

# Barron County Wisconsin LIDAR PROJECT

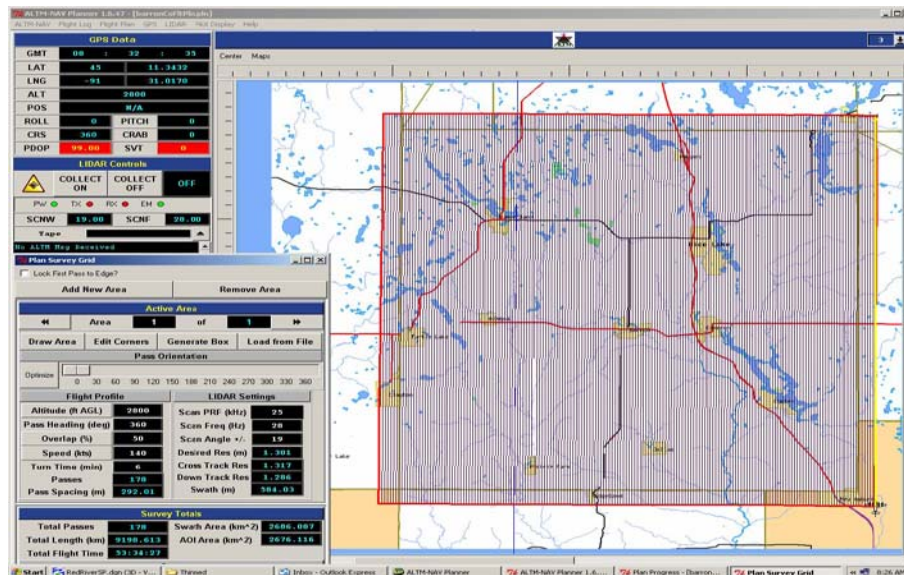
## PROJECT REPORT

### Introduction

LMSI was contracted to perform a LIDAR survey project of Barron County Wisconsin. The project consisted of airborne LIDAR data collection, aerial photo acquisition, GPS control for the LIDAR survey and aerial photography, GPS and conventional survey for ground truthing and quality assurance of the LIDAR bare earth DTM, and LIDAR mapping of the project area.

### LIDAR Data Acquisition

The project consisted of 1 flight area encompassing the county of Barron Wisconsin with an additional 1-mile collar extended outside of the county boundary. Twenty-one LIDAR survey missions were conducted to complete the Barron County Wisconsin LIDAR survey project. LIDAR data collection commenced on May 25, 2005 and concluded on June 8, 2005. Airborne navigation for the flight was from the airborne GPS system integrated with the Optech ALTM LIDAR system called ALTM NAV. The flight boxes shown below are from a screen capture from the ALTM NAV system. There were a total of 178 flight lines to complete the flight plus a calibration line with each flight session.



Laser Firing Rate:	25000
Altitude (ft. AGL):	2800
Swath Overlap (%):	50
Approx. Ground Speed (mph):	150
Scan Rate (Hz):	28.0
Scan Angle (°±):	19.0
Computed Along Track Spacing (ft.):	4.2
Computed Cross Track Spacing (ft.):	4.2
Average Raw Point Spacing (ft.)	3.0
Computed Swath Width (ft.):	1928
Number of Lines Req'd:	178
Line Spacing (ft.)	964

### Base Stations

A total of (3) GPS base station monuments were used for the LIDAR flights. The monuments used were:

NGS monument - Moose Ear (PID AH8947) located 6.45 MI east of the village of Cameron, 380 feet west of the centerline of 27<sup>th</sup> ST. 59 feet south of the center line of US HWY 8, 1 foot north of witness post.

NGS monument Barron (PID AH8948) located 0.8 MI (1.3 KM) west of the city of Barron in the NE 1/4 of the SE 1/4 of SEC 29, T34N,R12W, 4TH principal meridian, Town of Barron, Barron County. To reach the station from the city of Barron from the intersection of US HWY-8 and ST HWY-25 South go west along US HWY-8 0.7 mi (1.1 km) to the station on the left. Station is 408 ft (124.4 m) west of centerline of driveway house number 1388, 318 ft (96.9 m) east of centerline of driveway leading to city of Barron property, 62 ft (18.9 m) south of the centerline of US HWY-8, plastic witness posts set 1 ft (0.3 m) north and 13 ft (4.0 m) north of station.

NGS monument Almena Sportsmens (PID AH8949) station is located 1.6 mi (2.6 km) e of the village of Almena, 6.4 mi (10.3 km) w of the city of Barron in the nw 1/4 of the ne 1/4 of sec 29, t34n, r13w, 4th principal meridian, town of Clinton, Barron Co. To reach the station from the village of Almena from the intersection of US highway 8 and county trunk highway p, go east on US HWY 8 for 1.6 mi (2.6 km) to the station on the right. Located 0.35 mi (0.56 km) w of 8th street, 190 ft (57.9 m) east of the centerline of a driveway to Almena Sportsmens Club shooting range, 45 ft (13.7 m) south of the centerline of US HWY 8 and 1 ft (0.3 m) north of a witness post.

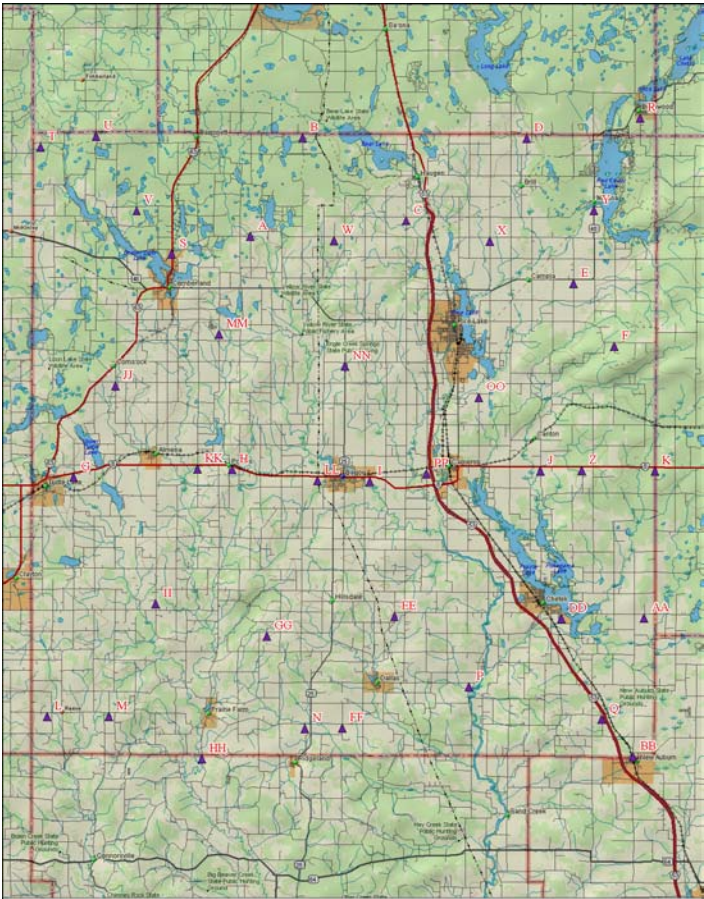
### LIDAR Missions

Twenty-one flights were required for the Barron County WI. LIDAR survey project with associated GPS base stations as shown below:

Flight 1 (5/25/05)– Base station Moose Ear (PID AH8947)  
Flight 2 (5/26/05)– Base station Moose Ear (PID AH8947)  
Flight 3 (5/26/05)– Base station Moose Ear (PID AH8947)  
Flight 4 (5/27/05)– Base station Moose Ear (PID AH8947)  
Flight 5 (5/28/05)– Base station Moose Ear (PID AH8947)  
Flight 6 (5/28/05)– Base station Moose Ear (PID AH8947)  
Flight 7 (5/29/05)– Base station Barron (PID AH8948)  
Flight 8 (5/29/05)– Base station Moose Ear (PID AH8947)  
Flight 9 (5/30/05)– Base station Barron (PID AH8948)  
Flight 10 (5/30/05)– Base station Barron (PID AH8948)  
Flight 11 (5/31/05)– Base station Barron (PID AH8948)  
Flight 12 (6/1/05)– Base station Barron (PID AH8948)  
Flight 13 (6/1/05)– Base station Barron (PID AH8948)  
Flight 14 (6/2/05)– Base station Barron (PID AH8948)  
Flight 15 (6/2/05)– Base station Almena Sportsmens (PID AH8949)  
Flight 16 (6/3/05)– Base station Almena Sportsmens (PID AH8949)  
Flight 17 (6/3/05)– Base station Almena Sportsmens (PID AH8949)  
Flight 18 (6/7/05)– Base station Almena Sportsmens (PID AH8949)  
Flight 19 (6/7/05)– Base station Almena Sportsmens (PID AH8949)  
Flight 20 (6/8/05)– Base station Almena Sportsmens (PID AH8949)  
Flight 21 (6/8/05)– Base station Almena Sportsmens (PID AH8949)

Survey Control

Forty ground control points (GCP) were established by the Barron County surveyors to control the LIDAR mapping of the Barron County Project area



Map  
symbol

- Location
- A - Intersection of CR B & 10 1/2 Street
  - B - Intersection of County Line Road (Barron-Washburn) & 13th Street
  - C - Intersection of CR B & 18th Street
  - D - Intersection of Bridge Road (Barron-Washburn County Line) & 23 3/4 Street
  - E - Intersection of Hwy 48 & 26th Street
  - F - Intersection of CR C & 28th Street
  - G - Intersection of Hwy 8 & 2nd Street
  - H - Intersection of Hwy 8 & 9 3/4 Street
  - I - 0.24 miles East of the Intersection of Hwy 8 & North 18th Street to the Intersection of Hwy 8 & Unclassified Road
  - J - Intersection of Hwy 8 & CR M
  - K - Intersection of Hwy 8 & County Line Road (Barron-Rusk)
  - L - 0.78 miles East of the Intersection of Polk Barron Street & CR A to the Intersection of CR A & Unclassified Road
  - M - Intersection of CR A & 3 3/4 Street
  - N - 0.28 miles West of the Intersection of Hwy 25 & CR A to the Intersection of CR A & Unclassified Road
  - P - Intersection of CR A (East-West & North-South) & CR I

Survey Control Cont.

Map  
symbol

Location

Q -	Intersection of 2nd Avenue & 27 1/2 Street
R -	In Birchwood (Washburn County) at the Intersection of South Main Street and Cedar Avenue
S -	Intersection of Hwy 63 & CR H
T -	0.38 miles East of the Intersection of Polk Barron Street and 29 1/2 Avenue to the Intersection of 29 1/2 Ave & Unclassified Street
U -	Intersection of CR H & 30th Avenue (Barron-Washburn County Line)
V -	Intersection of 26 1/2 Avenue & 5th Street
W -	Intersection of CR B & 14 1/2 Street
X -	Intersection of CR m (22nd Street) & 25th Avenue
Y -	Intersection of Hwy 48 & 26 1/2 Street (Avenue???) South Edge of Mikana
Z -	Intersection of Hwy 8 & 26 1/2 Street
AA -	Intersection of CR D & Undisclosed Road 0.50 miles from the 30th Street(Barron/Rusk County Line)
BB -	Intersection of CR SS & CR M (1/4 Ave)
DD -	Intersection of Lakeview Drive & N McClurg Avenue East edge of the Chetek Municipal-Southworth Public Airport
EE -	Intersection of CR D & 17 1/2 Street
FF -	Intersection of CR A & 15th Street
GG -	Intersection of 6th Avenue & Unclassified Road 0.64 miles West of 12th Street
HH -	Intersection of 1450th Avenue (Barron/Dunn County Line) & CR F
II -	Intersection of CR D & 7 1/2 Avenue
JJ -	Intersection of 18th Avenue & 4th Street South of Constock
KK -	Intersection of Hwy 8 & 8th Street
LL -	Intersection of Hwy 8 & the Intersection of the fork of 2 Unclassified Roads 0.75 miles East of 13th Street (CR T)
MM -	Intersection of CR T & 20 1/2 Avenue east of the Cumberland Airport
NN -	Intersection of Hwy 25 & 19th Avenue
OO -	Intersection of 21 1/2 Street & 17 1/4 - 17 1/2 Avenue South of Rice Lake
PP -	Intersection of CR O & CR W on the West edge of Cameron

### LIDAR Data Processing

#### Airborne GPS Trajectories

The airborne GPS trajectory solutions were processed in the field by our data acquisition team to insure we had high quality airborne trajectories, an important step in obtaining high accuracy in a LIDAR survey. Also, we kept our baseline lengths to less than 20 miles and planned our survey missions during times of low PDOP. Back in the office after data acquisition, we re-processed the airborne GPS to achieve the highest accuracy possible. The vertical RMS separation between the forward/reverse trajectory solutions ranged from 1cm-8cm. We use POS PAC software consisting of POS GPS and POS PROC for all airborne GPS processing. We use POS GPS to obtain the optimum trajectory solution and then run that solution through POS PROC that further refines the accuracy of the trajectory and smoothes the finished results. This completed trajectory solution is then output as an sbet file.

#### LIDAR System Calibration

We use the Optech suite of software called Realm for LIDAR x y z processing. In addition to the LIDAR system manufacturers' calibration, we do a flight calibration for each LIDAR mission. We re-fly all or a portion of one of the flight lines in each session in the opposite direction. We then process these two flight lines in Realm to x y z points and cross section each line over a flat surface. We use

this information to compute new calibration values for roll and scale. Once we have obtained the optimum results for the calibration lines, we use these values in the Realm software to compute the laser points for each flight session. The completed raw laser points are output in UTM meter format.

#### Data Conversion

When we have completed processing the LIDAR data, CorpsCon v6.0 is used to convert data to the Geoid 03 model. We then use WISCON v2.2 to convert the LIDAR x y z i points to the Barron County Wisconsin coordinate system.

#### Vertical Adjustment of the LIDAR DTM

The completed LIDAR x,y,z,i points are imported into Terra Model cad software by flight line, and all lines that flew over a GCP are noted in a spreadsheet with the control point value and difference. Preliminary adjustments are made to the flight lines called control lines, and then the remaining lines between the control lines are cross sectioned along roads and edge matched to tie in between control lines to within a few centimeters. Any areas that do not match to within a few centimeters are investigated. When all adjustment numbers and ties are complete and the flight lines adjusted to the control points, the LIDAR data is ready for vegetation removal.

#### LIDAR Data Classification

We use Terra Scan/ Terra modeler software for LIDAR data classification. The LIDAR flight lines are imported into Terra Scan and the LIDAR data classified to a bald earth surface model. Various parameters and iterations are utilized until the optimum project classification parameters are determined. These numbers will be utilized and an overall classification of the project will be run with the data being separated into ground, vegetation and water classes.

#### Ortho-DEM Generation

A sub-15cm RMSE Ortho-DEM grid was created using the classified bald earth data for Ortho-rectification of the aerial photography. The Ortho-DEM was generated from the classified bald earth DTM points and gridded at 15 feet with no breaklines incorporated into the surface.

#### Breakline Generation

Breaklines were generated in both Terra Scan and Terra Model. These breaklines were generated for water surfaces including rivers, lakes and ponds, to enhance the LIDAR data.

#### DTM Surface Model

We create a DTM surface model using the edited LIDAR classified bald earth points. We manually remove all erroneous points found in the data caused by multi path or water that were not addressed in processing.

#### Gridded Surface Model

A gridded bald earth surface model was generated from the edited LIDAR classified bald earth points incorporating the 3d breakline files into the surface. The surface was gridded at 6.5 feet and an x,y,z, point file exported by project tile.

#### Contour Generation

Contours were generated by Terra-Model CAD software at 2-foot increments from the Gridded Surface Model. Index contours were designated every 5<sup>th</sup> contour and were labeled with the respective elevation every 500 feet along the contour line and located on the Index\_text layer. Contours

designated as a depression were located on the Intermediate\_Dep layer, and Index\_Dep layer respectively. All contour files were converted to Shape files using the CAD2Shape v2.0 software.

#### Data Output

The LIDAR x y z i data for the first return and last return bald earth were imported into the Terra Scan project and output by project tiles. The classified bald earth x y z points were also output by project tiles and delivered as DTM files.

#### Delivery files

Files delivered used the project tile nomenclature and the following suffixes:

\_dtm.pts – DTM Surface Module points

\_grid.pts – Gridded DTM Surface Module points

\_brkline.dxf – 3d Breaklines

\_contours.dxf – 2-ft contours with elevation labels

\_hydros.dxf – 3d water surface breaklines

Shape files: contours.dbf

contours.shp

contours.shx

#### Summary

All the LIDAR flights were executed as planned. There were no unusual occurrences and all equipment operated normally. The LIDAR flights provided complete area coverage with no data holidays. All data voids in the bald earth points are from water surfaces. LIDAR points become sparse in areas of dense vegetation, but typically are closer than 15 or 20 feet, with occasional areas with very dense canopy with points greater than 50'. No data anomalies were encountered. Data accuracy and quality is very good with an RMSE of 0.33 feet or 10cm at the 95% distribution.