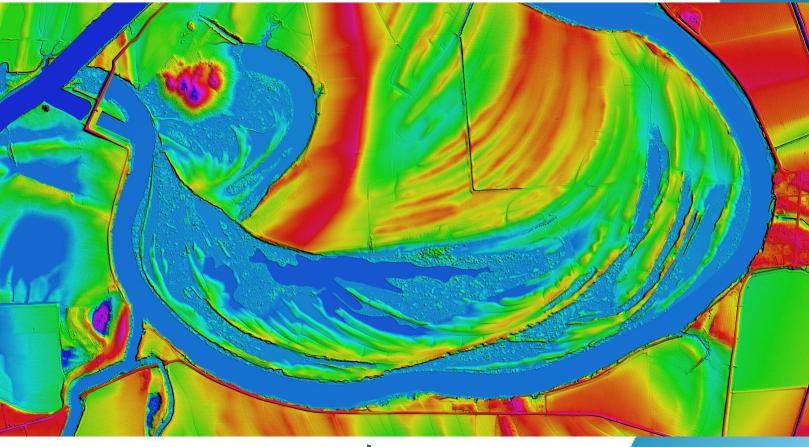
NV5 GEOSPATIAL

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MS_MISSISSIPPIDELTA_2018_D18
LIDAR PROCESSING REPORT

Project ID: 78034 Work Unit: 222316 **2021**

Submitted:September7,2021

Prepared for:



Prepared by:



523 Wellington Way, Suite 225 Lexington, KY 40503

859.277.8700



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1. Summary / Scope

1.1. Summary

This report contains a summary of the MS_MississippiDelta_2018_D18 lidar acquisition task order, issued by USGS under their Contract G16PC00016 on February 27, 2018. Work Unit 222316 yielded a project area covering approximately 2,733 square miles over Mississippi. The intent of this document is only to provide specific validation information for the data acquisition/collection, processing, and production of deliverables completed as specified in the task order.

1.2. Scope

Aerial topographic LiDAR was acquired using state of the art technology along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

Table 1. Originally Planned LiDAR Specifications

Average Point Density	Flight Altitude (AGL)	Field of View	Minimum Side Overlap	RMSEz
2 pts / m ²	2000-2200 m	36°-60°*	20%	≤ 10 cm

*FOV is dependent upon sensor utilized. See Table 2 for more info

1.3. Coverage

The project boundary covers approximately 2,733 square miles over Mississippi. A buffer of 100 meters was created to meet task order specifications. Project extents are shown in Figure 1.

1.4. Duration

LiDAR data was acquired from February 26, 2018 to December 13, 2020 in 30 total lifts. See "Section: 2.4. Time Period" for more details.

1.5. Issues

Due to different flying seasons, several temporal differences occur throughout the dataset.



MS_MississippiDelta_2018_D18 Work Unit 222316 Projected Coordinate System: Albers

Horizontal Datum: NAD 1983(2011) Vertical Datum: NAVD88 (GEOID 12b)

Units: Meters

	Units: Meters
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	 1-meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in IMG format 1-meter Intensity images in GeoTIFF format
Vectors	Shapefiles (*.shp) • Project Boundary • LiDAR Tile Index Geodatabase (*.gdb) • Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format • Focus on Delivery • Processing Report
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • Intensity Imagery



MS_MississippiDelta_2018_D18 Work Unit 222316 Boundary

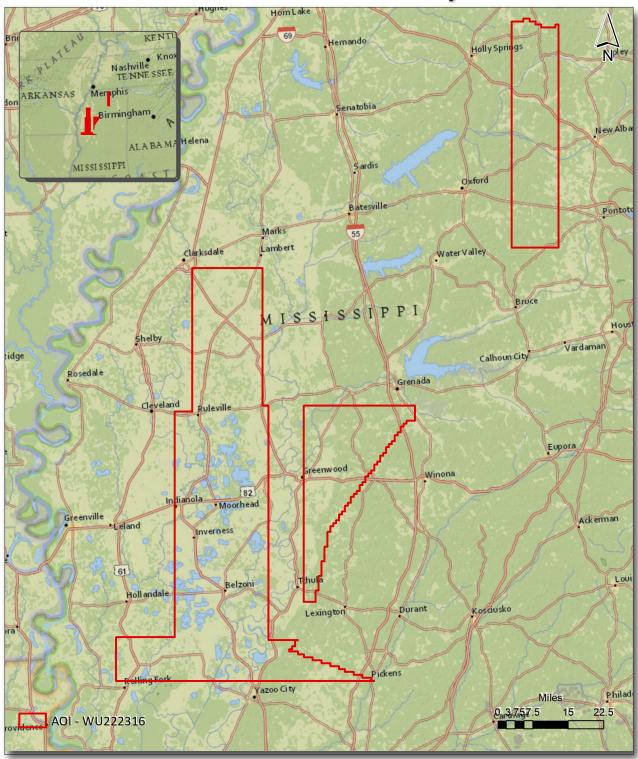


Figure 1. Work Unit Boundary



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 Leica MissionPro and RiPARAMETER planning software. Planned flight lines are shown in Figure 2.

2.2. Lidar Sensor

NV5 Geospatial utilized Leica ALS70, Leica ALS80, Riegl VQ1560i/VQ1560ii LiDAR sensors (Figure 3) for lidar acquisition.

The Leica ALS 70 system is capable of collecting data at a maximum frequency of 500 kHz, which affords elevation data collection of up to 500,000 points 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 4 returns per outgoing pulse from the laser and these come in the form of 1st, 2nd, 3rd and last returns. The intensity of the returns is also captured during aerial acquisition.

The Leica ALS 80 system is capable of collecting data at a maximum frequency of 1,000 kHz. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor also has the capacity for unlimited range returns from each outbound pulse. The intensity of the returns is also captured during aerial 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.

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.



MS_MississippiDelta_2018_D18 Work Unit 222316 Planned Flight Lines

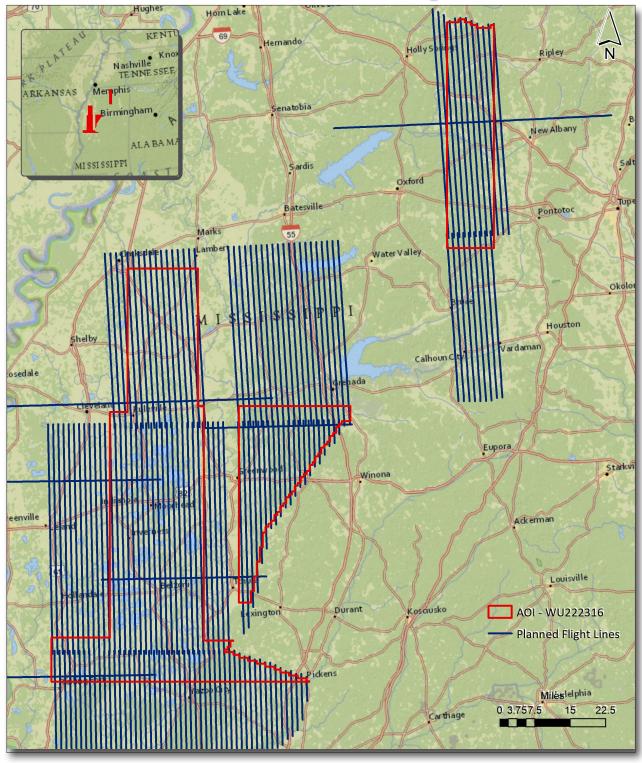


Figure 2. Planned Flight Lines



Table 2. LiDAR System Specifications

		Leica ALS70	Leica ALS80	Riegl VQ1560i/ Riegl VQ1560ii
Terrain and	Flying Height	2000 m	2200 m	2000 m
Aircraft Scanner	Recommended Ground Speed	150 kts	150 kts	160 kts
Scanner	Field of View	36°	40°	60°
Scarifier	Scan Rate Setting Used	56 Hz	49 Hz	129 Hz
Laser	Laser Pulse Rate Used	278 kHz	372.8 kHz	700 kHz
Laser	Multi Pulse in Air Mode	yes	yes	yes
Coverage	Full Swath Width	1300 m	1601 m	2309 m
Coverage	Line Spacing	1040 m	1120.7 m	1847.2 m
Point Spacing	Average Point Spacing	0.6 m	0.6 m	0.7 m
and Density	Average Point Density	2.78 pts / m ²	2.78 pts / m ²	2.04 pts / m ²

Figure 3. Leica ALS70, Leica ALS80, and Riegl VQ1560i/VQ1560ii Lidar Sensors





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

- Piper Navajo (twin-piston), Tail Numbers: N262AS, N73TM, C-FFRY, N6GR, C-GJMT, C-GMEC
- Cessna Caravan (single-turboprop), Tail Number: N704MD

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 lidar systems. Some of Quantum Spatial's operating aircraft can be seen in Figure 4 below.



Figure 4. Some of NV5 Geospatial's Planes



2.4. Time Period

Project specific flights were conducted between February 18, 2018 and December 13, 2020. Thirty aircraft lifts were completed. Accomplished lifts are listed below.

- 02262018A (SN8227,N6GR)
- 01102019B (SN7161,N262AS)
- 01162019A (SN7161,N262AS)
- 01242019A (SN043-AI,C-FFRY)
- 01252019A (SN043-AI,C-FFRY)
- 01252019A (SN7161,N262AS)
- 01272019A (SN546,N73TM)
- 01272019A (SN7161,N262AS)
- 01282019A (SN546,N73TM)
- 01282019A (SN7161,N262AS)
- 01292019A (SN043-AI,C-FFRY)
- 01302019A (SN043-AI,C-FFRY)
- 01302019A (SN546,N73TM)
- 01302019B (SN546,N73TM)
- 01312019A (SN043-AI,C-FFRY)
- 01312019A (SN546,N73TM)
- 01312019B (SN546,N73TM)
- 02022019A (SN546,N73TM)
- 02082019A (SN043-AI,C-FFRY)
- 02092019A (SN043-AI,C-FFRY)
- 02242019A (SN043-AI,C-FFRY)
- 02292019A (SN043-AI,C-FFRY)

- 12062020A (SN4040,N704MD)
- 12072020A (SN2737,C-GJMT)
- 12082020A (SN2737,C-GJMT)
- 12092020A (SN2737,C-GJMT)
- 12092020A (SN3062,C-GMEC)
- 12092020A (SN4040,N704MD)
- 12102020A (SN2737,C-GJMT)
- 12132020A (SN3062,C-GMEC)



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).



3.2. LiDAR Processing

Applanix + POSPac and Leica Inertial Explorer software were 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 and Inertial Explorer 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 RiPROCESS and Leica CloudPro 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
Leica Inertial Explorer	8.90
Leica CloudPro	1.2.4
RiPROCESS	1.8.6
Applanix + POSPac	8.4
GeoCue	2020.1.22.1
Global Mapper	19.1;20.1
TerraModeler	21.008
TerraScan	21.0016
TerraMatch	21.007



3.3. LAS Classification Scheme

The classification classes are determined by the USGS Version 1.3 specifications 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 scaterring from reflective surfaces, or artificial points below the ground surface
9	Water	Laser returns that are found inside of hydro features
10	Ignored Ground	Ground points that fall within the given threshold of a collected hydro feature.
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
22	Temporal Exclusion	Points that are excluded due to differences in collection dates

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 hydrobreaklines 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 1 meter was also used around each hydro flattened feature to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 10). 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. Quantum Spatial'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 Quantum Spatial'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 10).

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

Class 2 LiDAR in conjunction with the hydro breaklines were used to create a 1-meter raster DEM. Using automated scripting routines within proprietary software, an IMG file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.7. Intensity Image Processing

GeoCue software was used to create the deliverable intensity images. All withheld points were ignored during this process. This helps to ensure a more aesthetically pleasing image. The



GeoCue software was then used to verify full project coverage as well. GeoTIFF files with a cell size of 1-meter were then provided as the deliverable for this dataset requirement.



MS_MississippiDelta_2018_D18 Work Unit 222316 Tile Layout

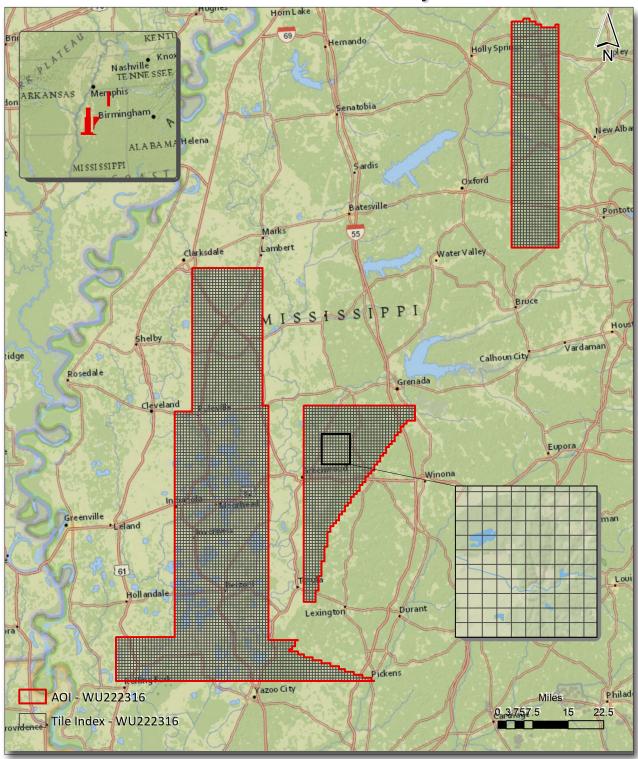


Figure 5. Lidar Tile Layout



4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 6.



MS_MississippiDelta_2018_D18 Work Unit 222316 Lidar Coverage

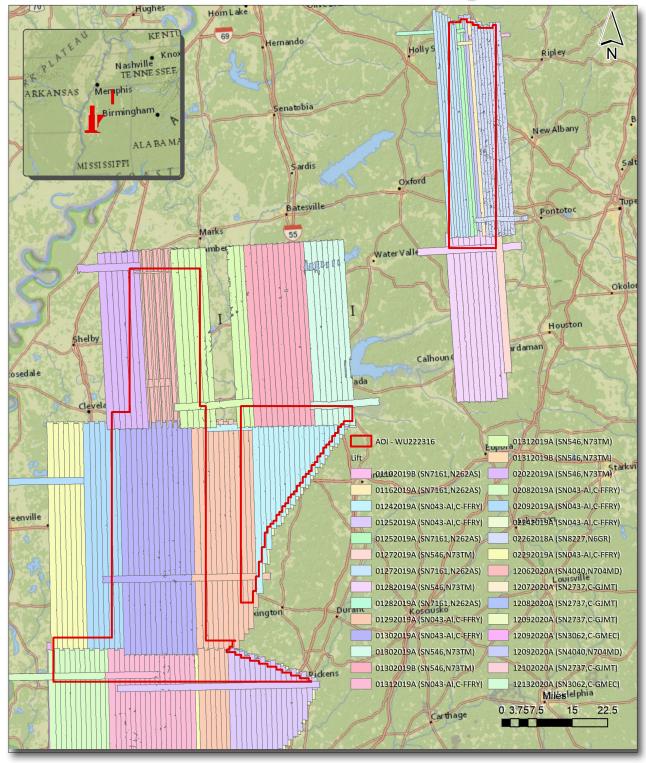


Figure 6. Lidar Coverage



Project Report Appendices

The following section contains the appendices as listed in the MS_MississippiDelta_2018_D18 Lidar Processing Report.



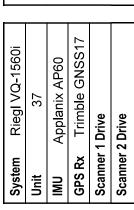
Appendix A

Flight Logs

Flight
342
Day
Julian

4

LIDAR Flight Log



D.Arteaga J.Mathieson C-GJMT

Operator

3210_QSI_Mississippi December 7, 2020

Date

Jackson MS

Location Project

Mission Objective

Aircraft Pilot

Time t	· 2 Drive
Hpa-1	· 1 Drive
AMLS	Trimble GNSS17
H-100	Applanix AP60
T-2C	37
Additio	Riegl VQ-1560i

AIRBORNE

T-2C		A Clea	A Clean Harbors Com
H-100%			
AMLS-106			
Hpa-1019			
Time to next maintenance:	intenance:	© 50 hr O 100 hr	Ŀ
	Static	49	GPS Time
700khz	Alignment	Start	Pug
182hz	Pre Mission	1445	1450
o degs	Post Mission	1810	1815

9

₽ 2 %

100 160

Target Speed Laser Current

m Pulse Rate kts Scan Rate

2000

AGL Height

Mission Plan

Aircraft Block Time

Takeoff 14:54 Landing 18:06 Total 3.2 hrs

Engine On 14:38 Engine Off 18:21

hrs

3.7

Total

Comments															
Time Stamp		151424	153136	155228	161052	162945	164638	170408	171942	173715					
nmi to End															
Time															
End	1509	1525	1550	1605	1626	1643	1701	1716	1734	1750	1756				
Start	1504	1514	1531	1552	1610	1629	1646	1704	1719	1737	1751				
Direction	ı	ı	005	183	700	183	005	183	005	183	-				
File Name		372034201	372034202	372034203	372034204	372034205	372034206	372034207	372034208	372034209					
Flight Line	F8	X-tie	4025	4026	4027	4028	4029	4030	4031	4032	F8				
	File Name Direction Start End Time nmi to End Time Stamp	File Name Direction Start End Time nmi to End Time Stamp - 1504 1509	File Name Direction Start End Time nmi to End Time Stamp - 1504 1509 1525 151424	File Name Direction Start End Time nmi to End Time Stamp - 1504 1509 1509 1514 1514 1514 372034201 - 1514 1550 153136 153136	File Name Direction Start End Time nmi to End Time Stamp 372034201 - 1504 1509 151424 151424 372034202 002 1531 1550 153136 153136 372034203 183 1552 1605 1605 15528	File Name Direction Start End Time nmi to End Time Stamp 372034201 - 1504 1509 151424 151424 372034202 002 1531 1550 153136 153136 372034203 183 1552 1605 1616 1626 161052	File Name Direction Start End Time nmi to End Time Stamp 372034201 - 1504 1525 mi to End 151424 mi to End 151424 372034202 002 1531 1550 mi to End 153136 mi to End 15528 372034203 183 1552 1605 mi to End 161052 mi to End 161052 372034204 183 1629 1643 mi to End 162945 mi to End	File Name Direction Start End Time nmi to End Time Stamp 372034201 - 1504 1509 - 151424 - 372034202 002 1531 1550 - 153136 - 372034203 183 1552 1605 - 161052 - 372034204 002 1610 1626 - 161052 - 372034205 183 1629 1643 - 164638 -	File Name Direction Start End Time Inmit o End Time Stamp 372034201 - 1504 1525 0 151424 0 372034202 002 1531 1550 0 151424 0 372034203 183 1552 1605 0 15528 0 372034204 002 1610 1626 0 161052 0 372034205 183 1629 1643 16483 164638 0 372034206 002 1646 1716 1716 0 164638 0	File Name Direction Start End Time nmi to End Time Stamp 372034201 - 1504 1509 151424 151424 372034202 002 1531 1550 1650 153136 372034203 183 1552 1605 0 161052 161052 372034204 002 1610 1626 0 161052 0 372034205 183 1629 1643 1701 164638 0 372034207 183 1704 1716 170408 170408 170408 372034208 002 1719 1734 17142 17142 17142	File Name Direction Start End Time Inmit to End Immit to End<	File Name Direction Start End Time band Time Stamp Time Stamp 372034201 - 1504 1509 151424 151424 151424 372034202 002 1531 1550 153136 153136 153136 372034203 183 1552 1605 0 1610652 16106 162945 162945 162945 162945 162945 1646 1701 170408 </th <th>File Name Direction Start End Time Time Stamp 372034201 - 1504 1509 151424 372034202 - 1514 1525 151424 372034202 002 1531 1550 155136 372034203 183 1552 1605 1610 161052 372034204 002 1610 1626 161052 162945 372034205 163 1704 1716 164638 170408 372034208 002 1646 1701 1716 1710408 372034208 163 1734 1750 173715 173715 372034209 183 1737 1756 173715 173715</th> <th>File Name Direction Start End Time Stamp Immit o End Imme Stamp 372034201 - 1504 1509 1514 1525 1514 1610 1610 1610 1610 1610 1610 1610 1629 1629 1629 1629 162945 162945 1646 1770</th> <th>File Name Direction Start End Time Immit or End Time Stamp 372034201 - 1504 1509 151424 372034202 - 1514 1525 151424 372034202 002 1531 1550 153186 372034203 183 1552 1605 161062 161062 372034204 002 1610 1626 0 162945 0 372034205 183 1704 1716 0 171942 0 372034208 002 1719 1734 1716 1734 171942 372034208 183 1734 1750 17342 17342 17342 372034208 183 1734 1756 17342 17342 17342 372034209 183 1751 1756 1734 17342 17342 4 1751 1756 1734 17342 17343 17343 8 1</th>	File Name Direction Start End Time Time Stamp 372034201 - 1504 1509 151424 372034202 - 1514 1525 151424 372034202 002 1531 1550 155136 372034203 183 1552 1605 1610 161052 372034204 002 1610 1626 161052 162945 372034205 163 1704 1716 164638 170408 372034208 002 1646 1701 1716 1710408 372034208 163 1734 1750 173715 173715 372034209 183 1737 1756 173715 173715	File Name Direction Start End Time Stamp Immit o End Imme Stamp 372034201 - 1504 1509 1514 1525 1514 1610 1610 1610 1610 1610 1610 1610 1629 1629 1629 1629 162945 162945 1646 1770	File Name Direction Start End Time Immit or End Time Stamp 372034201 - 1504 1509 151424 372034202 - 1514 1525 151424 372034202 002 1531 1550 153186 372034203 183 1552 1605 161062 161062 372034204 002 1610 1626 0 162945 0 372034205 183 1704 1716 0 171942 0 372034208 002 1719 1734 1716 1734 171942 372034208 183 1734 1750 17342 17342 17342 372034208 183 1734 1756 17342 17342 17342 372034209 183 1751 1756 1734 17342 17342 4 1751 1756 1734 17342 17343 17343 8 1

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LIDAR Flight Log

D.Arteaga J.Mathieson C-GJMT Operator Aircraft Pilot 3210_QSI_Misisipi December 8, 2020 Jackson MS Mission Objective Location Project Date

Cyctom	Dio 21 1/0 4 F. C. Di
oystelli	പല്യ v പ്- പാഠവ
Unit	37
NWI	Applanix AP60
SPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

/stem	Riegl VQ-1560i	Ac	Addi
nit	37		Pos
2	Applanix AP60	- 2	2 tir
PS Rx	Trimble GNSS17	<u> </u>	<u>~</u>
canner 1 Drive	1 Drive	<u> </u>	Ξ
canner 2 Drive	2 Drive	_	Tim

		I	
ditional Notes		4	AIRBORNE
ostView not	ostView not connecting need to restart		A Clean Harbors Company
times.			
30			
.100%		83	
ime to next maintenance:		© 50 hr O 100 hr	
	Static	GP	GPS Time
00khz	Alignment	Start	End

	Aircraft Block Time		Mis	sio	Aission Plan	
Engine On 14:36 Takeoff 15:06	Takeoff 15:06	AGL Height	2000	Ε	2000 m Pulse Rate	700khz
Engine Off 21:46	ingine Off 21:46 Landing 21:33	Target Speed 160 kts Scan Rate	160	cts	Scan Rate	320hz
Total 7.2 hrs Total 6.5 hrs	Total 6.5 hrs	Laser Current 100 % FOV	100	%	FOV	р 09
	*					

	Static	GF	GPS Time
ZI	Alignment	Start	End
2	Pre Mission	1455	1500
degs	Post Mission	2136	2141

	Comments															
Mission ID	Time Stamp		152933	154017	155633	161130	162822	164405	170121	171723	173423	175057	180735	182402	183953	185538
Line Aborted	nmi to End															
Line	Time															
Time	End	1528	1536	1552	1607	1624	1639	1658	1713	1729	1745	1803	1818	1835	1849	1905
GPS Tim	Start	1523	1529	1540	1556	1611	1628	1644	1701	1717	1734	1750	1807	1824	1839	1855
Flight	Direction	ı	1	002	183	002	183	002	183	002	183	002	183	002	183	002
Lidar	File Name		372034301	372034302	372034303	372034304	372034305	372034306	372034307	372034308	372034309	372034310	372034311	372034312	372034313	372034314
	Flight Line	F8	X-tie	4033	4034	4035	4036	4037	4038	4039	4040	4041	4042	4043	4044	4045

Flight
343
Day
Julian

<

LIDAR Flight Log



Date	December 8, 2020	Aircraft	C-GJMT
Project	3210_QSI_Misisipi	Pilot J	J.Mathieson
Location	Jackson MS	Operator	Operator D.Arteaga
Mission Objective	bjective		

System	Riegl VQ-1560i
Unit	37
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

tem	Riegl VQ-1560i	Additional
	37	PostViev
	Applanix AP60	2 times.
K	Trimble GNSS17	T-3C
nner	nner 1 Drive	H-100%
nner	nner 2 Drive	Time to ne

litional Notes	AIRBORNE
stView not connecting need to restart	A Clean Harbors Company
mes.	
30	
100%	
ne to next maintenance:) 100 hr
	- · · · · · · · · · · · · · · · · · · ·

	,	Aircraft Block Time	
 Engine On		Takeoff 15:06	
Engine Off		Landing 21:33	
Total 7.2 hrs	hrs	Total 6.5 hrs	

AGL Height 2	2000	ш	m Pulse Rate	700khz
Target Speed	160	kts	Scan Rate	320hz
Laser Current	100	%	% FOV	e0 degs

s 	Static	<u>В</u>	GPS Time
Alic	 	Start	End
Pre Mission	ssion	1455	1500
Post M	Post Mission	2136	2141

	I DAR	Flight	GPS Tim	Time	Line	Line Aborted	Mission ID	
Flight Line	File Name	Direction	Start	End	Time	nmi to End	Time Stamp	Comments
4047	372034315	183	1910	1911			191016	
X-tie	372034316	ı	1913	1915			191342	
4046	372034317	183	1922	1931			192228	
6001	372034318	002	1937	1945			193733	
6002	372034319	183	1950	1957			195014	
6003	372034320	002	2002	2010			200258	
6004	372034321	183	2015	2021			201505	
6005	372034322	002	2026	2033			202633	
9009	372034323	183	2038	2044			203812	
2009	372034324	002	2049	2055			204930	
6008	372034325	183	2100	2106			210028	
X-tie	372034326	1	2110	2114			211046	
F8			2114	2119				

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Flight A

3210 QSI Mississippi December 8, 2020

Jackson, MS

Location Project Date

Mission Objective

LIDAR Flight Log

Applanix AP6 Trimble GN S2223062 1560i Scanner 1 Drive Scanner 2 Drive **GPS Rx** System Unit \mathbb{R} Operator B. Eisenbart C-GMEC Y. Kadota Aircraft Pilot

			ance: ⊙ 50 h
Additional Notes			Time to next maintenance:
	09	ISS17	

AIRBORNEIMAGING A Clean Harbors Company 30 hr

⊙ 50 hr O 100
maintenance:
ime to next
₫

		,	Aircraft Block Time	Slock Tim	Э
Engine On 15:21	O	15:21	Takeoff	15:35	
Engine (Off	Engine Off 21:39	Landing 21:30	21:30	
Total 6.3 hrs	6.3	hrs	Total 5.9 hrs	.9 hrs	

AGL Height 2000 m Pulse Rate 700 kHz Target Speed 160 kts Scan Rate 182 hz Laser Current 100 % FOV 60 degs		2	Mission	n Plan	
160 kts Scan Rate 182 hz 100 % FOV 60	AGL Height	2000	ш	Pulse Rate	700 kHz
100 % FOV 60	Target Speed	160	kts	Scan Rate	182 hz
	Laser Current	100	%	FOV	

	Static	GP	GPS Time
	Alignment	Start	End
	Pre Mission	15:25	15:30
sgs	Post Mission	21:32	21:37

																	1
	Comments	Figure 8		snapshot crashed, stopped scanning	reflew line												
Mission ID	Time Stamp 201208	-	160911	163006	164527	170437	172505	174411	180444	180932	181510	181933	182411	184115	185225	185817	
Line Aborted	nmi to End																
Lin	Time																
Fime	End	16:04	16:26	16:34	17:00	17:22	17:40	18:01	18:05	18:11	18:16	18:21	18:28	18:48	18:55	19:00	
GPS Time	Start	15:59	16:09	16:30	16:45	17:04	17:25	17:44	18:04	18:09	18:15	18:19	18:24	18:41	18:52	18:58	
Flight	Direction	-	003°	183°	183°	°£00	183°	°E00	183°	003°	183°	003°	273°	269°	003°	273°	
LiDAR	File Name	-	622034301	622034302	622034303	622034304	622034305	622034306	622034307	622034308	622034309	622034310	622034311	622034312	622034313	622034314	
	Flight Line	8-ddd	1015	1016	1016	1017	1018	1019	1020	1021	2002	2001	X-TIE1015-19	X-TIE 4001-10	4001	4002	

Flight
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LIDAR Flight Log

App Scanner 1 Driv Scanner 2 Driv **GPS Rx** System ₽ N Unit

Operator B. Eisenbart

C-GMEC Y. Kadota

Aircraft Pilot

3210 QSI Mississippi December 8, 2020

Jackson, MS

Location Project

Mission Objective

Additional Notes					Time to next maintenance:	
1560i	32223062	olanix AP60	imble GNSS17	ve	Ne	

AIRBORNEIMAGING A Clean Harbors Company

GPS Time	Start End	15:25 15:30	21:32 21:37
Static	Alignment	Pre Mission	Post Mission
St.	 	Pre Mi	Post I

700 KHz 182 hz

m Pulse Rate kts | Scan Rate

2000

AGL Height

Mission Plan

Aircraft Block Time

Takeoff 15:35

Engine On 15:21

Total 5.9 hrs **Landing** 21:30

hrs

6.3

Total

Engine Off 21:39

9

. 2 %

100 160

Laser Current Target Speed

⊙ 50 hr **O** 100 hr

	Comments									Figure 8		
Mission ID	Time Stamp 201208	190430	191150	192550	194038	200142	201939	203656	205535	-		
Line Aborted	nmi to End											
Line	Time											
GPS Time	End	19:08	19:22	19:37	19:51	20:16	20:33	20:52	21:09	21:16		
GPS	Start	19:04	19:11	19:25	19:40	20:01	20:19	20:36	20:55	21:10		
Flight	Direction	003°	183°	003°	183°	003°	183°	003°	183°	-		
LiDAR	File Name	622034315	622034316	622034317	622034318	622034319	622034320	622034321	622034322			
	Flight Line	4003	4004	4005	4006	4007	4008	4009	4010	8-ddd		

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LIDAR Flight Log

Trimble GNSS17 Riegl VQ-1560i Applanix AP60 Scanner 1 Drive Scanner 2 Drive **GPS Rx** System ₽ Unit

D.Arteaga J.Mathieson C-GJMT

Operator

3210_QSI_Misisipi December 9, 2020

Jackson MS

Location Project Date

Mission Objective

Aircraft Pilot

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AMLS-106m T-1C H-86%

Hpa-1022

O 100 hr



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maintenance:
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ime to

	1	Aircraft Block Time	
Engine On 14:11		Takeoff 14:35	
Engine Off 20:52	:52	Landing 20:41	
Total 6.7 hrs		Total 6.1 hrs	

	Σ	Mission	n Plan	
AGL Height	2000	Е	m Pulse Rate	700khz
Target Speed	160	kts	kts Scan Rate	320hz
Laser Current	100	%	% FOV	sbep 09

	Static	9	GPS Time
	Alignment	Start	End
	Pre Mission	1423	1428
	Post Mission	2044	2049
ľ			

	Comments															
Mission ID	Time Stamp		145245	150608	152215	153342	153806	154304	154757	155315	155920	160548	161243	161953	162743	163602
Line Aborted	nmi to End															
Lin	Time															
Time	End	1449	1459	1515	1528	1534	1539	1545	1549	1555	1602	1609	1617	1624	1632	1641
GPS Tim	Start	1444	1452	1506	1522	1533	1538	1543	1547	1553	1559	1605	1612	1619	1627	1636
Flight	Direction	-	003	003	-	183	003	183	003	183	003	183	003	183	003	183
LiDAR	File Name		372034401	372034402	372034403	372034404	372034405	372034406	372034407	372034408	372034409	372034410	372034411	372034412	372034413	372034414
	Flight Line	F8	6009	5001	X-tie	5019	5018	5017	5016	5015	5014	5013	5012	5011	5010	5009

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770	4 40
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	770

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LIDAR Flight Log

GPS Rx Scanner Scanner System NMI Unit

D.Arteaga J.Mathieson C-GJMT

Operator

3210_QSI_Misisipi December 9, 2020

Jackson MS

Location Project Date

Mission Objective

Aircraft Pilot

Riegl VQ-1560i	Additio
37	T-1C
Applanix AP60	H-86%
Trimble GNSS17	AMLS
	Hpa-1
	Time t

	Alianment		
GPS	Static		
		١,	
© 50 hr O 100 hr		nain	ime to next maintenance:
			pa-1022
		_	MLS-106m
			%98-
A Clean			-1C
AIR		es	ditional Notes

AIRBORNEIMAGING A Clean Harbors Company

	Aircraft Block Time		Σ	Nissio
Engine On 14:11 Takeoff 14:35	Takeoff 14:35	AGL Height	2000	Ε
Engine Off 20:52 Landing 20:41	Landing 20:41	Target Speed 160 kts	160	kts
Total 6.7 hrs Total 6.1 hrs	Total 6.1 hrs	Laser Current 100 %	100	%

	≥	issio	Mission Plan			St
3L Height	2000	Ε	m Pulse Rate	700khz		Align
rget Speed	160	kts	160 kts Scan Rate	320hz		Pre Miss
ser Current	100 % FOV	%	FOV	eg degs		Post Mis
					ī	

Static		GPS Time
Alignment	ent Start	End
Pre Mission	1423	1428
Post Mission	n 2044	2049

15	LiDAR	Flight	GPS Tim	Time	Line	Line Aborted	Mission ID	
003 1645 1651 8 183 1704 1712 8 003 1715 1722 8 183 1737 1747 8 003 1751 1825 8 183 1810 1825 8 003 1829 1845 8 183 1848 1903 8 183 1915 1920 8 183 1915 1929 8 003 1924 1938 8 183 1933 1938 8 183 1945 1946 8	File Name	Direction	Start	End	Time	nmi to End	Time Stamp	Comments
183 1654 1701 8 003 1704 1712 8 183 1715 1722 8 003 1737 1747 8 183 1751 1802 8 003 1751 1825 8 183 1848 1903 8 - 1907 1909 8 183 1924 1929 8 003 1924 1938 8 183 1933 1946 8	372034415	003	1645	1651			164503	
003 1704 1712 6 183 1726 1734 6 003 1726 1734 7 183 1751 1802 7 183 1810 1825 8 003 1829 1845 8 183 1848 1903 8 - 1907 1920 8 003 1924 1929 8 183 1933 1938 8 183 1946 1946 8	372034416	183	1654	1701			165438	
183 1715 1722 003 1726 1734 183 1737 1747 003 1751 1802 183 1810 1825 003 1829 1845 - 1907 1909 183 1915 1920 003 1924 1929 183 1933 1946	372034417	003	1704	1712			170445	
003 1726 1734 8 183 1751 1802 8 003 1751 1825 8 183 1829 1845 8 - 1907 1909 8 - 1915 1920 8 003 1924 1929 8 183 1933 1946 8	372034418	183	1715	1722			171550	
183 1737 1747 603 1751 1802 603 1751 1802 603 1848 1845 603 1848 1903 603 1915 1909 603 1924 1929 603 1924 1938 603 1942 1946 603 1942 1946 603 1942 1946 603 1942 1946 603 1942 603 1942 603 1942 603 1942 1946 603 1942 1946 603 1942 603 1942 603 1942 603 1944 1946 603 1942 603 1944 603 1944 1946 603 1944 603 1944 603 1944 603 1944 603 1944 1944 603 1944 603 1944 603 1944 1944 603 1944 1944 1944 1944 1944 1944 1944 1944 1944 1944 1944	372034419	003	1726	1734			172636	
003 1751 1802 8 183 1810 1825 8 003 1829 1845 8 183 1848 1903 8 - 1907 1909 8 003 1924 1929 8 183 1938 1938 8 183 1946 1946 8	372034420	183	1737	1747			173758	
183 1810 1825 8 003 1829 1845 8 183 1848 1903 8 183 1915 1920 8 003 1924 1929 8 183 1933 1946 8	372034421	600	1751	1802			175149	
003 1829 1845 6 183 1848 1903 6 - 1907 1909 6 183 1915 1920 7 003 1924 1929 7 183 1938 1946 7	372034422	183	1810	1825			181001	
183 1848 1903 6 - 1907 1909 6 183 1915 1920 7 003 1924 1929 7 183 1933 1946 7	372034423	600	1829	1845			182902	
- 1907 1909 6 183 1915 1920 1920 003 1924 1929 1938 183 1938 1946 1946	372034424	183	1848	1903			182822	
183 1915 1920 8 1924 1929 8 1929 8 1929 8 1924 1938 1938 1938 1945 1946	372034425	-	1907	1909			190717	
003 1924 1929 8 183 1938 8 8 003 1942 1946 8	372034426	183	1915	1920			191506	
183 1933 1938 003 1942 1946	372034427	600	1924	1929			192402	
003 1942 1946	372034428	183	1933	1938			193314	
	372034429	£00	1942	1946			194234	

Flight
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Day
Julian

Date

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LIDAR Flight Log

D.Arteaga J.Mathieson C-GJMT Operator Aircraft Pilot 3210_QSI_Misisipi **December 9, 2020** Jackson MS Mission Objective Location Project

System	Riegl VQ-1560i
Unit	37
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	1 Drive
Scanner 2 Drive	2 Drive

stem	Riegl VQ-1560i	Add
<u>#</u>	37	Ξ
_	Applanix AP60	Ξ̈́
S Rx	Trimble GNSS17	¥
anner	anner 1 Drive	Ħ
anner	anner 2 Drive	Ē

Additional Notes		AMLS-106m	Hpa-1022	Time to next maintenance:	¥5	700khz Aligi	Pre Mission	degs Post Mission
					Static	Alignment	sion	ssion
4	A Clea			⊙ 50 hr O 100 hr	GP	Start	1423	2044
AIRBORNE	A Clean Harbors Company				GPS Time	End	1428	2049
							I I	

9

₽ 2 %

100 160

Target Speed Laser Current

m Pulse Rate kts | Scan Rate

2000

AGL Height

Mission Plan

Aircraft Block Time

Takeoff 14:35 Landing 20:41 **Total** 6.1 hrs

Engine On 14:11 Engine Off 20:52

hrs

6.7

Total

	Comments										
Mission ID	Time Stamp	195030	195914	200605	201202	201723					
Line Aborted	nmi to End										
Line	Time										
Time	End	1954	2002	2007	2013	2021	2026				
GPS Time	Start	1950	1959	2006	2012	2017	2021				
Flight	Direction	183	003	183	003	-	ı				
LiDAR	File Name	372034430	372034431	372034432	372034433	372034434					
	Flight Line	6014	6015	6016	6017	X-Tie	F8				

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Day
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Aircraft Pilot

3210 QSI Mississippi December 13, 2020

Jackson, MS

Location Project Date

Mission Objective

LIDAR Flight Log

Trimble GNSS17 Applanix AP60 S2223062 1560i Scanner 1 Drive Scanner 2 Drive **GPS Rx** System Unit \mathbb{R} Operator B. Eisenbart A. Lavalliere C-GMEC

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



	Aircraft Block Time		
Engine On 15:41 Takeoff 16:13	Takeoff 16:13	AGL Height	2
Engine Off 18:15 Landing 18:05	Landing 18:05	Target Speed	_
Total 2.6 hrs Total 1.9 hrs	Total 1.9 hrs	Laser Current	

2000 m Pulse Rate 160 kts Scan Rate		Ξ	MISSION	ושוו	
160 kts Scan Rate	AGL Height	2000	ш	Pulse Rate	700 kHz
100 % FOV	Target Speed	160		Scan Rate	182 hz
	Laser Current	100	%	FOV	s6ep 09

	Static	d9	GPS Time
	Alignment	Start	End
	Pre Mission	15:59	16:04
Sc	Post Mission	18:08	18:13
1			

	Comments	Figure 8			Flew through virga, line aborted	clouds on the south end, line aborted		Figure 8				
Mission ID	Time Stamp 201213	-	163439	164958	170721	172327	174217	-				
Line Aborted	nmi to End											
Line	Time				17:15	17:38						
Time	End	16:32	16:46	17:03			17:45	17:49				
GPS Time	Start	16:27	16:34	16:49	17:07	17:23	17:42	17:45				
Flight	Direction	-	°E00	183°	°E00	183°	93°	ı				
Lidar	File Name	-	622034801	622034802				1				
	Flight Line	8-ddd	4031	4030	4029	4032	X-TIE	8-ddd				

Q	Air	borne	LiDA	R Data	Colle	ction L	og SI	heet :: (Quantun	n Spati	al, Inc			Date: 12	-06-	2020
anaulth.	MA C	N 1	1.		(email tog d	Proi #	72	ribution_list@quan	tumspatiaLcom		. 51			Lift: A) B C		Pg of _
Project:	MS	Del-	+9	100	11/1	Proj #:				Flight Mgr			206A			Swan
Aircraft:	7041			bbs: 150		12.17	: 150	111.9 Tota	£ 5.7	Pilot:	Baumg	arten	Co-Pilot	: :	Tech	Schoone
Dep Apt	OLV	/	Dep Time	(Lcl): 93	9 (Z):	76		Arr Apt: 0	-V	ur Time (L	.ocal):15	24 (Z)	+6	7	Tot Time Ald	oft: 5.77
CORS:	YIN	l Sta	1:			ta 2:		F	lyovers: Y	/ N	f Y, time	s: Sta1)		Sta2)		
GPS Unit	: Y/N	l Sta	1:			ta 2:		F	lyovers: Y	/ N I	f Y, times	: Sta 1)		Sta2)		
Gd Temp	beg:	•0	End:	•c	OAT b	eg:	c Er		Altimete		145	end:	3001	T	Beg GB	848 Storage
	1-		Serial #		Alt 219	_	t	Ave	and the same of th	Max	195 160	Avg Pt	7001	\dashv	End GB	898 Namele
LIDAR	FOV	60 ii	Scan	1040			MSL Nace	Ht Pulse	2-10	Gdepd Power	00%	Spacing PPSM		-	Tot	
			Freq	831es	MpiA '	I N In	Air	Rate	350 KH	٤ /	00/0	PPSM 2			G8	
Line #	Hdg S	start (UTC):	End (UTC):	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0, -, +)		F	LIGHT LINE	NOTES – visib	ility, clouds,	smoke, partial,	.etc.	
6009	181	631	1640	131	1/33	7310										
6008	1 1	1643	1652	138	1/31	7296										
6007	181	1653	1703	125	1/28	7296	P., .			W 8			1			
6006	181	1706	1714	134	1/29	7286										
6005	181	1717	1726	120	1/28	7286			1	H655.	5 = 5.	7				
6004	1/	729	1737	135	1/27	7308				phline	= 4.2					
6003	181	1744	1745	138	1/30	7295				mos	- 1.5					
6002	-	1749	1752	138	1/29	7342		7 (1)								
6001	181	1755	1757	144	1/29	7361										
6025	91	1801	1807	155	1/30	7290		Xtie	Planned							
6016		1815	1830	1476	1/29	7299										
6017	181	1832	1846	120	1/26	7299										1,
6018	- /	1848	1903	149	1/25	7299			-	MANAGE	y pre	Leip	on 1.	5/2	Lines	6026/6024
		1906	1920	12 0	1/24	7299										/
6020	-	923	1937	143	1/26	7299										
6021	181 /	939	1953	140	1/24	7299	1	Xtien	lanned D	r sta	rt Sta	9 Sp	red	AH		<u> </u>
6022	1 /		2010	143	1/24	7322		602	9 - 27	9 203			4	7299	Re	
6023/	18/2	0/3	2027	144	1/24	7306		6024	= 01	2045	T Abor	1/13	٥	7306	Re	1/4
tal Proj Lin	008:	L	Ines Flowr	n:	Lines R	emain:		Online Time	:	Mob Ti	me:		Notes:			J

Allborne	ELIDAR Data Coue	ction Log Sneet	:: Quantum Spatial, Inc Date: 12-9-2020
Project: MS Delta	AO/QSI	Proj #: 32274	
	Begin Hobbs: 15 020.3	End Hobbs: 1	Flight Mgmt File: 2020/209_SN4040_A-R032274 SWAN Total: 2.8 Pilot: Baumgarten Co-Pilot: Tech: Schoone
Dep Apt: ()/_\/	Dep Time (Lcl): 925 (Z):	+6 15023.1ATT A	pt: OLV Arr Time (Local): (Z):+6 Tot Time Aloft: 2.8
CORS: Y / N Sta	20	Sta 2:	Flyovers: Y / N If Y, times: Sta1) Sta2)
GPS Unit: Y / N Sta	1:	Sta 2:	Flyovers: Y / N If Y, times: Sta1) Sta2)
Gd Temp beg: °c	End: °c OAT	eg: °c End:	°C Altimeter begin: end: Dog Store
Type 156011	Seriel 4 440 AGL	Alt AMSL	Avg Terr Mex 160 Avg Pt End Game Ga
LIDAR FOV	Scan 83 Ps MplA	Y / N Pulses In Air	Pulse 350 KHz Power 10090 PPSM Z
Line # Hdg Start (UTC):		GPS Altitude Crab Turb	FLIGHT LINE NOTES - visibility, clouds, smoke, partial, etc.
0 6024 181 1602	1616 145 1/29	73.0	Roflight good
6026 271 1623		7323	1. (1:4) and
6023 1 1636	1652 126 1/31	7293	Reflight good * Assite complete *
QsI site			
	1713 160 1/31	7460	planned Xfie
4 501 2 1718	1736 145 1/30	7391	5021
20 5020 182 1738	1756 185 1/29	7391	* OST Site Complete *
			(A) 11/1 2 P
			A) Hob (s = 2.8)
			oN : n=1.9 m 0 8 = 0.9
			7.(10
J 2 1179			
Total Proj Lines:	Lines Flown: Lines	Remain: On	lune Time: Notes: