April 18, 2017

FEMA Topographic Data
Aerial LiDAR Data Collection & Processing
Calhoun County, MI
Project Plan (Pre-flight)

Purpose

The Strategic Alliance For Risk Reduction (STARR II) has been tasked to provide the Federal Emergency Management Agency (FEMA) with topographic data for Calhoun county, Michigan. For this effort, Continental Mapping Consultants (Continental) collected, processed, and classified high accuracy LiDAR data.

The area of interest (AOI) covers approximately seven hundred eighteen (718) square miles and is located in south central Michigan.

Planned Schedule

Data Acquisition- November 18, 2016 – April 30, 2017
Data Processing-May 1, 2017-July 27, 2017
Data Delivery-July 28, 2017

Project Personnel

Project Manager- (Project POC)	Benjamin Leonard Continental Mapping Consultants Inc Continental Building 121 South Bristol Street Sun Prairie, WI 53590 Phone #-> (608) 501.1561 Email->bleonard@continentalmapping.com
Survey Crew	Compass Data Inc.

Prior to the survey or aerial lidar acquisition, Continental will contact the STARR II POC of the specific dates in which staff and/or aircraft will be onsite.

Aircraft & Sensor Information

Aircraft-> PA-31 Piper Navajo Chieftain
Registration/Ownership->Kucera International
Sensor->Leica ALS70 (SN7232_HP)
Planning Software-> Leica's AeroPlan

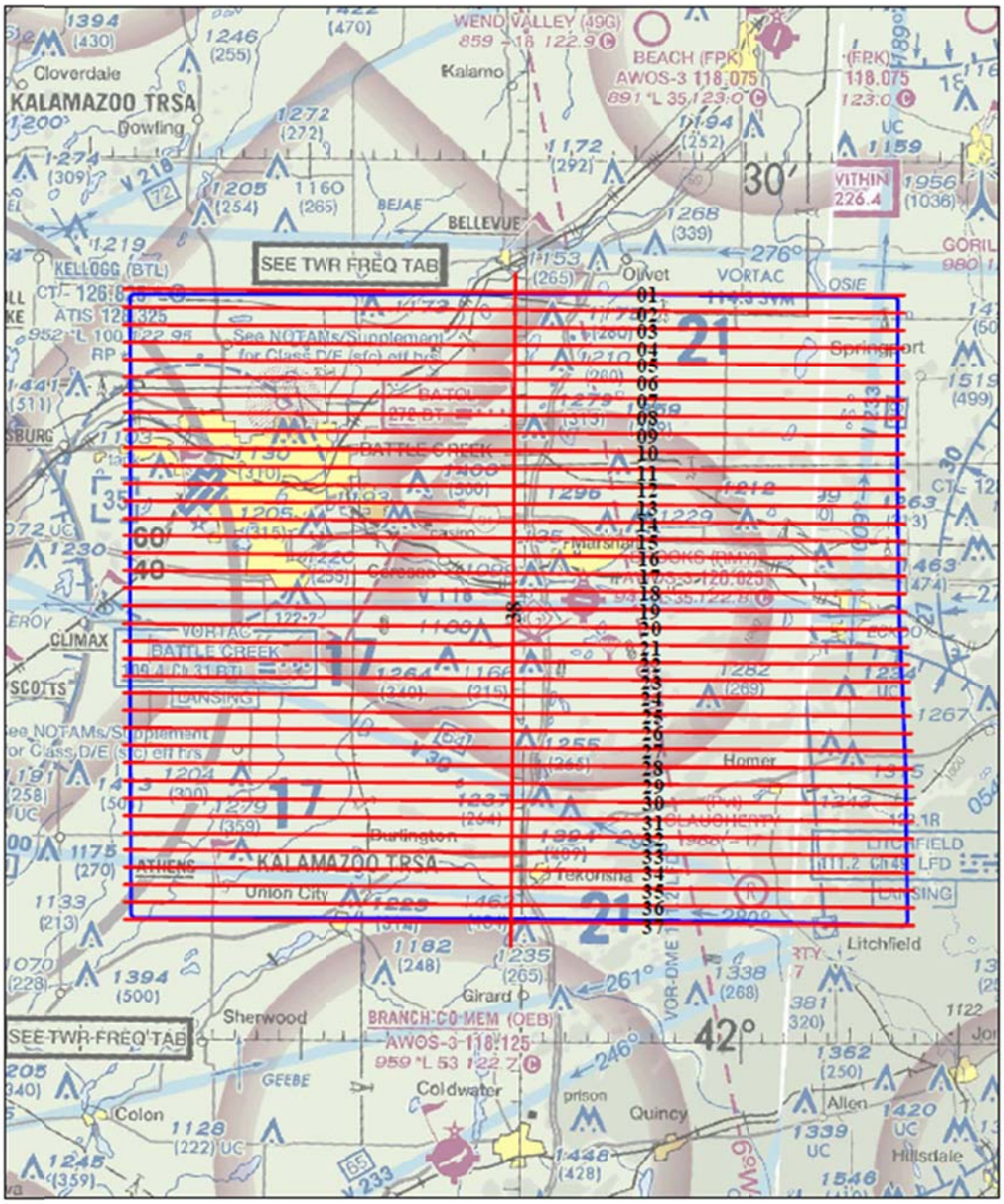
Acquisition Parameters

Description	Computed	Target	Unit
Sensor ID	ALS70_SN7232_HP		
Terrain and Aircraft	PA-31 Piper Navajo Chieftain		
Reference Height	208 - 305		m
Flying Height AGL	1981 - 2078	2078	m
Altitude AMSL	2286 / 7500		m/ft
Recommended Ground Speed (GS)	150	150	kts
Scanner			
Field of View (FOV)	38.0	38.0	degrees
Maximum Scan Rate	54.7		Hz
Scan Rate Setting used (SR)	48.1		Hz
Aircraft Speed Sensitivity	2.88		kts
Delta Scan	48.55 - 53.86		# scans
Automatic scan delta optimization	not possible	enabled	
Laser			
Maximum Laser Pulse Rate	263200		Hz
Laser Pulse Rate used	263200		Hz
Multi Pulse in Air Mode	2	2	
Fixed Gain	255		
Range Intensity mode	7		
Nominal Maximum Slant Range	2255.90		m
Minimum Range Gate	1339.03		m
Maximum Range Gate	2257.07		m
Range Gate size	918.04		m
Range margin above hills	641.97		m
Range margin below valleys	56.10		m
Recommended Laser Power	100		%
Coverage			
Full Swath Width	1431.03		m
Coverage Rate (No line optimization)	346.24		km^2/h
Recommended Line Spacing (No DTM)	1246.35		m
Minimum Sidelap (No DTM, lower)	12.91		%
Minimum Sidelap (upper)	8.64		%
Point Spacing and Density			
Maximum Point Spacing Across Track	1.27		m
Maximum Point Spacing Along Track (in phase)	1.60		m

Optimal Point Spacing Along Track (out of phase)	0.80		m
Across Track/Along Track Ratio	0.79	0.72	
Average Point Density	2.38	1.00	pts / m^2
Average Point Spacing	0.65		m
Worst case Point Density	1.96		pts / m^2
Reflectivity and SNR			
Illuminated Footprint Diameter	0.48		m, 1/e^2
Terrain Reflectivity	0.10		
Estimated SNR for diffuse targets	13.82 - 12.82		
Line/Rail Cross Section	10.00		mm
Line/Rail Reflectivity	0.30		
Best Case Wire SNR	1.15 - 0.00		
Average SNR	13.32	25.00	
Accuracy			
Estimated Across Track Accuracy	0.20 - 0.22		m
Estimated Along Track Accuracy	0.20 - 0.22		m
Estimated Height Accuracy	0.08 - 0.11		m
Eye safety			
Eye Safety Shutoff Distance (Binoculars)	1069		m
Eye Safety Shutoff Distance (naked eye)	166		m
WFD Configuration			
Waveform configuration set	False		

Proposed Flight Lines

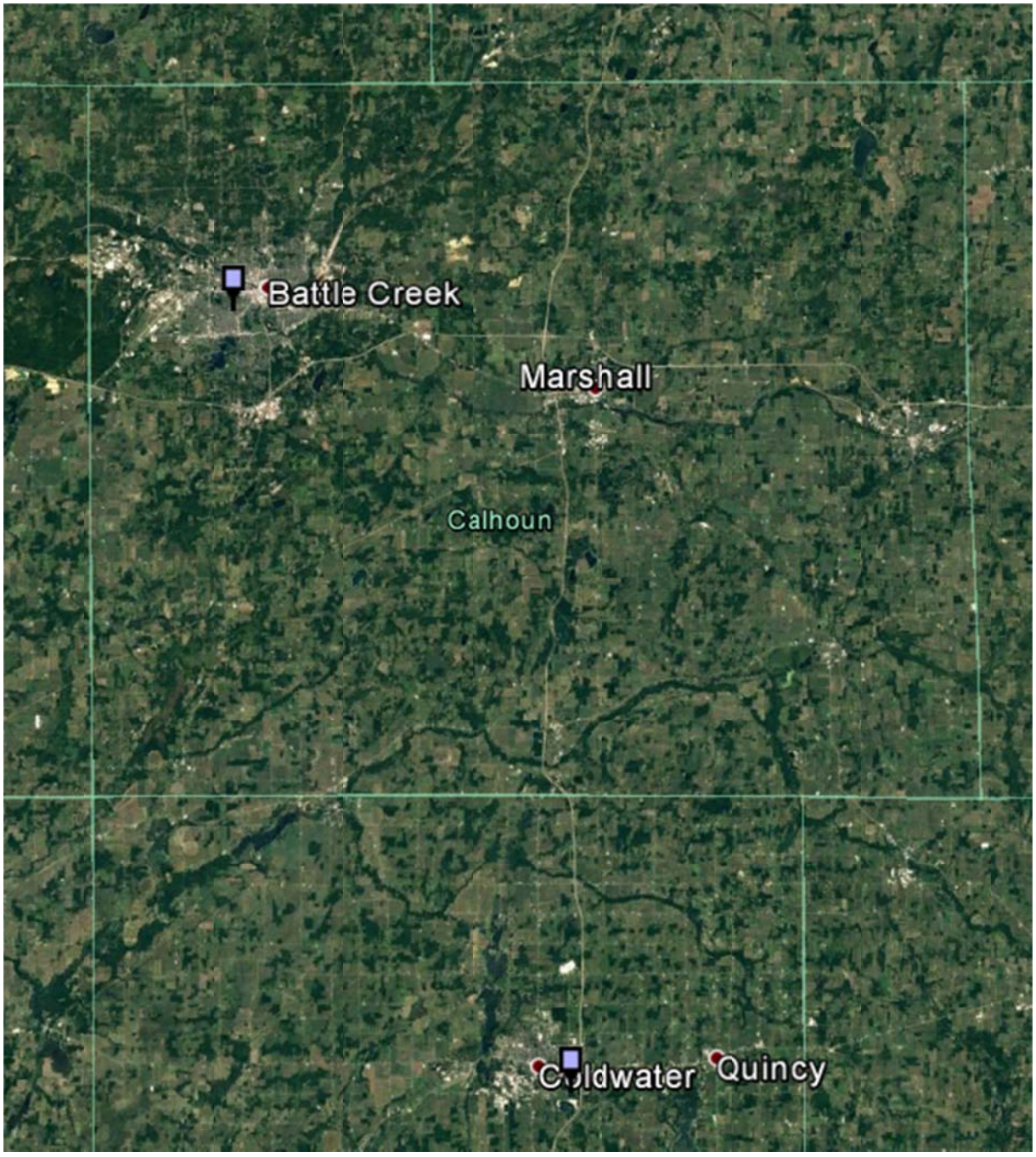
60765 Calhoun Co, MI



ALS70 Lines 1-38 @7500' MSL

Base Stations

Battle Creek- MIBC (Michigan Department of Transportation)
Coldwater – MICW (Michigan Department of Transportation)



Risk

In the occurrence that an issue arises with the primary aircraft or sensor, Continental's partner has a Leica ALS 80 and aircraft stationed in Willoughby OH, that will be utilized. If re-flights are determined to necessary, re-flights will occur as soon as weather permits.

Calibration Processing/Testing Methodology

The team will utilize a number of software packages to complete the calibration process. Below are the individual tasks and software packages.

The Continental team utilized Leica's CloudPro to initially process the data and convert into LAS format. TerraMatch was then used to refine the calibration of the LiDAR dataset. The trajectory files and point cloud swaths are imported into GeoCue to perform project setup. This project set up phase sets the project parameters, tiling scheme, and is the platform for initial macro runs. After the LiDAR boresite calibration is checked, the flight lines are then adjusted using a z-bump method to each other to within projection specifications for relative accuracy. Control values are run against the point cloud to verify the accuracy of the data prior to classification. Flightline separation images are created to confirm the LiDAR dataset is within project specifications for relative accuracy. A final overall z adjustment is performed to the ground survey control.

Internal Verification Quality Control

Continental will utilize various software packages and techniques to verify the accuracy of the data. Utilizing QCoherent's LP360, Continental will run a survey to las check, followed by seamline analysis. The survey to las check will calculate the deviation between the survey point elevation and the point cloud elevation and export a Non-Vegetated Vertical Accuracy (NVA) report. The second check will check the seamlines of the point cloud swaths. The third check, the Vegetated Vertical Accuarcy (VVA) testing will occur after the ground classification has been completed. Other software like Terra Solid and Global Mapper will be utilized to verify the results of LP360. Once all of the deliverables have been produced and verified, the data will move to the Quality office for final review. The Quality office will verify that the correct procedures were followed, test the data, and will verify that all of the deliverables in the SOW are finished.

LIDAR REPORT

FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

AERIAL LIDAR DATA COLLECTION & PROCESSING

CALHOUN COUNTY, MICHIGAN

DATA CREATED BY THE STRATEGIC ALLIANCE FOR RISK REDUCTION (STARR II)

CONTINENTAL MAPPING CONSULTANTS, INC.

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Overview

1.1 Vendor Contact Information:

Continental Mapping Consultants, Inc.
121 South Bristol Street
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(888) 815-3327

Contact: Benjamin Leonard
Telephone: (608) 501.1561
Email: bleonard@continentalmapping.com

1.2 Purpose

The Strategic Alliance for Risk Reduction (STARR II) has been tasked to provide the Federal Emergency Management Agency (FEMA) with topographic data for Calhoun County, Michigan. For this effort, Continental Mapping Consultants (Continental Mapping) collected, processed, and classified high accuracy LiDAR data.

The area of interest (AOI) covers approximately seven hundred eighteen (718) square miles and is located in south central Michigan. The AOI and specific project boundary are shown in Figure 1.3.

Project Specifications/Accuracy Requirements

The specifications of this project were designed to conform to all applicable FEMA Standards, USGS LiDAR Base Specification v1.2 (2014), ASPRS LAS Specification Version 1.4-R13 (2013), and ASPRS Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014).

LiDAR will be collected considering the following requirements:

- Atmospheric conditions will be cloud and fog free between the aircraft and the ground
- Ground conditions will be snow free without extensive flooding or other inundation

The county boundary was downloaded from the State of Michigan website, and buffered by 100 meters. All LiDAR point cloud data, breaklines, and DEMs were developed to the extent of the buffered project area.

The classification codes followed the USGS LiDAR Base Specification v1.2 (2014) classes utilizing the following:

- Class 1 – Processed, but unclassified
- Class 2 – Bare earth
- Class 7 – Low noise
- Class 9 – Water
- Class 10 – Ignored ground (near a breakline)
- Class 17 – Bridge decks
- Class 18 – High noise

Class 1 will be used for feature points that are not in Classes 2, 7, 9, 10, 17 and 18.
Class 2 will be used for feature points that represent the bare-earth.
Class 7 will be used for feature points that represent low noise.
Class 9 will be used for feature points that represent water.
Class 10 will be used for feature points that represent ignored ground near breaklines.
Class 17 will be used for feature points that represent bridge decks.
Class 18 will be used for feature points that represent high noise.

Resolution of LiDAR – To comply with the USGS Lidar Base Specification QL2, the project was flown at an altitude to produce at least 2 ppsm.

Quality Level (QL)	Aggregate nominal pulse spacing (ANPS) (m)	Aggregate nominal pulse density (ANPD) (pls/m^2)
QL0	≤0.35	≥8.0
QL1	≤0.35	≥8.0
QL2	≤0.71	≥2.0
QL3	≤1.41	≥0.5

Figure 1.1 Nominal Pulse Spacing Requirements

Absolute Vertical Accuracy Requirement

The USGS Lidar Base Specification QL2 non-vegetated RMSE accuracy requirement is 10 cm RMSE.

Quality Level (QL)	$RMSE_z$ (nonvegetated) (cm)	NVA at 95-percent confidence level (cm)
QL0	≤5.0	≤9.8
QL1	≤10.0	≤19.6
QL2	≤10.0	≤19.6
QL3	≤20.0	≤39.2

Figure 1.2 Project Accuracy Requirements

Deliverables

- Certification of Compliance
- Flight Logs
- Raw lidar point cloud swaths in LAS v1.4
    - Including associated swath index in shapefile format
- Tiled/classified lidar point clouds in LAS v1.4
    - Including associated tile index in shapefile format
    - The tile scheme shall be 5,000 X 5,000 foot
- 3D breakline shapefiles
    - Including associated breakline tile index in shapefile format
- File Geodatabase
    - Including topology report
- Hydro-Flattened DEMS in ERDAS Imagine .IMG 32-bit floating point format
    - Including associated DEM tile index in shapefile format
- Acquisition Spatial Data
- Metadata
- Ancillary Information

Figure 1.3: Calhoun County, Michigan

Project Constraints

- Lake effect snow.
- Lake effect clouds.
- Required lower altitude flights, due to cloud ceiling height
- Leaf Off requirement

2.0 Acquisition

2.1 Project Planning

Planning was based on project requirements, constraints and industry best practices. The project area was defined based on the required accuracies, geometry of the project area, the amount and type of vegetation and the required data post spacing. A brief summary of the aerial acquisition parameters for this project are shown in Table 2.1. To meet the accuracies required, a control layout including checkpoints was developed, presented to the STARR II for review and surveyed by Compass Data, Inc. along with the require validation points

Table 2.1: Planned LiDAR System Specifications

Parameters	10 cm RMSEz (non-vegetated)
Flying Height	2078 m AGL
Aircraft Ground Speed (knots)	150
Pulse Rate (Hz)	263200
Scan Rate (Hz)	48.1
Full Field of View (degrees)	38
Multi-Pulse	Yes
Full Swath Width (meters)	1431
Swath Overlap (percentage)	20%
Max. Point Spacing Across Track (meters)	1.24
Max. Point Spacing Along Track (meters)	1.6
Average point density (pts/mˆ2)	2.38
Lowest point density (pts/mˆ2)	1.96

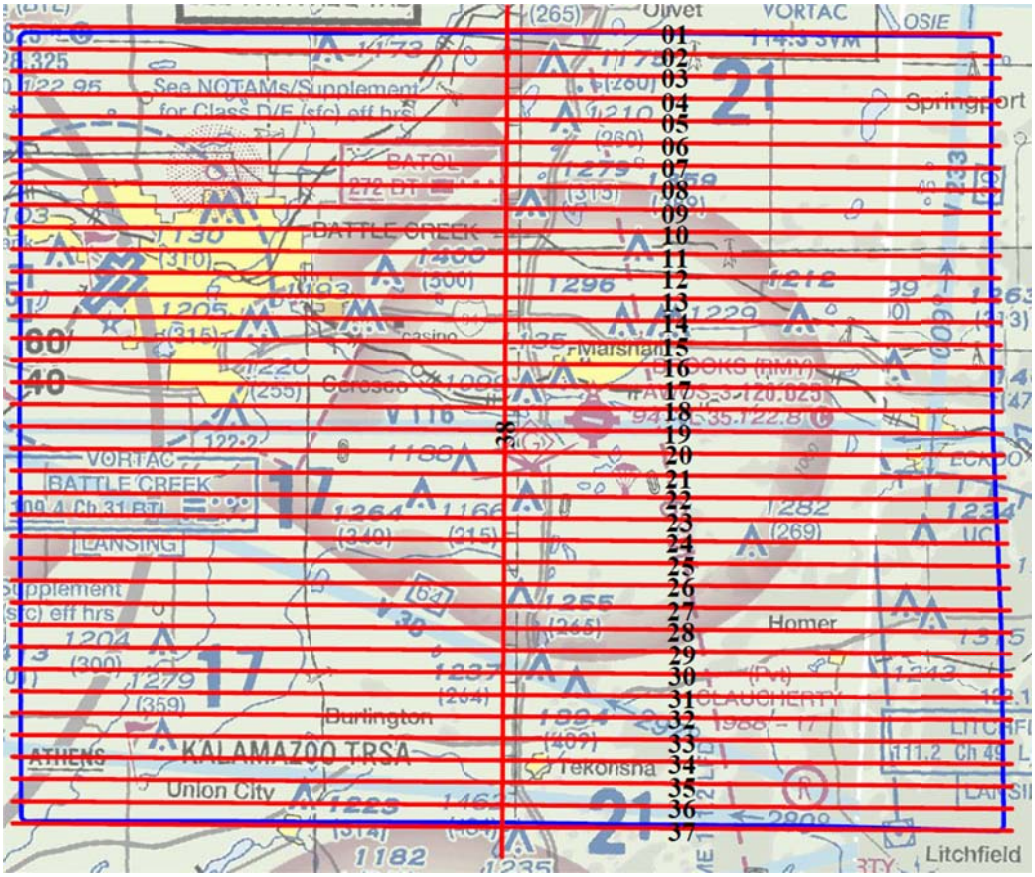


Figure 2.1 Planned Flight Lines

2.2 Ground Survey

All survey responsibilities were performed by Compass Data, Inc.

Datum
Coordinate Reference System: Michigan State Plane South, FIPS 2113
Horizontal Datum: NAD83 (2011), Epoch 2010.00
X, Y Linear Units: International Survey Feet
Vertical Datum: NAVD88, Geoid 12B
Z Linear Units: International Survey Feet

2.3 Aerial LiDAR

Aerial LiDAR Base Station
The base stations determine where LiDAR can be collected with the highest confidence of accuracy by measuring both satellites and base stations. Base Stations typically are set at airports and provide a 20 to 25 mile radius. Due to the timing constraints of weather and leaf

off conditions requirement and the high quality of the CORS network, the MIBC station located in Battle Creek and the MICW station located in Coldwater were used for this project. Both stations collect a 1 second sampling rate and are maintained by the Michigan Department of Transportation. TerraPOS was then used for processing.

Aerial LiDAR Boresight Procedures

The purpose of boresighting is to determine the offset values for the IMU used in the LiDAR sensor. To determine the boresight offset values, the LiDAR sensor has to be flown in a certain configuration over a well-controlled site. The boresighting is done both prior to the flight of the project area and after. This insures that the quality of the LiDAR was maintained throughout the process.

Aerial LiDAR Acquisition

The aerial survey teams were deployed at the first opportunity based on acceptable weather conditions. Due to snow cover and lake effect precipitation, the flight was delayed until April. Leica's AeroPlan software was utilized to conduct the final flight planning. The sensor used was a Leica ALS70, which is owned and operated by Kucera International. There were 37 project flight lines, and 1 cross flight collected. The LiDAR acquisition started on April 18, 2017. Due to weather concerns approaching, two aircraft were initially deployed. At date of the flight the weather was clear & smooth with low winds and low turbulence. Due to sensor complications, a re-flight of the northern portion of the county was performed 5 days later on April 23, 2017.

Table 2.2 Flight Specifications

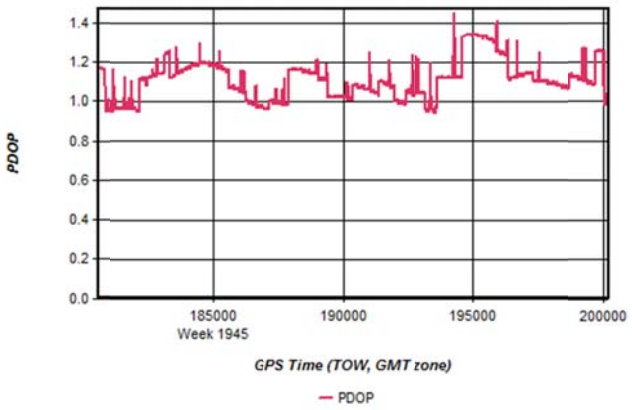
Parameters	10 cm RMSEz (non-vegetated)
Altitude AMSL (ft)	7500
Aircraft Ground Speed (knots)	150
Pulse Rate (kHz)	263.2
Scan Rate (Hz)	48.1
Full Field of View (degrees)	38
Multi-Pulse	Yes
Full Swath Width (ft)	4650
Swath Overlap (percentage)	20%
Max. Point Spacing Across Track (meters)	1.24
Max. Point Spacing Along Track (meters)	1.6
Average point density (pts/m^2)	2.3
Lowest point density (pts/m^2)	1.96

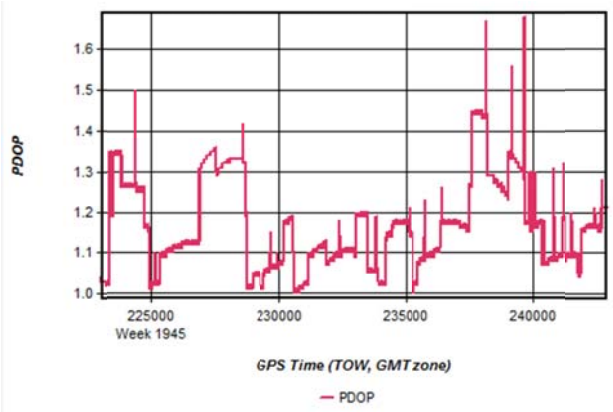
Table 2.3: Flight Line Detail

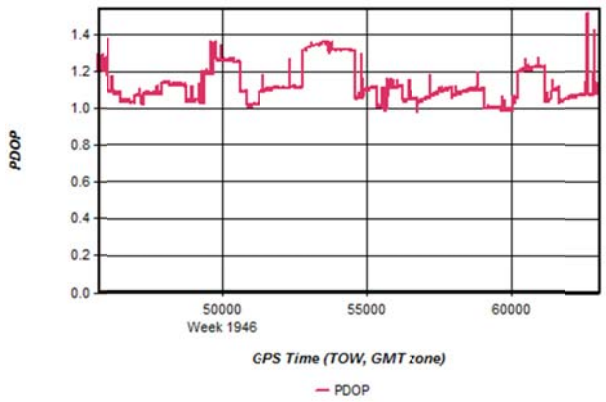
Flight Plan Line	LAS LINE	TRJ NAME	Flight Date
1	20513	170430	04/23/17
2	20512	165050	04/23/17
3	20511	163706	04/23/17
4	20510	162345	04/23/17
5	20509	160957	04/23/17
6	20508	155624	04/23/17
7	20507	154236	04/23/17
8	20506	152855	04/23/17
9	20505	151507	04/23/17
10	20504	150131	04/23/17
11	20503	144726	04/23/17
12	20502	143410	04/23/17
13	20501	141945	04/23/17
14	20301	023433	04/18/17A
15	20302	024901	04/18/17A
16	20303	030512	04/18/17A
17	20304	031613	04/18/17A
18	20305	032858	04/18/17A
19	20306	034322	04/18/17A
20	20307	035618	04/18/17A
21	20308	041017	04/18/17A
22	20309	042303	04/18/17A
23	20310	043746	04/18/17A
24	20311	045046	04/18/17A
25	20312	050501	04/18/17A
26	20313	051818	04/18/17A
27	20314	053147	04/18/17A
28	20315	054451	04/18/17A
29	20316	055910	04/18/17A
30	20317	061217	04/18/17A
31	20318	062612	04/18/17A
32	20319	063903	04/18/17A
33	20320	065302	04/18/17A
34	20401	142009	04/18/17B
35	20402	143403	04/18/17B
36	20403	144833	04/18/17B
37	20404	150207	04/18/17B
38	20321	071045	04/18/17A

Position Dilution of Precision Report (PDOP)

Solar activity reached low levels on 17-18 Apr due to isolated C-class flare activity from Region 2651 (N12, L=070, class/area=Cso/150 on 23 Apr), but solar activity was at very low levels through the remainder of the period (19-23 Apr).







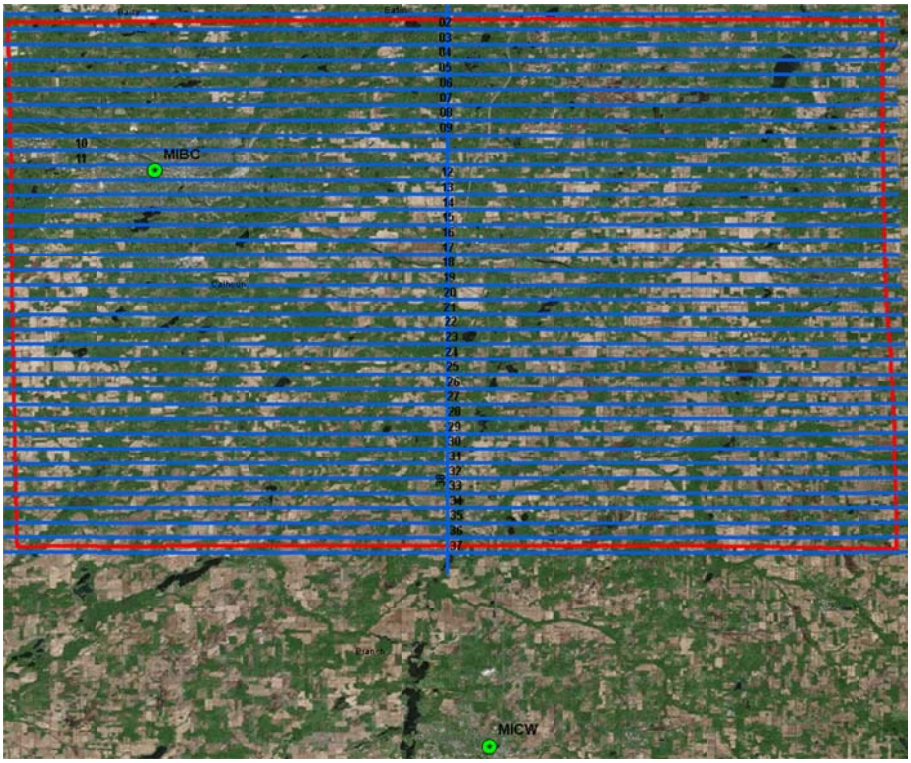


Figure 2.5: Acquired LiDAR Flight Lines/Base Station Locations

Project Site Definition	
Min/Max Ground Elevation	650-1000'
Flight Altitude AGL	6600'
Geographic Location	Calhoun Co, MI
Distance Units	Int'l Feet
Coordinate System	SPC - MI-S
Horizontal Datum	NAD83 - 2011
Vertical Datum	NAVD88 – Geoid12A
Leica ALS70 System Settings (SN7232)	
Scan FOV	38
Flying Altitude AMSL	7500
Laser Pulse Rate (Hz)	263200
Scan Rate (Hz)	48.1
Laser Power %	100
Raw Laser Statistics	
Swath Width	4650
Flight Line Spacing	3650.00
Footprint Diameter	1.5'
Average Point Density	2.3 points/sq meter
Average Point Spacing	2.1'
Flight Mission Data	

Aircraft	PA-31 Piper Navajo Chieftain
Date Flown	04/18/17, 04/23/17
Number of Flight Lines	38
Total Flight Line Miles	1200
Flight Speed	~150knots
LiDAR Notes	data is unclassified, unbumped, calibrated
Base Station Type	CORS
GPS/INS Notes	Multi-CORS/TPOS
Data Processing	
New Boresight Calibration?	yes
Boresight Reg. File Name	041817A,041817B,042317.tms
Minimum/Maximum Scan Angle Output	+/- 19 degrees
Actual Scan Angle Output	full FOV
Tile Layout Used	arbitrary
Class 1	Unclassified
Data Formats Created	LAS v1.4
Data Formats Delivered to Client	data is unclassified, unbumped, calibrated
Processing Notes	
Accuracy Results	
Number of Control Points Used in Analysis	25
Number of Control Points Eliminated from Original Set	0
Reasons for Point Removal	N/A
Average Elevation Variation	0.449
Minimum Elevation Dz	0.183
Maximum Elevation Dz	0.821
RMS	0.484
Standard Deviation	0.186
Horizontal Accuracy	<1m

3.0 Processing Summary

The Continental Mapping team utilized Leica's CloudPro to initially process the data and convert it into LAS format. TerraMatch was then used to refine the lidar dataset's calibration. The trajectory files and point cloud swaths are imported into GeoCue to perform project setup and calibration QC. This project set up phase sets the project parameters, tiling scheme, and is the platform for initial macro runs. After import, checkpoints are run against the point cloud to verify the accuracy of the data prior to classification. The detailed description of this process is below in 4.0 Accuracy Assessment. After verifying the accuracy, the processing continues.

Multiple macros are run through TerraScan to flag overlap, and to classify the ground. Due to differing terrain, this step may take multiple iterations. Once the analyst has verified the results with the ground macro, the ground classification QC begins. During the QC phase, analysts are reclassifying the point cloud in areas where the macro was not able to, or were misclassified. Multiple macros are run on the dataset after the ground classification is complete including water macros. The water macros utilize the hydro breaklines that were manually digitized. These digitized breaklines were classified as ponds and rivers. After the hydro features were digitized, the ponds were flattened. This process calculated the lowest elevation of the feature, and used that elevation to populate the remaining vertices. This process verifies that all ponds are flat. The river polygons that were digitized were ran against a monotonicity tool. This tool utilized the elevation of a centerline that had the correct elevation and pushed that elevation to the river polygon. This process not only maintains the monotonicity of the river, but also ensures that the river is flat from bank to bank. Then rigorous quality steps are performed each classification level. The bare earth lidar points that were within 3 feet of the water were classified to class 10. After the analysts have completed the QC process in TerraScan, raster files were produced into 32-bit floating GeoTiffs and Erdas Imagine IMG files using Global Mapper. These files were created using only the ground and building classes. The DEMS are ran against proprietary tools to identify any remaining potential blunders. These checks look for issues with the breaklines, and the overall DEM deviations.

4.0 Accuracy Assessment

Continental Mapping utilized various software packages and techniques to verify the accuracy of the data. Utilizing QCoherent's LP360, Continental Mapping ran a survey to las check, followed by seamline analysis (swath to swath analysis) to verify the absolute and relative accuracy of the dataset. The survey to las check calculates the deviation between the survey point elevation and the point cloud elevation and exports an RMSE report. This check was ran by Continental Mapping, utilizing the provided control, and by Compass Data Inc. utilizing the NVA points. The second check, calculates the deviation between the seamlines of the point cloud swaths. This check is performed in QCoherent's GeoCue after classifying the initial ground. The output of the seamline analysis is represented visually on an intensity image. These images were delivered with the project deliverables. Below is the specification for this check.

Quality Level (QL)	Smooth surface repeatability (cm)	Swath overlap difference, $RMSD_Z$ (cm)	Swath overlap difference, maximum (cm)
QL0	≤3	≤4	±8
QL1	≤6	≤8	±16
QL2	≤6	≤8	±16
QL3	≤12	≤16	±32

Table 4.1 Seamline analysis requirements

The third and final check, the Vegetated Vertical Accuracy (VVA) testing occurred after the ground classification has been completed. The VVA testing was performed by Compass Data Inc.

Quality Level (QL)	$RMSE_z$ (nonvegetated) (cm)	NVA at 95-percent confidence level (cm)	VVA at 95th percentile (cm)
QL0	≤5.0	≤9.8	≤14.7
QL1	≤10.0	≤19.6	≤29.4
QL2	≤10.0	≤19.6	≤29.4
QL3	≤20.0	≤39.2	≤58.8

Table 4.2 NVA and VVA accuracy requirements

Non-Vegetated Vertical Accuracy Assessment
There were 45 NVA points collected and tested in Calhoun County. Below are the results.

Summary is in International Feet			International Feet	Meters
Z Mean	0.03	RMSE:	0.168	0.051
Z Min:	-0.37	* 1.9600	0.330	0.100
Z Max:	0.37			

Vegetated Vertical Accuracy Assessment
There were 35 VVA points collected and tested in Calhoun County. Below are the results.

Summary is in International Feet			International Feet	Meters
Z Average	0.06	RMSE:	0.300	0.091
Z Min:	-0.79	* 1.9600	0.587	0.179
Z Max:	0.64	95th Percentile	0.366	0.112

Once all of the deliverables had been produced and verified, the data was moved to the Quality office for final review. The Quality office determined that the correct procedures were followed, tested the data, and verified that all of the deliverables in the SOW were finished.

APPENDIX A FLIGHT LOG

KUCERA INTERNATIONAL INC.

LiDAR FLIGHT REPORT

	Pilot/Operator			*Tail Number*			*Sky conditions, light conditions, horizon, shadowing, visibility/haze, cloud types, wind, turbulence, etc..*										
CREW	B.Sell/ Nico		AIRCRAFT	350GB		WEATHER	clear										
	mm/dd/yy																
DATE	4/22/2017				GPS source			LiDAR STARTUP CHECKS			SSD						
	LIDAR #			*used*	fwd			*Lens cleaned*			Drive #						
Camera System	7232							*All fpds uploaded*			*SSD2*						
	fwd/aft							*Pilot's screen functional*			*Space Rem.*						
Camera Location (Hole)	fwd				Start-up	Shut-down		*Compact flash drive space*			200						
				Time				*SSDs have space*									
				Location	KLNN	KBTL		*Startup beeps & IPAS recording*									
									Initials:	NC							

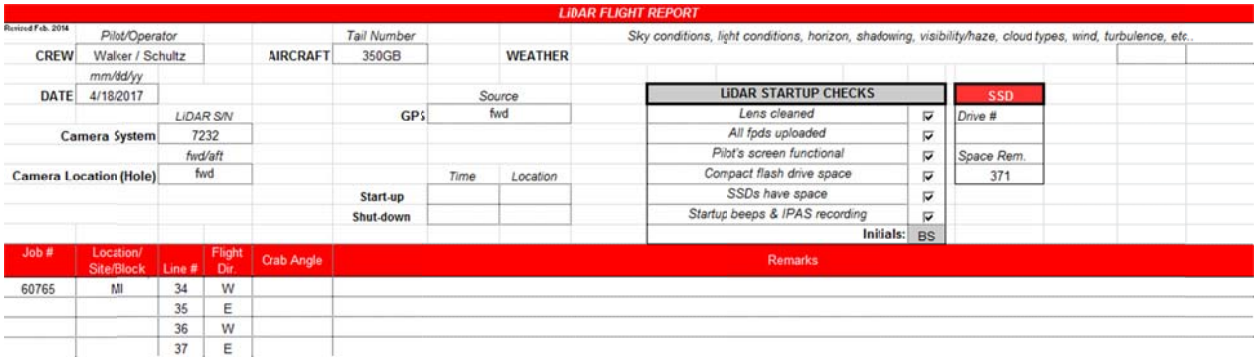
Job #	Location/ Site/Block	Line #	Flight Dir.	Crab Angle	Remarks
Sandborn	60739	382	W		
		383	E		
		384	W		
		385	E		
		386	W		
		387	E		
		388	W		
Calhoun	60765	13	W	0	
		12	E	0	
		11	W		
		10	E		
		9	W	2	
		8	E		
		7	W		
		6	E		
		5	W	3	
		4	E		
		3	W		
		2	E	3	
		1	W		

LiDAR FLIGHT REPORT

Revised Feb. 2014

	Pilot/Operator			*Tail Number*			*Sky conditions, light conditions, horizon, shadowing, visibility/haze, cloud types, wind, turbulence, etc..*										
CREW	Jay/Fay		AIRCRAFT	350GB		WEATHER											
	mm/dd/yy																
DATE	4/17/2017				*Source*			LiDAR STARTUP CHECKS			SSD						
	LIDAR S/N			GPS	Fwd			*Lens cleaned*			*Drive #*						
Camera System	7232							*All fpds uploaded*			SSD3						
	fwd/aft							*Pilot's screen functional*			*Space Rem.*						
Camera Location (Hole)	Fwd				*Time*	*Location*		*Compact flash drive space*			371						
				Startup	2:10	KJXN		*SSDs have space*									
				Shut-down	7:37	KJXN		*Startup beeps & IPAS recording*									
									Initials:	AF							

Job #	Location/ Site/Block	Line #	Flight Dir.	Crab Angle	Remarks
60765	Calhoun CO	14	E-W	5	
		15	W-E	6	
		16	E-W	5	
		17	W-E	6	
		18	E-W	5	
		19	W-E	6	
		20	E-W	5	
		21	W-E	6	
		22	E-W	5	
		23	W-E	6	
		24	E-W	5	
		25	W-E	6	
		26	E-W	5	
		27	W-E	6	
		28	E-W	5	
		29	W-E	6	
		30	E-W	5	
		31	W-E	6	
		32	E-W	5	
		33	W-E	6	
		38	S-N	5	



LiDAR FLIGHT REPORT

Revised Feb. 2014

	Pilot/Operator		Tail Number		Sky conditions, light conditions, horizon, shadowing, visibility/haze, cloud types, wind, turbulence, etc..		
CREW	Walker / Schultz	AIRCRAFT	350GB	WEATHER			
	mm/dd/yy						
DATE	4/18/2017			Source			
	LiDAR S/N		GPS	fwd			
Camera System	7232						
	fwd/aft						
Camera Location (Hole)	fwd			Time	Location		
			Start-up				
			Shut-down				

LiDAR STARTUP CHECKS		SSD
Lens cleaned	☑	Drive #
All fpds uploaded	☑	
Pilot's screen functional	☑	Space Rem.
Compact flash drive space	☑	371
SSDs have space	☑	
Startup beeps & IPAS recording	☑	
Initials:	BS	

Job #	Location/ Site/Block	Line #	Flight Dir.	Crab Angle	Remarks
60765	MI	34	W		
		35	E		
		36	W		
		37	E		