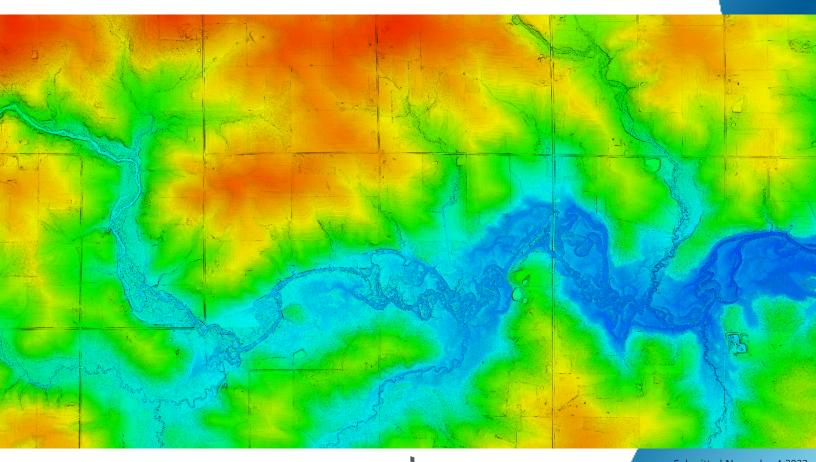
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37876_WI_Statewide_2021_B21 LIDAR PROCESSING REPORT

2022

Submitted: November 4, 2022

Project ID: 218061 Work Unit: 218061

Prepared for:



National Map Help Desk: tnm_help@usgs.gov

Prepared by:





Contents

1. Summary / Scope	
1.1. Summary	
1.2. Scope	1
1.3. Coverage	
1.4. Duration	1
1.5. Issues	1
2. Planning / Equipment	4
2.1. Flight Planning	4
2.2. Lidar Sensor	4
2.3. Aircraft	6
2.4. Time Period	7
3. Processing Summary	8
3.1. Flight Logs	8
3.2. Lidar Processing	9
3.3. LAS Classification Scheme	10
3.4. Classified LAS Processing	
3.5. Hydro-Flattened Breakline Processing	11
3.6. Hydro-Flattened Raster DEM Processing	
3.7. Swath Separation Raster Processing	
3.8. Maximum Surface Height Raster Processing	13
4. Project Coverage Verification	
5. Accuracy Testing	
5.1. Calibration Control Point Testing	17
5.2. Point Cloud Testing	17
5.3. Digital Elevation Model (DEM) Testing	
6. Geometric Accuracy	22
6.1. Horizontal Accuracy	22
6.2. Relative Vertical Accuracy	23
Project Report Appendices	xxiv
Appendix A	xxv
Flight Logs	VVV



List of Figures

Figure 1. Work Unit Boundary	3
Figure 2. Riegl VQ1560ii Lidar Sensor	
Figure 3. Some of NV5 Geospatial's Planes	
Figure 4. Lidar Tile Layout	
Figure 5. Lidar Coverage	
Figure 6. Calibration Control Point Locations	
Figure 7. QC Checkpoint Locations - NVA	
Figure 8. QC Checkpoint Locations - VVA	

List of Tables

Table 1. Originally Planned Lidar Specifications	1
Table 2. Lidar System Specifications	
Table 3. LAS Classifications	

List of Appendices

Appendix A: Flight Logs



1. Summary / Scope

1.1. Summary

This report contains a summary of the 37876_WI_Statewide_2021_B21, Work Unit 218061 lidar acquisition task order, issued by USGS under their Contract G16PC00016 on April 8, 2021. The task order yielded a project area covering 6,730 square miles across 8 counties in Wisconsin with work unit 218061 accounting for 1,443 square miles in Marinette. 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	2,300 m	60°	20%	≤ 10 cm

1.3. Coverage

The project boundary covers 1,443 square miles over Wisconsin. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from April 1, 2021 to April 22, 2021 in 3 total lifts. See "Section: 2.4. Time Period" for more details.

1.5. Issues

There were no issues to report.



Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	 2-foot Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format 2-foot Intensity images in GeoTIFF format
Vectors	Shapefiles (*.shp) Project Boundary Lidar Tile Index Calibration and QC Checkpoints (NVA/VVA) Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format • Focus on Delivery • Focus on Accuracy • Survey Report • Processing Report
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • Intensity Imagery



37876_WI_Statewide_2021_B21 Marinette Work Unit 218061 Boundary

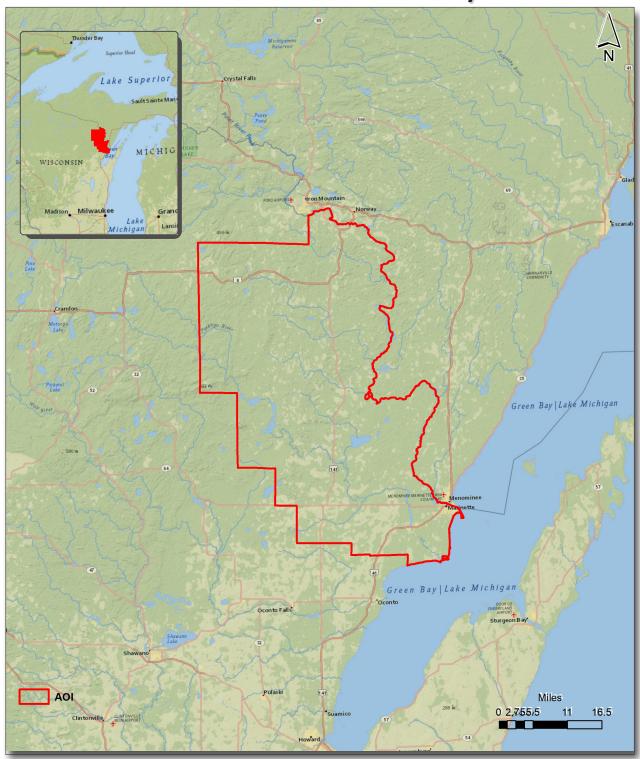


Figure 1. Work Unit Boundary



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 RiParameter planning software.

2.2. Lidar Sensor

NV5 Geospatial utilized Riegl lidar sensors (Figure 2), serial number(s) 4045 for data acquisition.

The Riegl 1560II system is a dual channel waveform processing airborne scanning system. It has a laser pulse repetition rate of up to 4 MHz resulting in up to 2.66 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA) and an integrated IMU/GNSS unit.

A brief summary of the aerial acquisition parameters for the project are shown in the lidar System Specifications in Table 2.



Table 2. Lidar System Specifications

		Riegl VQ1560ii (SN4045)
Terrain and	Flying Height	2300 m
Aircraft Scanner	Recommended Ground Speed	180 kts
	Field of View	58.5°
Scanner	Scan Rate Setting Used	2 x 160 Hz
Laser Pulse Rate Used		500 kHz
Laser	Multi Pulse in Air Mode	yes
Carraga	Full Swath Width	2577 m
Coverage	Line Spacing	0.558 m
Point Spacing	Average Point Spacing	1.16 m
and Density	Average Point Density	2 x 1.16 pts / m ²

Figure 2. Riegl VQ1560ii 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

Cessna Caravan, Tail Number(s): N473TW

These aircraft provided an ideal, stable aerial base for lidar acquisition. These aerial platforms have 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 Riegl VQ1560i, VQ1560ii, LMS-Q1560 lidar systems. Some of NV5 Geospatial's operating aircraft can be seen in Figure 3 below.



Figure 3. Some of NV5 Geospatial's Planes



2.4. Time Period

Project specific flights were conducted between April 1, 2021 to April 02, 2021. Three aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
04012021A (SN4045,N473TW)	4/01/2021 4:44:32 PM	4/01/2021 9:17:16 PM
04012021B (SN4045,N473TW)	4/01/2021 10:40:08 PM	4/02/2021 12:06:37 AM
04022021C (SN4045,N473TW)	4/02/2021 8:25:51 PM	4/03/2021 12:42:00 AM



3. Processing Summary

3.1. Flight Logs

Flight logs were completed by Lidar sensor technicians for each mission during acquisition. These logs depict a variety of information, including:

- Job / Project #
- Flight Date / Lift Number
- FOV (Field of View)
- Scan Rate (HZ)
- Pulse Rate Frequency (Hz)
- Ground Speed
- Altitude
- Base Station
- PDOP avoidance times
- Flight Line #
- Flight Line Start and Stop Times
- Flight Line Altitude (AMSL)
- Heading
- Speed
- Returns
- Crab

Notes: (Visibility, winds, ride, weather, temperature, dew point, pressure, etc). Project specific flight logs for each sortie are available in Appendix A.



3.2. Lidar Processing

Applanix + POSPac 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 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 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.

Point clouds were created using the RiPROCESS software. The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. The point cloud is imported into GeoCue distributive processing software. Imported data is tiled and then calibrated using TerraMatch and proprietary software. Using TerraScan, the vertical accuracy of the surveyed ground control is tested and any bias is removed from the data. TerraScan and TerraModeler software packages are then used for automated data classification and manual cleanup. The data are manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler.

DEMs and Intensity Images are then generated using proprietary software. In the bare earth surface model, above-ground features are excluded from the data set. Global Mapper is used as a final check of the bare earth dataset.

Finally, proprietary software is used to perform statistical analysis of the LAS files.

Software	Version
Applanix + POSPac	8.6
RiPROCESS	1.8.6
GeoCue	2020.1.22.1
Global Mapper	19.1;20.1
TerraModeler	21.008
TerraScan	21.016
TerraMatch	21.007



3.3. LAS Classification Scheme

The classification classes are determined by Lidar Base Specifications 2020, Revision A and are an industry standard for the classification of lidar point clouds. All data starts the process as Class 1 (Unclassified), and then through automated classification routines, the classifications are determined using TerraScan macro processing.

The classes used in the dataset are as follows and have the following descriptions:

Table 3. LAS Classifications

	Classification Name	Description
1	Processed, but Unclassified	Laser returns that are not included in the ground class, or any other project classification
2	Bare earth	Laser returns that are determined to be ground using automated and manual cleaning algorithms
7	Low Noise	Laser returns that are often associated with scattering from reflective surfaces, or artificial points below the ground surface
9	Water	Laser returns that are found inside of hydro features
17	Bridge Deck	Laser returns falling on bridge decks
18	High Noise	Laser returns that are often associated with birds or artificial points above the ground surface
20	Ignored Ground	Ground points that fall within the given threshold of a collected hydro feature.



3.4. Classified LAS Processing

The bare earth surface is then manually reviewed to ensure correct classification on the Class 2 (Ground) points. After the bare- earth surface is finalized; it is then used to generate all hydro-breaklines through heads-up digitization.

All ground (ASPRS Class 2) lidar data inside of the Lake Pond and Double Line Drain hydro flattening breaklines were then classified to water (ASPRS Class 9) using proprietary tools. A buffer of 3 feet was also used around each hydro flattened feature to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 20). All Lake Pond Island and Double Line Drain Island features were checked to ensure that the ground (ASPRS Class 2) points were reclassified to the correct classification after the automated classification was completed.

Any noise that was identified either through manual review or automated routines was classified to the appropriate class (ASPRS Class 7 and/or ASPRS Class 18) followed by flagging with the withheld bit.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper is used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable industry-standard LAS files for all point cloud data. NV5 Geospatial's proprietary software was used to perform final statistical analysis of the classes in the LAS files, on a per tile level to verify final classification metrics and full LAS header information.

3.5. Hydro-Flattened Breakline Processing

Class 2 lidar was used to create a bare earth surface model. The surface model was then used to heads-up digitize 2D breaklines of Inland Streams and Rivers with a 100 foot nominal width and Inland Ponds and Lakes of 2 acres or greater surface area.

Elevation values were assigned to all Inland streams and rivers using NV5 Geospatial's proprietary software.

All ground (ASPRS Class 2) lidar data inside of the collected inland breaklines were then classified to water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 3 feet was also used around each hydroflattened feature. These points were moved from ground (ASPRS Class 2) to Ignored Ground (ASPRS Class 20).

The breakline files were then translated to Esri file geodatabase format using Esri conversion tools.

Breaklines are reviewed against lidar intensity imagery to verify completeness of capture. All breaklines are then compared to TINs (triangular irregular networks) created from ground only points prior to water classification. The horizontal placement of breaklines is compared to terrain features and the breakline elevations are compared to lidar elevations to ensure all breaklines match the lidar within acceptable tolerances. Some deviation is expected between breakline and lidar elevations due to monotonicity, connectivity, and flattening rules that are enforced on the breaklines. Once completeness, horizontal



placement, and vertical variance is reviewed, all breaklines are reviewed for topological consistency and data integrity using a combination of Esri Data Reviewer tools and proprietary tools.

3.6. Hydro-Flattened Raster DEM Processng

Hydro-Flattened DEMs (topographic) represent a lidar-derived product illustrating the grounded terrain and associated breaklines (as described above) in raster form. NV5 Geospatial's proprietary software was used to take all input sources (bare earth lidar points, bridge and hydro breaklines, etc.) and create a Triangulated Irregular Network (TIN) on a tile-by-tile basis. Data extending past the tile edge is incorporated in this process so that proper triangulation can occur. From the TIN, linear interpolation is used to calculate the cell values for the raster product. The raster product is then clipped back to the tile edge so that no overlapping cells remain across the project area. A 32-bit floating point GeoTIFF DEM was generated for each tile with a pixel size of 2-foot. NV5 Geospatial's proprietary software was used to write appropriate horizontal and vertical projection information as well as applicable header values into the file during product generation. Each DEM is reviewed in Global Mapper to check for any surface anomalies and to ensure a seamless dataset. NV5 Geospatial ensures there are no void or no-data values (-999999) in each derived DEM. This is achieved by using propriety software checking all cell values that fall within the project boundary. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the DEMs against what is required before final delivery.

3.7. Swath Separation Raster Processng

Swath Separation Images are rasters that represent the interswath alignment between flight lines and provide a qualitative evaluation of the positional quality of the point cloud. NV5 Geospatial proprietary software generated 2-foot raster images in GeoTIFF format using last returns, excluding points flagged with the withheld bit, and using a point-in-cell algorithm. Images are generated with a 75% intensity opacity and (4) absolute 8-cm intervals, see below for interval coloring. Intensity images are linearly scaled to a value range specific to the project area to standardize the images and reduce differences between individual tiles. Appropriate horizontal projection information as well as applicable header values are written to the file during product generation. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the images against what is required before final delivery.





3.8. Maximum Surface Height Raster Processing

Maximum Surface Height rasters (topographic) represent a lidar-derived product illustrating natural and built-up features. NV5 Geospatial's proprietary software was used to take all first-return classified lidar points, excluding those flagged with a withheld bit, and create a Triangulated Irregular Network (TIN) on a tile-by-tile basis. Data extending past the tile edge is incorporated in this process so that proper triangulation can occur. From the TIN, linear interpolation is used to calculate the cell values for the raster product. The raster product is then clipped back to the tile edge so that no overlapping cells remain across the project area. A 32-bit floating point GeoTIFF was generated for each tile with a pixel size of 2-foot. NV5 Geospatial's proprietary software was used to write appropriate horizontal and vertical projection information as well as applicable header values into the file during product generation. Each maximum surface height raster is reviewed in Global Mapper to check for any anomalies and to ensure a seamless dataset. NV5 Geospatial ensures there are no void or no-data values (-999999) in each derived raster. This is achieved by using propriety software checking all cell values that fall within the project boundary. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the DEMs against what is required before final delivery.



37876_WI_Statewide_2021_B21 Marinette Work Unit 218061 Tile Layout

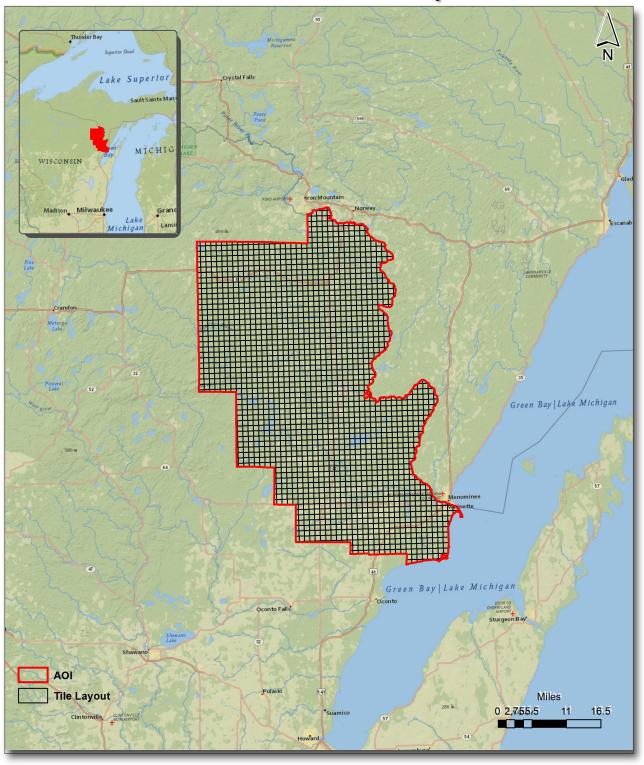


Figure 4. Lidar Tile Layout



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 5.



37876_WI_Statewide_2021_B21 Marinette Work Unit 218061 Lidar Coverage

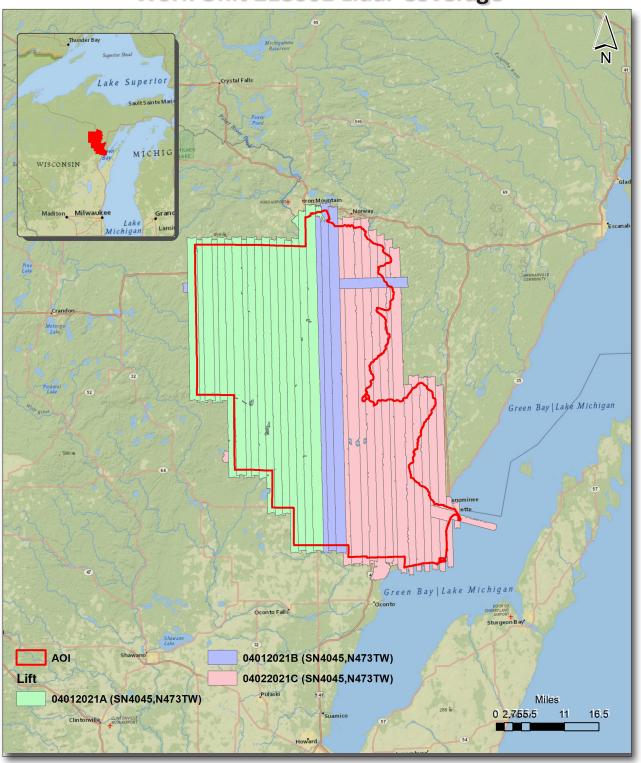


Figure 5. Lidar Coverage



5. Accuracy Testing

5.1. Calibration Control Point Testing

Figure 6 shows the location of each bare earth calibration point for the project area. TerraScan was used to perform a quality assurance check using the lidar bare earth calibration points. The 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.

5.2. Point Cloud Testing

The project specifications require that only Non-Vegetated Vertical Accuracy (NVA) be computed for raw lidar point cloud swath files. The required accuracy (ACCz) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. The NVA was tested with 167 checkpoints located in bare earth and urban (non-vegetated) areas. These check points were not used in the calibration or post processing of the lidar point cloud data. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See survey report for additional survey methodologies.

Elevations from the unclassified lidar surface were measured for the x,y location of each check point. Elevations interpolated from the lidar surface were then compared to the elevation values of the surveyed control points. AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines.

5.3. Digital Elevation Model (DEM) Testing

The project specifications require the accuracy (ACCz) of the derived DEM be calculated and reported in two ways:

- The required NVA is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. This is a required accuracy. The NVA was tested with 159 checkpoints located in bare earth and urban (non-vegetated) areas. See Figure 7.
- 2. Vegetated Vertical Accuracy (VVA): VVA shall be reported for "brushlands/low trees" and "tall weeds/ crops" land cover classes. The target VVA is: 29.4 cm at the 95th percentile, derived according to ASPRS Guidelines, Vertical Accuracy Reporting for lidar Data, i.e., based on the 95th percentile error in all vegetated land cover classes combined. This is a target accuracy. The VVA was tested with 159 checkpoints located in tall weeds/crops and brushlands/low trees (vegetated) areas. The checkpoints were distributed throughout the project area. See Figure 8.



AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASRPS Guidelines.

A brief summary of results are listed below.

	Target	Measured	Point Count
Raw NVA	0.196 m	0.0543	167
NVA	0.196 m	0.053	159
VVA	0.294 m	0.1675	159



37876_WI_Statewide_2021_B21 Marinette Calibration Points

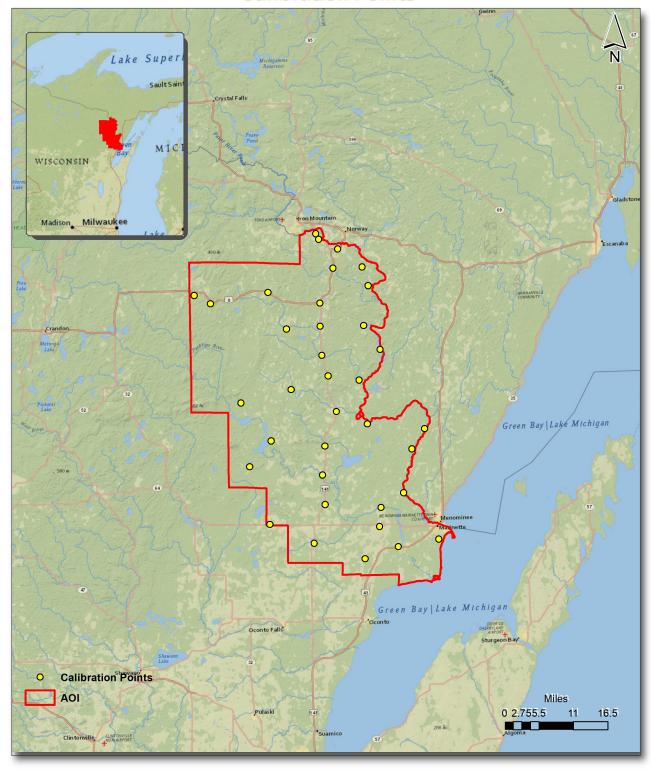


Figure 6. Calibration Control Point Locations



37876_WI_Statewide_2021_B21 Marinette NVA Points

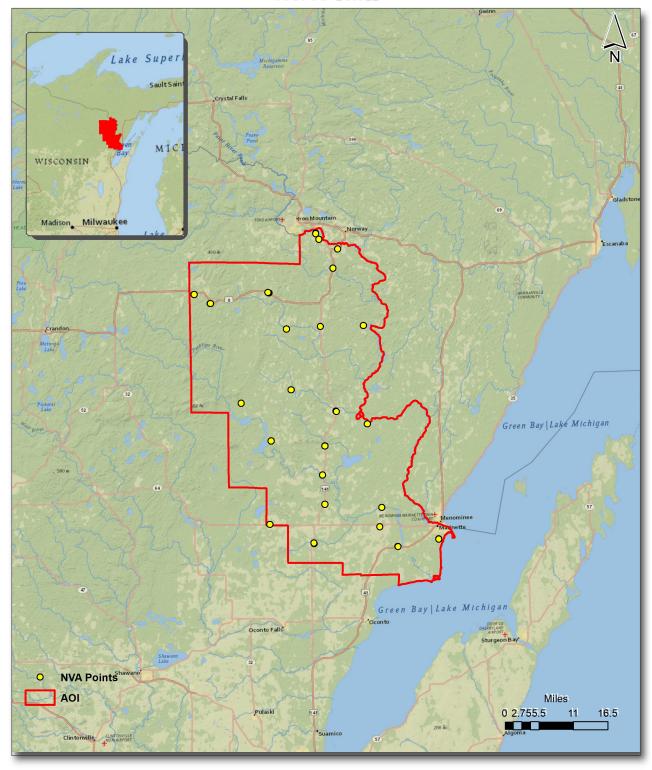


Figure 7. QC Checkpoint Locations - NVA



37876_WI_Statewide_2021_B21 Marinette VVA Points

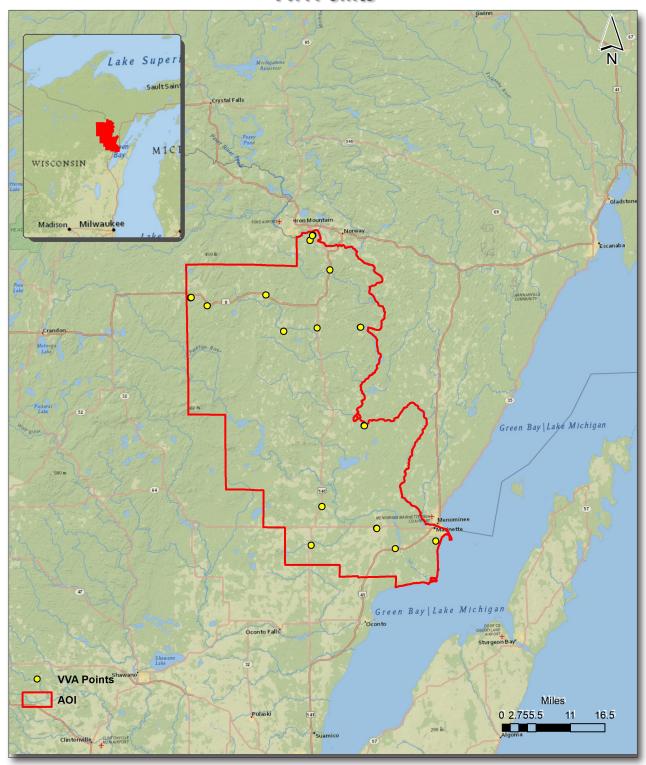


Figure 8. QC Checkpoint Locations - VVA



6. Geometric Accuracy

6.1. Horizontal Accuracy

Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained RMSEr value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial Data Accuracy (NSSDA) reporting standard where a theoretical point will fall within the obtained radius 95% of the time. Based on a flying altitude of 7,545 feet, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.015 meters (0.049 ft), this project was compiled to meet 0.25 (0.82 ft) meter horizontal accuracy at the 95% confidence level. A summary is shown below.

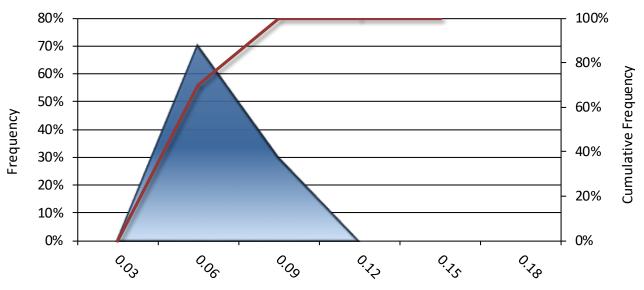
Horizontal Accuracy		
RMSE _r	0.47 ft	
	0.14 m	
ACC _r	0.82 ft	
	0.25 m	



6.2. Relative Vertical Accuracy

Relative vertical accuracy refers to the internal consistency of the data set as a whole: the ability to place an object in the same location given multiple flight lines, GPS conditions, and aircraft attitudes. When the lidar system is well calibrated, the swath-to-swath vertical divergence is low (<0.10 meters). The relative vertical accuracy was computed by comparing the ground surface model of each individual flight line with its neighbors in overlapping regions. The average (mean) line to line relative vertical accuracy for the WI_Statewide_2021_B21 project was 0.050 feet (0.015 meters). A summary is shown below.

Relative Vertical Accuracy		
Sample	117 flight line surfaces	
A	0.050 ft	
Average	0.015 m	
Madian	0.046 ft	
Median	0.014 m	
RMSE	0.052 ft	
	0.016 m	
	0.012 ft	
Standard Deviation (1σ)	0.003 m	
	0.023 ft	
1.96σ	0.007 m	



Marinette County, Wisconsin Relative Vertical Accuracy (ft) Total Compared Points (n = 10,446,343,727)



Project Report Appendices

The following section contains the appendices as listed in the 37876_WI_8_Counties Lidar Project Report.



Appendix A

Flight Logs

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Flight
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Julian



C-GJMT	System	Riegl Q1560
Krista R	Unit	64
Daniel A	NMI	Applanix AP60
	GPS Rx	Trimble GNSS17
	Scanner 1 Drive	1 Drive
	Scanner 2 Drive	2 Drive

Operator

Aircraft

Project 3218_QSI_PierceMarathon | Pilot

April 22, 2021

Date

Location Eau Claire WI Airport

Mission Objective

System	Riegl Q1560	
Unit	64	
IMU	Applanix AP60	
GPS Rx	Trimble GNSS17	
Scanner 1 Drive	1 Drive	
Scanner 2 Drive	2 Drive	

Mission Plan	AGL Height 2300 m Pulse Rate 800Khz	Target Speed 160 kts Scan Rate	Laser Current 100 % FOV 60	
Aircraft Block Time	13:10 Takeoff 13:30	18:59 Landing 18:49	hrs Total 5.3 hrs	
7	ine On 13:10	ingine Off 18:59	al 5.8 hrs	

	Comments													
Mission ID	Time Stamp	ı	140330	142544	143928	150504	152737	154958	161217	163415	165537	ı	ı	180020
Line Aborted	nmi to End													
Line	Time													
Time	End	1350	1422	1427	1458	1521	1545	1606	1629	1651	1658	1703	1757	1801
GPS Tim	Start	1345	1403	1425	1439	1505	1527	1549	1612	1634	1655	1658	1752	1800
Flight	Direction	ı	092	ı	274	092	274	092	274	092		ı		ı
LIDAR	File Name													
	Flight Line	F8	1028	X-Tie	1006	1005	1004	1003	1002	1001	X-Tie	F8	F8	X-Tie

180845

1823 1828

1808 1823

181

1062 F8

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Flight
112
Julian Day



A Clean Harbors Company

				ļ
Date /	April 22, 2021	Aircraft	C-GJMT	
Project 3218	Project 3218_QSI_PierceMarathon Pilot	Pilot	Krista R	
Location Ea	Location Eau Claire WI Airport	Operator	Daniel A	
Mission Objective	ive			
				<u> </u>

System	Riegl Q1560	
Unit	64	
NMI	Applanix AP60	
GPS Rx	Trimble GNSS17	
Scanner 1 Drive	1 Drive	
Scanner 2 Drive	2 Drive	

System	Riegl Q1560	ĕ
Unit	64	_
NMI	Applanix AP60	
GPS Rx	Trimble GNSS17	⋖
Scanner 1 Drive	1 Drive	ㅗ
Scanner 2 Drive	2 Drive	•

	Static	В	GPS Time
	Alignment	Start	End
	Pre Mission	1317	1322
sgs	Post Mission	1851	1856

800Khz 178

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Takeoff 13:30 Landing 18:49 Total 5.3 hrs

Engine Off 18:59 Engine On 13:10

5.8 hrs

Total

9

% FOV

100 160

Laser Current Target Speed AGL Height

⊙ 50 hr O 100 hr

	Comments								
Mission ID	Time Stamp								ı
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
GPS	Start								
Flight	Direction								ı
LiDAR	File Name								
	Flight Line								

Page 2 of 5

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Flight
112
Julian Day



Date	April 22, 2021	Aircraft	Aircraft C-GJMT	Sysi
Project 32	Project 3218_QSI_PierceMarathon Pilot	Pilot	Krista R	Unit
Location	Location Eau Claire WI Airport Operator	Operator	Daniel A	IMU
Mission Objective	jective			GPS
				Scal
				Sca

System Riegl Q1560 Unit 64 IMU Applanix AP60 GPS Rx Trimble GNSS17 Scanner 1 Drive Scanner 2 Drive		
Rx Iner 1 [System	Riegl Q1560
Rx nner 1 [Unit	64
GPS Rx Trimble GNSS17 Scanner 1 Drive Scanner 2 Drive	IMU	Applanix AP60
Scanner 1 Drive Scanner 2 Drive	GPS Rx	Trimble GNSS17
Scanner 2 Drive	Scanner	1 Drive
	Scanner	2 Drive

System	Riegl Q1560	Additional Notes
Unit	64	T3C
MU	Applanix AP60	%98 -H
GPS Rx	Trimble GNSS17	AMLS-278m
Scanner 1 Drive	1 Drive	Hpa-1016
Scanner 2 Drive	2 Drive	Time to next main

		Comments
	Mission ID	Time Stamp
	ine Aborted	nmi to End
	Line	Time
	Time	End
]	Sd9	Start
-	Flight	Direction
-	I iDAR	File Name
		Flight Line

m Pulse Rate kts Scan Rate

Mission Plan

Aircraft Block Time

Engine On 13:10 | Takeoff 13:30 Engine Off 18:59 | Landing 18:49 9

Laser Current 100 % FOV 160 2300

Total 5.8 hrs Total 5.3 hrs

Target Speed AGL Height

			l		l					Ī
	Comments									
Mission ID	Time Stamp									
Line Aborted	nmi to End									
Line	Time									
GPS Time	End									
S49	Start									
Flight	Direction									
LiDAR	File Name									
	Flight Line									

Page 3 of 5

⋖
Flight
112
Julian Day



A Clean Harbors Company

_		⋖		
C-GJMT	Krista R	Daniel A		
Aircraft	Pilot	Operator		
April 22, 2021	Project 3218_QSI_PierceMarathon Pilot	Location Eau Claire WI Airport	bjective	
Date	Project 3;	Location	Mission Objective	

System	Riegl Q1560
Unit	64
NWI	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

U Applanix AP60 H- 8 SRx Trimble GNSS17 AMI anner 1 Drive Hpa	ايدا	Riegl Q1560 64	Additional Notes T3C
	S S	Applanix AP60 Trimble GNSS17	H- 86% AMI S- 278m
	anner '	1 Drive	Hpa-1016
anner 2 Drive	anner ;	2 Drive	Time to next mainte

пра-1016			
Time to next maintenance:		⊙ 50 hr O 100 hr	_
	Static	49	GPS Time
800Khz	Alignment	Start	End
178	Pre Mission	1317	1322
0 degs	Post Mission	1851	1856

m Pulse Rate kts | Scan Rate

2300

AGL Height

Mission Plan

Aircraft Block Time

Engine On 13:10 | Takeoff 13:30

Landing 18:49 Total 5.3 hrs

Engine Off 18:59

hrs

5.8

Total

9

₽ 2 %

100 160

Target Speed Laser Current

	Comments							
Mission ID	Time Stamp							
Line Aborted	nmi to End							
Line	Time							
GPS Time	End							
GPS	Start							
Flight	Direction							
LiDAR	File Name							
	Flight Line							

Page 4 of 5

⋖
Flight
112
Julian Day

LIDAR Flight Log



A Clean Harbors Company

System	Unit	IMO	GPS R	Scanne
Aircraft C-GJMT	Krista R	Daniel A		
Aircraft		Operator		
April 22, 2021	Project 3218_QSI_PierceMarathon Pilot	Location Eau Claire WI Airport Operator Daniel A	bjective	
Date	Project 32	Location	Mission Objective	

Syctem	
Oysian	Riegl Q1560
Unit	64
IMU Ap	Applanix AP60
GPS Rx T	Trimble GNSS17
Scanner 1 Drive	ive
Scanner 2 Drive	ive

stem	Riegl Q1560	Addition	tio
it	64) - T-	\sim
	Applanix AP60	98 - H	ွတ္တ
S Rx	Trimble GNSS17	AMLS	တ
anner	anner 1 Drive	Hpa-1	Ξ
anner	anner 2 Drive	Time to	e E

Additional Notes	T3C	%98 -H	AMLS-278m	Hpa-1016	Time to next maintenance:	Ctat
egl Q1560	64	nix AP60	ble GNSS17			Mission Plan

⊙ 50 hr **O** 100 hr

GPS Time	ent Start End	1317 1322	in 1851 1856	
Static	Alignment	ssion	Post Mission	
SE	Alić	Pre Mission	Post	

800Khz 178

m Pulse Rate kts | Scan Rate

2300

Aircraft Block Time

Engine On 13:10 | Takeoff 13:30

Landing 18:49 Total 5.3 hrs

Engine Off 18:59 5.8 hrs

Total

9

% F0V

100 160

Laser Current Target Speed AGL Height

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
GPS	Start								
Flight	Direction								
LiDAR	File Name								
	Flight Line								

Page 5 of 5

Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

Date: 4/1/2021

CORS: Gd Temp beg: GPS Unit: Y / N Dep Apr: LLSE Aircraft: 4737W Begin Hobbs: 5794,0 End Hobbs: 5800,3 Total: 6.3 Project: UL LiDAR FOV 58,52 Scan 500 K HZ ₹ Z Sta 1:000 Sta 1: റ Dep Time (Lcl): 10:06 (Z): 15:06 Serial # 4045 റ് (email log daily to flight_log_distribution_list@quantumspatial.com) AGL 236 MpiA Y / Z OAT beg: Sta 2: Sta 2: Proj #: 37876 Pulses in Air റ് End Arr Apt: ICTMT Arr Time (Local): 4729 (Z): 2 120 Avg Terr Pulse Rate °c Altimeter begin: Flyovers: Y / N Flyovers: Y / N Flight Mgmt File: 20210401_504045 Gdspd / 30 + Luy 140 Spacing Pilot: Ban Lydet / Co-Pilot: If Y, times: Sta1) If Y, times: Sta1) end: Sta2) 5ta2) Tot Time Aloft: 6:23 Tech: 1/cal Tollow 00 Tot 28 28 Storage Name/

× ()	Ī	6	S	ī	w	2		0	2	00	1		2	<u>_</u>	۸,	Li	~	Line #
75	5	S	?	~	2	5	7	S	7	N	7	5	2	S	2	S	7	Hdg
K-112 /W 211519 21716	9 E1 251112 022500 N	241 62602 521602	N 200917 TURBO130	2 41 838702224BABI	17: 555 HD 1758 W	(4) 11 Kby 25/1h1	451 01511 122581	56 KI	561 (SNB! 5242A	ifue 3	(51 EDROR 217561 N	527 (1554) 821/LII	V 172845 17 403817 2	5 171810 17278133 .48/14 2635 -3	V 17646 171648 132	> 165602 176518 152	051 MHS 164M N	Hdg Start (UTC): End (UTC): Gd Spd
1 211	2113	505	7 W	6220	Sibil	7 1931	AM 6	Ori Gressi BARKI	Ē	18432 18258 1+5	2 1808	8 175	5174	0 17:	11119	2/17/5	1654	2): End (L
91	175	13 i	1068	1838	(55 j	i 11	101	المرا أر	153	1 84	123	31) [18	1869	1 3/15	18	18 1	7	лс):
	9	42	30	47	3	43	77	6	2	5	33	53	7	2	7	25	05	Gd Spd
	18/2	.87/	1118	2/18	1442	A4/2	A612	189/21255	31/2	176/12 2570	25.52 12/18.	14/1	A421 2610	188.	195/21 2165	2/3/2	115 hs	PDOP/# Sa
	18/2-2495 5	.87/ 2500 -5	SHAZ 17/18	87/23 2510	14721 2525	24/22 2540	461222545	2):	31/23 2560	275	1.52	,94/10 2580	1261	926	(216	46/21 266 m	115h	PDOP/# Sats GPS Altitude Crab
	5 5	00 ~	. 53				5	55	Ö	1 500	7	0		- 58	S		HD.	ltitude (
			2	-	0 4	4	0	W.	C	-7 [2	0	n		3	2	2	
	}	2	3	3	-	0	O	Q,	C	S	0 1	O	0	0	رن 	0	10	Turb (0, -, +)
	- ten small thoughtervals	and offered on light two list half line		this starting mid line you by and	touched on 200 ft low to a second mid line							Some lakes the have ice mount looks supplied		O loster 75ts burning will line	breadwind	trilling States the -160 gives 140 13 in	Fill sun, (4/m a)	FLIGHT UNE NOTES – visibility, clouds, smoke, partial, etc.

Total Proj Lines: 125

Lines Flown: 17

Lines Remain: 62

Online Time: U. S

Mob Time:

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Eure Personstes as A					Acceptance of the second	
Stary: 316 Start: 263 End 263		mobe total	time time		2 SS	Hony ton 28
<760) Sats wandy from 4-8miles	2	37/21 2490	632 148	119262	5	6
and (7 6%) sats waring midline	+	.85/23 2495	812 138	23838 23812	N	h)
0	w	148/22 2500	254 142	230212 23254 142	5 2	8
C Latt 2.56		2530	144	96852V 809622	7	120
The Note	-	1	-	Start Stap	S -30H	CIME A HACE
Annival KLSTE 8:15 1641, 115 & Hotel eloft: 2:48	313	Junival KL		1/1/21 B WI SPEP 37876 1/1/21 B WI SPEP 37876	IM 4	12/1/51

Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

Date: 4/2/200

		email log daily to flight_log_distribution_list@quantumspatial.com	tribution_list@quanturnspatial.com	m : (Lift: A & C D E Pg of \
Project: WI 3DEP		Proj #: 37876	928	Flight Mgmt File: 202/0402 _ SN4045_	C_ 37876
Aircraft: 477 W B	Begin Hobbs: 5204、1	₹. \ End Hobbs:	Total:	Pilot: Dan Lulkett Co-Pilot:	Mot: Tech: Nowy Edelson
Dep Apr: 10 CWA De	Dep Time (Lcl):2 S8	8 (z): 19 S8	Arr Apt: KS DM	Arr Time (Local): 8; 21 (Z): 121	Tot Tim
CORS: (7) N Sta 1: (7)	199	Sta 2:	Flyovers: Y / N	Y / N If Y, times: Sta1)	Sta 2)
GPS Unit: Y / N Sta 1:		Sta 2:	Flyovers: Y / N	Y / N If Y, times: Sta1)	Sta2)
Gd Temp beg: °c	End: °c	OAT beg: °c E	End: °c Altime	Altimeter begin: end:	Beg Storage GB Name/s
1 10951 JANE 12601	serial # UUS	Alt 2300 M Alt	Avg Terr Ht	Max 180 Set to Avg Pt Gdspd 180 Set to Spacing	End GB
FOV 58,52	Scan Sookit2	MpiA Y / N Pulses	Pulse Rate		Tot GB
Line # Hdg Start (UTC): E	End (UTC): Gd Spd	PDOP/#Sats GPS Altitude Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds smoke, partial, etc.	ouds smoke, partial, etc.
114 E 20250 204116	153	2- 0123 52/18		high broken overtast	C 7 Sats GNS Lewish, heall GAS huberafter
35 5 204B2 2	541 MGAM 2920	C- 9252 5218			
821502 N	841 hessa	28/23 2465 7	0		
2 220122 5 62	151 232112	8- 01h2 22/hb	4		
32 N 211456 2	212547 144	.82/25 2475 7	D 176401 Sc154	7 6+01 sers wally wish the 164+0+ ADE	
) / > 213/12<*c12637	12637 155	85/24 2475 -q	0		
2 618612 11 02	21407 151	8 5242 52/18	Ď		
~	361 92000	15- ast 92158	O 27 GMs Sels warning	waruly, b seconds for ailes in	
1	5212 STIBLE 1922	36/26 2470 9	0		
19022 LILLE S L2	241 122	8- 0842 52/18	0		
26 N 24006 22800	indi	.95/23 2480 7	0		
25 S 21592523824	3624 150	191/23 2480 -7	1) live dishit sp	I've dish of spreced-gater line	
24 1 231856 23753		on 10 54 hg	O want has	the didn't hope extension, stated loggy - 3 seconds was	-3 Scards 12to 1.AL
23 5 22401 5350	148m	85/24 Z4MB	\$ 500 CD	<7 bod Sab harming 235 will this chart lowling to the	· longle lite the
12 N 12 W 22	1824 123	10/25 c415 8	-msporess with	spored wight two norther 13 line	
5 1456	251 17bs	106 12 2500 - a	1	byce light two same spotas last fine 5 ansct downing the	; + dering line
4613 v 22			retui fra	rethings at 15 should be lest start	st start
			1,7		

duy fotal: 4,3 Online Time: 43

Total Proj Lines:

Lines Flown: 16,

Lines Remain:

Mob Time: 48

Notes:

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Project 3218_QSI_PierceMarathon

April 01, 2021

Date

Eau Claire WI Airport

Location

Mission Objective

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LIDAR Flight Log

GPS Scar Scar Syst Unit NN. Pilot Andy S-Krista R D.Arteaga C-GJMT Operator Aircraft

	1		
F		nner 2 Drive	nner
Ĭ		nner 1 Drive	ınner
₹		Trimble GNSS17	s Rx
İ		Applanix AP60	
Ļ		64	t.
Ad		Riegl VQ-1560	tem

	į	278m 35	next maintenance:		Z		degs
				Static	Alignment	Pre Mission	Post Mission
	e e e e e e e e e e e e e e e e e e e		O 50 hr O 100 hr	19	Start	1537	2211
M A G I N G	A Clean narbors comp		ľ	GPS Time	End	1542	2216

800Khz 89

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Takeoff 15:54 **Landing** 22:08 **Total** 6.2 hrs

Engine Off 22:18 Engine On 15:26

hrs

6.9

Total

9

<u></u> %

100 160

Laser Current **Target Speed AGL Height**

	LiDAR	Flight	GPS	GPS Time	Line	Line Aborted	Mission ID	
Flight Line	File Name	Direction	Start	End	Time	nmi to End	Time Stamp	Comments
Test Strip		-	1602	1603			160220	
X- tie		_	1606	1618			160625	
F8		ı	1624	1629			ı	
1030		180	1638	1647			163858	
1031		000	1654	1706			165430	
1032		180	1712	1724			174722	
1033		000	1730	1742			173003	
1034		180	1747	1800			174722	
1035		000	1806	1819			180617	
1036		180	1824	1838			182444	
1037		000	1844	1857			184405	

190224 192239

1917 1937 1957

1902

180 000 180 000

1038 1039 1040 1041

200230 194227

2018

2002

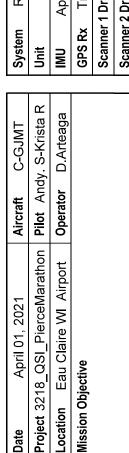
1922 1942

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Flight	
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Mission Objective

Cychom	0:0.21.7.0.4560
System	Riegi VQ-1000
Unit	64
NWI	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

/stem	Riegl VQ-1560	Additional
nit	64	T2C
⊋	Applanix AP60	H-37%
PS Rx	Trimble GNSS17	AMLS-2
canner 1 Drive	1 Drive	Hpa-103
canner 2 Drive	2 Drive	Time to ne

A Clean Harbors Company

AMLS- 278m Hpa-1035	Time to next maintenance:		800Khz	89	sbap (
		Static	Alignment	Pre Mission	Post Mission	
	© 50 hr O 100 hr	d9	Start	1537	2211	
	_	GPS Time	End	1542	2216	

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Takeoff 15:54 **Landing** 22:08 Total 6.2 hrs

Engine On 15:26 Engine Off 22:18

hrs

6.9

Total

9

₽ 2 %

100 160

Laser Current **Target Speed** AGL Height

				_			_	_	 	_	 	_
	Comments											
Mission ID	Time Stamp	202209	204254	210256	212330	•						
Line Aborted	nmi to End											
Line	Time											
Time	End	2037	2058	2118	2138	2144						
GPS Time	Start	2022	2042	2102	2123	2139						
Fliaht	Direction	180	000	180	000	I						
LiDAR	File Name											
	Flight Line	1042	1043	1044	1045	F8						

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Flight
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lian Day
7



System	RiegI VQ-1560
Unit	64
 IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

Pilot Andy. S-Krista R Operator D.Arteaga

Project 3218_QSI_PierceMarathon

April 01, 2021

Date

Location Eau Claire WI Airport

Mission Objective

C-GJMT

Aircraft

System	Riegl VQ-1560
Unit	64
NM	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

Additional Notes		A .	AIRBORNE
T2C		A Clea	A Clean Harbors Company
H-37%			
AMLS-278m			
Hpa-1035			
Time to next maintenance:		© 50 hr O 100 hr	
	Static	49 	GPS Time
800Khz	Alignment	Start	End
89	Pre Mission	1537	1542
sbap 09	Post Mission	2211	2216

m Pulse Rate kts Scan Rate

2300

AGL Height

Mission Plan

Aircraft Block Time

Takeoff 15:54 Landing 22:08 Total 6.2 hrs

Engine Off 22:18 Engine On 15:26

hrs

6.9

Total

₽ 2 %

100 160

Target Speed Laser Current

Comments							
Mission ID	Time Stamp						
Line Aborted	nmi to End						
Line	Time						
Time	End						
GPS	Start						
Flight Direction							
LiDAR File Name							
	Flight Line						

Page 3 of 5

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Flight
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Project 3218_QSI_PierceMarathon | Pilot Andy. S-Krista R

Location Eau Claire WI Airport

Mission Objective

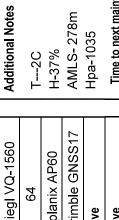
C-GJMT

Aircraft

April 01, 2021

Date

Operator D.Arteaga



System	Riegl VQ-1560	Additional No
Unit	64	T2C
IMU	Applanix AP60	H-37%
GPS Rx	Trimble GNSS17	AMLS-278
Scanner 1 Drive	1 Drive	Hpa-1035
Scanner 2 Drive	2 Drive	Time to next

Notes	Ş	4	AIRBORNE
		A Clea	A Clean Harbors Company
78m			
ıO			
xt m	xt maintenance:	© 50 hr O 100 hr	
	Static	49	GPS Time
	Alignment	Start	End
	Pre Mission	1537	1542
egs	Post Mission	2211	2216

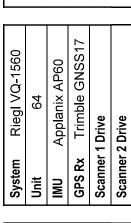
	Aircraft Block Time		<u>S</u>	sion	Mission Plan	Static		
Engine On 15:26 Takeoff 15:54	Takeoff 15:54	AGL Height	2300	Ε	2300 m Pulse Rate 800Khz	Alignmen	ınt	Ś
Engine Off 22:18 Landing 22:08	Landing 22:08	Target Speed 160 kts Scan Rate	160	cts	Scan Rate 89	Pre Mission		1,
Total 6.9 hrs Total 6.2 hrs	Total 6.2 hrs	Laser Current 100 % FOV	100	%	.00 degs	s Post Mission	u	22

		.								
1342	2216			S						Ī
1001	2211			Comments						Ī
rie mission	Post Mission									
_	P	l	<u>a</u>							
60	sbep		Mission ID	Time Stamp						
ocall rate	FOV 60		Line Aborted	nmi to End						
IOO KIS	100 %		Line	Time						
I alget Speed 100 Kts Scall rate	Laser Current 100 %	Lasei Cuileiit	GPS Time	End						
		<u>-</u>	3d9	Start						
00	hrs		Fliaht	Direction						
Laliuliy 22.	Total 6.2 hrs		LiDAR	File Name						
Flighte Oil 22.10 Latiuitig 22.00	Fotal 6.9 hrs			Flight Line						

Flight /	
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LIDAR Flight Log



Q-1560 Additional	T2C	AP60 H-37%	GNSS17 AMLS-2	Hpa-103	
Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	

iditional Notes	A
2C	A Clean F
-37%	
MLS-278m	
pa-1035	
ime to next maintenance:	© 50 hr O 100 hr

Clean Harbors Company

⊙ 50 hr (
maintenance:
to next ma
me

System Riegl VQ-1560	t 64	J Applanix AP60	GPS Rx Trimble GNSS17	Scanner 1 Drive	Scanner 2 Drive	Mission Plan
Sys	Unit	IMO	GP	Sca	Sce	
Aircraft C-GJMT	Pilot Andy. S-Krista R	Operator D.Arteaga				ne
April 01, 2021	Project 3218_QSI_PierceMarathon Pilot Andy. S-Krista R	Location Eau Claire WI Airport Operator D.Arteaga	Mission Objective			Aircraft Block Time
Date	Project	Locatior	Mission			

Mission	n Plan		Static	95	GPS Time
Ε	m Pulse Rate	800Khz	Alignment	Start	3
kts	kts Scan Rate	89	Pre Mission	1537	11
%	% FOV	60 degs	Post Mission	2211	77

2300

AGL Height

Engine On 15:26 | Takeoff 15:54 Engine Off 22:18 | Landing 22:08 **Total** 6.2 hrs

6.9 hrs

Total

100 160

Target Speed Laser Current

2216

1542 End

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
GPS	Start								
Flight	Direction								
LiDAR	File Name								
	Flight Line								

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LIDAR Flight Log



D.Arteaga

Operator

C-GJMT Andy. S

Aircraft Pilot

Project 3218_QSI_PierceMarathon

April 02, 2021

Date

Location Eau Claire WI Airport

Mission Objective

Time	r 2 Drive
Нра-	1 Drive
AML8	Trimble GNSS17
H-47	Applanix AP60
T-80	64
Addition	Riegl VQ-1560

Notes	
tional	
Addi	

A Clean Harbors Company AIRBORN IMAGING

.C 7% -S-278m -1028

⊙ 50 hr **O** 100 hr 32hrs to next maintenance:

	Aircraft Block Time	
Engine On 12:56	Takeoff 13:17	AGL Hei
gine Off 17:43	Engine Off 17:43 Landing 17:35	Target S
Total 4.8 hrs	Total 4.3 hrs	Laser Cu

	Σ	issio	Mission Plan	
AGL Height	2300	Ε	m Pulse Rate	800Khz
Target Speed	160	kts	kts Scan Rate	178
Laser Current	100	%	% FOV	eo degs

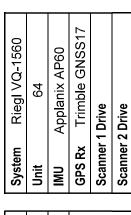
Static	GP	GPS Time
Alignment	Start	End
Pre Mission	1304	1308
Post Mission	-	-

	LiDAR	Flight	GPS Tim	Time	Line	Line Aborted	Mission ID	
Flight Line	File Name	Direction	Start	End	Time	nmi to End	Time Stamp	Comments
X-tie		ı	1329	1336			132923	
F8		1	1344	1349			1	
1046		180	1355	1411			135536	
1047		000	1415	1431			141558	
1048		180	1436	1453			143644	
1049		000	1457	1512			145729	
1050		180	1518	1535			151849	
1051		000	1539	1555			153935	
1052		180	1600	1618			160046	
1053		000	1622	1637			162212	
1054		180						DR Crashed while aproching the line
								Full system restart and troubleshooting
								for 20 minutes- Riacquire crashed

Flight
092
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Flight A

LIDAR Flight Log



D.Arteaga

Operator

C-GJMT Andy. S

Aircraft Pilot

Project 3218_QSI_PierceMarathon

April 02, 2021

Date

Location Eau Claire WI Airport

Mission Objective

dditional Notes	
ပ	

T--8C H-47% AMLS-278m Hpa-1028

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A I R B O R N G I M G A Clean Harbors Company

Time to next maintenance: 32hrs \odot 50 hr O 100 hr

lock Time	13:17	17:35	3 hrs
Aircraft Block Time	Takeoff 13:17	Landing 17:35	Total 4.3 hrs
,	Engine On 12:56	Engine Off 17:43	hrs
	ou () Off	4.8
	Engine	Engine	Total 4.8 hrs

	Σ	issio	Mission Plan	
AGL Height	2300	Е	m Pulse Rate	800Khz
Target Speed	160	kts	kts Scan Rate	178
Laser Current	100	%	FOV	ego degs

Static	GP	GPS Time
Alignment	Start	End
Pre Mission	1304	1308
Post Mission	-	-

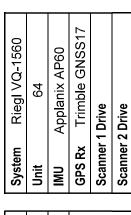
	Comments								
Mission ID	Time Stamp								-
Line Aborted	nmi to End								
Line	Time								
Time	End								
GPS Tim	Start								
Flight	Direction								-
LiDAR	File Name								
	Flight Line								

Page 2 of 5

Flight
092
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LIDAR Flight Log



D.Arteaga

Operator

C-GJMT Andy. S

Aircraft Pilot

Project 3218_QSI_PierceMarathon

April 02, 2021

Date

Location Eau Claire WI Airport

Mission Objective

Additional Notes	T-80

AMLS-278m H-47%

A Clean Harbors Company AIRBORN

Hpa-1028

⊙ 50 hr **O** 100 hr 32hrs Time to next maintenance:

lock Time	13:17	17:35	3 hrs
Aircraft Block Time	Takeoff	Landing 17:35	Total 4.3 hrs
	Engine On 12:56	Engine Off 17:43	hrs
	00 t	off of	4.8
	Engine	Engine	Total 4.8 hrs

	IN	115510	MISSION FIAN	
AGL Height	2300	ш	Pulse Rate	800Khz
Target Speed	160	kts	Scan Rate	178
Laser Current	100	%	% FOV	60 degs

Static	GP.	GPS Time
Alignment	Start	End
Pre Mission	1304	1308
Post Mission	-	-

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
GPS	Start								
Fliaht	Direction								
LiDAR	File Name								
	Flight Line								

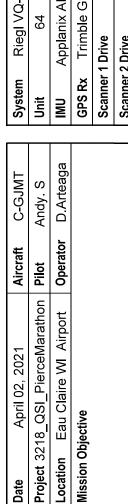
Flight
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April 02, 2021

Date

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Mission Objective

System	Riegl VQ-1560	◂
Unit	64	•
IMU	Applanix AP60	_
GPS Rx	Trimble GNSS17	_
Scanner 1 Drive	1 Drive	
Scanner 2 Drive	2 Drive	

Additional Notes	T8C	H-47%	AMLS-278m	Hpa-1028	Time to next maint
Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	· 1 Drive	· 2 Drive

A Clean Harbors Con	32hrs © 50 hr O 100 hr	GPS Time	ent Start End	1304 1308	- u
		Static	Alignment	Pre Mission	Post Mission
T8C H-47% AMLS-278m Hpa-1028	Time to next maintenance:		800Khz	178	o degs

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Landing 17:35 **Takeoff** 13:17

Engine Off 17:43 Engine On 12:56

Total 4.3 hrs

4.8 hrs

Total

9

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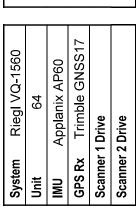
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Laser Current Target Speed AGL Height

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
Sd9	Start								
Flight	Direction								
LiDAR	File Name								
	Flight Line								

Flight
092
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LIDAR Flight Log



D.Arteaga

Operator

Project 3218_QSI_PierceMarathon

April 02, 2021

Date

Location Eau Claire WI Airport

Mission Objective

C-GJMT Andy. S

Aircraft Pilot

stem	Riegl VQ-1560	Addir
	64	H-8
	Applanix AP60	H 4
S Rx	Trimble GNSS17	AMI
nner	anner 1 Drive	Нра
nner	anner 2 Drive	Ë

lotes	
onal N	
Additi	

A Clean Harbors Company AIRBORN IMAGING

-8C 47% ALS-278m 1a-1028

le to next maintenance:

		Aircraft Block Time	
<u>-</u>	2:56	Engine On 12:56 Takeoff 13:17	AGL Heigh
₩ 1	7:43	Engine Off 17:43 Landing 17:35	Target Spe
Total 4.8 hrs		Total 4.3 hrs	Laser Curi

	Σ	issio	Mission Plan	
AGL Height	2300	Ε	m Pulse Rate	800Khz
Target Speed	160	kts	kts Scan Rate	178
Laser Current	100	%	FOV	60 degs

Static	Alignment	Pre Mission	Post Mission
9	Start	1304	-
GPS Time	риЭ	1308	-

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
GPS	Start								
Fliaht	Direction								
LiDAR	File Name								
	Flight Line								

Flight
093
Julian Day

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LIDAR Flight Log

Additional Notes



A Clean Harbors Company

Date April 03, 2021	21	Aircraft	C-GJMT	
Project 3218_QSI_PierceMarathon Pilot	Marathon	Pilot	Andy. S	
Location Eau Claire WI Airport		Operator	Operator D.Arteaga	
Mission Objective				
				_

System	Riegl VQ-1560
Unit	64
NMI	Applanix AP60
SPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

System	Riegl VQ-1560	Additiona
Unit	64	T21C
NWI	Applanix AP60	H-16%
SPS Rx	Trimble GNSS17	AMLS-27
Scanner 1 Drive	1 Drive	Hpa-101
Scanner 2 Drive	2 Drive	Time to ne

AMLS-278m

Hpa-1018

			degs
Static	Alignment	Pre Mission	Post Mission
GP	Start	2006	-
GPS Time	pug	2011	-

800Khz

m Pulse Rate kts | Scan Rate

2300

AGL Height

Mission Plan

Aircraft Block Time

Takeoff 20:16 Landing 22:58 **Total** 2.7 hrs

Engine On 20:00 Engine Off 23:02

hrs

3.0

Total

178

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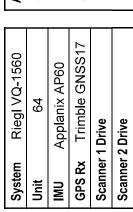
Target Speed Laser Current

Time to next maintenance:

									ne			Γ
	Comments	Data recorder error- full system	restart and cable swap						System crashed after 8 minutes on line			
Mission ID	Time Stamp		204836	-	210103	212113	214306	220425	222609			
Line Aborted	nmi to End											
Line	Time								2233			
GPS Time	End		2049	2055	2117	2138	2159	2221	2226			
GPS	Start		2048	2050	2101	2121	2143	2204	180			
Flight	Direction	-		-	180	000	180	000	180			
LiDAR	File Name											
	Flight Line	Test Strip 01	Test Strip 02	F8	1054	1055	1056	1057	1058			

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Flight
093
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D.Arteaga

Operator

C-GJMT Andy. S

Aircraft Pilot

Project 3218_QSI_PierceMarathon

April 03, 2021

Date

Location Eau Claire WI Airport

Mission Objective

system	Riegl VQ-1560		Ad
Jnit	64		Ė
MU	Applanix AP60		Ĭ
3PS Rx	Trimble GNSS17		₹
Scanner 1 Drive	1 Drive		Ī
Scanner 2 Drive	2 Drive		-
		•	

Additional Notes	T21C	H-16%	AMLS-278m	Hpa-1018	Time to next maint
Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	1 Drive	2 Drive

8m. Static Alignment Start Brost Mission Compared to the Archen Harbors Compared to the Ar
© 50 hr O 100 h Start 2006

800Khz 178

m Pulse Rate kts | Scan Rate

2300

AGL Height

Mission Plan

Aircraft Block Time

Takeoff 20:16 Landing 22:58 **Total** 2.7 hrs

Engine Off 23:02 Engine On 20:00

hrs

3.0

Total

9

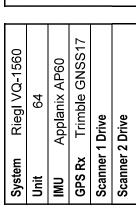
₽ 2 %

100 160

Target Speed Laser Current

	Comments								
Mission ID	Time Stamp								-
Line Aborted	nmi to End								
Line	Time								
Time	End								
GPS Time	Start								
Flight	Direction								-
LiDAR	File Name								
	Flight Line								

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D.Arteaga

Operator

Eau Claire WI Airport

Location

Mission Objective

C-GJMT Andy. S

Aircraft Pilot

Project 3218_QSI_PierceMarathon

April 03, 2021

Date

Additi	T21	H-16	AML	Нра-	Time
Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	nner 1 Drive	nner 2 Drive
tem	_		S RX	nner	nner

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100 160

Laser Current **Target Speed AGL Height**

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Takeoff 20:16 Landing 22:58 **Total** 2.7 hrs

Engine On 20:00 Engine Off 23:02

hrs

3.0

Total

Comments												
Time Stamp												
nmi to End												
Time												
End												
Start												
Direction												
File Name												
Flight Line												
	End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time Stamp Image: Control of the properties of the pr	File Name Direction Start End Time nmi to End Time Stamp Time Stamp	File Name Direction Start End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp

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C-GJMT	System	Riegl VQ-1560
Andy. S	Unit	64
D.Arteaga	NMI	Applanix AP60
	GPS Rx	Trimble GNSS17
	Scanner 1 Drive	1 Drive
	Scanner 2 Drive	2 Drive

Operator

Aircraft Pilot

Project 3218_QSI_PierceMarathon

April 03, 2021

Date

Location Eau Claire WI Airport

Mission Objective

Additional Notes	T-21C	H-16%	AMLS-278m	Hpa-1018	Time to next main
n Riegl VQ-1560	64	Applanix AP60	x Trimble GNSS17	er 1 Drive	er 2 Drive

m Pulse Rate kts | Scan Rate

2300

AGL Height

Mission Plan

Aircraft Block Time

Takeoff 20:16

Engine On 20:00 Engine Off 23:02

Total 2.7 hrs Landing 22:58

3.0 hrs

Total

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₽ 2 %

100 160

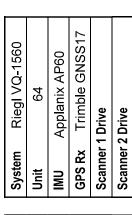
Target Speed Laser Current

	Comments							
Mission ID	Time Stamp							
Line Aborted	nmi to End							
Line	Time							
GPS Time	End							
GPS	Start							
Fliaht	Direction							
LiDAR	File Name							
	Flight Line							

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LIDAR Flight Log



D.Arteaga

Operator

Project 3218_QSI_PierceMarathon | Pilot

April 03, 2021

Date

Location Eau Claire WI Airport

Mission Objective

C-GJMT Andy. S

Aircraft

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next

O 50 hr O 100 hr	
t maintenance:	

,	Aircraft Block Time		Z	Mis
Engine On 20:00 Takeoff 20:16	Takeoff 20:16	AGL Height	2300	
Engine Off 23:02 Landing 22:58	Landing 22:58	Target Speed 160	160	¥
Total 3.0 hrs Total 2.7 hrs	Total 2.7 hrs	Laser Current	100	_

	Σ	Mission	n Plan		
AGL Height	2300	ш	m Pulse Rate	800Khz	
Target Speed	160	kts	Scan Rate	178	
Laser Current	100	%	% FOV	60 degs	
					l

	Static	GР	GPS Time
	Alignment	Start	End
	Pre Mission	2006	2011
'n	Post Mission	-	-

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
	Start								
Flight Direction									
LiDAR	File Name								
	Flight Line								

Page 5 of 5

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Project 3218_QSI_PierceMarathon | Pilot Andy. S- Krista R

LIDAR Flight Log

Scanner GPS Rx Scanner System NM Unit

D.Arteaga

Operator

Location Eau Claire WI Airport

Mission Objective

C-GJMT

Aircraft

April 05, 2021

Date

Additional Notes	T-6C	H-70%	AMLS-278m	Hpa-1010	Time to next maintens
Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	r 1 Drive	r 2 Drive

Additional Notes
T-6C
H-70%
AMLS-278m
Hpa-1010

A Clean Harbors Company AIRBORN IMAGING

⊙ 50 hr O 100 hr
enance:

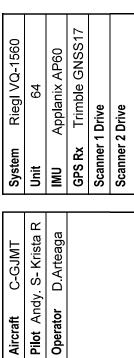
			Aircraft Block Time	lock Tim	•
Engine	o	Engine On 13:22	Takeoff	13:41	
Engine	Off	Engine Off 15:53	Landing 15:50	15:50	
Total 2.5 hrs	2.5	hrs	Total 2.2 hrs	2 hrs	

	Σ	VIISSION	n Plan	
AGL Height	2300	Ε	Pulse Rate	800Khz
Target Speed	160	kts	Scan Rate	178
Laser Current	100	1 %	FOV	eo degs

		l		l	l	1	l			l	l	l	l	
	Comments						System crashed just before we	enter the line- tried to restart while	in the air but it froze 2 times					
Mission ID	Time Stamp	135212	-	141350	143404	145534								
Line Aborted	nmi to End													
Line	Time													
Time	End	1354	1409	1429	1450	1511								
GPS Tim	Start	1352	1404	1413	1434	1455								
Fliaht	Direction	ı	-	180	000	180	000							
LiDAR	File Name													
	Flight Line	X-Tie	F8	1058	1059	1060	1061							

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LIDAR Flight Log



Operator

Eau Claire WI Airport

Location

Mission Objective

Aircraft

Project 3218_QSI_PierceMarathon

April 05, 2021

Date

/stem	Riegl VQ-1560		Ad
nit	64		Ļ
₽	Applanix AP60		土
PS Rx	Trimble GNSS17		₹
canner 1 Drive	1 Drive		Ĭ
canner 2 Drive	2 Drive		F
		-	

Additiona		%0Z-H	AMLS-27	Hpa-1010	Time to ne
Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Takeoff 13:41 Landing 15:50 **Total** 2.2 hrs

Engine On 13:22 Engine Off 15:53

hrs

2.5

Total

9

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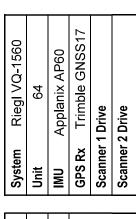
100 160

Laser Current **Target Speed** AGL Height

Comments								
Mission ID	Time Stamp							
Line Aborted	nmi to End							
Line	Time							
GPS Time	End							
GPS	Start							
Flight	Direction							
LiDAR	File Name							
	Flight Line							

Flight
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Pilot Andy. S- Krista R

Project 3218_QSI_PierceMarathon

April 05, 2021

Date

Location Eau Claire WI Airport

Mission Objective

C-GJMT

Aircraft

D.Arteaga

Operator

stem	Riegl VQ-1560	Add
iit	64	9 <u>-</u> L
n	Applanix AP60	Η-
S Rx	Trimble GNSS17	¥
anner	anner 1 Drive	Η̈́
anner	anner 2 Drive	Ë
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dditional Notes	Si	A .	AIRBORNE
-ec		A Clea	A Clean Harbors Company
%0 / -1			
MLS-278m			
Ipa-1010			
Time to next maintenance:		© 50 hr O 100 hr	
	Static	49	GPS Time
800Khz	Alignment	Start	End
178	Pre Mission	1330	1335

	,	Aircraft Block Time	
Engine On 13:22		Takeoff 13:41	
Engine Off 15:53		Landing 15:50	
Total 2.5 hrs		Total 2.2 hrs	
			ı

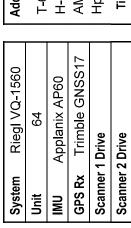
	Δ	ISSIO	Mission Plan		
AGL Height	2300	Ε	m Pulse Rate	800Khz	
Target Speed	160	kts	160 kts Scan Rate	178	
Laser Current	100 %	%	FOV	eo degs	

	Static	49	GPS Time
)Khz	Alignment	Start	риЭ
78	Pre Mission	1330	1335
degs	Post Mission	-	-

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
GPS	Start								
Fliaht	Direction								
LiDAR	File Name								
	Flight Line								

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Flight
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Pilot Andy. S- Krista R

Project 3218_QSI_PierceMarathon

April 05, 2021

Date

C-GJMT

Aircraft

D.Arteaga

Operator

Eau Claire WI Airport

Location

Mission Objective

Addition		%0/-H	AMLS	Hpa-1	Time to
Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	ner 1 Drive	ner 2 Drive
Ë			RX	ner	ner

9

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%

100 160

Laser Current **Target Speed AGL Height**

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Takeoff 13:41 Landing 15:50 **Total** 2.2 hrs

Engine Off 15:53 Engine On 13:22

hrs

2.5

Total

	Comments								
Mission ID	Time Stamp								
Line Aborted	nmi to End								
Line	Time								
GPS Time	End								
Sd9	Start								
Fliaht	Direction								
LiDAR	File Name								
	Flight Line								

Flight
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LIDAR Flight Log



Date	April 05, 2021	Aircraft C-GJMT	C-GJMT	Sy
Project 32	Project 3218_QSI_PierceMarathon Pilot Andy. S- Krista R	Pilot And	y. S- Krista R	'n
Location	Location Eau Claire WI Airport Operator D.Arteaga	Operator	D.Arteaga	M
Mission Objective	bjective			В
				Sc
				Sc

System	Riegl VQ-1560
Unit	64
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

System	Riegl VQ-1560	◀	Add
Jnit	64		9 - L
MU	Applanix AP60	_	-H
3PS Rx	Trimble GNSS17	_	ΑM
Scanner 1 Drive	1 Drive	_	랖
Scanner 2 Drive	2 Drive		Ë
		l	

Additional Notes		A .	AIRBORNE
T-6C		A Clea	A Clean Harbors Company
%0Z-H			
AMLS-278m			
Hpa-1010			
Time to next maintenance:		⊙ 50 hr O 100 hr	
	Static	49	GPS Time
800Khz	Alignment	Start	End
178	Pre Mission	1330	1335
o degs	Post Mission	1	-

m Pulse Rate kts | Scan Rate

2300

Mission Plan

Aircraft Block Time

Takeoff 13:41 Landing 15:50 **Total** 2.2 hrs

Engine Off 15:53 Engine On 13:22

hrs

2.5

Total

9

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100 160

Laser Current Target Speed AGL Height

	Comments							
Mission ID	Time Stamp							
Line Aborted	nmi to End							
Line	Time							
Time	End							
II Sd9	Start							
Fliaht	Direction							
LiDAR	File Name							
	Flight Line							

Page 5 of 5