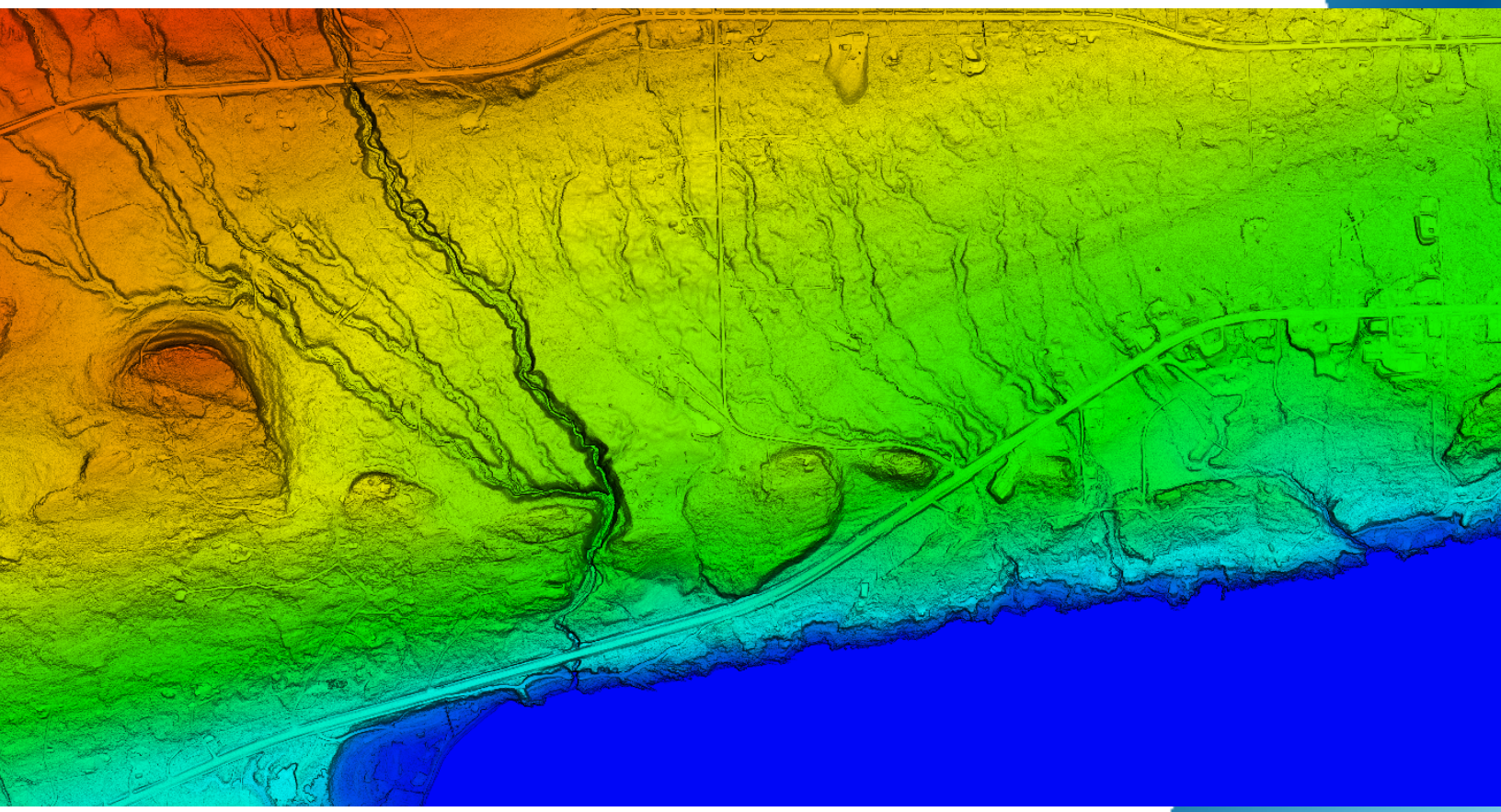
NV5 GEOSPATIAL



MN_RAINYLAKE_2020_B20 LIDAR PROCESSING REPORT

2022

Project ID: 197392
Work Unit: 197389

Submitted: September 14, 2022

Prepared for:

USGS
science for a changing world

Prepared by:

NV5 GEOSPATIAL

Contents

List of Figures

List of Tables

List of Appendices

1. Summary / Scope

1.1. Summary

This report contains a summary of the MN_RainyLake_2020_B20, Work Unit 197389 lidar acquisition task order 140G0220F0248, issued by USGS under their Contract G16PC00016 on August 26, 2020. The task order yielded a project area covering 5382 square miles over Minnesota. 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
8 pts / m2	1325 m	58.5°	20%	≤ 10 cm

1.3. Coverage

The project boundary covers 5382 square miles over Minnesota. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from April 16, 2021 to May 17, 2021 in 29 total lifts. See “Section: 2.4. Time Period” for more details.

1.5. Issues

There are a total of 33 tiles that are located over water and contains no deliverable points. Because of this, there are 33 fewer LAS, height separation, and intensity deliverables than the 15,650 that appear in the tile index.

MN_RainyLake_2020_B20 Work Unit 197389 Projected Coordinate System: UTM Horizontal Datum: NAD 1983 (2011) Vertical Datum: NAVD88 (GEOID 18) Units: Meters	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	• 0.5-meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format • 0.5-meter Intensity images in GeoTIFF format • 0.5-meter Height Separation Raster in GeoTiff format • 0.5-meter Maximum Surface Height Raster in GeoTIFF format
Vectors	Shapefiles (*.shp) • Project Boundary • Lidar Tile Index Geodatabase (*.gdb) • Continuous Hydro-flattened Breaklines • Flight Index
Reports	Reports in PDF format • Processing Report • Focus on Delivery
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • Intensity Imagery • Height Separation

MN_RainyLake_2020_B20
Work Unit 197389 Boundary

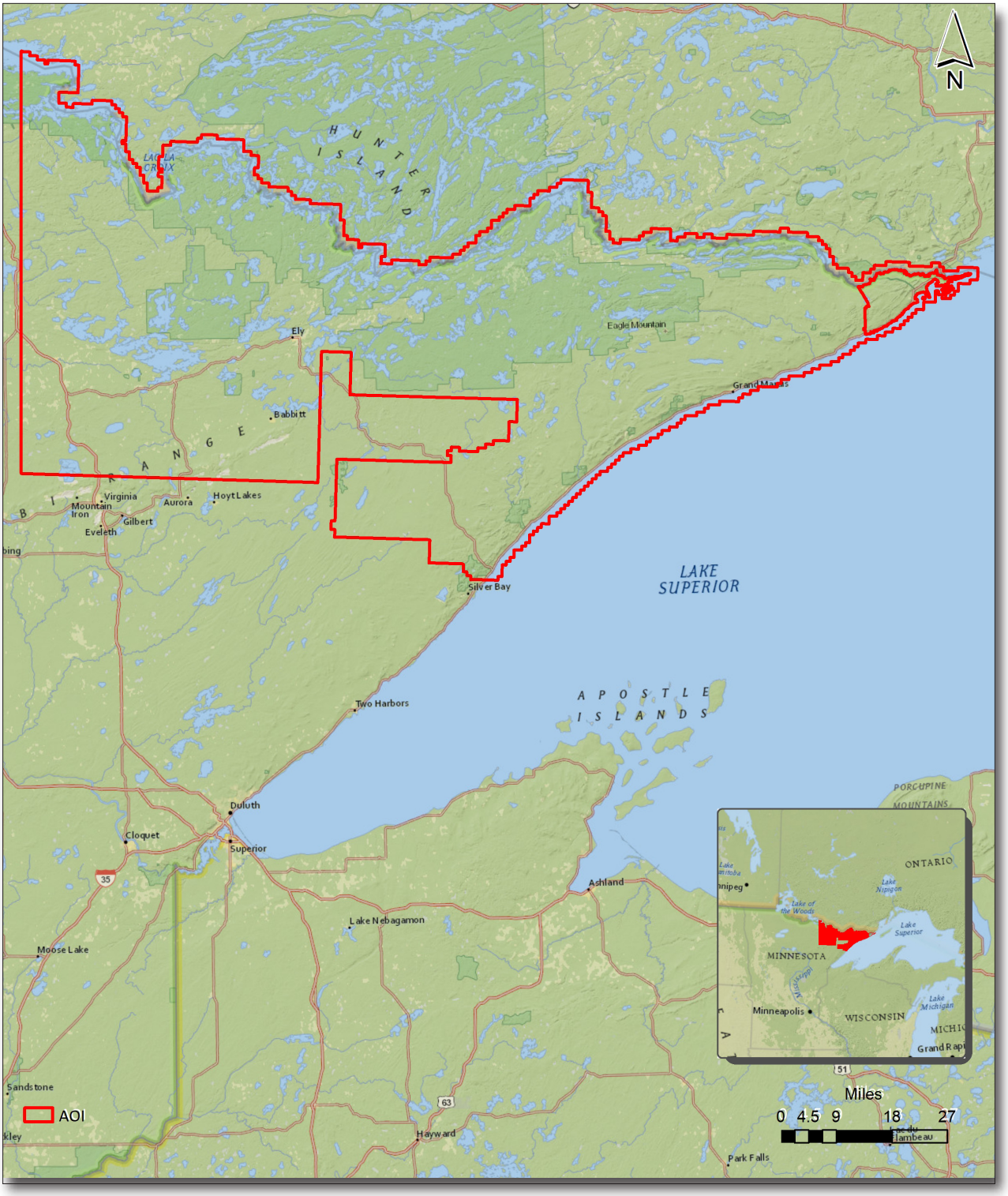


Figure 1. Work Unit Boundary

2. Planning / Equipment

2.1. Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount / type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project using RiPARAMETER planning software.

2.2. Lidar Sensor

NV5 Geospatial utilized Riegl VQ780ii, VQ1560i, and VQ1560ii lidar sensors (Figure 2), serial numbers 3544, 3368, 3543, 3544, 4040, and 4051 for data acquisition.

The Riegl 780ii 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 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.

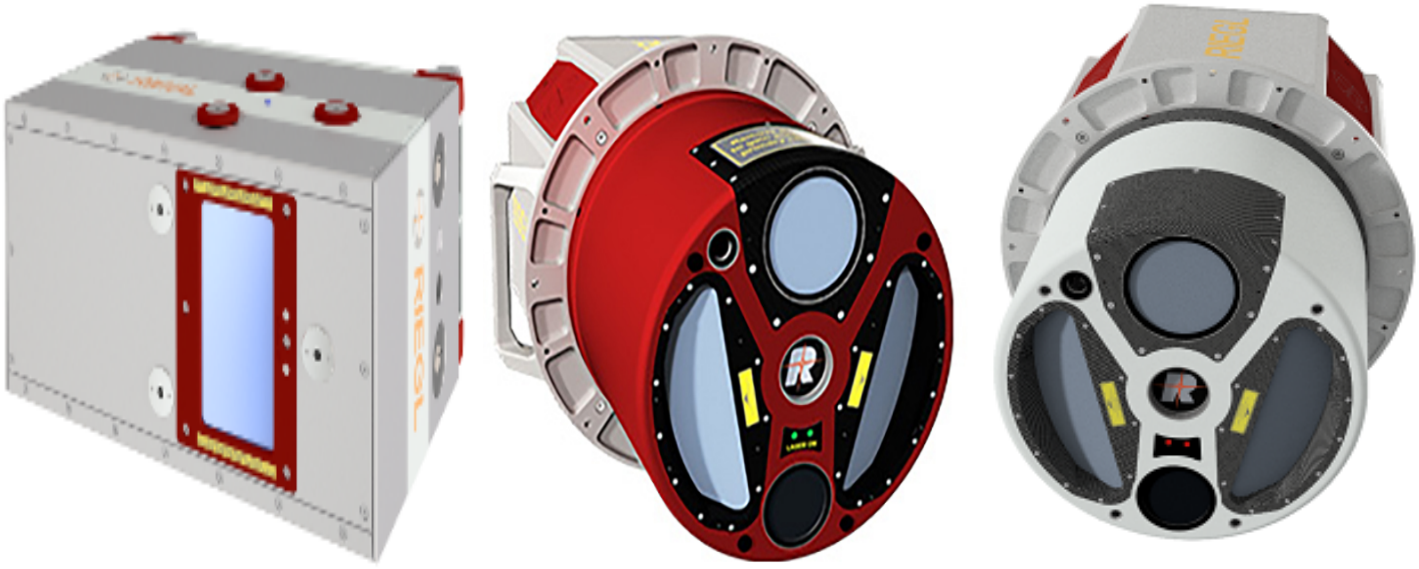
The Riegl 1560ii system is a dual channel waveform processing airborne scanning system. It has a laser pulse repetition rate of up to 4 MHz resulting in up to 2.66 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA) and an integrated IMU/GNSS unit.

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

Table 2. Lidar System Specifications

		Riegl VQ-780ii	Riegl VQ-1560i	Riegl VQ-1560ii
Terrain and Aircraft Scanner	Flying Height	1050 m	1326 m	1500 m
	Recommended Ground Speed	180 kts	180 kts	160 kts
Scanner	Field of View	60°	58.5°	60°
	Scan Rate Setting Used	300 Hz	400 Hz	350 Hz
Laser	Laser Pulse Rate Used	2000 kHz	2000 kHz	2000 kHz
	Multi Pulse in Air Mode	Yes	Yes	Yes
Coverage	Full Swath Width	1300 m	1484 m	1275-1700 m
	Line Spacing	970 m	1190 m	1107 m
Point Spacing and Density	Average Point Spacing	.290 m	.459 m	.419 m
	Average Point Density	11.90 pts / m^2	9.70 pts / m^2	9.64 pts / m^2

Figure 2. Riegl VQ-780ii, 1560i, 1560ii 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 PA-31 (piston-multi), Tail Numbers: N22GE, C-FDCY
- Cessna 206 Stationair (piston-single), Tail Numbers: N223TC

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 lidar system. Some of NV5 Geospatial's operating aircraft can be seen in Figure 3 below.

Figure 3. Some of NV5 Geospatial's Planes

2.4. Time Period

Project specific flights were conducted between April 16, 2021 to May 17, 2021. 29 aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
04162021B (SN4040,N22GE)	4/16/2021 6:27:30 PM	4/16/2021 8:06:14 PM
04172021A (SN4040,N22GE)	4/17/2021 1:13:48 PM	4/17/2021 5:57:28 PM
04172021B (SN4040,N22GE)	4/17/2021 7:17:31 PM	4/17/2021 9:38:25 PM
04182021A (SN4040,N22GE)	4/18/2021 12:55:56 PM	4/18/2021 3:41:40 PM
04192021A (SN4040,N22GE)	4/19/2021 8:58:28 PM	4/20/2021 12:32:35 AM
04222021A (SN4040,N22GE)	4/22/2021 1:39:59 PM	4/22/2021 6:11:28 PM
04242021A (SN4040,N22GE)	4/24/2021 10:58:13 PM	4/25/2021 12:48:52 AM
04252021A2 (SN3544,N223TC)	4/25/2021 7:16:35 PM	4/25/2021 9:45:29 PM
04252021C (SN4040,N22GE)	4/25/2021 7:53:31 PM	4/25/2021 11:26:48 PM
04282021A (SN3368,C-FDCY)	4/28/2021 3:32:23 PM	4/28/2021 8:08:53 PM
04282021A (SN3544,N223TC)	4/28/2021 6:19:34 PM	4/28/2021 9:50:27 PM
04282021B (SN3368,C-FDCY)	4/28/2021 8:58:10 PM	4/28/2021 11:59:34 PM
04292021A (SN3544,N223TC)	4/29/2021 6:25:51 PM	4/29/2021 7:04:19 PM
04302021A (SN3368,C-FDCY)	4/30/2021 11:49:40 AM	4/30/2021 4:58:30 PM
04302021A (SN4040,N22GE)	4/30/2021 2:04:20 PM	4/30/2021 6:47:39 PM
04302021A1 (SN3544,N223TC)	4/30/2021 1:13:00 PM	4/30/2021 4:43:05 PM
04302021A2 (SN3544,N223TC)	4/30/2021 6:12:35 PM	4/30/2021 9:16:17 PM

Lift	Start UTC	End UTC
04302021B (SN3368,C-FDCY)	4/30/2021 5:47:32 PM	4/30/2021 10:53:47 PM
04302021B (SN4040,N22GE)	4/30/2021 8:34:07 PM	4/30/2021 10:07:33 PM
04302021C (SN3368,C-FDCY)	4/30/2021 11:29:23 PM	5/01/2021 12:35:52 AM
05012021A (SN4040,N22GE)	5/01/2021 1:59:09 PM	5/01/2021 7:28:14 PM
05012021A1 (SN3544,N223TC)	5/01/2021 1:23:58 PM	5/01/2021 4:29:50 PM
05012021A2 (SN3544,N223TC)	5/01/2021 5:58:35 PM	5/01/2021 7:03:48 PM
05022021A (SN4040,N22GE)	5/02/2021 1:59:37 PM	5/02/2021 4:54:30 PM
05132021A (SN3544,N223TC)	5/13/2021 3:06:31 PM	5/13/2021 6:08:20 PM
05152021A (SN3544,N223TC)	5/15/2021 6:14:20 PM	5/15/2021 7:35:04 PM
05162021A (SN3544,N223TC)	5/16/2021 12:36:31 PM	5/16/2021 3:05:19 PM
05172021A1 (SN3544,N223TC)	5/17/2021 12:24:01 PM	5/17/2021 2:23:50 PM
05172021A2 (SN3544,N223TC)	5/17/2021 3:33:15 PM	5/17/2021 5:32:55 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.).

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

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

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

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

3.3. LAS Classification Scheme

The classification classes are determined by Lidar Base Specifications 2.1 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
3	Low Vegetation	
7	Low Noise	Laser returns that are often associated with scattering from reflective surfaces, or artificial points below the ground surface
9	Water	Laser returns that are found inside of hydro features
17	Bridge Deck	Laser returns falling on bridge decks
18	High Noise	Laser returns that are often associated with birds or artificial points above the ground surface
20	Ignored Ground	Ground points that fall within the given threshold of a collected hydro feature.

3.4. Classified LAS Processing

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

All ground (ASPRS Class 2) lidar data inside of the Lake Pond and Double Line Drain hydro flattening breaklines were then classified to water (ASPRS Class 9) using proprietary tools. A buffer of 0.5 meter 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 0.5 meter 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 0.5-meter.

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. Intensity Image Processing

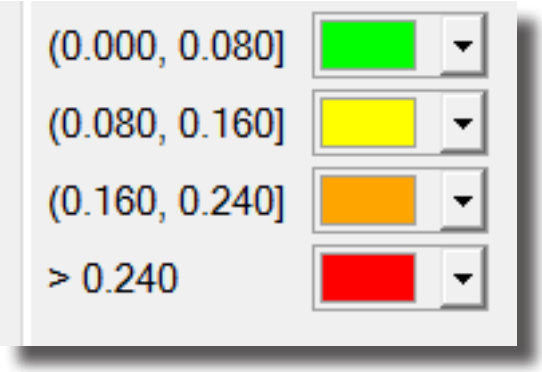
GeoCue software was used to create the deliverable intensity images. All withheld points were ignored during this process. This helps to ensure a more aesthetically pleasing image. The GeoCue software was then used to verify full project coverage as well. GeoTIFF files with a cell size of 0.5 meter were then provided as the deliverable for this dataset requirement.

3.8. Height 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 0.5-meter 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 (Figure 4) 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.

Figure 4. Intervals for Swath Separation Images



3.9. Maximum Surface Height Raster Processing

Maximum Surface Height rasters (topographic) represent a lidar-derived product illustrating natural and built-up features. NV5 Geospatial's proprietary software was used to take all first-return classified lidar points, excluding those flagged with a withheld bit, and create a Triangulated Irregular Network (TIN) on a tile-by-tile basis. Data extending past the tile edge is incorporated in this process so that proper triangulation can occur. From the TIN, linear interpolation is used to calculate the cell values for the raster product. The raster product is then clipped back to the tile edge so that no overlapping cells remain across the project area. A 32-bit floating point GeoTIFF was generated for each tile with a pixel size of 0.5-meter.

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.

MN_RainyLake_2020_B20
Work Unit 197389 Tile Layout

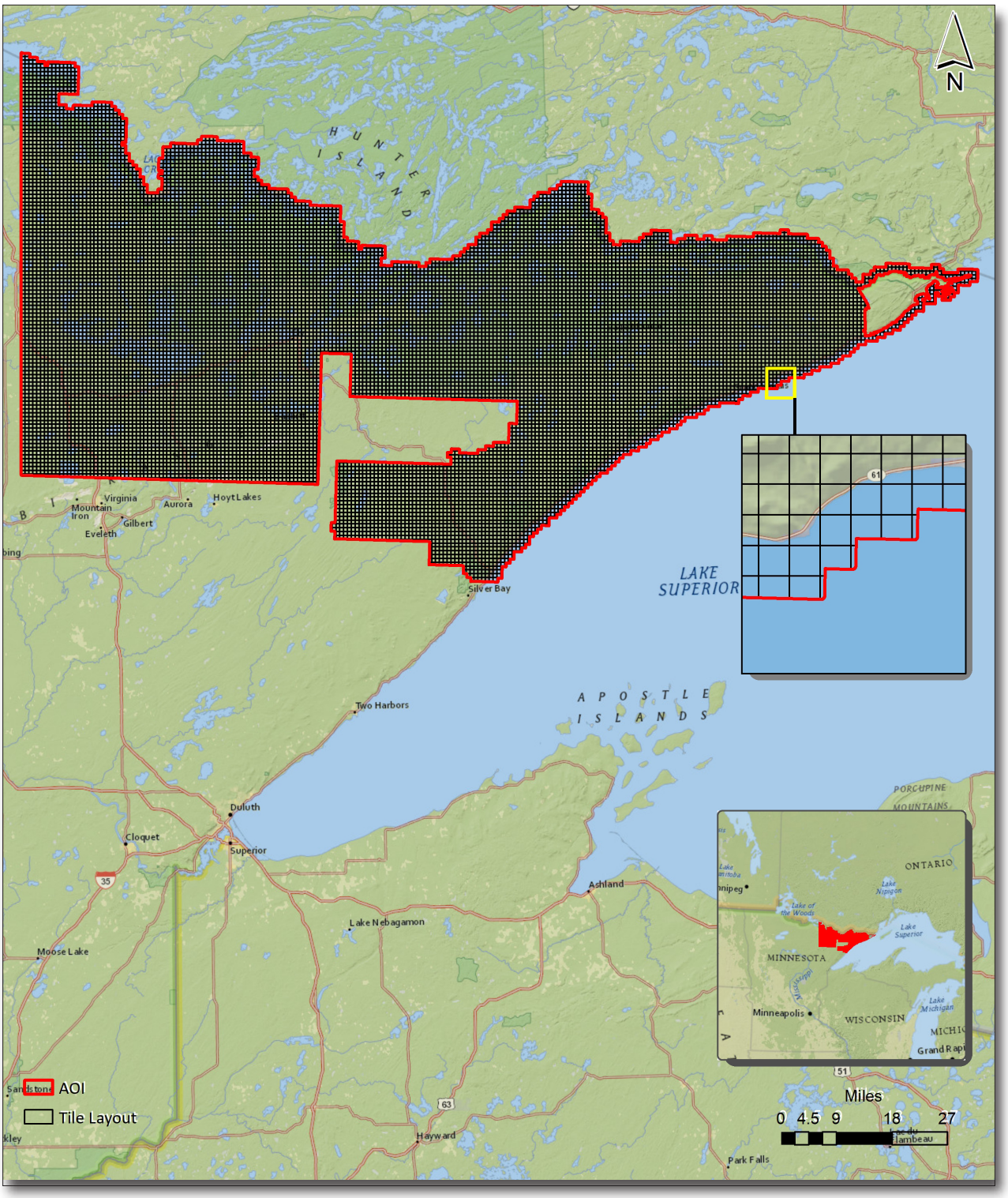


Figure 5. Lidar Tile Layout

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.

MN_RainyLake_2020_B20
Work Unit 197389 Lidar Coverage

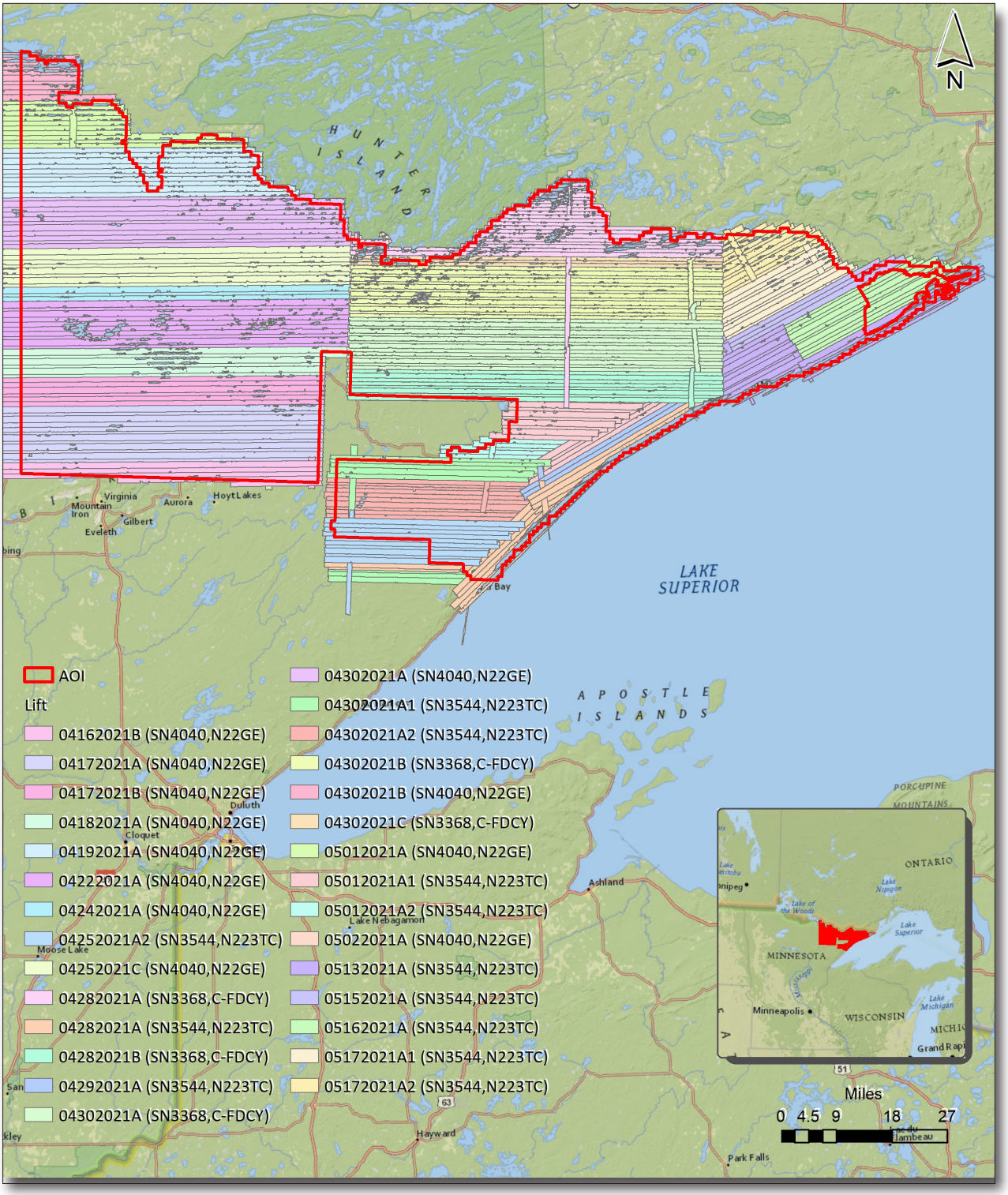


Figure 6. Lidar Coverage

5. Geometric Accuracy

5.1. Horizontal Accuracy

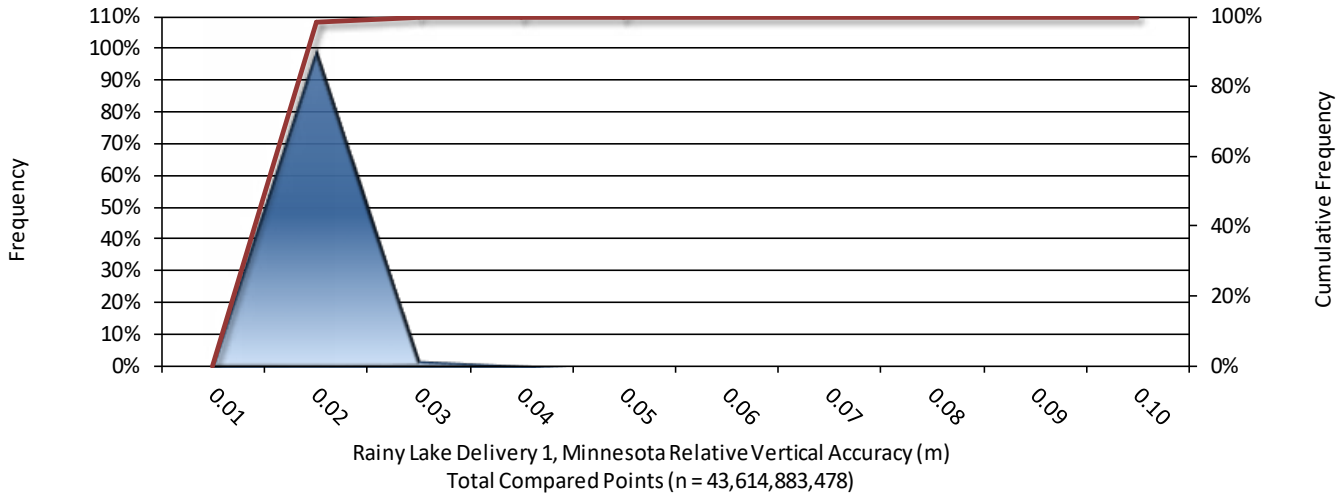
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial 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 1828 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.015 meters, this project was compiled to meet 0.20 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.38 ft
	0.11514 m
ACC_r	0.65 ft
	0.20 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 MN_RainyLake_2020_B20 project was 0.048 feet (0.015 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	478 flight line surfaces
Average	0.048 ft
	0.015 m
Median	0.051 ft
	0.016 m
RMSE	0.052 ft
	0.016 m
Standard Deviation (1σ)	0.005 ft
	0.002 m
1.96σ	0.011 ft
	0.003 m



Project Report Appendices

The following section contains the appendices as listed in the MN_RainyLake_2020_B20 Lidar Project Report.

Appendix A

Flight Logs

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4/6/21

Lift: (A) B C D E Pg 1 of __

Project: Rainy Lake Proj #: 36740 Flight Mgmt File: 20210416_4040_36740_Rainy

Aircraft: 22TE Begin Hobbs: End Hobbs: 5982.3 Total: 6.1 Pilot: Kruger Co-Pilot: Tech: Smith

Dep Apt: EAU Dep Time (Lcl): (Z): Arr Apt: HIB Arr Time (Local): 717 (Z): Tot Time Aloft:

CORS: Y / (N) Sta 1: 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: 09 °c End: °c OAT beg: °c End: °c Altimeter begin: 30.07 end:

LiDAR									Beg GB	Storage Name/#
	Type 156011	Serial # 4040	Alt AGL 1500M	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		End GB	
	FOV 58	Scan Freq 1000	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100%	PPSM 8		Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
XTie	N	1827:·	—	131	.8/27	6618		0	XTie = unplanned S-TURN SKC NO SNOW
97	272	182214	183714	150	.8/27	6430		0	
96	092	184445	185648	158	.8/27	6191		0	
95	272	185856	191750	154	.8/28	6191		2	SNOW on Ski Hill 23 m AGL
94	092	192103	194330	145	.8/26	6285		2	
93	272	194507	200615	152	.8/29	6279		2	
									S-TURN
									1.2

Total Proj Lines: 97 Lines Flown: 5 Lines Remain: 92 OnLine Time: 1.5 Mob Time: 1.1 Notes:

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4/7/21 Lift: (A) B C D E Pg 1 of __

Project: Rainy Lake Proj #: 36740 Flight Mgmt File: 20210417_4040-36740_Rainy

Aircraft: 22T½ Begin Hobbs: 5982.3 End Hobbs: 6987.6 Total: 5.3 Pilot: Braden Co-Pilot: Tech: Smith

Dep Apt: H18 Dep Time (Lcl): 0800 (Z): Arr Apt: H18 Arr Time (Local): 116 (Z): Tot Time Aloft:

CORS: Y / (N) Sta 1: 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 beg: °c End: °c Altimeter begin: 30.05 end:

LiDAR									Beg GB	Storage Name/#
	Type 1560 II	Serial # 4040	Alt AGL 1500m	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		End GB	
	FOV 58	Scan Freq 1000	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100%	PPSM 8		Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
92	090	133148	133530	150	.8/26	6273		0	SKC – S-TURN
91	272	133724	135936	145	.8/25	6246		0	
90	090	140129	142316	147	.9/24	6250		0	
89	272	142514	144721	143	1.1/23	6243		0	
88	090	144923	151059	152	.9/26	6223		0	
87	272	151252	153500	144	1.1/24	6223		1	
86	090	153704	155818	155	.8/30	6214		2	SKT 8000+
85	272	160008	162224	143	.8/29	6201		3	
84	090	162420	164524	158	1.0/27	6194		4	Mod Turbulence
83	272	164714	171004	142	.9/26	6194		4	
82	090	171158	173305	160	.8/27	6144		4	00 zero 6 :)
81	272	173453	175728	145	.9/29	6191		4	
L Tim	S	1800	1802						Extra unplanned S-TURN

Total Proj Lines:	Lines Flown: 12	Lines Remain:	On-line Time: 4.9	Mob Time: 0.4	Notes:

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4/7/21

Lift: A (B) C D E Pg __ of __

Project: Rainy Lake Proj #: 56740 Flight Mgmt File: 2021_04_17_B_4040_56740_Rainy

Aircraft: 22TE Begin Hobbs: 5487.6 End Hobbs: 5490.4 Total: 2.8 Pilot: Rocken Co-Pilot: Tech: Smith

Dep Apt: 4I0 Dep Time (Lcl): 202 (Z): Arr Apt: 4I3 Arr Time (Local): 454 (Z): Tot Time Aloft:

CORS: Y / (N) Sta 1: 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 beg: °c End: °c Altimeter begin: end:

LiDAR	Type 1560 II	Serial # 4040	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing
	FOV 58	Scan Freq 100	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100	PPSM 8

Beg GB	Storage Name/#
End GB	
Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
80	090	191727	193817	154	.8/29	6184		3	STurn SKY 8000+
79	272	194126	200302	149	.9/27	6184		3	Mod Turbulence
78	090	200159	202548	151	.8/26	6184		3	
77	272	202749	205108	145	.8/28	6174		3	
76	090	205255	211338	161	.8/30	6171		3	
75	272	211534	213825	145	.8/31	6168		4	Pre-LOC S1 Non FWE
XTie	S	214001	214149	164	.8/30	6340		2	X-Tie Unplanned S-Turn

Total Proj Lines:	Lines Flown:	Lines Remain:	Online Time: 2.4	Mob Time: 0.4	Notes:

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

(email Log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4 18 21

Lift: A B C D E Pg 1 of __

Project: Rainy Lake Proj #: 36740 Flight Mgmt File: 20210418_4040_36740_Rn-y

Aircraft: 227E Begin Hobbs: 5940.4 End Hobbs: 5943.9 Total: 3.5 Pilot: Bradna Co-Pilot: Tech: Smith

Dep Apt: HIB Dep Time (Lcl): 731 (Z): Arr Apt: HIB Arr Time (Local): 1102 (Z): Tot Time Aloft:

CORS: Y / (N) Sta 1: 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 beg: °c End: °c Altimeter begin: 29.77 end:

LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	1SG011	4040	150			160	
	FOV 58	Scan Freq 100	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100	PPSM 8

Beg GB	Storage Name/#
End GB	
Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
74	090	125557	131554	165	.8/28	6158		1	S-Turn OVL 800-
73	272	131821	134234	136	.9/25	6158		0	
72	090	134442	140421	169	.8/27	6161		0	
71	272	140632	—	134	.9/28	6148		0	Lazaw Rec stopped 39. FWE
R 71	272	142516	144950	134	1.0/25	6148		0	
70	090	145201	151248	172	.9/27	6145		0	LT Haze
69	272	151506	154140	138	.9/28	6145		0	LT Sailing Full GT west end - 3m FWE
X Tie	S	154425	154637	150	.9/29	5992		0	X Tie Unplanned
									S-Turn

Total Proj Lines:	Lines Flown: 6	Lines Remain:	Online Time: 2.7	Mob Time: 0.8	Notes:

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4,19,21

Lift: (A) B C D E Pg 1 of

Project: Rainy Lake Proj #: 36740 Flight Mgmt File: 20210419_4040_36740-Rainy

Aircraft: 22TE Begin Hobbs: 5993.9 End Hobbs: 5998.1 Total: Pilot: Larosse Co-Pilot: Tech: Smith

Dep Apt: H18 Dep Time (Lcl): 327 (Z): Arr Apt: H18 Arr Time (Local): 601 (Z): Tot Time Aloft:

CORS: Y / (N) Sta 1: 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 beg: °c End: °c Altimeter begin: end:

LiDAR									Beg GB	Storage Name/#
	Type 1560 II	Serial # 4040	Alt AGL 1500	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		End GB	
	FOV 58	Scan Freq 1000	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100	PPSM 6		Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
36	090	208829	211925	139	.9/26	6020		3	Strm SKT - 7000 Turbulence Severe in shadow
35	272	212206	214315	135	.9/26	6020		2	Lt Snow in shadow areas
34	090	214600	220508	151	1.0/25	6020		2	
33	272	220757	222711	148	.9/26	6023		3	Turning X RLoC FL-10
32	090	222956	224821	151	.9/26	6023		2	Gas change
31	272	225118	231039	138	.8/31	6023		2	
30	090	231310	233111	144	.9/29	6017		1	
29	272	233337	235214	134	.8/31	6023		1	Lt Haze 25 m FWE TO WE
28	090	235447	001245	150	.9/30	6023		1	Lt Haze
27	272	001502	003124	145	1.0/27	6023		1	Lt Haze — Cloud Fog - Sm FWE - TWE
X Tie	S	003627	003937	160	1.1/27	5237		2	X Tie unplanned Lt Snow Fall at N end
									Strm

Total Proj Lines:	Lines Flown:	Lines Remain:	On line Time:	Mob Time:	Notes:

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

(email Log daily to flight_Log_distribution_list@quantumspatial.com)

Date: 4 22 21 Lift: (A) B C D E Pg 1 of

Project: Rainy NW Proj #: 36740 Flight Mgmt File: 20210422A_490_36740_Rainy

Aircraft: 22 E Begin Hobbs: 5998.4 End Hobbs: 6003.6 Total: 5.2 Pilot: Larosa Co-Pilot: Tech: Smith

Dep Apt: H18 Dep Time (Lcl): 617 (Z): Arr Apt: H18 Arr Time (Local): 133 (Z): Tot Time Aloft:

CORS: Y / (N) Sta 1: 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 beg: °c End: °c Altimeter begin: 29.84 end:

LiDAR	Type 156011	Serial # 4040	Alt AGL 1500 M	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing
	FOV 58	Scan Freq 100	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100	PPSM 4

	Beg GB	Storage Name/#
	End GB	
	Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
68	090	133956	140231	159	.9/27	6138		0	HAF S-Turn - SKC LT Haze
67	272	140543	143041	135	1.0/25	6138		0	
66	090	145308	145535	159	.9/28	6125		0	
65	272	145826	152317	137	.9/28	6122		0	
64	090	152607	154853	155	.9/2	6115		0	
63	272	155118	161606	143	.8/30	6115		0	
62	090	161839	164103	155	.8/31	6119		0	
61	272	164343	X	145	.9/30	6132		0	Lost connection LAN Pilot Display
61	272	165218	171709	147	.9/32	6132		2	
60	090	171952	174221	157	.9/31	432		2	S-Turn 17 M FRE
59	272	174509	181128	138	.8/31	6178		3	
X-Tie	S	181520	181911	126	.8/30	6342		4	XTie - unplanned
									Pic Did not want to Fly a second LIST

x-38
x 1

Total Proj Lines: 97 Lines Flown: 11 Lines Remain: OnLine Time: 4.5 Mob Time: 0.7 Notes:

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4/24/2021

Lift: (A) B C D E Pg 1 of 1

Project: MN Rainy Lake **Proj #:** 36740 **Flight Mgmt File:** 36740 MN Rainy Lake

Aircraft: 22TE **Begin Hobbs:** 6003.6 **End Hobbs:** 6006.2 **Total:** 2.6 **Pilot:** Jamon Nelson **Co-Pilot:** **Tech:** Spencer Berk

Dep Apt: KHIB **Dep Time (Lcl):** 05:30 **(Z):** **Arr Apt:** KHIB **Arr Time (Local):** 08:09 **(Z):** **Tot Time Aloft:** 2.6

CORS: Y / (N) **Sta 1:** **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 beg:** °c **End:** °c **Altimeter begin:** **end:**

LiDAR									
Type	1560ii	Serial #	4040	Alt AGL	4921	Alt AMSL	[illegible]	Avg Terr Ht	
Max Gdspd	160	Avg Pt Spacing		FOV	58.52	Scan Freq		MpiA Y / N	
Pulses In Air		Pulse Rate	1000 KHz	Power	100	PPSM	8		

Beg GB	Storage Name/#
End GB	
Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
1056									last line of mission
1057									PD Froze, flew through 6pS midnight - leftly?
1058					0.93				
1069									

Total Proj Lines:	Lines Flown:	Lines Remain:	Online Time:	Mob Time:	Notes:

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	**Project Number(s):**	220030 Rainey Lake			**Date:**	4/25/2021
Operator:	AC	**Project Name(s):**				**Mission Start (LT):**	3922.7 / 3928.2
Aircraft:	223TC	**Hobbs Start:**	3922.2 / 3927.7	**Hobbs Stop:**	3927.7 / 3931.2	**Mission End (LT):**	3927.3 / 3930.7

LiDAR Unit:	3) VQ-1560i S2223544	**Scan Rate:**	2X239	**Camera Unit:**	Phase One	**Drive:**	B
MTA Zones:	8 TO 12	**Grnd Spd Max (kts):**	130	**FOV (deg):**	58.52	**Sun Angle:**	
PRR (kHz):	2x1000	**Altitude (feet AMT):**	5600	**Lateral Overlap (%):**		**Lens:**	
Laser Power (%):	100	**Point Spacing (m):**	0.321	**Forward Overlap (%):**		**Point Density (ppms):**	11.6

		Camera Counter		**Line Start/Stop**							
Line #	**Direction**	**To**	**From**	**Start Time UTC**	**Stop Time UTC**	**Altitude (Planned)**	**Altitude (Actual)**	**Remarks**	**Clouds**	**Aperture**	**Shutter Speed**
85	NE			8:17	8:30	5655+-		220030 482 So Rainey TC VQ3dDC (Flightplans)			
84	SW			8:33	8:46						
83	NE			8:50	9:03						
82	SW			9:06	9:18						
81	NE			9:21	9:34						
80	SW			9:37	9:48						
79	NE			9:51	9:57						
78	SW			10:00	10:05						
77	NE			10:08	10:13						
76	SW			10:15	10:18						
75	NE			10:21	10:25						
74	SW			10:28	10:30						
73	NE			10:33	10:36						
72	SW			10:40	10:42						
71	NE			10:46	10:47						
94 XTIE	E			10:50	10:56						
95 XTIE	NE			11:04	11:08						
60	E			11:13	11:20						
61	W			11:23	11:31						
62	E			11:33	11:41						

63	W			11:43	11:50						
64	E			11:53	12:00						
65	W			12:03	12:09						
66	E			12:11	12:17						
67	W			12:19	12:25						
68	E			12:28	12:34						
69	W			12:36	12:41						
70	E			12:44	12:49						
95 XTIE	NE			14:16	14:22						
40	E			14:28	14:41						
41	W			14:43	14:56						
42	E			14:59	15:12						
43	W			15:16	15:26						
44	E			15:29	15:40						
45	W			15:42	15:52						
46	E			15:55	16:06						
47	W			16:09	16:19						
48	E			16:22	16:34						
49	W			16:35	16:45						

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4/25/2021

Lift: A B (C) D E Pg 1 of 1

Project: MN Rainy Lake **Proj #:** 36740 **Flight Mgmt File:** 36740 MN Rainy lake

Aircraft: 22TE **Begin Hobbs:** 6010.2 **End Hobbs:** 6014.6 **Total:** 4.4 **Pilot:** Jamon Nielson **Co-Pilot:** **Tech:** Spencer Beck

Dep Apt: KHIB **Dep Time (Lcl):** 02:31 (Z): **Arr Apt:** KHIB **Arr Time (Local):** 06:54 (Z): **Tot Time Aloft:** 4.4

CORS: Y / N **Sta 1:** **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 beg:** °c **End:** °c **Altimeter begin:** **end:**

LiDAR	Type 1560ii	Serial # 4040	Alt AGL 4921	Alt AMSL	Avg Terr Ht	Max Gdspd 160 KTS	Avg Pt Spacing		Beg GB		Storage Name/#
	FOV 58.52	Scan Freq	MpiA Y / N	Pulses In Air	Pulse Rate 1000 KHZ	Power 100	PPSM 8		End GB		
									Tot GB		

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
1048									last line of mission
1049									
1050									
1051									overcast above
1052									
1053									
1054									Moderate turb, sensor kept recording after line end
1055									First line of mission

XEOS Imaging Inc

LiDAR flight report

Project : PR3080
Mission (yyyy-mm-dd_#) : 2021-04-28_1
Aircraft : FDCY
Pilot : Renaud Charron / Emilio Cuartas
Operator : Eric Dionne

LIDAR ID :
Density ppm² : 8
Pulse Rate (PRR) : 2000
Laser Power : 100%
FOV : (60°) or other :

Pattern : (Regular) or Powerline
Ground Speed (knt): 180
Flying height AGL (ft) : 3444
ENOHD (ft) : 2624

Lines			WPT				
Time	+/- Lines	L,P or C *	FROM	TO	Sky Condition **	Out T°	Comments
15:32	-1	L	ALL		FEW		Low clouds on the south
15:49	+65	L	ALL		FEW		
15:55	-64	L	ALL		FEW		
16:01	+63	L	ALL		FEW		DUI
16:06	-62	L	ALL		FEW		
16:12	+61	L	ALL		FEW		
16:19	-60	L	ALL		FEW		
16:25	+59	L	ALL		SKC		
16:32	-58	L	ALL		SKC		
16:40	+57	L	ALL		SKC		
16:49	-56	L	ALL		SKC		
16:57	+55	L	ALL		SKC		
17:09	-54	L	ALL		SKC		
17:16	+53	L	ALL		SKC		
17:28	-52	L	ALL		SKC		
17:41	+51	L	ALL		SKC		
17:57	-50	L	ALL		SKC		
18:12	+48	L	ALL		SKC		
18:28	-46	L	ALL		SKC		
18:45	+44	L	ALL		SKC		
19:01	-43	L	ALL		SKC		
19:23	+45	L	ALL		SKC		
19:28	-47	L	ALL		FEW		
19:34	+49	L	ALL		FEW		
19:38	+41	L					

* L = Line P = Profil C = Crossline

** SKC - FEW - SCT - BKN - LOVC = light OVC - HOVC = Heavy OVC

*** L = Light M = Moderate S = Severe

Clouds **: FEW
Haze ***: L
Turbulence ***: L
Cleaned lense : ☒
Aircraft hole open : ☒

UTC Hour
AEROctrl ON : 15:10
AEROctrl OFF :

Time UTC
Engine ON : 15:08
Engine OFF :
Departure airport : KCKC
Arrival airport :

Flight time

Project	Hrs
PR3080	5.2

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	**Project Number(s):**	220030 Rainey Lake			**Date:**	4/28/2021
Operator:	AC	**Project Name(s):**				**Mission Start (LT):**	3932
Aircraft:	223TC	**Hobbs Start:**	3931.3	**Hobbs Stop:**	3936.3	**Mission End (LT):**	3935.8

LiDAR Unit:	3) VQ-1560i S2223544	**Scan Rate:**	2X239	**Camera Unit:**	Phase One	**Drive:**	B
MTA Zones:	8 TO 12	**Grnd Spd Max (kts):**	130	**FOV (deg):**	58.52	**Sun Angle:**	
PRR (kHz):	2x1000	**Altitude (feet AMT):**	5600	**Lateral Overlap (%):**		**Lens:**	
Laser Power (%):	100	**Point Spacing (m):**	0.321	**Forward Overlap (%):**		**Point Density (ppms):**	11.6

		Camera Counter		Line Start/Stop							
Line #	**Direction**	**To**	**From**	**Start Time UTC**	**Stop Time UTC**	**Altitude (Planned)**	**Altitude (Actual)**	**Remarks**	**Clouds**	**Aperture**	**Shutter Speed**
86	NE			13:07	13:14	5655+-		220030 482 So Rainey TC VQ3dDC (Flightplans)			
96 XTIE	NE			13:19	13:25						
50	W			13:28	13:39						
51	E			13:41	13:51						
93	NE			13:58	14:13						
92	SW			14:15	14:28						
91	NE			14:31	14:45						
90	SW			14:47	14:57						
89	NE			15:00	15:11						
88	SW			15:12	15:21						
87	NE			15:23	15:31						
10	NE			15:36	15:51						
9	SW			15:53	16:08						
8	NE			16:10	16:24						
7	SW			16:27	16:41						
99 XTIE	NE			16:45	16:49						

XEOS Imaging Inc

LiDAR flight report

Project : PR3080
Mission (yyyy-mm-dd_#) : 2021-04-28_2
Aircraft : CFDCY
Pilot : Ronaud Chaceon / Emilio Cuesta
Operator : Eric Dionne

LIDAR ID :
Density ppm² : 8
Pulse Rate (PRR) : 2000
Laser Power :
FOV : (60°) or other : 100

Pattern : (Regular) or Powerline
Ground Speed (knt): 180
Flying height AGL (ft) : 3444
ENOHD (ft) : 2624

Lines			WPT				
Time	+/- Lines	L,P or C *	FROM	TO	Sky Condition **	Out T°	Comments
20:58	-2	L	ALL		SKC		
21:20	+3	L	ALL		FEW		
21:42	-4	L	ALL		FEW		
22:05	+5	L	ALL		FEW		
22:27	-6	L	ALL		FEW		
22:50	+7	L	ALL		FEW		
23:12	-8	L	ALL		FEW		
23:34	+9	L	ALL		FEW		
23:56	—	C	—	—	LOVC		

* L = Line P = Profil C = Crossline

** SKC - FEW - SCT - BKN - LOVC = light OVC - HOVC = Heavy OVC

*** L = Light M = Moderate S = Severe

Clouds **: FEW
Haze ***: L
Turbulence ***: L
Cleaned lense : ☒
Aircraft hole open : ☒

UTC Hour
AEROctrl ON : 20:43
AEROctrl OFF : 00:07

Time UTC
Engine ON : 20:41
Engine OFF : 00:07
Departure airport : KCKC
Arrival airport : KCKC

Flight time

Project	Hrs
PR3080	3.4

axis geospatial	AXIS GeoAviation	LiDAR and Imagery Flight Report						Project(s):	220030 Rainey Lake		
Pilot:	JT			Project Number(s):	220030 Rainey Lake			Date:	4/29/2021		
Operator:	AC			Project Name(s):				Mission Start (LT):	3937.0		
Aircraft:	223TC			Hobbs Start:	3936.3	Hobbs Stop:	3938.4	Mission End (LT):	3937.7		
LiDAR Unit:	3) VQ-1560i S2223544		Scan Rate:	2X239		Camera Unit:	Phase One	Drive:	B		
MTA Zones:	8 TO 12		Grnd Spd Max (kts):	130		FOV (deg):	58.52	Sun Angle:			
PRR (kHz):	2x1000		Altitude (feet AMT):	5600		Lateral Overlap (%):		Lens:			
Laser Power (%):	100		Point Spacing (m):	0.321		Forward Overlap (%):		Point Density (ppms):	11.6		

		Camera Counter		Line Start/Stop							
Line #	Direction	To	From	Start Time UTC	Stop Time UTC	Altitude (Planned)	Altitude (Actual)	Remarks	Clouds	Aperture	Shutter Speed
6	NE			13:25	13:39	5655+-		LIGHT / MODERATE TURBULENCE			
5	SW			13:42	13:56			CLOUDED OUT / AT & BELOW MSN ALT			
99 XTIE	NW			14:01	14:03			220030 482 So Rainey TC VQ3dDC (Flightplans)			

XEOS Imaging Inc

LiDAR flight report

Project : PR3080
Mission (yyyy-mm-dd_#) : 2021-04-30_1
Aircraft : C-FDCY
Pilot : Renaud Charron/Emmanuel Courtes
Operator : Eric Dionne

LIDAR ID :
Density ppm² : 8
Pulse Rate (PRR) : 2000
Laser Power : 100
FOV : (60°) or other :

Pattern : (Regular) or Powerline
Ground Speed (knt): 180
Flying height AGL (ft) : 3444
ENOHD (ft) : 2624

Lines			WPT				
Time	+/- Lines	L,P or C *	FROM	TO	Sky Condition **	Out T°	Comments
11:49	-10	L	ALL		SKC	-1°C	
12:12	+11	L	ALL		SKC		
12:34	-12	L	ALL		SKC		
12:57	+13	L	ALL		SKC		
13:18	-14	L	ALL		SKC		
13:41	+15	L	ALL		SKC		
14:02	-16	L	ALL		SKC		
14:25	+17	L	ALL		SKC		
14:45	-18	L	ALL		SKC		
15:08	+19	L	ALL		SKC		
15:29	-20	L	ALL		SKC		
15:51	+21	L	ALL		SKC		
16:12	-22	L	ALL		SKC		
16:34	+23	L	ALL		SKC		
16:54		C			SKC		

* L = Line P = Profil C = Crossline

** SKC - FEW - SCT - BKN - LOVC = light OVC - HOVC = Heavy OVC

*** L = Light M = Moderate S = Severe

Clouds **: SKC
Haze ***: L
Turbulence ***: L
Cleaned lense : ☒
Aircraft hole open : ☒

UTC Hour
AEROctrl ON : 11:30
AEROctrl OFF : 17:07

Time UTC
Engine ON : 11:24
Engine OFF : 17:07
Departure airport : KCKC
Arrival airport : KCKC

Flight time

Project	Hrs
PR3080	5.7

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	Project Number(s):	220030 Rainey Lake			Date:	4/30/2021
Operator:	AC	Project Name(s):	482			Mission Start (LT):	3938.9 / 3943.4
Aircraft:	223TC	Hobbs Start:	3938.4 / 3943.0	Hobbs Stop:	3943.0 / 3947.1	Mission End (LT):	3942.6 / 3946.6

LiDAR Unit:	3) VQ-1560i S2223544	Scan Rate:	2X239	Camera Unit:	Phase One	Drive:	B
MTA Zones:	8 TO 12	Grnd Spd Max (kts):	130	FOV (deg):	58.52	Sun Angle:	
PRR (kHz):	2x1000	Altitude (feet AMT):	5600	Lateral Overlap (%):		Lens:	
Laser Power (%):	100	Point Spacing (m):	0.321	Forward Overlap (%):		Point Density (ppms):	11.6

		Camera Counter		Line Start/Stop								
Line #	Direction	To	From	Start Time UTC	Stop Time UTC	Altitude (Planned)	Altitude (Actual)	Remarks	Clouds	Aperture	Shutter Speed
95 XTIE	N			8:03	8:07	5655+-		Area 482			
52	E			8:12	8:22						
53	W			8:25	8:36						
54	E			8:39	8:49						
55	W			8:51	9:02	ABORT FOR TRAFFIC AT MISSION ALT / PICK UP WEST END					
59	E			9:06	9:16						
58	W			9:19	9:28						
57	E			9:30	9:39						
56	W			9:42	9:49	ABORT FOR TRAFFIC AT MISSION ALT / PICK UP WEST END					
56	W			9:54	9:57			PATCH			
55	E			10:00	10:02			PATCH			
95 XTIE	N			10:06	10:12						
25	E			10:18	10:33						
26	W			10:35	10:50						
27	E			10:53	11:06						
28	W			11:12	11:26						
29	E			11:28	11:41	LIGHT / MODERATE TURBULENCE AS THE DAY PROGRESSES					
30	W			13:11	13:25			IMAGERY FOR FMR			
31	E			13:28	13:41						
32	W			13:45	14:00						
33	E			14:03	14:16						

34	W			14:21	14:38						
35	E			14:40	14:54						
36	W			14:58	15:13						
37	E			15:15	15:27						
38	W			15:32	15:48						
39	E			15:50	16:04						
96 XTIE	N			16:01	16:15						

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4/30/2021

Lift: A B C D E Pg 1 of 2

Project: MNDOT / Rainy **Proj #:** 38613 / 36740 **Flight Mgmt File:** 20200430_SW4040_A_MN_Projects

Aircraft: 22TE **Begin Hobbs:** 6016.6 **End Hobbs:** **Total:** **Pilot:** Dan Luckett **Co-Pilot:** **Tech:** Noah Edelson

Dep Apt: KHIB **Dep Time (Lcl):** 8:48 **(Z):** 1348 **Arr Apt:** KINL **Arr Time (Local):** 2:10 **(Z):** 1910 **Tot Time Aloft:** 5:22

CORS: Y / N **Sta 1:** PPP **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 beg:** °c **End:** °c **Altimeter begin:** **end:**

LiDAR									Beg GB	Storage Name/#
	Type 1560 ii	Serial # 4040	Alt AGL 1500 m	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		End GB	
	FOV	Scan Freq 1000 kHz	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100%	PPSM		Tot GB	

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
22	N	140555	141021	122	.41/23	2120	4	0	MNDOT 38613, ~30 kt headwind, smooth air
1047	W	142537	144453	145	.48/21	1860	-6	0	Rainy, line didn't auto trigger, manually started a second or two in, smooth air
1046	E	145105	151418	152	.45/20	1870	7	0	smooth
1045	W	151534	153419	147	.86/21	1860	-7	0	smooth
1044	E	154014	160236	155	.42/20	1870	6	0	few small pockets snow/ice on shady shorelines, smooth
1043	W	160333	162617	145	.81/23	1870	-6	0	smooth
1042	E	162714	164933	154	.86/24	1870	5	0	smooth
1041	W	165037	171312	155	.41/22	1870	-7	0	smooth
1040	E	171413	173654	150	.87/23	1850	4	~0	few small bumps in air
1039	W	173751	180039	146	.86/21	1850	-5	~	sloppy line entry 43 40 FWE few bumps, 26, 3, 25, 19, 18-46, 6-5, 3, 1
1038	E	180140	182400	155	.80/22	1840	3	~	FWE 55, 52.5, 51, 49, 48, 44.5, 40.5, 39, 37, 32, 19-16.5, 13.5, 12, 7
1037	W	182645	184740	150	.78/22	1840	-3	~	FWE 48, 43.5-42, 26-16.15
x-line	S	184923	185304						

Total Proj Lines: 99 **Lines Flown:** 11 **Lines Remain:** 32 **OnLine Time:** 4.6 **Mob Time:** .8 **Notes:**

XEOS Imaging Inc

LiDAR flight report

Project : PR3080
Mission (yyyy-mm-dd_#) : 2021-04-30_2
Aircraft : C-FDCY
Pilot : Renaud Charron/Esmilaire Montas
Operator : EMS Drone

LIDAR ID :
Density ppm² : 12
Pulse Rate (PRR) : 2000
Laser Power : 100
FOV : (60) or other :

Pattern : (Regular) or Powerline
Ground Speed (knt): 180
Flying height AGL (ft) : 3444
ENOHD (ft) : 2624

Lines			WPT				Comments
Time	+/- Lines	L,P or C *	FROM	TO	Sky Condition **	Out T°	
17:47	-24	L	ALL		SKC		
18:10	+25	L	ALL		SKC		
18:31	-26	L	ALL		SKC		
18:54	+27	L	ALL		SKC		
19:16	-28	L	ALL		SKC		
19:38	+29	L	ALL		SKC		
19:59	-30	L	ALL		SKC		
20:21	+31	L	ALL		SKC		
20:42	-32	L	ALL		SKC		
21:04	+33	L	ALL		SKC		
21:26	-34	L	ALL		SKC		
21:47	+35	L	ALL		SKC		
22:08	-36	L	ALL		SKC		
22:30	+37	L	ALL		SKC		
22:49	—	C			SKC		

* L = Line P = Profil C = Crossline

** SKC - FEW - SCT - BKN - LOVC = light OVC - HOVC = Heavy OVC

*** L = Light M = Moderate S = Severe

Clouds **: SKC
Haze ***: L
Turbulence ***: L → M
Cleaned lense : ☒
Aircraft hole open : ☒

UTC Hour
AEROctrl ON : 17:32
AEROctrl OFF : 23:00

Time UTC
Engine ON : 17:28
Engine OFF : 22:59
Departure airport : KCKC
Arrival airport : KCKC

Flight time

Project	Hrs
PR3080	5.5

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

(email log daily to flight_Log_distribution_list@quantumspatial.com)

Date: 4/30/2021 Lift: A B C D E Pg 2 of 3

Project: Rainy **Proj #:** 36740 **Flight Mgmt File:** 20210430_SN4040_B_36740

Aircraft: 22TE **Begin Hobbs:** 6022.0 **End Hobbs:** 6024.9 **Total:** 2.9 **Pilot:** Dan Luckett **Co-Pilot:** **Tech:** Noah Edelson

Dep Apt: KINL **Dep Time (Lcl):** 2:53 **(Z):** 19:53 **Arr Apt:** KHIB **Arr Time (Local):** 5:50 **(Z):** 2250 **Tot Time Aloft:** 2:57

CORS: Y / N **Sta 1:** PPP **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 beg:** °c **End:** °c **Altimeter begin:** **end:**

LiDAR									Beg GB	Storage Name/#
	Type 1560ii	Serial # 4040	Alt AGL 1500 m	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		End GB	
	FOV	Scan Freq 1000 kHz	MpIA Y / N	Pulses In Air	Pulse Rate	Power 100 %	PPSM 8		Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
1001	E	200350	200635	154	.90/23	1830	-1	0	smooth
1002	W	200746	201058	143	.87/	1835	2	0	Smooth
1003	E	201158	201510	160	.87/24	1825	-1	0	smooth
1004	W	201635	202041	142	.87/24	1830	2	0	Smooth
1005	E	202133	202539	154	.88/24	1840	-1	0	stopping line entry, Smooth air
1006	W	202739	203117	142	.87/24	1830	2		minor turb
1007	E	203406	203932	151	.93/23	1840	-4		
1008	W	204303	205121	145	.89/22	1840	2		
1009	E	205215	205751	152	.98/20	1835	-3		light turb
1010	W	210045	210928	138	.93/20	1830	5		
1011	E	211012	211756	154	.95/20	1840	-4		
1012	W	211852	212728	137	.94/20	1830	6.5		
1013	E	212814	213605	160	.87/20	1840	-3		
1014	W	213705	214542	140	.85/21	1830	5		turb
1015	E	214628	215415	153	.88/20	1840	-3		6 GPS sats started line, 29 total
1016	W	215655	220733	140	.85/22	1840	5		6 GPS sats most line
1017	E	221334	222113	136	.91/23	1840	-4		

Total Proj Lines: 44 **Lines Flown:** 17 **Lines Remain:** 32 **OnLine Time:** 2.3 **Mob Time:** .6 **Notes:**

XEOS Imaging Inc

LiDAR flight report

Project : PR3080
Mission (yyyy-mm-dd_#) : 2021-04-30_3
Aircraft : C-FJCY
Pilot : Emilio Cuarteta/Renaud Charron
Operator : Eric Pionne

LIDAR ID :
Density ppm² : 8
Pulse Rate (PRR) : 2000
Laser Power : 100
FOV : (60°) or other :

Pattern : (Regular) or Powerline
Ground Speed (knt): 180
Flying height AGL (ft) : 3444
ENOHD (ft) : 2626

Lines			WPT				
Time	+/- Lines	L,P or C *	FROM	TO	Sky Condition **	Out T°	Comments
23:29	-38	L	ALL		SKC		
23:51	+39	L	ALL		SKC		
00:12	-40	L	ALL		SKC		
00:33		C			SKC		

* L = Line P = Profil C = Crossline

** SKC - FEW - SCT - BKN - LOVC = light OVC - HOVC = Heavy OVC

*** L = Light M = Moderate S = Severe

Clouds **: SKC
Haze ***:
Turbulence ***: L
Cleaned lense : ☒
Aircraft hole open : ☒

UTC Hour
AEROctrl ON : 23:14
AEROctrl OFF : 01:23

Time UTC
Engine ON : 23:10
Engine OFF : 00:55
Departure airport : KCKC
Arrival airport : KCKC

Flight time

Project	Hrs
PR3080	1.8

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	Project Number(s):	220030 Rainey Lake			Date:	5/1/2021
Operator:	AC	Project Name(s):	482 / 1099			Mission Start (LT):	3947.9 / 3952.0
Aircraft:	223TC	Hobbs Start:	3947.1 / 3951.5	Hobbs Stop:	3951.5 / 3954.7	Mission End (LT):	3951.0 / 3954.3

LiDAR Unit:	3) VQ-1560i S2223544	Scan Rate:	2X159	Camera Unit:	Phase One	Drive:	B
MTA Zones:	8 TO 12	Grnd Spd Max (kts):	130	FOV (deg):	58.52	Sun Angle:	
PRR (kHz):	2x1000	Altitude (feet AMT):	5600	Lateral Overlap (%):		Lens:	
Laser Power (%):	100	Point Spacing (m):	0.321	Forward Overlap (%):		Point Density (ppms):	11.6

		Camera Counter		Line Start/Stop							
Line #	Direction	To	From	Start Time UTC	Stop Time UTC	Altitude (Planned)	Altitude (Actual)	Remarks	Clouds	Aperture	Shutter Speed
97 XTIE	N			8:23	8:28	5655+-		AREA 482			
11	E			8:38	8:47						
1	SW			8:51	9:02						
2	NE			9:06	9:16						
3	SW			9:20	9:34						
4	NE			9:37	9:49						
12	W			9:54	10:05						
13	E			10:08	10:16						
14	W			10:20	10:32						
15	E			10:34	10:41						
16	W			10:46	10:56						
17	E			10:59	11:06						
18	W			11:09	11:18						
19	E			11:21	11:29						
24	W			12:58	13:06	CHANNEL 1 WOULD NOT INITIALIZE / REBOOT / 5 MINUTE STATIC IN FLIGHT					
23	E			13:10	13:18			MODERATE TURBULENCE / CONVECTION			
22	W			13:20	13:33						
21	E			13:36	13:43						
20	W			13:47	13:55						
99 XTIE	S			14:00	14:02						

25	W			14:21	14:33			AREA 1099			
26	E			14:36	14:50						
47	W			14:53	15:08						
52 XTIE	S			15:13	15:14						

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 5/1/21

Lift: (A) B C D E Pg 1 of 7

Project: Rainy MN **Proj #:** 36140 **Flight Mgmt File:** 20210501_SN4040_A_36740

Aircraft: 22TE **Begin Hobbs:** 6024.9 **End Hobbs:** 6030.9 **Total:** **Pilot:** Dan Luckett **Co-Pilot:** **Tech:** Noah Edelson

Dep Apt: KHIB **Dep Time (Lcl):** 8:42 **(Z):** 1342 **Arr Apt:** **Arr Time (Local):** 2:39 **(Z):** 1939 **Tot Time Aloft:**

CORS: Y / N **Sta 1:** MP **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 beg:** °c **End:** °c **Altimeter begin:** **end:**

LiDAR								
Type 1560ii	Serial # 4040	Alt AGL 1500m	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		
FOV	Scan Freq 1000/112	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100%	PPSM 8		

Storage	Beg GB	End GB	Tot GB	Name/#

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
1099	N	135908	135948	137	.97/21	1900	13	0	30 knot X-wind from W, smooth air, sunny
1026	W	142124	144239	120	.95/21	1840	-5	0	
1025	E	144333	150010	155	.92/22	1840	10	0	
1024	W	150229	152218	125	.91/23	1835	-8	0	
1023	E	152315	153338	155	.96/22	1840	13	0	
1022	W	153437	154742	126	.98/20	1840	-8	0	
1021	E	154838	155843	158	.93/20	1840	13	0	
1020	W	155947	161217	128	.94/20	1840	-4	0	
1019	E	161314	162312	160	.89/21	1840	11	0	
1018	W	162422	163615	130	.88/21	1835	-8	0	
1017	E	163712	164656	155	.98/20	1840	10	0	
x-line	S	165127	165544					0	
1024	E	165843						0	Gimbal locked/frozen, smooth conditions, a/c refly line
1028	W	170302	170711	135	.94/20	1835	-7	0	Gimbal locked/frozen, smooth air, a/c refly line
1027	E	170833	171124	157	.97/14	1840		0	Gimbal on, refly of partial line
1031	W	171355	171947	140	1.00/18	1840	-7	0	refly of partial line
1032	E	172351	173421	156	.93/19	1840	9	0	refly line
1033	W	173059	181536	125	.99/19	1880	-7	+	light turb, refly line

Total Proj Lines: 11 **Lines Flown:** 22 **Lines Remain:** 11 **Online Time:** 5.4 **Mob Time:** .6 **Notes:**

Line #	Hdg	Start	Stop	Gd speed	PDOP/sats	GPS alt	Crab	Turb	Notes
1077	E	181646	183720	160	91/20	1880	6	+	turb
1078	W	183825	190215	130	88/21	1880	-2	+	turb
1076	E	140321	142113		91/20	1880	3	+	turb
1073	W	141921	142815	135	87/20	1910	0	+	turb

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 5/2/2021

Lift: A B C D E Pg 1 of __

Project: Rainy QSI **Proj #:** 36740 **Flight Mgmt File:** 20210502_SN4040_A_36740

Aircraft: 227E **Begin Hobbs:** 6030.9 **End Hobbs:** 6034.3 **Total:** 3.4 **Pilot:** Dan Lullett **Co-Pilot:** **Tech:** Noah Edelson

Dep Apt: KHIB **Dep Time (Lcl):** 9:46 **(Z):** 1346 **Arr Apt:** KHIB **Arr Time (Local):** 12:10 **(Z):** 1710 **Tot Time Aloft:** 3:24

CORS: Y / N **Sta 1:** PPP **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 beg:** °c **End:** °c **Altimeter begin:** **end:**

LiDAR									Beg GB	Storage Name/#
	Type 1560ii	Serial # 4040	Alt AGL 1500m	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		End GB	
	FOV	Scan Freq 1000kHz	MpiA Y / N	Pulses In Air	Pulse Rate	Power 100%	PPSM 8		Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
1085	W	135937	140254	153	.95/21	1890	-2	0	2-9 FWE
1087	E	140425	140730	150	.94/21	1890	3	0	8-11 FWE
1086	W	140919	141414	154	.98/20	1890	-1	0	2-11 FWE
1084	E	141604	142851	150	1.05/18	1890	3	0	24 FWE
1083	W	143152	144626	148	.98/20	1890	-1	0	34 FWE
1082	E	144747	150425	149	.92/19	1890	2	0	Full refly
1081	W	151020	153143	149	.89/20	1890	0	0	reflew full line
1080	E	153251	155428	151	.93/19	1890	3	0	reflew full line
1079	W	155529	161642	153	1.02/18	1890	-2	0	reflew full line
1078	E	162631	162822	152	1.00/19	1890	4	0	16-18 FWE
1057	E	162923	167130		1.06/18	1890	5	0	22-24 FWE
1058	E	167608		150	1.00/19	1890	4	0	10-17 FEE
164309									x-line
165229									x-line

Total Proj Lines: 49 **Lines Flown:** 11 **Lines Remain:** 0 **Online Time:** 2.8 **Mob Time:** .6 **Notes:**

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	**Project Number(s):**	220030 Rainey Lake			**Date:**	5/13/2021
Operator:	AC	**Project Name(s):**	AREA EAST			**Mission Start (LT):**	3978.6
Aircraft:	223TC	**Hobbs Start:**	3977.0 / 78.2 / 81.9	**Hobbs Stop:**	3978.2 / 81.9 /	**Mission End (LT):**	3981.7

LiDAR Unit:	3) VQ-1560i S2223544	**Scan Rate:**	2X159	**Camera Unit:**	Phase One	**Drive:**	A 0/1
MTA Zones:	8 TO 12	**Grnd Spd Max (kts):**	130	**FOV (deg):**	58.52	**Sun Angle:**	
PRR (kHz):	2x1000	**Altitude (feet AMT):**	5600	**Lateral Overlap (%):**	15%	**Lens:**	
Laser Power (%):	100	**Point Spacing (m):**	0.321	**Forward Overlap (%):**		**Point Density (ppms):**	11.6

		Camera Counter		Line Start/Stop							
Line #	**Direction**	**To**	**From**	**Start Time UTC**	**Stop Time UTC**	**Altitude (Planned)**	**Altitude (Actual)**	**Remarks**	**Clouds**	**Aperture**	**Shutter Speed**
55 XTIE	NW			10:05	10:08	5600+-		MODERATE TURBULENCE / CONVECTION / HAZE			
25	NE			10:15	10:20			AREA EAST			
31	SW			10:21	10:28						
37	NE			10:31	10:38						
44	SW			10:40	10:47						
46	NE			10:49	10:55						
38	SW			10:57	11:04			Lines 38/39 are one in the same... line over line. I flew line 38 therefore line 39 does not need/will not be flown.			
33	NE			11:06	11:12						
27	SW			11:14	11:20						
30	NE			11:22	11:27						
34	SW			11:30	11:37						
42	NE			11:39	11:45						
52 XTIE	SE			11:48	11:50						
49	SW			11:53	11:56						
50	NE			12:02	12:17						
51	SW			12:21	12:34						
47	NE			12:36	12:50						
48	SW			12:52	13:07			HAZE / VIRGA			

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	**Project Number(s):**	220030 Rainey Lake			**Date:**	5/15/2021
Operator:	AC	**Project Name(s):**	AREA EAST			**Mission Start (LT):**	3984.2
Aircraft:	223TC	**Hobbs Start:**	3983.0	**Hobbs Stop:**	3986.5	**Mission End (LT):**	3985.6

LiDAR Unit:	3) VQ-1560i S2223544	**Scan Rate:**	2X159	**Camera Unit:**	Phase One	**Drive:**	A 0/1
MTA Zones:	8 TO 12	**Grnd Spd Max (kts):**	130	**FOV (deg):**	58.52	**Sun Angle:**	
PRR (kHz):	2x1000	**Altitude (feet AMT):**	5600	**Lateral Overlap (%):**	15%	**Lens:**	
Laser Power (%):	100	**Point Spacing (m):**	0.321	**Forward Overlap (%):**		**Point Density (ppms):**	11.6

		Camera Counter		**Line Start/Stop**							
Line #	**Direction**	**To**	**From**	**Start Time UTC**	**Stop Time UTC**	**Altitude (Planned)**	**Altitude (Actual)**	**Remarks**	**Clouds**	**Aperture**	**Shutter Speed**
55 XTIE	NW			13:13	13:15	5600+-					
24	NE			13:20	13:32			DNU / TRACKAIR ABORTED MID LINE / REFLY			
24	SW			13:48	14:02						
23	NE			14:05	14:18						
22	SW			14:20	14:33			CLOUDS AT & BELOW MISSION ALTITUDE			

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	**Project Number(s):**	220030 Rainey Lake			**Date:**	5/16/2021
Operator:	AC	**Project Name(s):**	AREA EAST			**Mission Start (LT):**	3987.4
Aircraft:	223TC	**Hobbs Start:**	3986.5 / 3990.2	**Hobbs Stop:**	3990.2 / 3991.3	**Mission End (LT):**	3990.0

LiDAR Unit:	3) VQ-1560i S2223544	**Scan Rate:**	2X159	**Camera Unit:**	Phase One	**Drive:**	A 0/1
MTA Zones:	8 TO 12	**Grnd Spd Max (kts):**	130	**FOV (deg):**	58.52	**Sun Angle:**	
PRR (kHz):	2x1000	**Altitude (feet AMT):**	5600	**Lateral Overlap (%):**	15%	**Lens:**	
Laser Power (%):	100	**Point Spacing (m):**	0.321	**Forward Overlap (%):**		**Point Density (ppms):**	11.6

		Camera Counter		Line Start/Stop							
Line #	**Direction**	**To**	**From**	**Start Time UTC**	**Stop Time UTC**	**Altitude (Planned)**	**Altitude (Actual)**	**Remarks**	**Clouds**	**Aperture**	**Shutter Speed**
45	NE			7:35	7:48	5600+-					
40	SW			7:51	8:05						
32	NE			8:07	8:18						
26	SW			8:20	8:31						
28	NE			8:32	8:44						
35	SW			8:47	8:59						
41	NE			9:01	9:14						
43	SW			9:16	9:30						
36	NE			9:32	9:44						
29	SW			9:45	9:56						
52 XTIE	SE			10:00	10:04			CLOUDS BUILDING BELOW MISSION ALTITUDE			

LiDAR and Imagery Flight Report

Project(s): 220030 Rainey Lake

Pilot:	JT	Project Number(s):	220030 Rainey Lake			Date:	5/17/2021
Operator:	AC	Project Name(s):	AREA EAST			Mission Start (LT):	3992.1 / 3994.8
Aircraft:	223TC	Hobbs Start:	3991.3 / 3994.5	Hobbs Stop:	3994.5 / 3997.8	Mission End (LT):	3994.2 / 3996.9

LiDAR Unit:	3) VQ-1560i S2223544	Scan Rate:	2X159	Camera Unit:	Phase One	Drive:	A 0/1
MTA Zones:	8 TO 12	Grnd Spd Max (kts):	130	FOV (deg):	58.52	Sun Angle:	
PRR (kHz):	2x1000	Altitude (feet AMT):	5600	Lateral Overlap (%):	15%	Lens:	
Laser Power (%):	100	Point Spacing (m):	0.321	Forward Overlap (%):		Point Density (ppms):	11.6

		Camera Counter		Line Start/Stop							
Line #	Direction	To	From	Start Time UTC	Stop Time UTC	Altitude (Planned)	Altitude (Actual)	Remarks	Clouds	Aperture	Shutter Speed
21	NE			7:23	7:33	5600+-		AREA EAST			
18	SW			7:36	7:47			HAZY CONDITIONS			
15	NE			7:49	7:58						
14	SW			8:01	8:12						
17	NE			8:14	8:23						
20	SW			8:26	8:38						
19	NE			8:40	8:51						
16	SW			8:53	9:04						
13	NE			9:05	9:14						
54 XTIE	SE			9:19	9:22						
12	NE			10:32	10:41						
9	SW			10:43	10:51						
6	NE			10:53	10:59			TRACKAIR ABORTED LINE			
6	NE			11:02	11:05			PATCH			
3	SW			11:07	11:11						
2	NE			11:14	11:17						
5	SW			11:22	11:27						
8	NE			11:30	11:37						
11	SW			11:41	11:50						
10	NE			11:53	12:01						
7	SW			12:03	12:10						

4	NE			12:12	12:18						
1	SW			12:20	12:22						
52 XTIE	SE			12:26	12:31						