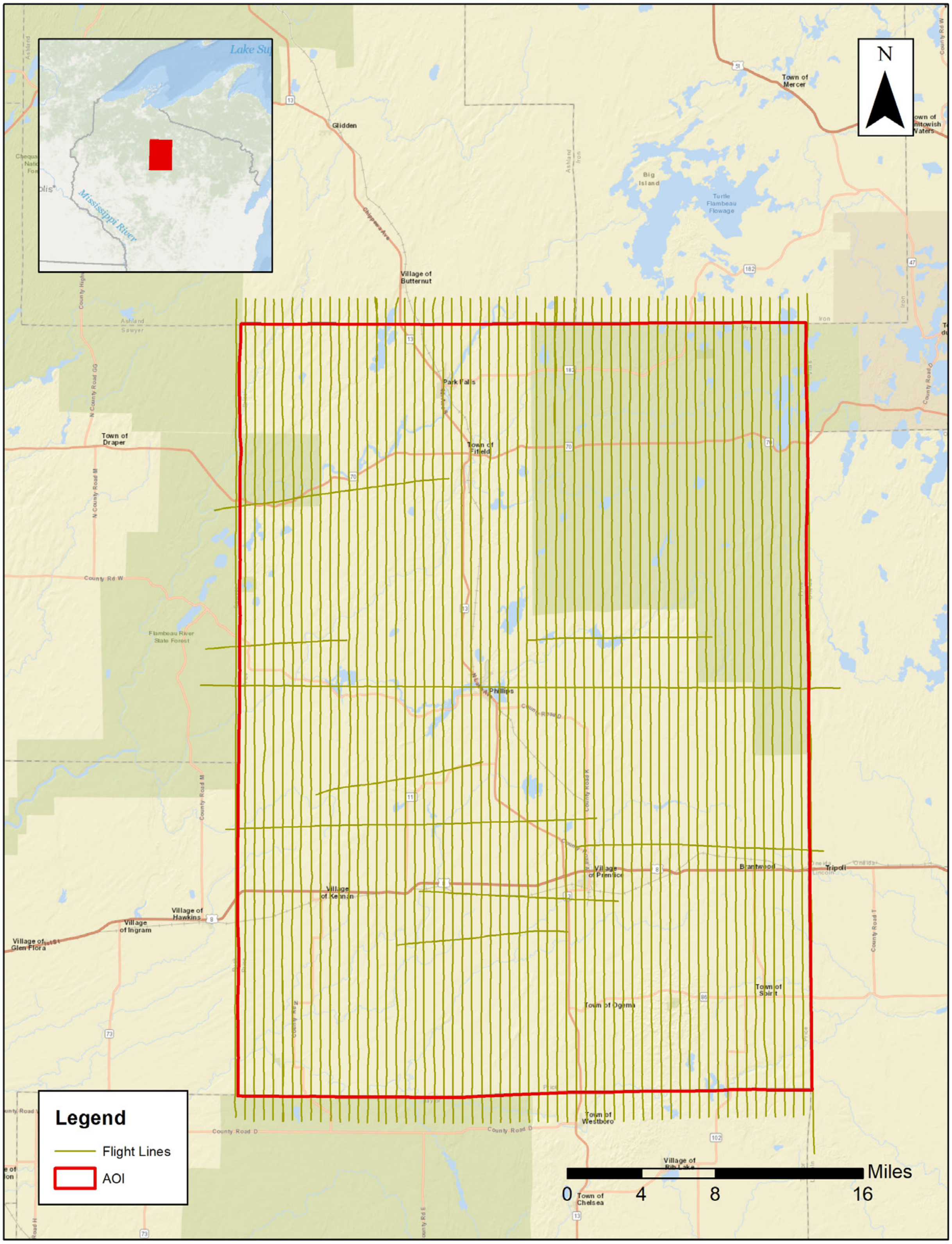


Table 2. Lidar System Specifications

Terrain and Aircraft Scanner	Flying Height	2000 m
	Recommended Ground Speed	150 kts
Scanner	Field of View	36°
	Scan Rate Setting Used	50 Hz
Laser	Laser Pulse Rate Used	300 kHz
	Multi Pulse in Air Mode	yes
Coverage	Full Swath Width	1457 m
	Line Spacing	1020 m
Point Spacing and Density	Average Point Spacing	0.71 m
	Average Point Density	2 pts / m^2

Figure 3. Optech Orion H300 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 Optech Orion H300 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. Nine aircraft lifts were completed. Accomplished lifts are listed below.

- May 11, 2018-A (N262AS, SN329)
- May 12, 2018-B (N262AS, SN329)
- May 13, 2018-A (N262AS, SN329)
- May 13, 2018-B (N262AS, SN329)
- May 14, 2018-A (N262AS, SN329)
- May 15, 2018-A (N262AS, SN329)
- May 16, 2018-A (N262AS, SN329)
- May 17, 2018-A (N262AS, SN329)
- May 17, 2018-B (N262AS, SN329)

3. PROCESSING SUMMARY

3.1. LIDAR PROCESSING

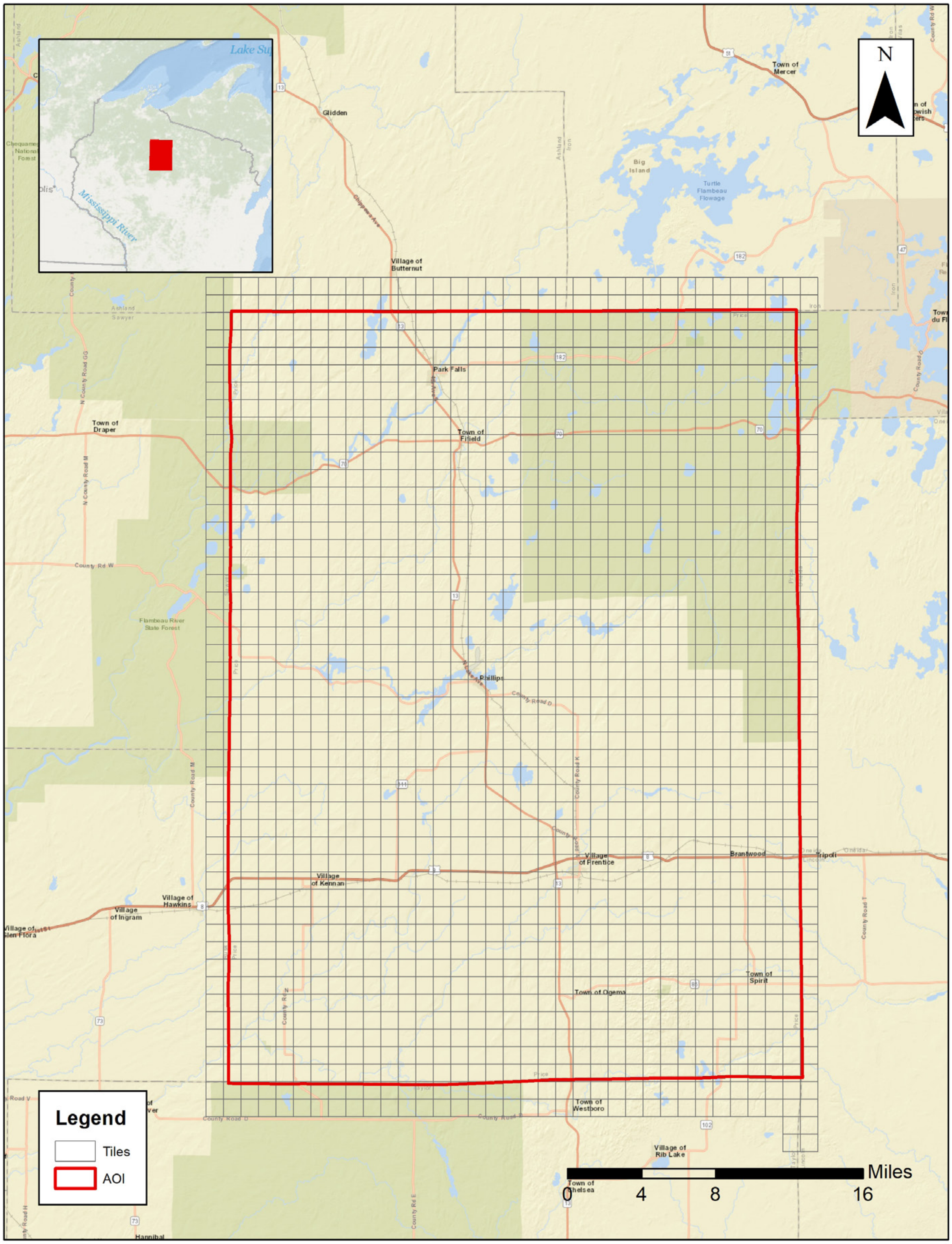
Applanix + POSPac Mobile Mapping Suite software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the lidar sensor during all flights. Applanix + POSPac Mobile Mapping Suite combines aircraft raw trajectory data with stationary 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 Mobile Mapping Suite 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 Optech DashMap 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.

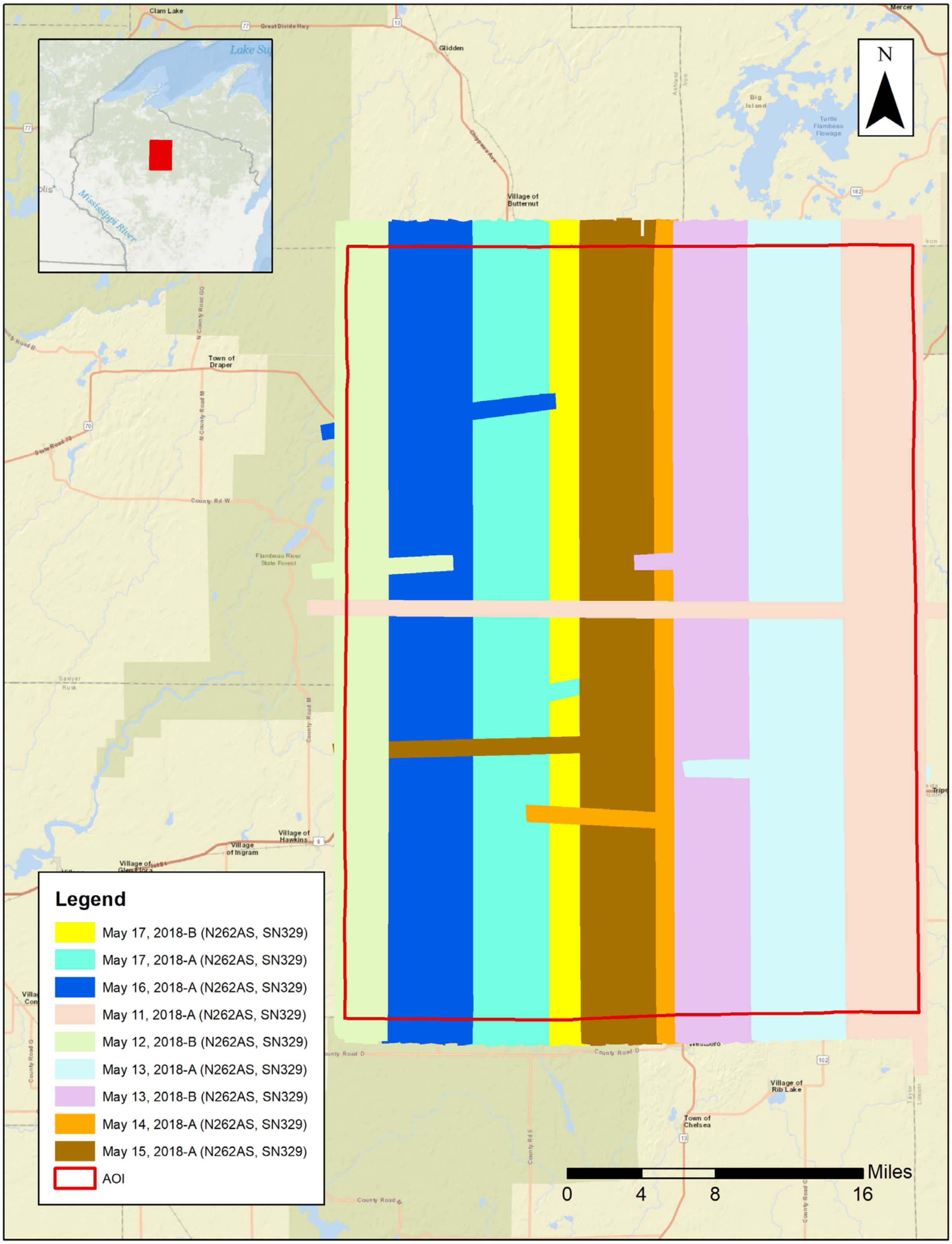
Figure 5. Lidar Tile Layout



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 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

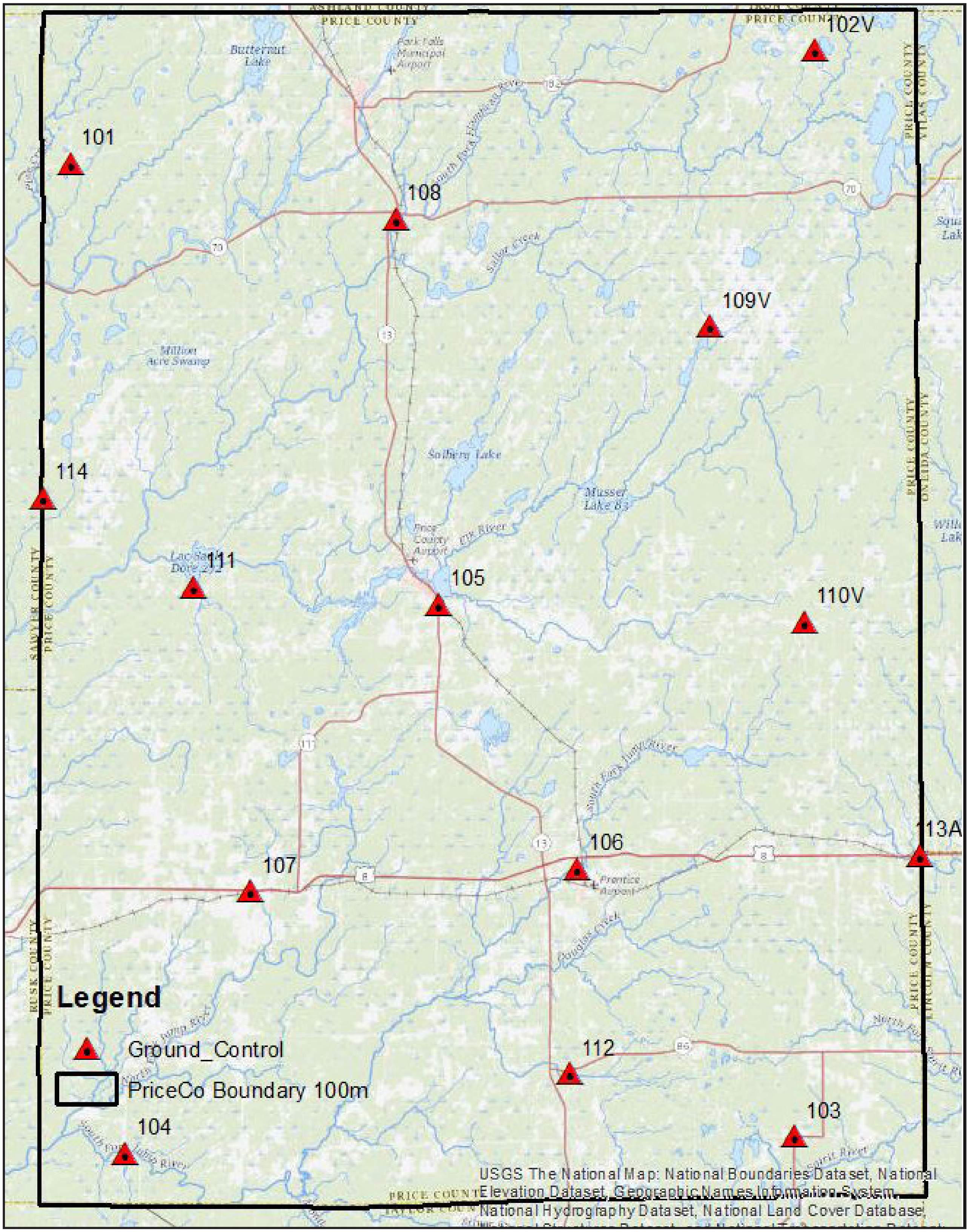


Table 3. Calibration Control Point Report
Units = US survey feet

Number	Easting	Northing	Known Z	Laser Z	Dz
101	704861.866	492293.222	1484.972	1484.791	-0.181
103	838956.997	312210.811	1690.381	1690.551	+0.170
104	715061.641	309058.149	1305.228	1304.950	-0.278
105	773027.392	410632.910	1503.190	1503.237	+0.047
106	798744.577	361731.237	1536.375	1536.344	-0.031
107	738151.966	357566.489	1500.987	1501.025	+0.038
108	765131.274	482055.926	1454.830	1454.969	+0.139
111	727697.519	413925.433	1430.895	1430.662	-0.233
112	797324.724	323874.534	1576.186	1576.434	+0.248
114	699820.031	430381.580	1427.321	1427.144	-0.177
102V	842608.509	513266.352	1611.147	1611.041	-0.106
109V	823237.938	462105.012	1554.760	1554.693	-0.067
110V	840891.190	407391.482	1716.197	1716.165	-0.032
113A	862164.320	364234.924	1569.404	1569.470	+0.066
Average Dz		-0.028			
Minimum Dz		-0.278			
Maximum Dz		+0.248			
Root Mean Square		0.154			
Std Deviation		0.157			