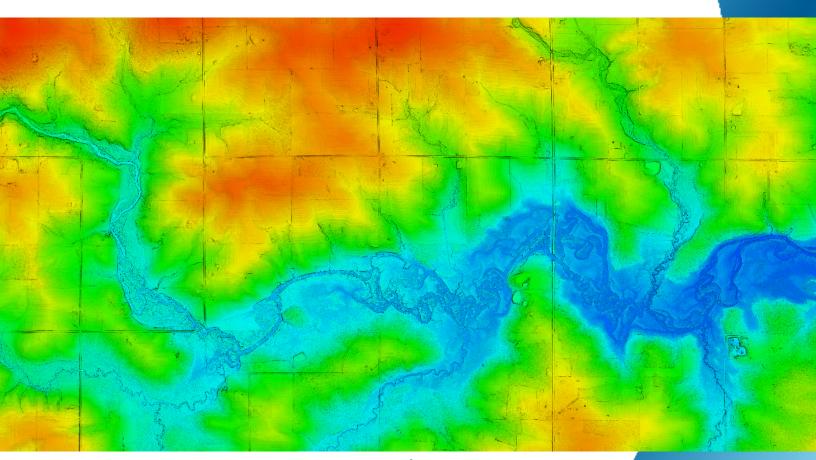
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WI_Statewide_2021_B21 LIDAR PROCESSING REPORT

Project ID: 218064 Work Unit: 300039

Prepared for:



National Map Help Desk: tnm_help@usgs.gov

2022

Submitted:September13,2022

Prepared by:





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Appendix A: Flight Logs

1. Summary / Scope

1.1. Summary

This report contains a summary of the WI Statewide 2021 B21, Work Unit 300039 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 300039 accounting for 349 square miles in Kewaunee. This project was done at Quality Level 2. 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.

	lable 1. Originally Planned Lidar Speci Ications				
Field of View		Minimum Side Overlap	RMSEz		
	2 pts / m ²	2,300 m	60°	20%	≤ 10 cm

Table 1 Originally Dlannad Lidar Specifications

1.3. Coverage

The project boundary covers 349 square miles over Wisconsin. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from April 2, 2021 to April 22, 2021 in 2 total lifts. See "Section: 2.4. Time Period" for more details.

1.5. Issues

There were no issues to report.

37876_WI_Statewide_2021_B21 Work Unit 300039 Projected Coordinate System: NAD_1983_2011_Wisconsin_State_Plane_Central Horizontal Datum: NAD83 (2011) Vertical Datum: NAVD88 (GEOID 18) Units: US Survey Feet		
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 	

WI_Statewide_2021_B21 Kewaunee County Work Unit 300039 Boundary

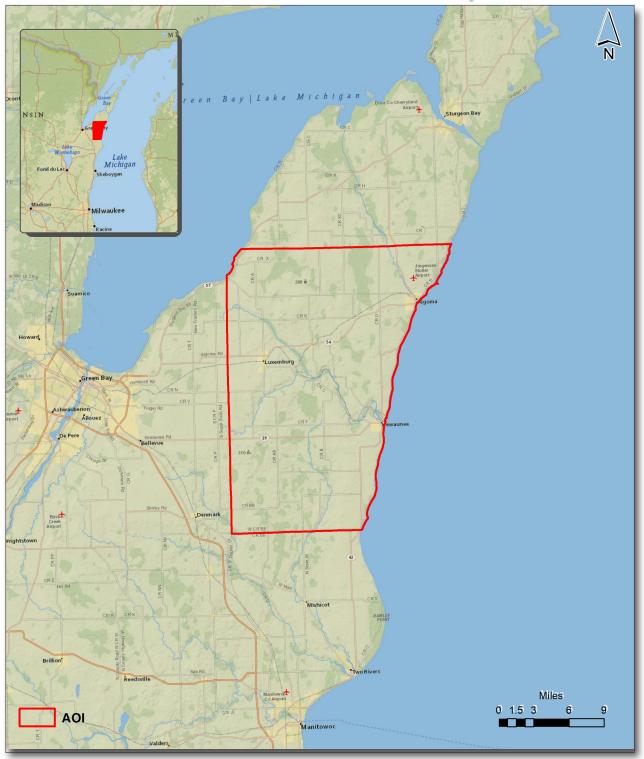


Figure 1. Work Unit Boundary

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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) 4040 for data acquisition.

The Riegl 1560i system has a laser pulse repetition rate of up to 2 MHz resulting in more than 1.3 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor is also equipped with the ability to measure up to an unlimited number of targets per pulse from the laser.

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

		Riegl VQ1560i (SN4040)
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	Laser Pulse Rate Used 1000 kHz	
Laser	Multi Pulse in Air Mode	yes
	Full Swath Width	2577 m
Coverage	Line Spacing	0.558 m
Point Spacing	Average Point Spacing	0.71 m
and Density	Average Point Density	2 x 1.16 pts / m ²

Table 2. Lidar System Specifications

Figure 2. Riegl VQ1560i 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 Conquest 2, Tail Number(s): N441CJ

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

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2.4. Time Period

Project specific flights were conducted between April 2, 2021 to April 2, 2021. Two aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
04022021A (SN4040,N441CJ)	4/02/2021 2:08:51 PM	4/02/2021 6:17:38 PM
04022021B (SN4040,N441CJ)	4/02/2021 7:31:37 PM	4/02/2021 8:49:28 PM

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.

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

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

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:

	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.

Table 3. LAS Classifications

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 hydro-flattened 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 Processing

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 Processing

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.

0-8cm	
8-16cm	
16-24cm	
>24cm	

3.8. Maximum Surface Height Raster Processing

Maximum Surface Height rasters (topographic) represent a lidar-derived product illustrating natural and builtup 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.

WI_Statewide_2021_B21 Kewaunee Work Unit 300039 Tile Layout

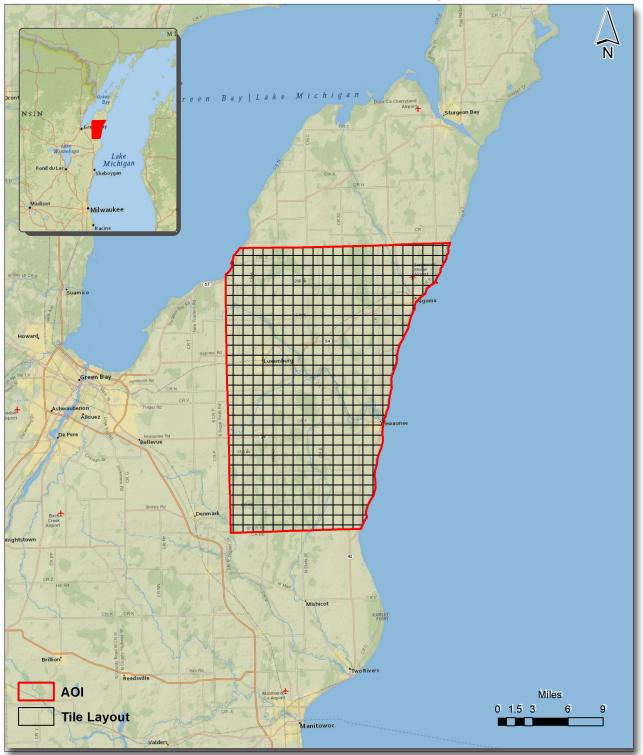


Figure 4. Lidar Tile Layout

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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.

WI_Statewide_2021_B21 Kewaunee Work Unit 300039 Lidar Coverage

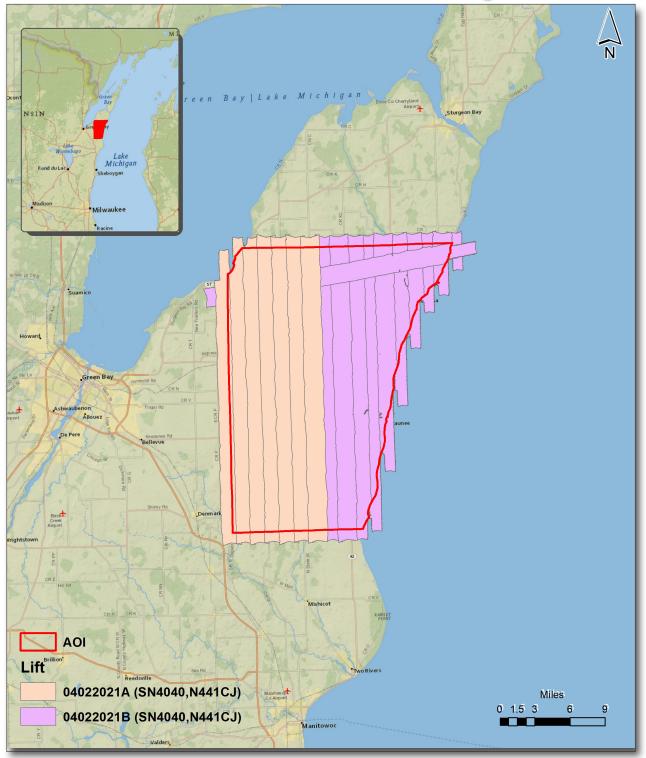


Figure 5. Lidar Coverage



5. Geometric Accuracy

5.1. Horizontal Accuracy

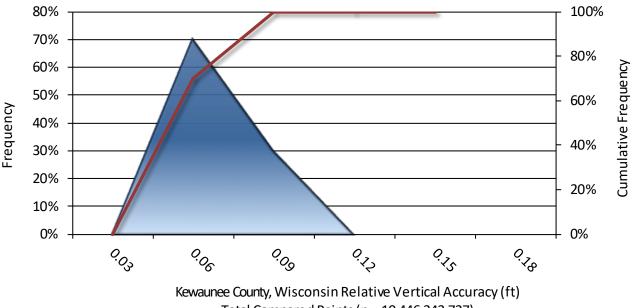
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained RMSEr value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial 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	

5.2. 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		
	0.050 ft		
Average	0.015 m		
Madian	0.046 ft		
Median	0.014 m		
DMCE	0.052 ft		
RMSE	0.016 m		
Standard Deviation (1σ)	0.012 ft		
	0.003 m		
	0.023 ft		
1.96σ	0.007 m		



Total Compared Points (n = 10,446,343,727)

Project Report Appendices

The following section contains the appendices as listed in

the WI_Statewide_2021_B21 Lidar Project Report.

Appendix A

Flight Logs

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80	N	135504		194	.88/15	2475											
79	5	140659		168	.83/17	2479											
78	N	142256		170	.8517	2474											
87	E	143853		180	.82/17	2540							1				
88	W	144940		172	.85/18	2540								`			
89	E	150 027	-	173	.88/18	2548											
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80	N	135504		194	.88/15									2			
79	5	140659		168	.83/17												
78	N	142256		170	.8517							-					
87	E	143853		180	.82/17								-				
88	W	144940		172	.85/18									x			
89	E	150027		173	.88/18												
90	W	151118		177	.85/17									2			
91	E	152155		177	99114	2541	15式		cra	b 15	+ to	the ri	ant				
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GPS Unit:		N) Sta	1: 1	'PP	S	ita 2:			Flyovers: Y / N	If Y, times: Stal		Sta2)		
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LIDAR	FOV	58,52		10 10	MpiA		Air			100% PPSM	2		Tot GB	
		Start (UTC):	End (UTC):	Gd Spd		GPS Altitude		Turb		FLIGHT LINE NOTES -	visibility, clouds, sm	oke, partial, etc.		
Line #	Hdg	1855		Gaspa	PDOF/# Sats	Gra Attitude	Crab	(0, -, +)	static B	sturns		7	fia	81
125	5	194543	121	181	18/16	2495			XF	5 / 4/ 11 3			10	.
94	E	200922		17-9		2507			/ 3/					
95		202456		176	.9/17					-				
96	E	204013		184	91/17									
97		205609		181	.87/16									
98		211151		175	.88/16									
99		212654		172										
100	•••	24206		177	1									
101	W	215714			,98/16					, il				
102		221230	2227	182	,95/18	2510								
											•		×	
											2 2			
												1	1	•
						1 A. 2		8						
											1			

roject:	V	II	3 DE	P				ition_list@quant 776		light Mg	gmt File:	202	103	28-SN	4040_	A- R0378
Aircraft:					0.9 E				: 2,4	Pilot	: J. Bi	Llingto	Co-Pilot:		Tech:	verson
Dep Apt		· · ·													ime Aloft:	2:26
CORS:	YK	0	1927			ta 2:			lyovers: Y		If Y, time			Sta2)		
GPS Unit		(N) Sta	1:	PP	s	ta 2:		F	lyovers: Y	/ N	If Y, time	s: Stal)		Sta2)		
Gd Temp		V	: End:	°c	OAT be		c End		Altimeter			end:		270m	Beg GB	Storage Name/#
					Alt AGL 23	•		Avg			180 kt				End	
Lidar	EOV	gL 1560	Seen	7040		Pu	lses	Ht Pulse	TAD	Gdspd Power	100%		0	-	Tot GB	
		58.52	Freq		ΜρίΑ Υ				500		100%	7	L		GB	
Line #	Hdg			Gd Spd	PDOP/# Sats	GPS Altitude		urb , -, +)		1			•	noke, partial, etc.		(19
		1237						Sta	ticAv	/	5	sturn	51	Comprac	loorv-	tigures u
86	N	131349		171	1.06/\$5							1	5 1	84	1 1	
85	5	132528		180		2992m		Last	er Kep	+ +j	ring	TILLI	iext Li	ine 84 sta	opea L	aser ->
84	N	134349		174		2490m		4	and T							
83	1	135604		174	.9/16				cLoui	ds	tormi	19 1	n ar	ea	140 1	in a th
82		140840		173	.83/17				CLOUC	ds n	earby	. 77	OFMIN ANT	ng in a	reat	nswain
124	F	142345		165	,79/18	2504		Cros	sline	- [[ouds	IN 1	40 <u>1</u>			
								UN	Λ Λ	669	3.2	10-	25/1	525		
										669.		103	-1, 1	538	20:	13
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	Sec. 10							×								
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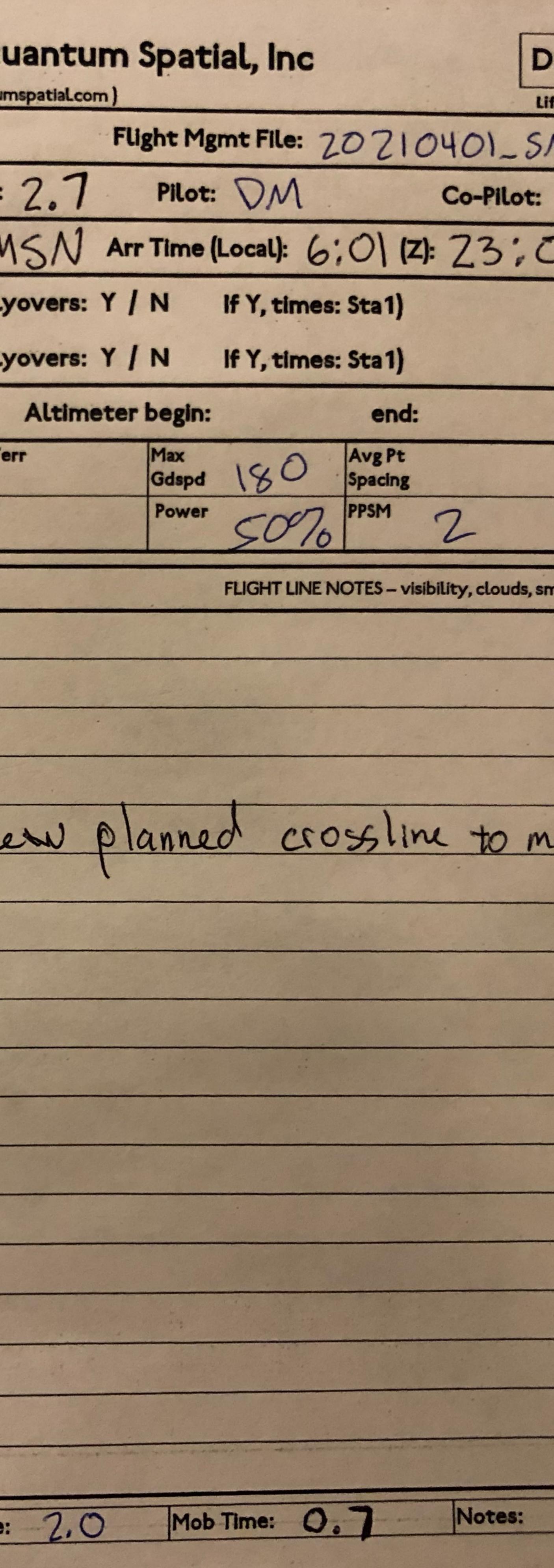
Airborne LIDAR enverning Project: WI3DEP Aircraft: N4416) Begin Hob Dep Apt: KMSN Dep Time (CORS: YIN Sta 1: GPS Unit: Y / N Sta 1: Gd Temp beg: End: °c Type 1560; Serial # LIDAR FOV 58.52 Scan Freq Start (UTC): End (UTC): Line # Hdg 0 104 40924 152440 06 153940 0 9 160916 min ----0 5 175214 125 Total Proj Lines: Lines Flown: 54

\ Data	Collec				
	(email log da	Proj #:	THE OWNER AND ADDRESS OF		
obs: 670	0 9 F	Ind Hobbs:			
	09 (Z):				pt: K
		ta 2:			F
PP9		ta 2:			F
°c			C Er	nd:	°c
	Alt AGL 2300				Ft Avg T Ht
SOOKHI		IN Pu	lses	.00	Pulse
	1		Air	Turb	Rate
Gd Spd		GPS Altitude	Crab	(0, -, +)	Cort
180	0.97/26			0	First
141	0,13/21			0	on
179	0,88/28			0	
197	D aa /20		-	0	
184	0,89/28			0	
179	1.03/25			0	mar
179	1,05/26			0	vof
	1.04/27			O	1~;
182	0.94/19			O	
	0.94/28			0	
183	0.94/28			0	
statement of the second statement of the second statement of the second statement of the second statement of the	0,95/27			0	
	0,94/27			0	
184	0,92/27			0	
182	0.96/25			0	
176	0.94/26			0	
180	0,90/28		91 - 108 - 5441 - 10 - 10	0	An opping in the sector will add the
: 19	Lines R	emain:	18	Or	line Time
1810	1.82/29			0	

Quantum Spatial, Inc Date: 4 202 Pg_of_ Lift: A (B) C D E ntumspatiaLcom) Flight Mgmt File: 20210401_SN4040_B_ R037876 Pilot: DM Tech: Herson JJ 4.5 Co-Pilot: MSN Arr Time (Local): 1;40 (Z): 18:40 4:31 Tot Time Aloft: Flyovers: Y / N If Y, times: Sta1) Sta2) Flyovers: Y / N If Y, times: Sta1) Sta2) Storage Name/# Beg GB Altimeter begin: end: Max Gdspd 180 Avg Pt End GB Terr Spacing Power PPSM Tot 10 FLIGHT LINE NOTES - visibility, clouds, smoke, partial, etc. restart due to Channel Zissue. All lines flown system line after mission B. Cross line (a) 162419 82 nua +2 VP Set tor ine 2 1 129 mission 0 * * . . Mob Time: 0,8 Notes:

- Contraction	A	irborne	LIDA	R Data	Collec Lemail log dai				: :: Qu list@quantume
Project:	W13	SDEP			Termare cog da	Proj #:			
Aircraft:/	144	ICS	Begin Ho	bbs: 67	'05.4 E		~		
Dep Apt:	KN	ISN	Dep Time	(Lcl): 3;	18 (Z):	20:19	3	Arr A	pt: KM
CORS:	Y /	N Sta	1:	pp	St	a 2:		-	Flye
GPS Unit:	• Y /	N Sta		Yr.		a 2:			Flye
Gd Temp	beg:	•	: End:	°c	OAT be	g: •	C EI	nd:	°c
	Type	560.	Serial #	1040	Alt AGL Z 30	m AL	t Asi g	100	Ft Avg Ter
LIDAR		56.52		DOKHI	MpiA Y	IN PU	Lses Air	4	Pulse Rate
Line #		Start (UTC):		Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	
55	3	203551		182	0.87/28			0	
56	183	205042		178	0,95/27			0	
57	3	210530		182	0.95/27			0	
58	183	212026		177	0.92/28			0	
123	Constant States	213741		183	0.84/29			O	Refle
75	3	214925		179	0.86/29			0	
74	183	215313		180	0,85/30			0	
73	3	215720		171	0,85/30			0	
72	183	220307		186	0.87/30			0	
71	3	220904		187	0,86/30			0	
70	183	221544	States in the second states in	185	0.88/30			0	
69	3	222222		178	0,89/30			0	
76	3	223147		184	0.93/30			0	
17	1453	223627		180	0.91/29			0	
			*						
								-	
			- and a second of the same of						a a more a compete
	1	1		- 111	Lines R	emain:	16		nline Time:
Total Proj	Lines;	125	Lines Flow	m: 14	Lines K		60		ichie inne.

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Date: 4/1/	12011	
	IDLI	
ift: A B CD E	Pg_	l of l
N4040_C	5-R0?	37876
	Tech:	page JD
つ) Tot Ti	me Aloft:	7:43
Sta2)		
Sta2)		
	Beg GB	Storage Name/#
	End GB	
	Tot GB	
moke, partial, etc.		
		the second se
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atch Fli	ght lin	25
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	ght line	

aneutry.		irborne	e LiDAI	R Data					:: Quantu
International International Content of the In		3DE	P		(email log da				list@quantumspatiaLco
-				bbs: (17	OSI E				JTotal: 4, (
Dep Apt					53(Z):				pt: KGRB
CORS:	Y /		4.	00	C	ta 2:			Flyovers:
GPS Unit				SYY		ta 2:			
				•			9- F		Flyovers:
Gd Temp				°C	OAT be		°C E	and the second second	°C Altim
LIDAR	FOV	1560:			and the second second second second		AMSL &	4004	Ht Avg Terr Ht Pulse
	1.	F6.52	Freq 50	0 Kth	MpiA Y		In Air		Rate
Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitu	ide Crab	Turb (0, -, +)	
68	3	140850		180	0.82/28			0	Test File
67	183	142332		179	0.88/27			0	
66	3	143819		186	0.90/28			0	
65	183	145249		178	0.95/27			0	
64		150722		186	0.99/27			0	
	183	152140		183	1.19/25			0	
62	3	153607		180	0.92/28			0	
61	183	155027		181	0,89/30	-		0	
60	3	160500		190	0.92/28			0	Service roken
59	183	61916		183	0.96/27	-		0	DI
122	93	164354		181 (0.84/31			$\frac{0}{2}$	Flannel
36	3	171241		168	0,89/30			0 m	FUST
51	185	172203		184	0,91/30			0	
38	5	173144		179	0.88/30	1		0	
39	185	174132		186	0.84/31			0	
40	5	175110		182	0.81/31			0	
41	185	180052		184	0.70/31				
Construction of the second sec		181022		110	0.7430		-		
Total Proj L	ines:	125 4	Ines Flowr	18	Lines R	emain:	26	Or	nline Time: 3,0

um Spatial, Inc	Date: $4/2/2021$ Lift: (A) B C D E Pg of
	Lift: (A) B C D E Pg of - SN4040_ A_ R037876
Pilot: DM Co-Pil	
Arr Time (Local): 1:30 (Z): 19:	30 Tot Time Aloft: 4:37
: Y / N If Y, times: Sta1)	Sta2)
: Y / N If Y, times: Sta1)	Sta2)
neter begin: end:	Beg GB Storage Name/#
Max Gdspd 180 Avg Pt Spacing	End GB
Power 0020 PPSM 2	Tot GB
FLIGHT LINE NOTES – visibility, clou	ds, smoke, partial, etc.
at 140209 to confirm	channel 2 function
String .	
d crossline th	en mob to Kewaune «15 min
line of Junio	A01 Kewaunee
Mob Time: 0,7 Not	es:

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	3 O R					O 50 hr 🕥 100 hr	GPS Time	Start End	1317 1322	1851 1856		Comments															
	Additional Notes			.278m	116	Time to next maintenance:	Static	NZ Alignment	Pre Mission	degs Post Mission				140330	142544	143928	150504	152737	154958	161217	163415	165537	-	•	180020	180845	
t Log		T3C			Hpa-1016	Time to	Mission Plan	Pulse Rate 800Khz	Scan Rate 178	FOV 60	l ine Ahorfed	End															
LIDAR Flight Log	System Riegl Q1560	Unit 64	IMU Applanix AP60	GPS Rx Trimble GNSS17	Scanner 1 Drive	Scanner 2 Drive	Missi	eight 2300 m	Target Speed 160 kts	Laser Current 100 %		End Time		1422	1427	1458	1521	1545	1606	1629	1651	1658	1703	1757	1801	1823	1828
	C-GJMT S	Krista R U	Daniel A	0	S	S		AGL Height	Target	Laser (GPS Time			1403 14	1425 14	1439 14	1505 11	1527 1:	1549 16	1612 16	1634 16	1655 16	1658 1	1752 1	1800 18	1808 18	1823 18
	Aircraft (Pilot	Operator				me					Flight		092		274	092	274	092	274	092	•			•	181	
Elight A	April 22, 2021	3218_QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:30	Landing 18:49	Total 5.3 hrs		LIUAK File Name															
Julian Day 112	Date April 2	Project 3218_QSI_I	Location Eau Clai	Mission Objective				Engine On 13:10	Engine Off 18:59	Total 5.8 hrs		Flight Line	E8	1028	X-Tie	1006	1005	1004	1003	1002	1001	X-Tie	F8	F8	X-Tie	1062	F8

Page 1 of 5

	AIRBORNE	IMAGING	A Clean Harbors Company) 100 hr	GPS Time	rt End	7 1322	1 1856		Comments									
						• 50 hr O 100 hr	Static	Alignment Start	Pre Mission 1317	Post Mission 1851		Col									
	Additional Notes	T3C	H- 86%	AMLS- 278m	Hpa-1016	Time to next maintenance:		800Khz A	178 Pre M	degs Post	Mission ID	Time Stamp								ı	
Log				317	Ĭ	Ë	on Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End									-
LIDAR Flight Log	n Riegl Q1560	64	Applanix AP60		Scanner 1 Drive	Scanner 2 Drive	Mission	2300 m	d 160 kts	nt 100 %	Line	Time									-
П	System	Unit	IMU	GPS RX	Scann	Scann		AGL Height	Target Speed	Laser Current	GPS Time	End									
	C-GJMT	Krista R	r Daniel A								5	Start									
	Aircraft	Pilot	Operator				ime				Eliaht	Direction								ı	
Elight A	April 22, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:30	Landing 18:49	Total 5.3 hrs											_
Julian Day 112	Date April 2	Project 3218_QSI_	Location Eau Cla	Mission Objective				Engine On 13:10	Engine Off 18:59	Total 5.8 hrs		Flight Line									

	VIRBORNE	6 I N 6					ше	End	1322	1856										
	AIRB					● 50 hr O 100 hr	GPS Time	Start	1317	1851		Comments								
							Static	Alignment	Pre Mission	Post Mission										
	otes			m		maintenan			Pre		Mission ID									
	Additional Notes	T3C	. 55 H- 86%	AMLS-278m	Hpa-1016	Time to next maintenance:		800Khz	178	degs	Mis	Time Stamp								
	Ad		· ±		 		E		Rate	60	p	nmi to End								-
ıt Log	1560		AP60	GNSS17			Mission Plan	m Pulse Rate	s Scan Rate		Line Aborted	nmi								
LIDAR Flight Log	Riegl Q1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Miss	2300 r	160 kts	100 %		Time								
LIDAR	System	Unit	A UMI	GPS Rx	Scanner 1 Drive	Scanner 2 Drive			Target Speed	Laser Current		End								-
					0,			AGL Height	Target	Laser	GPS Time									
	C-GJMT	Krista R	Daniel A								GP	Start								
	Aircraft	Pilot	Operator				e B				Eliaht	Direction								-
Flight A	April 22, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:30	Landing 18:49	Total 5.3 hrs		е е								
, 112	April 2:		Eau Clai	ective			A	13:10							 	 	 		 	
Julian Day	Date	Project 3218	Location	Mission Objective				Engine On	Engine Off 18:59	Total 5.8		Flight Line								

	RBORNE	AIRBORNE IMAGING A Clean Harbors Company				L	GPS Time	End	1322	1856		ts								
•	AI					● 50 hr O 100 hr	9	Start	1317	1851		Comments								
							Static	Alignment	Pre Mission	Post Mission										
	es			_		aintenanc		_	Pre		<u> </u>									
	Additional Notes	T3C	. 55 H- 86%	AMLS- 278m	Hpa-1016	Time to next maintenance:		800Khz	800Khz 178) degs	Mission ID	Time Stamp								
bo-				\$17	 		Plan	Pulse Rate	Scan Rate	FOV 60	oorted	nmi to End								
LIDAR Flight Log	Riegl Q1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m F	160 kts \$	100 % F	Line Aborted	Time								
LIDAR	System			GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height 2	Target Speed	Laser Current	e	End								
					_		AG	Tar	Las	Lase GPS Time					 	 	 	 		
	C-GJMT	Krista R	Daniel A								. 0	Start								
	Aircraft	Pilot	Operator				ре				Eliaht	Direction								
Elight A	April 22, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:30	Landing 18:49	Total 5.3 hrs		<u>е</u>								
Julian Day 112	Date April 2	Project 3218_QSI_F	Location Eau Clai	Mission Objective			4	Engine On 13:10	Engine Off 18:59			Flight Line								

	3 O R N E	A I R B O R N E I M A G I N G A Clean Harbors Company					ime	End	1322	1856											
	A I R I A Clean H				● 50 hr O 100 hr	GPS Time	Start	1317	1851		Comments										
							Static	Alignment	Pre Mission	Post Mission											
	S			_		aintenance		▲	Pre I		DIN										
	Additional Notes	T3C	. <u> </u>	AMLS-278m	Hpa-1016	Time to next maintenance:		800Khz	178) degs	Mission ID	Time Stamp	-								
D	▼		· _		 		Plan	Pulse Rate	Scan Rate	60	ted	nmi to End									
ht Lo	Riegl Q1560		AP60	GNSS1			Mission PI	m Puls	kts Scar	% FOV	Line Aborted	μu		 							
Fligh	Riegl (64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mis	2300	160 k	100		Time									
LIDAR Flight Log	System		GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current		End										
								AGL	Targ	Lase	CPS Time										
	C-GJMT	Krista R	Daniel A								. 5	Start									
	Aircraft	Pilot	Operator				e				Eliabt	Direction									-
Flight A	2, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:30	Landing 18:49	Total 5.3 hrs											1
112	April 22, 2021		Eau Clair	ctive			A	13:10									 				-
Julian Day	Date	Project 3218	Location E	ļģ				Engine On 1	Engine Off 18:59	Total 5.8		Flight Line									

	K-112 Ju 2/15/19	N C	52/62 5 91	15 N 200707	it Signation	N	12 5 141507	1 N 185725	SAMER! 5 01	0 N R2428	8 5 180932	2 11-12 L	821261 5 9 9	SNIZLI N 5 8	4 S INVIO	3 12 176646	2 S 165602	1 N 1644 31	Line # Hdg Start (UTC):	For 58,52	LIDAR ISUS	Gd Temp beg: °c	GPS Unit: Y / N Sta 1:	CORS: () N Sta	Dep Apt: LLSE	Aircraft: 4737W	Project: UI 301		
	2.1716	1 961 75112 022502	1-		19494220887147 ~	5 140	in 11 11 147	185723 WITIN 154 4	185343 440	261 (2113)	18238 145	180893 133	17531) 145	17+035172	1727/0133	171648 132	176518 152	165424 130 ·	End (UTC): Gd Spd	- Freq SUC IC H Z	Serial # 4045 Alt	End: °c	11:	Sta 1: AV	Dep Time (Lcl): (0; $0b$	Begin Hobbs: 5 794,0	EP	e LIDAR Data C	
(7		AS/2222495 5	.87/ 2500 -5	37/21 2445 5	7- 0157 62/68	14721 2525 4	A4/22 2540 -2	461222545 3	189/21255 -3	\$11/23 2560 3	- 2570 -	51/2/2575 3	,94/20 2580 D	AV/21 2610 3	2-5292 W 126.		46/21266m -2	2 4202 8 LUISH	PDOP/#Sats GPS Altitude Crab	MpiAY/N Pulses	al 2 200 Alt	OAT beg: °c End	Sta 2:	Sta 2:	(Z): 15:06	O End Hobbs: $SEO, 3$	Proj #: 3787	Airborne LiDAR Data Collection Log Sheet :: Quantum (email log daily to flight_log_distribution_list@quantumspatial.com)	
Online Time: U.S		- few Smill th	man offerd on light	0	-un this starting mid line	O tanuadon 20	0	0	Ď	G	0	6 1255 HS. 75413	O Gome ales	0	0 lenter 75ts h	6 heydwind	wind	O FLII Sun, (4)	Turb (0, -, +)	Pulse Rate	Avg Terr Ht	ດໍ	Flyovers: Y	, có), 3 Total: 6.3	76	ist@qu	
Mob Time: X		two intervals	14 ture (ist hailt line		home	200 A low by a second mid)	have a Cl & Cral	Still have ice in		entry 75ts huming unst line	,	Stand De -160 gues 140 13 in	(alma ar	FLIGHT UNE NOTES - visibility, clouds, smoke, partial, etc	Power ((10 °C PSM 2	$\frac{Max}{Gdspd} \left(\frac{30}{20} \int l_{l_{\rm L}} l_{\rm V} \frac{140}{140} \frac{Avg}{Spacing} \right)$	Altimeter begin: end:	Y / N If Y, times: Sta1)	Y / N If Y, times: Sta1)	Arr Time (Local): リンスタ (Z): こ 1 2 0	Pilot: Ban Luder + Co-Pilot:	Flight Mgmt File: 20210401 5244045	Quantum Spatial, Inc	
Notes:						line							Jours Woles Syllebrac				رح ج		louds, smoke, partial, etc.	GB 200	and 200 316	GB CD Name/*	Sta2)	Sta2)	29 Tot Time Aloft: 6,23	Pilot: Tech: Joak Glebon	A_ 378	Date: 4/1/2021	

Same Paramstes 25/4							
Perel : 202 End 502 Start: 500 202		1.5 2.9 moloce total	time.		3	n Sg Yemain	thread con the
						ar	
<76N Sats waraly first a-8miles) 2	0 22/2/28	8 mil 1	631	274611	\sim	20
+ <7 GNS sats turning milline,	T -	+ 5662 62/58	138	234812	23235)	N	14
	0	18/22 2500 -3		27225	230212 272254 142	\sim	18
	0	18/27 2570	しょし	125336	224608	נדק	120
Ling to I Notes	,	1	speed	Stalo	Start	HBG	Live #
10(4), 115 7 total slott: 2:48	1-1 51:8 31		KIMT	1.0m 1	I SPED	m 4	1/1/21 \$ MISTER 2201 X 100 KINT

27 Total Proj Lines: CORS: Project: WI JDEP -----Dep Apt: C LWA とい GPS Unit: Y / N Aircraft: 475 TW Begin Hobbs: 5204.1 524 23 24 25 24 35 LIDAR Gd Temp beg: 32 11 9 20 Line # FOV 58,52 Type 1560 1 N 2354 21 1824 N 231856 23753 151 Hdg Start (UTC): End (UTC): Gd Spd 8 0/ N Sta 1: 10/ ACIA N N 211456 212547 144 2 1956 zari N 220139 221946 148 Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc 2224 12353 148 m 82/24 2440 204 BZ 24728 143 22 5925 23624 150 151 25/112 L2L012 20371257212637 155 20250 204/16 153 22117 223461 152 224006 22.5000 151 LINNIZ LIBRIZ 215017 220076 155 Sta 1: Dep Time (Lcl):2.58 റീ Lines Flown: serial # 4045 Freq 500 (CI+2 MpiA Y / N In Air End: 153 iyu 152 ° PDOP/#Sats GPS Altitude Crab (0,-,+ AGE 2300 M 84/25 2480 .15/23 2480 \$123 Jur76 81/23 2270 -2 0 21425 2445 A1/23 2480 2465 7 106 122 2500 ash 72150 11/23 2480 -7 84 h5 2490 10 \$5/24 2475 ,82/25 2475 (email log daily to flight_log_distribution_list@quantumspatial.com 36/26 2470 37/25 2475 AH/22 2470 -8 OAT beg: Lines Remain: 85 NI : IZI End Hobbs Sta 2: Sta 2: Proj #: 37876 Alt 50 റ് 6-1 19 - 9 + 2 x v 19 4 8 End: duy total : 0 đ C 0 0 C 0 Arr Apt: KS DM O the didn't hope atomatically status logging - I seconds it it 0 O <7 bool sab harming 235 miles thes chant longle into lite 0 Online Time: 4, hazey The data t sprecoding after the breef light two same spotas last line, Sanget during line 27 Bull sers winty in a the , but of ADE <7 GWS Scls WRINKY, b Seconds fey willes in reflect first (5 seconds to cover the Total: Avg Terr Ht Pulse Rate റ് Flyovers: Y / N Flyovers: Y / N Altimeter begin slues ر ت ک Arr Time (Local): \mathcal{S} , \mathcal{L} ((Z): \mathcal{L} (10,01 11. Life A 8 ① D 1 Flight Mgmt File: 202(0代02 - SN 代0代5- C- 37876 Power Wdo Gdspd 180, Set to Pilot: Dan Luckett Mob Time: 48 broken overtast If Y, times: Sta1) If Y, times: Sta1) FLIGHT LINE NOTES - visibility, clouds, smoke, partial, etc. ご Avg Pt Spacing PPSM 2 end C7 Sats Grys Lewing, healt bys huber after Co-Pilot: Notes: 1st start Date: 4/2/2021 Sta2) Sta2) Tot Time Aloft: 5 2 3 Tech: Noah Elelson 68 GB GB Pg t of 1 Storage Name/•

	OR					O 50 hr 💽 100 hr	ic GPS Time	nent Start End	n 1537 1542	ion 2211 2216		Comments																Page 1 of 5
	Additional Notes	T2C	H-37%	AMLS-278m	Hpa-1035	Time to next maintenance:	Stat	800Khz Alignment	89 Pre Mission	60 degs Post Mission	Mission ID	Time Stamp	160220	160625	•	163858	165430	174722	173003	174722	180617	182444	184405	190224	192239	194227	200230	
ht Log	Riegl VQ-1560		k AP60	Trimble GNSS17			Mission Plan	m Pulse Rate	kts Scan Rate	% FOV 6	Line Aborted	nmi to End																
LIDAR Flight Log		64	Applanix AP60		Scanner 1 Drive	Scanner 2 Drive	Mis	lt 2300	160	ent 100		Time																
5	System	Unit	IMU	GPS Rx	Scan	Scan		AGL Height	Target Speed	Laser Current	GPS Time	End	1603	1618	1629	1647	1706	1724	1742	1800	1819	1838	1857	1917	1937	1957	2018	
	C-GJMT	Pilot Andy. S-Krista R	D.Arteaga								Ð	Start	1602	1606	1624	1638	1654	1712	1730	1747	1806	1824	1844	1902	1922	1942	2002	
	Aircraft		Operator				ime				Flight	Direction	ı		•	180	000	180	000	180	000	180	000	180	000	180	000	
1 Flight A	April 01, 2021	PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 15:54	Landing 22:08	Total 6.2 hrs	LIDAR																	
Julian Day 091	Date April (Project 3218_QSI_PierceMarathon	Location Eau Cla	Mission Objective				Engine On 15:26	Engine Off 22:18	Total 6.9 hrs		Flight Line	Test Strip	X- tie	F8	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	v 20200520

	_					• 50 hr O 100 hr	GPS Time	Start End	1537 1542	2211 2216		Comments										
	Additional Notes	T2C	H-37%	AMLS- 278m	Hpa-1035	Time to next maintenance:	Static	800Khz Alignment	89 Pre Mission	degs Post Mission	Mission ID	Time Stamp	202209	204254	210256	212330	•					
LIDAR Flight Log	Riegl VQ-1560 Ad	64	Applanix AP60 H	\$17			Mission Plan	2300 m Pulse Rate 8	160 kts Scan Rate	100 % FOV 60	Line Aborted	Time nmi to End										
LIDAR	System R	Unit	IMU Ap	GPS RX Tr	Scanner 1 Drive	Scanner 2 Drive		AGL Height 23	Target Speed 16		Time	End	2037	2058	2118	2138	2144					
	C-GJMT	Pilot Andy. S-Krista R	D.Arteaga								GPS Time	Start	2022	2042	2102	2123	2139					
	Aircraft		Operator				ime		~		Elioht	Direction	180	000	180	000	I					
Flight A	April 01, 2021	^D ierceMarathor	Eau Claire WI Airport				Aircraft Block Time	Takeoff 15:54	Landing 22:08	Total 6.2 hrs		File Name										
Julian Day 091	Date April 0	Project 3218_QSI_PierceMarathon	Location Eau Clai	Mission Objective			4	Engine On 15:26	Engine Off 22:18	Total 6.9 hrs		Flight Line	1042	1043	1044	1045	F8					

v 20200520

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	AIRBORNE					• 50 hr O 100 hr	GPS Time	Start End	1537 1542	2211 2216		Comments							
						intenance:	Static	Alignment	Pre Mission	Post Mission	a c								
	Additional Notes	T2C	H-37%	AMLS-278m	Hpa-1035	Time to next maintenance:		800Khz	89	60 degs	Mission ID	Time Stamp							
t Log	-1560		P60	INSS17			Mission Plan	Pulse Rate	Scan Rate	FOV	Line Aborted	nmi to End							
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	1 Drive	2 Drive	Missi	2300 m	160 kts	100 %	Lin	Time							
LIDA	System	Unit	IMU	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	ne	End							
		R	a					AC	Ta	La	GPS Time					 		 	
	C-GJMT	Pilot Andy. S-Krista R	D.Arteaga								0	Start							
	Aircraft	Pilot And	Operator				ne				Fliaht	Direction							
Flight A	April 01, 2021	OSI_ PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 15:54	Landing 22:08	Total 6.2 hrs	LIDAR								
Julian Day 091	Date April C	Project 3218_QSI_	Location Eau Cla	Mission Objective				Engine On 15:26	Engine Off 22:18	Total 6.9 hrs		Flight Line							

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	AIRBORNE	D N D A G I N G				● 50 hr O 100 hr	GPS Time	Start End	1537 1542	2211 2216		Comments								Page 4 of 5
							Static	Alignment	Pre Mission	Post Mission	0									
	Additional Notes	T2C	H-37%	AMLS- 278m	Hpa-1035	Time to next maintenance:		800Khz	89	o degs	Mission ID	Time Stamp								
Log	<u> </u>						n Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time								
LIDAI	System	Unit	IMU	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	ne	End								
	MT	ista R	eaga					AG	Ta	La	GPS Time	۲								
	C-GJMT	Pilot Andy S-Krista R	r D.Arteaga									Start								
	Aircraft	Pilot A	Operator				ne				Eliaht	Direction								
Flight A	April 01, 2021	bierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 15:54	Landing 22:08	Total 6.2 hrs										
Julian Day 091	Date April 0	Project 3218_QSI_PierceMarathon	Location Eau Clair	Mission Objective			•	Engine On 15:26	Engine Off 22:18	Total 6.9 hrs		Flight Line F								v 20200520

	S O R	A Closed Conduction				● 50 hr O 100 hr	GPS Time	Start End	1537 1542	2211 2216		Comments								Page 5 of 5
							Static	Alignment	Pre Mission	Post Mission		<u>2</u>								
	Additional Notes	T2C	· = 5 H-37%	AMLS- 278m	Hpa-1035	Time to next maintenance:		800Khz	89	D degs	Mission ID	Time Stamp								
Log				317			ר Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time								
LIDAI	System	Unit	IMU	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	me	End								
	ΜT	ista R	ega					Ā	ц <u>г</u>	۳ ۲	GPS Time									
	C-GJMT	dy. S-Kri	D.Arteaga									Start								
	Aircraft	Pilot Andy. S-Krista R	Operator				ne					Flight Direction								
Flight A	April 01, 2021	ierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 15:54	Landing 22:08	Total 6.2 hrs		LIUAK File Name D								
Julian Day 091	Date April 0	Project 3218_QSI_PierceMarathon	Location Eau Clair	Mission Objective			A	Engine On 15:26	Engine Off 22:18	hrs		Flight Line F								v 20200520

	3 O R					32hrs © 50 hr O 100 hr	C GPS Time	ent Start End	n 1304 1308	- u		Comments											DR Crashed while aproching the line	Full system restart and troubleshooting	for 20 minutes- Riacquire crashed	
	Additional Notes	T-8C	H-47%	AMLS-278m	Hpa-1028	Time to next maintenance: $\frac{32}{3}$	Stati	800Khz Alignment	178 Pre Mission	60 degs Post Mission	Mission ID	Time Stamp	132923	•	135536	141558	143644	145729	151849	153935	160046	162212	D	Ful		
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	rive	rive	Mission Plan	2300 m Pulse Rate	160 kts Scan Rate	100 % FOV 6	Line Aborted	Time nmi to End														
LIDAR	System	Unit	IMU	GPS Rx 1	Scanner 1 Drive	Scanner 2 Drive		AGL Height 2	Target Speed 1		GPS Time	End	1336	1349	1411	1431	1453	1512	1535	1555	1618	1637				
	C-GJMT	Andy. S	D.Arteaga								GPS	Start	1329	1344	1355	1415	1436	1457	1518	1539	1600	1622				
	Aircraft	Pilot	Operator				me				:	Direction		1	180	000	180	000	180	000	180	000	180			
2 Flight A	April 02, 2021	OSI_ PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:17	Landing 17:35	Total 4.3 hrs		File Name														
Julian Day 092	Date April 0	Project 3218_QSI_	Location Eau Cla	Mission Objective				Engine On 12:56	Engine Off 17:43	Total 4.8 hrs		Flight Line	X-tie	F8	1046	1047	1048	1049	1050	1051	1052	1053	1054			

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	AIRBORNE					● 50 hr O 100 hr	GPS Time	Start End	1304 1308	-		Comments									Page 2 of 5
						intenance: <u>32hrs</u>	Static	Alignment	Pre Mission	Post Mission		2									
	Additional Notes	T8C	H-47%	AMLS-278m	Hpa-1028	Time to next maintenance:		800Khz	178	0 degs		Time Stamp								I	
Log							n Plan	Pulse Rate	Scan Rate	FOV 60	l ine Ahorted	nmi to End									
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	l ine	Time									
LIDAI	System	Unit	NMI	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	an	End									
	۸T	0	aga					AC	Ta	La	GPS Time										
	C-GJMT	Andy. S	D.Arteaga									Start									
	Aircraft	Pilot	Operator				е					Flight Direction								I	
Elight A	April 02, 2021	PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:17	Landing 17:35	Total 4.3 hrs		File Name Di									
Julian Day 092	Date April 0	Project 3218_QSI_PierceMarathon	Location Eau Cla	Mission Objective				Engine On 12:56	Engine Off 17:43	Total 4.8 hrs		Flight Line									v 20200520

	A I R B O R N E I M A G I N G A Clean Harbors Company		● 50 hr O 100 hr	GPS Time	Start End	1304 1308	,		Comments							Parie 3 of 5
	Additional Notes T8C H-47%	.78m 28	Time to next maintenance: 32hrs	Static	thz Alignment	Bre Mission	degs Post Mission	Mission ID	Time Stamp							
ıt Log		17	Time t	Mission Plan	m Pulse Rate 800Khz	s Scan Rate 178	% FOV 60	Line Aborted	nmi to End Time							
LIDAR Flight Log	SystemRiegl VQ-1560Unit64IMUApplanix AP60	GPS Rx Trimble Scanner 1 Drive	Scanner 2 Drive	Miss	AGL Height 2300	Target Speed 160 kts	100		End Time							
	C-GJMT Andy. S D.Arteaga				AGL	Targ	Lase	GPS Time	Start							
	Aircraft Pilot Operator			ne				Fliaht	Direction							
Elight A	April 02, 2021 18_QSI_PierceMarathon Eau Claire WI_Airport			Aircraft Block Time	Takeoff 13:17	Landing 17:35	Total 4.3 hrs	LiDAR	G							
Julian Day 092	Date April 0 Project 3218_QSI_I Location Eau Clai	Mission Objective			Engine On 12:56	Engine Off 17:43	Total 4.8 hrs		Flight Line							

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	AIRBORNE					32hrs © 50 hr O 100 hr	GPS Time	ent Start End	1304 1308	u			Comments								Page 4 of 5
	es			_			Static	Alignment	Pre Mission	Post Mission		Mission ID									
	Additional Notes	T8C	H-47%	AMLS-278m	Hpa-1028	Time to next maintenance:		800Khz	178	60 degs		Missi	Time Stamp								
Log			60	VSS17			n Plan	Pulse Rate	Scan Rate	FOV 6	A 1- 2-4-1	LINE ADORTED	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	-		Time								
LIDAI	System	Unit	IMU	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current			End								
	F		ga					A	ц Ч	La		פרט וושפ		 		 	 	 			
	C-GJMT	Andy. S	D.Arteaga										Start								
	Aircraft	Pilot	Operator				ne					Flight	Direction								
Elight A	April 02, 2021	DierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:17	Landing 17:35	Total 4.3 hrs			File Name D	 							
Julian Day 092	Date April 0	Project 3218_QSI_PierceMarathon	Location Eau Clai	Mission Objective				Engine On 12:56	Engine Off 17:43	Total 4.8 hrs			Flight Line								v 20200520

	AIRBORNE					32hrs • 50 hr O 100 hr	GPS Time	ent Start End	1 1304 1308	- u		Comments								Page 5 of 5
	es			_			Stati	Alignment	Pre Mission	Post Mission	Mission ID									
	Additional Notes	T8C	H-47%	AMLS-278m	Hpa-1028	Time to next maintenance:		800Khz	178	60 degs	Missi	Time Stamp_								
Log			60	ISS17			n Plan	Pulse Rate	Scan Rate		Line Aborted	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	: Drive	Mission	2300 m	160 kts	100 %	Line	Time								
LIDA	System	Unit	NN	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	me	End								
	٨T	G	aga					Ā	Ĕ	L.	GPS Time	t				 				
	C-GJMT	Andy. S	D.Arteaga									Start								
	Aircraft	Pilot	Operator				ЭС				Flight	Direction								
Elight A	April 02, 2021	DierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:17	Landing 17:35	Total 4.3 hrs	Lidar	е								
Julian Day 092	Date April 0	Project 3218_QSI_PierceMarathon	Location Eau Clai	Mission Objective				Engine On 12:56	Engine Off 17:43	3 hrs		Flight Line								v 20200520

	00	I M A G I N G				O 50 hr 🕥 100 hr	GPS Time	Start End	2006 2011	-		Comments	Data recorder error- full system	restart and cable swap						System crashed after 8 minutes on line				
							Static	Alignment	Pre Mission	Post Mission			Data	-						System c				
	Additional Notes	T21C	н-16%	AMLS-278m	Hpa-1018	Time to next maintenance:		800Khz	178 Pre	degs	Mission ID	Time Stamp		204836	•	210103	212113	214306	220425	222609				
Log					<u> </u>		Mission Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End												
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Missio	2300 m	160 kts	100 %	Line	Time								2233				
LIDAF	System	Unit	IMU	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	e	End		2049	2055	2117	2138	2159	2221	2226				
	C-GJMT	Andy. S	D.Arteaga					AG	Та	La	GPS Time	Start		2048	2050	2101	2121	2143	2204	180				
	Aircraft	Pilot	Operator				пе					Direction		1		180	000	180	000	180				
Flight B	April 03, 2021	PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 20:16	Landing 22:58	Total 2.7 hrs														
Julian Day 093	Date April 0	Project 3218_QSI_F	Location Eau Clai	Mission Objective				Engine On 20:00	Engine Off 23:02	Total 3.0 hrs		Flight Line	Test Strip 01	Test Strip 02	F8	1054	1055	1056	1057	1058				

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	AIRBORNE					● 50 hr O 100 hr	GPS Time	Start End	2006 2011			Comments									Page 2 of 5
							Static	Alignment	Pre Mission	Post Mission											
	Additional Notes	T21C	· = . Н-16%	AMLS-278m	Hpa-1018	Time to next maintenance:		800Khz	178	0 degs	Mission ID	Time Stamp	-							I	
Log				317			n Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End									
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time									
LIDAI	System	Unit	NMI	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	Je	End									
								AG	Tai	La:	GPS Time				 						
	C-GJMT	Andy. S	D.Arteaga								. (5	Start									
	Aircraft	Pilot	Operator				ne				Elizab t	Direction								1	
Flight B	April 03, 2021	^D ierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 20:16	Landing 22:58	Total 2.7 hrs											
Julian Day 093	Date April 0:	Project 3218_QSI_PierceMarathon	Location Eau Clai	Mission Objective			4	Engine On 20:00	Engine Off 23:02) hrs		Flight Line									v 20200520

	OR					• • • • • • • • • • • • • • • • • • •	GPS Time	Start End	2006 2011			Comments								Page 3 of 5
	Additional Notes	10		AMLS-278m	Hpa-1018	Time to next maintenance:	Static	800Khz Alignment	178 Pre Mission	degs Post Mission	 Mission ID	Time Stamp								
jht Log	Riegl VQ-1560 Additi	4 T21C		317	Hpa-	Time	Mission Plan	m Pulse Rate 800	kts Scan Rate 17	% FOV 60	Line Aborted	nmi to End								
LIDAR Flight Log	System Riegl \	Unit 64	IMU Applanix AP60	GPS Rx Trimble	Scanner 1 Drive	Scanner 2 Drive	W	AGL Height 2300	Target Speed 160	Laser Current 100	me	End Time								
	C-GJMT	Andy. S	D.Arteaga					AC	Ta	La La	GPS Time	Start								
	Aircraft	n Pilot	Operator				ime				Flight	Direction								
Flight B	April 03, 2021	OSI_ PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 20:16	Landing 22:58	Total 2.7 hrs	LIDAR	a								
Julian Day 093	Date April 0	Project 3218_QSI_F	Location Eau Clai	Mission Objective			1	Engine On 20:00	Engine Off 23:02	Total 3.0 hrs		Flight Line								

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	-	0																		
	0 8	AGINO	A clean narbors company				GPS Time	End	2011	ı		S								Doce 1 of 5
	AI	A M I	A Clea			• 50 hr O 100 hr	GP	Start	2006	ı		Comments								
							Static	Alignment	Pre Mission	Post Mission										
						intenance:		A	Pre N	Post										
	Additional Notes	T21C	н-16%	AMLS-278m	Hpa-1018	Time to next maintenance:		800Khz	178) degs	Mission ID	Time Stamp								
Log	<u> </u>	 		317			n Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time								-
LIDAI	System	Unit	IMU	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	e e	End								
								AG	Tai	La:	GPS Time					 	 	 		-
	C-GJMT	Andy. S	D.Arteaga								. 0	Start								
	Aircraft	Pilot	Operator				Je				Eliobt	Direction								
Flight B	, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 20:16	Landing 22:58	Total 2.7 hrs										
^{Jay} 093	April 03, 2021			Mission Objective			Aii	20:00	Engine Off 23:02 L	1							 	 		-
Julian Day	Date	Project 3218	Location	Mission (Engine On	Engine O	Total 3		Flight Line								

	AIRBORNE						GPS Time	End	2011			S								Page 5 of 5
	AI					• 50 hr O 100 hr	6	Start	2006			Comments								
							Static	Alignment	Pre Mission	Post Mission										
	Additional Notes	T21C	H-16%	AMLS-278m	Hpa-1018	Time to next maintenance:		800Khz	178	degs	Mission ID	Time Stamp								
Log				317	_		n Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time								
LIDAF	System	Unit	IMU	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	υ	End								
						-		AG	Tar	Las	GPS Time		 _							
	C-GJMT	Andy. S	D.Arteaga								5	Start								
	Aircraft	Pilot	Operator				e				Eliobt	Direction								
Flight B	April 03, 2021	bierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 20:16	Landing 22:58	Total 2.7 hrs		е е								
Julian Day 093	Date April 00	Project 3218_QSI_PierceMarathon	Location Eau Clair	Mission Objective			A	Engine On 20:00	Engine Off 23:02) hrs		Flight Line F								v 20200520

	3 O R					• • • • • • • • • • • • • • • • • • •	GPS Time	Start End	1330 1335				Comments						System crashed just before we	enter the line- tried to restart while	in the air but it froze 2 times					
						tenance:	Static	Alignment	Pre Mission	Post Mission		<u> </u>		2		0	+	+	Syst	enter	in					
	Additional Notes	T-6C	H-70%	AMLS-278m	Hpa-1010	Time to next maintenance:		800Khz	178	60 degs	ľ	Mission	Time Stamp	135212	•	141350	143404	145534								
nt Log	Q-1560		AP60	Trimble GNSS17			Mission Plan	m Pulse Rate	kts Scan Rate	% FOV		Line Aborted	nmi to End													
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60		Scanner 1 Drive	Scanner 2 Drive	Mis	2300	160	100			Time													
rid/	System	Unit	IMU	GPS Rx	Scanne	Scanne		AGL Height	Target Speed	Laser Current		Ime	End	1354	1409	1429	1450	1511								
	C-GJMT	Pilot Andy. S- Krista R	D.Arteaga									GPS IIMe	Start	1352	1404	1413	1434	1455								
	Aircraft	Pilot Andy	Operator				ne					Flight	Direction			180	000	180	000							
Flight A	, 2021	_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:41	Landing 15:50	Total 2.2 hrs		Lidar	е													
Julian Day 095	Date April 05, 2021	Project 3218_QSI_Pi	Location Eau Claire	Mission Objective			Air	Engine On 13:22 T	Engine Off 15:53 L	5 hrs			Flight Line Fi	X-Tie	F8	1058	1059	1060	1061							

v 20200520

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	AIRBORNE	I M A G I N G				● 50 hr O 100 hr	GPS Time	Start End	1330 1335			Comments									Page 2 of 5
							Static	Alignment	Pre Mission	Post Mission											
	Additional Notes	T-6C	<u></u> С Н ТО%	AMLS-278m	Hpa-1010	Time to next maintenance:		800Khz	178	o degs	Mission ID	Time Stamp	-							I	
Log				317			n Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End									
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time									
LIDAI	System	Unit	NMI	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	E	End									
		sta R	aga					AG	Tai	La	GPS Time							 			
	C-GJMT	y. S- Kris	D.Arteaga									Start									
	Aircraft	Pilot Andy. S- Krista R	Operator				e														
Flight A	April 05, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:41	Landing 15:50	Total 2.2 hrs											
Julian Day 095	Date April 0	Project 3218_QSI_F	Location Eau Clair	Mission Objective			A	Engine On 13:22	Engine Off 15:53	Total 2.5 hrs		Flight Line F									v 20200520

	AIRBORNE	I M A G I N G				● 50 hr O 100 hr	GPS Time	Start End	1330 1335			Comments								Page 3 of 5
							Static	Alignment	Pre Mission	Post Mission		<u> </u>								
	Additional Notes	T-6C	<u></u> С Н ТО%	AMLS-278m	Hpa-1010	Time to next maintenance:		800Khz	178	o degs	Mission ID	Time Stamp								
Log				317			n Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time								
LIDAI	System	Unit	NMI	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	e e	End								
		sta R	aga					AG	Tai	La	GPS Time									
	C-GJMT	/ S-Kris	D.Arteaga									Start								
	Aircraft	Pilot Andy. S- Krista R	Operator				e					Direction								
Flight A	April 05, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:41	Landing 15:50	Total 2.2 hrs		File Name Di								
Julian Day 095	Date April 0	Project 3218_QSI_F	Location Eau Clai	Mission Objective			4	Engine On 13:22	Engine Off 15:53	Total 2.5 hrs		Flight Line								v 20200520

	AIRBORNE	IMAGING				● 50 hr O 100 hr	GPS Time	Start End	1330 1335			Comments								Page 4 of 5
							Static	Alignment	Pre Mission	Post Mission										
	Additional Notes	T-6C	<u></u> С Н ТО%	AMLS-278m	Hpa-1010	Time to next maintenance:		800Khz	178	0 degs	Mission ID	Time Stamp								
Log				317			n Plan	Pulse Rate	Scan Rate	FOV 60	Line Aborted	nmi to End								
LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %	Line	Time								
LIDAI	System	Unit	NMI	GPS Rx	Scanner 1 Drive	Scanner 2 Drive		AGL Height	Target Speed	Laser Current	E	End								
		sta R	aga					AG	Tai	La	GPS Time									
	C-GJMT	y. S- Kris	D.Arteaga									Start								
	Aircraft	Pilot Andy. S- Krista R	Operator				e					Direction								
Flight A	April 05, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:41	Landing 15:50	Total 2.2 hrs										
Julian Day 095	Date April 0	Project 3218_QSI_F	Location Eau Clair	Mission Objective			A	Engine On 13:22	Engine Off 15:53	5 hrs		Flight Line F								v 20200520

	AIRBORNE					• 50 hr O 100 hr	GPS Time	Start End	1330 1335	•		Comments									Page 5 of 5
						tenance:	Static	Alignment	Pre Mission	Post Mission											
	Additional Notes	T-6C	н-70%	AMLS-278m	Hpa-1010	Time to next maintenance:		800Khz	178	60 degs	Miccie		lime Stamp								
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LIDAR Flight Log	Riegl VQ-1560	64	Applanix AP60	Trimble GNSS17	Drive	Drive	Mission	2300 m	160 kts	100 %		Time									
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		R	a			-		AG	Tai	Las	GPS Time									 	
	C-GJMT	Pilot Andy. S- Krista R	D.Arteaga									Start									
	Aircraft	Pilot And	Operator				Je					Flight									
Flight A	April 05, 2021	QSI_PierceMarathon	Eau Claire WI Airport				Aircraft Block Time	Takeoff 13:41	Landing 15:50	Total 2.2 hrs		LiDAR File Name Di									
Julian Day 095	Date April 0	Project 3218_QSI_	Location Eau Clai	Mission Objective				Engine On 13:22	Engine Off 15:53	Total 2.5 hrs		Flight Line									v 20200520