Airborne Lidar Report

WOOLPERT

Mississippi NRCS FY16 Lidar

Contract Number: G16PC0022
Task Number: G16PD00331

Contractor: Woolpert, Inc.
Woolpert Project # 76268

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Section 1: Overview

TASK ORDER NAME: Mississippi NRCS FY16 Lidar

Project: # 76268

This report contains a comprehensive outline of the Mississippi NRCS FY16 Lidar. Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G16PC0022, Task Order No. G16PD00331. This task order requires lidar data to be acquired over 4,780 square miles of V.1.2 lidar, for the area of interest (AOI) collected at a nominal pulse spacing (NPS) of 0.7 meters. The NPS assessment is made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath.

The data was collected using:

- Two Leica ALS80 HP 1000 kHz Multiple Pulses in Air (MPiA) lidar systems on board WoolpertQSI aircraft. The ALS80 sensor collects up to four returns per pulse, as well as intensity data, for the first three returns. If a fourth return was captured, the system does not record an associated intensity value. The aerial lidar was collected at the following sensor specifications:

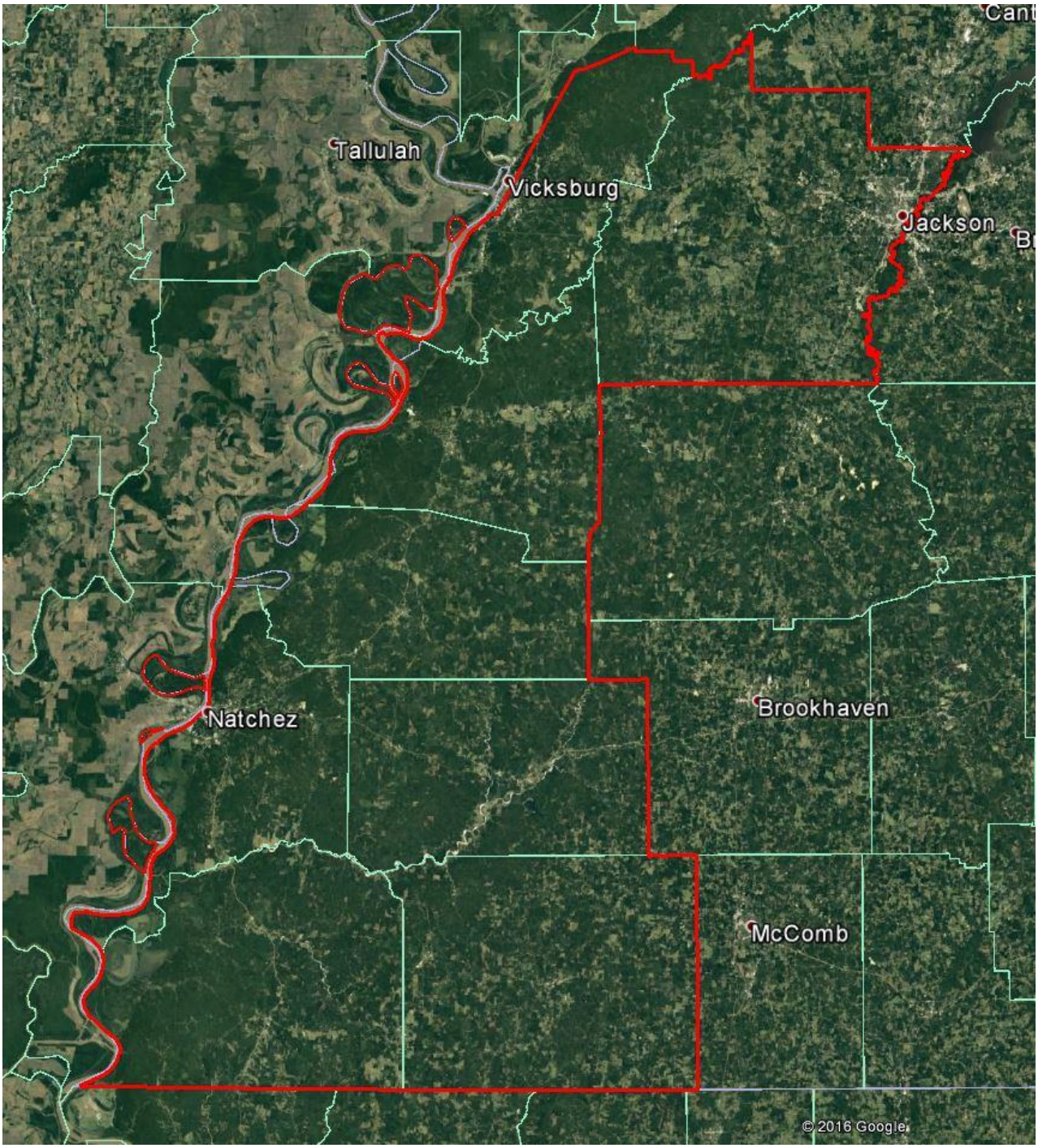
Table 1.1: ALS80 Specifications – WOOLPERT and QSI	
Post Spacing	0.70 m
AGL (Above Ground Level) average flying height	1,981 m
Average Ground Speed:	150 knots
Field of View (full)	40 degrees
Pulse Rate	272 kHz
Scan Rate	50 Hz
Side Lap	25%

- One Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) lidar sensors owned and operated by Quantum Spatial. The sensor was mounted in Quantum Spatial aircraft. The aerial lidar was collected at the following sensor specifications:

Table 1.2: ALS70 Specifications - QSI	
Post Spacing	0.7 m
AGL (Above Ground Level) average flying height	1,900m
Average Ground Speed:	170 knots
Field of View (full)	40 degrees
Pulse Rate	273 kHz
Scan Rate	53 Hz
Side Lap	25%

The horizontal datum used for the task order was referenced to NAD83 (2011), Zone 15, Meters. The vertical datum used for the task order was referenced to NAVD 1988, Meters, GEOID12B.

Figure 1.1: Mississippi NRCS FY16 Lidar Task Order AOI



Section 2: Acquisition

The lidar data was acquired with three Leica ALS80HP 1000 kHz Multiple Pulses in Air (MPiA) Lidar Sensor Systems. The ALS80 HP lidar system, developed by Leica Geosystems of Heerbrugg, Switzerland, includes the simultaneous first, intermediate and last pulse data capture module, the extended altitude range module, and the target signal intensity capture module.

The ALS80HP 1000 kHz Multiple Pulses in Air (MPiA) Lidar System has the following specifications:

Table 2.1: ALS80 HP Lidar System Specifications	
Operating Altitude	100 – 7,620 meters
Scan Angle	0 to 72° (variable)
Swath Width	0 to 1.5 X altitude (variable)
Scan Frequency	0 – 200 Hz (variable based on scan angle)
Maximum Pulse Rate	1000 kHz (Effective)
Range Resolution	Better than 1 cm
Elevation Accuracy	6 - 19 cm single shot (one standard deviation)
Horizontal Accuracy	5 – 43 cm (one standard deviation)
Number of Returns per Pulse	Unlimited
Number of Intensities	3 (first, second, third)
Intensity Digitization	8 bit intensity + 8 bit AGC (Automatic Gain Control) level
MPiA (Multiple Pulses in Air)	8 bits @ 1nsec interval @ 50kHz
Laser Beam Divergence	0.22 mrad @ $1/e^2$ (~0.15 mrad @ 1/e)
Laser Classification	Class IV laser product (FDA CFR 21)
Eye Safe Range	400m single shot depending on laser repetition rate
Roll Stabilization	Automatic adaptive, range = 75 degrees minus current FOV
Power Requirements	28 VDC @ 25A
Operating Temperature	0-40°C
Humidity	0-95% non-condensing
Supported GNSS Receivers	Ashtech Z12, Trimble 7400, Novatel Millenium

The lidar data was acquired with a Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) Lidar Sensor System. The ALS70 lidar system, developed by Leica Geosystems of Heerbrugg, Switzerland, includes the simultaneous first, intermediate and last pulse data capture module, the extended altitude range module, and the target signal intensity capture module.

The ALS70 500 kHz Multiple Pulses in Air (MPiA) Lidar System has the following specifications:

Table 2.2: ALS70 Lidar System Specifications	
Operating Altitude	200 – 3,500 meters
Scan Angle	0 to 75° (variable)
Swath Width	0 to 1.5 X altitude (variable)
Scan Frequency	0 – 200 Hz (variable based on scan angle)
Maximum Pulse Rate	500 kHz (Effective)
Range Resolution	Better than 1 cm
Elevation Accuracy	7 - 16 cm single shot (one standard deviation)
Horizontal Accuracy	5 – 38 cm (one standard deviation)
Number of Returns per Pulse	7 (infinite)
Number of Intensities	3 (first, second, third)
Intensity Digitization	8 bit intensity + 8 bit AGC (Automatic Gain Control) level
MPiA (Multiple Pulses in Air)	8 bits @ 1nsec interval @ 50kHz
Laser Beam Divergence	0.22 mrad @ $1/e^2$ (~0.15 mrad @ 1/e)
Laser Classification	Class IV laser product (FDA CFR 21)
Eye Safe Range	400m single shot depending on laser repetition rate
Roll Stabilization	Automatic adaptive, range = 75 degrees minus current FOV
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Operating Temperature	0-40°C
Humidity	0-95% non-condensing
Supported GNSS Receivers	Ashtech Z12, Trimble 7400, Novatel Millenium

Prior to mobilizing to the project site, flight crews coordinated with the necessary Air Traffic Control personnel to ensure airspace access.

Crews were onsite, operating a Global Navigation Satellite System (GNSS) Base Station for the airborne GPS support.

The Lidar data was collected in Twenty-five (25) missions, flown as close together as the weather permitted, to ensure consistent ground conditions across the project area. An initial quality control process was performed immediately on the Lidar data to review the data coverage, airborne GPS data, and trajectory solution. Initial collection of lidar data took place January and February of 2016. During this time some significant precipitation events occurred in the region and led to significantly increased water levels in the Mississippi River and surrounding low-lying areas. Due to these high water levels it was determined that data acquisition be postponed until water levels lowered. Approximately 80% of the AOI had been acquired at this point. The remaining 20% was collected in January of 2017. Some water level differences will be observed in the point cloud and DEM data due to the differing collection dates, specifically in the low-lying areas near the Mississippi River. Woolpert has taken great care to limit the amount of temporal differences between the two collection dates.

Figure 2.1: Lidar Flight Layout, Mississippi NRCS FY16 Lidar

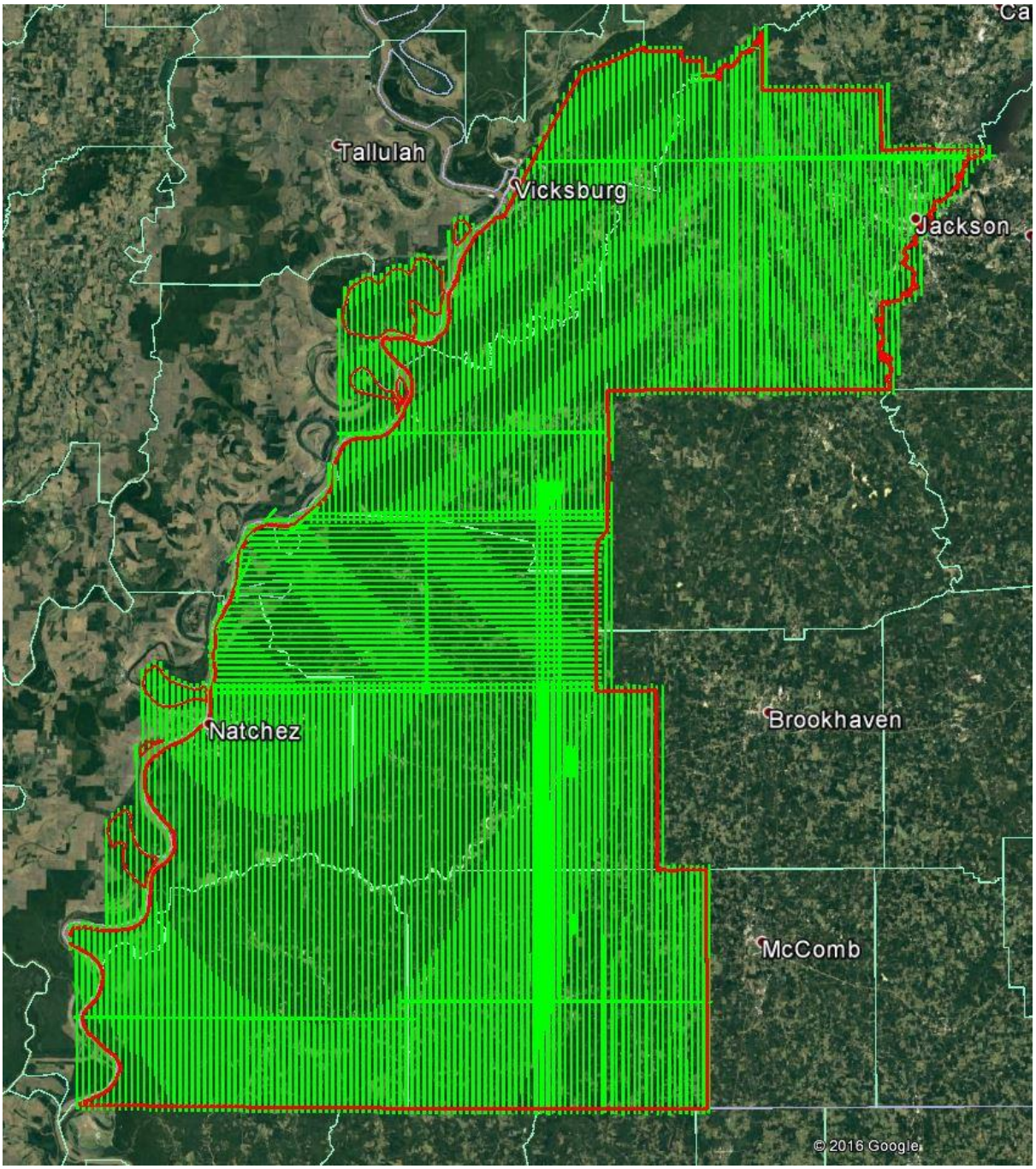


Table 2.3: Airborne Lidar Acquisition Flight Summary

Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down
January 16, 2016_QSI7178_A	**501-508**	**16:16 – 18:08**
January 16, 2016_QSI7178_B	**509-514, 599**	**19:59 – 21:41**
January 17, 2016_QSI7178	**518-539**	**20:17 – 20:36**
January 18, 2016_QSI7178_A	**944-954**	**16:00 – 18:34**
January 18, 2016_QSI7178_B	**936-943**	**20:24 – 23:02**
January 19, 2016_QSI7178_A	**515-517, 924-927**	**15:34 – 19:10**
January 19, 2016_ QSI7178_B	**665-671**	**23:37 – 1:15**
January 24, 2016_QSI7178	**672-674**	**17:35 – 18:33**
January 30, 2016_SH8170	**192-196**	**14:30 – 17:01**
February 3, 2016_SH8170	**171-191**	**16:04 – 22:36**
February 4, 2016_SH8170_A	**167-170**	**15:31 – 16:45**
February 4, 2016_SH8170_B	**161-166**	**21:50 – 23:43**
February 5, 2016_SH8170	**139-160**	**15:57 – 22:46**
February 6, 2016_SH8170	**106, 107, 133-138, 197, 198**	**20:10 – 23:58**
February 7, 2016_SH8170	**82-105**	**15:47 – 23:06**
February 8, 2016_SH8170	**37, 38, 61-65, 76-81, 108**	**15:53 – 20:50**
February 11, 2016_SH8170	**39-60, 66**	**17:48 – 01:38**
February 13, 2016_SH8170	**37, 38, 61-64, 167, 176, 185, 192, 193**	**15:45 – 19:56**
January 8, 2017_SH8170	**109 - 127**	**17:11 – 22:38**
January 9, 2017_SH8170	**1-7, 9, 128**	**22:49 – 01:00**
January 13, 2017_SH8170	**8-25**	**21:19 – 2:23**
January 14, 2017_SH8170_A	**5, 6, 24-36**	**15:11 – 19:23**
January 14, 2017_SH8170_B	**1-4**	**20:42 – 22:03**
January 15, 2017_SH8170	**7, 8, 128-132**	**00:48 – 03:26**
January 20, 2017_SH8170	**8, 25**	**19:30 – 20:43**

Section 3: LiDAR Data Processing

Applications and Work Flow Overview

1. Resolved kinematic corrections for three subsystems: inertial measurement unit (IMU), sensor orientation information and airborne GPS data. Developed a blending post-processed aircraft position with attitude data using Kalman filtering technology or the smoothed best estimate trajectory (SBET).
Software: POSPac Software v. 5.3, IPAS Pro v.1.35., Novatel Inertial Explorer v8.60.6129
2. Calculated laser point position by associating the SBET position to each laser point return time, scan angle, intensity, etc. Created raw laser point cloud data for the entire survey in LAS format. Automated line-to-line calibrations were then performed for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift.
Software: ALS Post Processing Software v.2.75 build #25, Proprietary Software, TerraMatch v. 16.01., Add Leica Cloud Pro v1.2.3
3. Imported processed LAS point cloud data into the task order tiles. Resulting data were classified as ground and non-ground points with additional filters created to meet the task order classification specifications. Statistical absolute accuracy was assessed via direct comparisons of ground classified points to ground RTK survey data. Based on the statistical analysis, the lidar data was then adjusted to reduce the vertical bias when compared to the survey ground control.
Software: TerraScan v.16.01.
4. The LAS files were evaluated through a series of manual QA/QC steps to eliminate remaining artifacts from the ground class.
Software: TerraScan v.16.01.

Global Navigation Satellite System (GNSS)–Inertial Measurement Unit (IMU) Trajectory Processing

Equipment

The pilots are skilled at maintaining their planned trajectory, while holding the aircraft steady and level. If atmospheric conditions are such that the trajectory, ground speed, roll, pitch and/or heading cannot be properly maintained, the mission is aborted until suitable conditions occur.

Base stations were set by acquisition staff and were used to support the Lidar data acquisition. The GNSS base station operated during the Lidar acquisition missions is listed below:

Table 3.1: GNSS Base Station

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
MSJK CORS	32°19'37.38128"	90°10'52.77645"	87.829
MSBU CORS	31°27'44.12478"	90°50'15.12326"	50.665
TALL CORS	32°24'01.19649"	91°10'58.81157"	7.477
NGS PID CP0258	32°19'44.13115"	90°12'57.82073"	70.11
KHEZ Base	31°36'51.75081"	91°17'39.33840"	55.736
KHEZ Airport	31°36'53.02032"	91°17'38.72688"	55.739
SIHS CORS	31°50'36.15839"	91°39'19.56089"	7.135

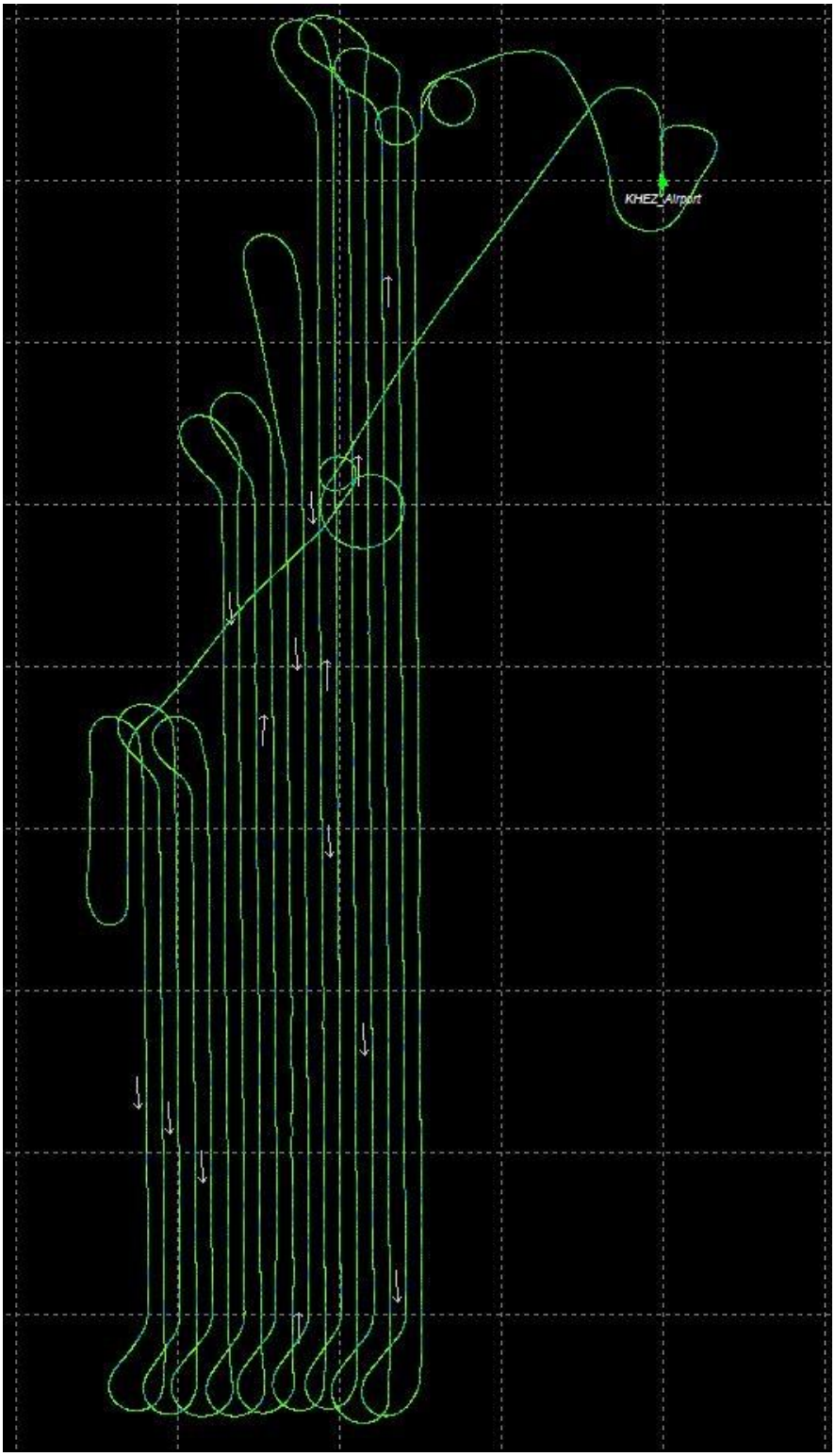
Data Processing

All airborne GNSS and IMU data was post-processed and quality controlled using Applanix MMS software. GNSS data was processed at a 1 and 2 Hz data capture rate and the IMU data was processed at 200 Hz.

Trajectory Quality

The GNSS Trajectory, along with high quality IMU data are key factors in determining the overall positional accuracy of the final sensor data. Within the trajectory processing, there are many factors that affect the overall quality, but the most indicative are the combined separation, the estimated positional accuracy, and the Positional Dilution of Precision (PDOP).

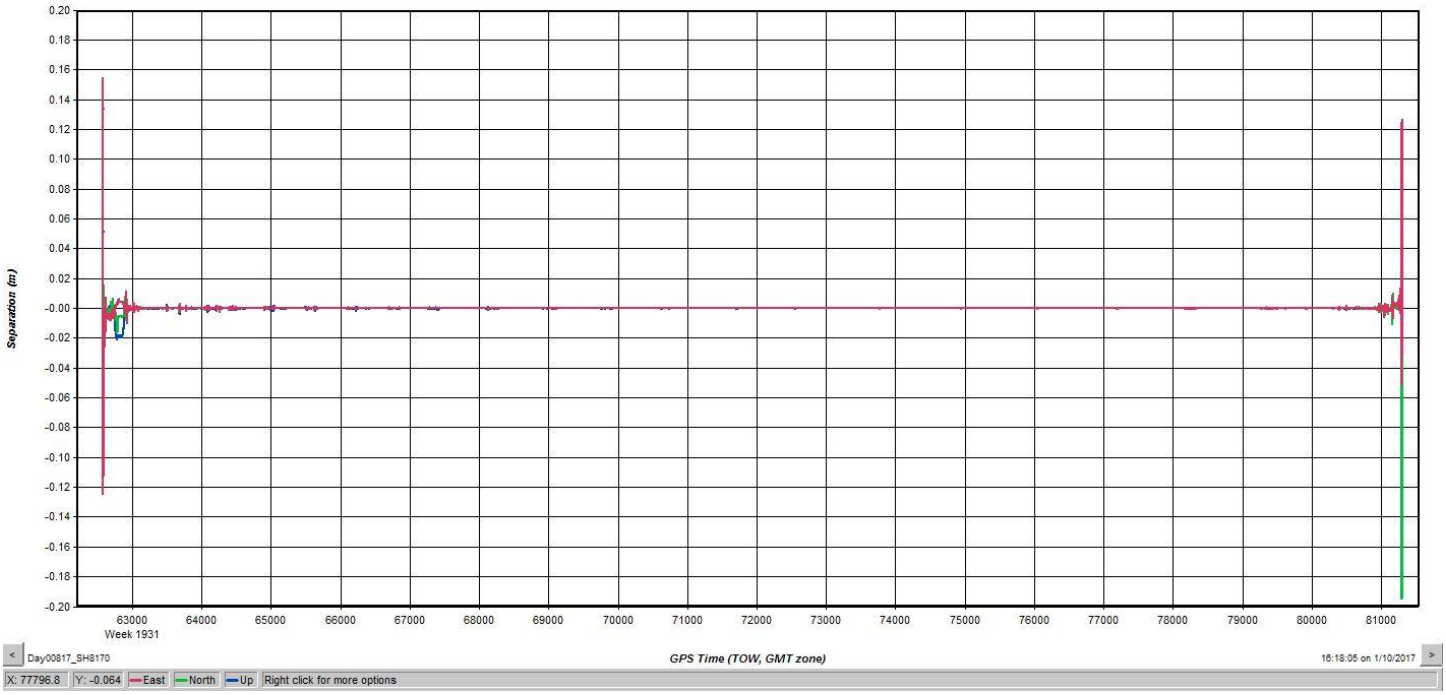
Figure 3.1: Trajectory, Day00817_SH8170



Combination Separation

The Combined Separation is a measure of the difference between the forward run and the backward run solution of the trajectory. The Kalman filter is processed in both directions to remove the combined directional anomalies. In general, when these two solutions match closely, an optimally accurate reliable solution is achieved.
Woolpert's goal is to maintain a Combined Separation Difference of less than ten (10) centimeters. In most cases we achieve results below this threshold.

Figure 3.2: Combined Separation, Day00817_SH8170

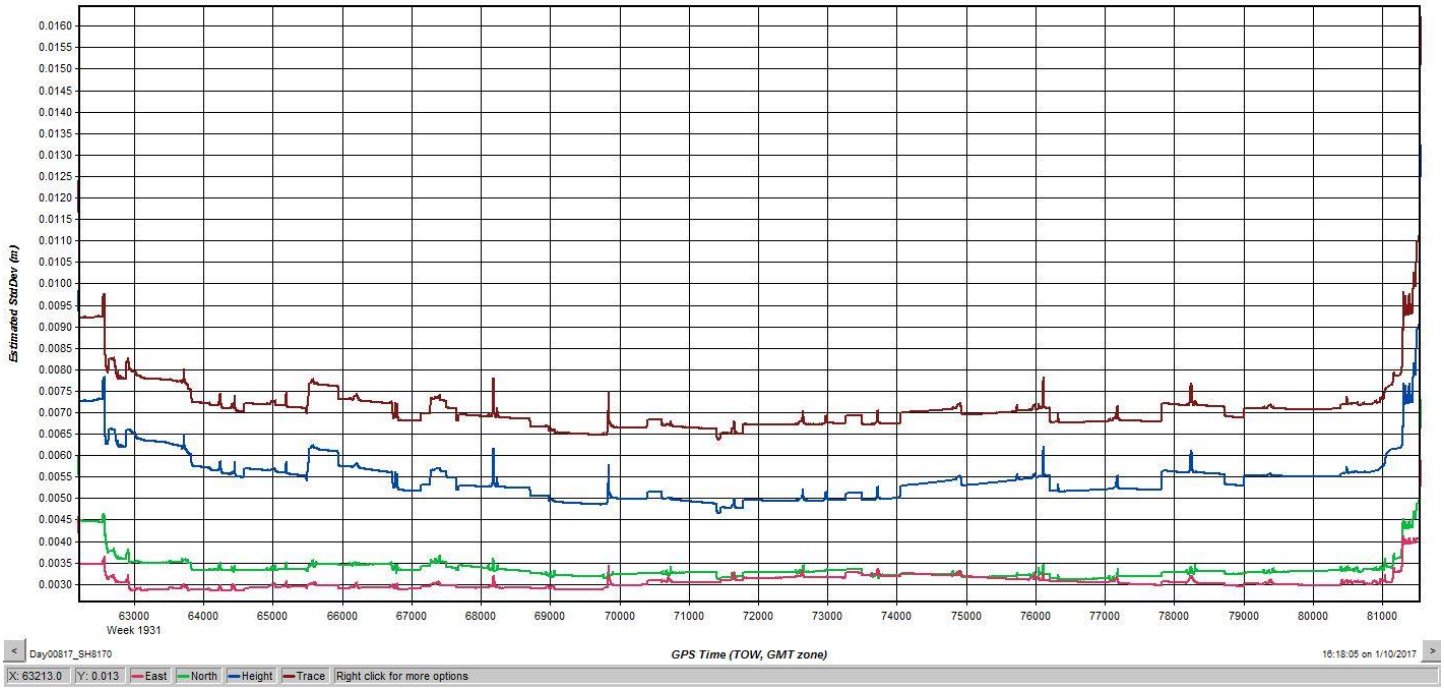


Estimated Positional Accuracy

The Estimated Positional Accuracy plots the standard deviations of the east, north, and vertical directions along a time scale of the trajectory. It illustrates loss of satellite lock issues, as well as issues arising from long baselines, noise, and/or other atmospheric interference.

Woolpert's goal is to maintain an Estimated Positional Accuracy of less than ten (10) centimeters, often achieving results well below this threshold.

Figure 3.3: Estimated Positional Accuracy, Day00817_SH8170

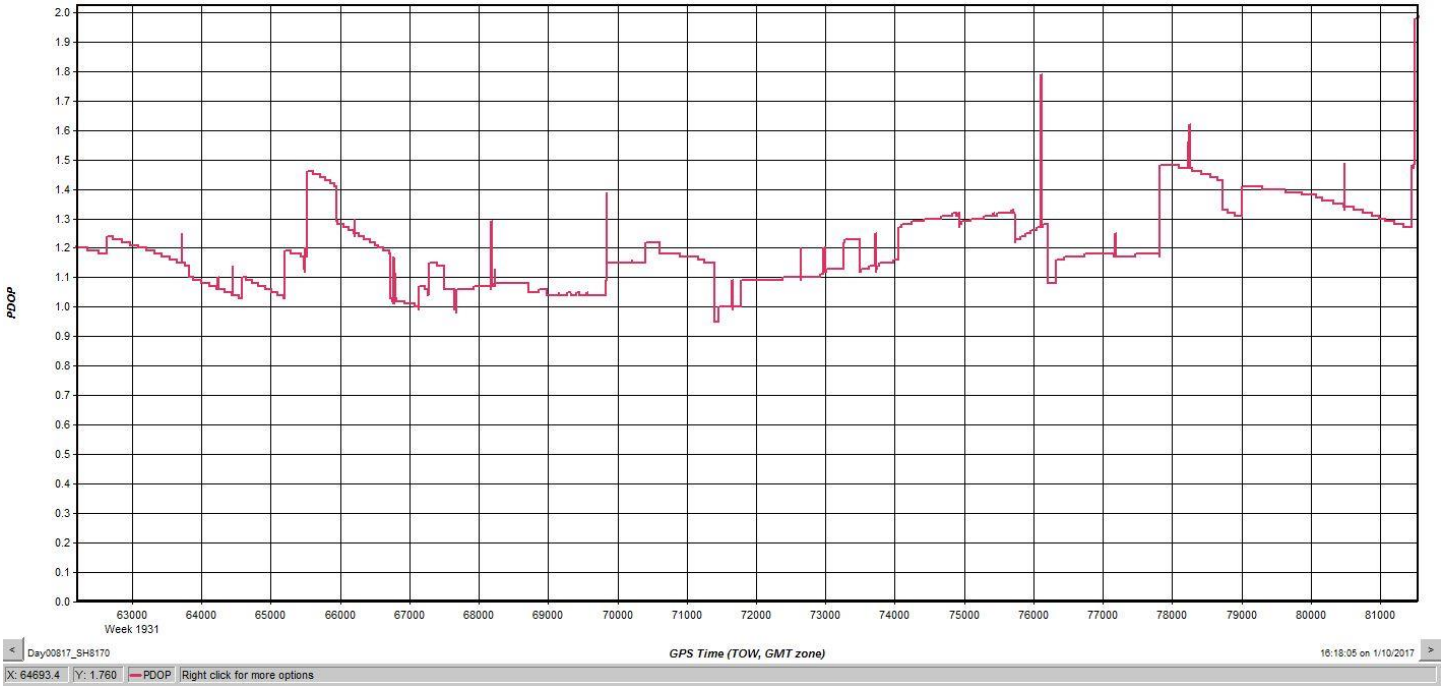


PDOP

The PDOP measures the precision of the GPS solution in regards to the geometry of the satellites acquired and used for the solution.

Woolpert's goal is to maintain an average PDOP value below 3.0. Brief periods of PDOP over 3.0 are acceptable due to the calibration and control process if other metrics are within specification.

Figure 3.4: PDOP, Day00817_SH8170



LiDAR Data Processing

When the sensor calibration, data acquisition, and GPS processing phases were complete, the formal data reduction processes by Woolpert lidar specialists included:

- Processed individual flight lines to derive a raw "Point Cloud" LAS file. Matched overlapping flight lines, generated statistics for evaluation comparisons, and made the necessary adjustments to remove any residual systematic error.
- Calibrated LAS files were imported into the task order tiles and initially filtered to create a ground and non-ground class. Then additional classes were filtered as necessary to meet client specified classes.
- Once all project data was imported and classified, survey ground control data was imported and calculated for an accuracy assessment. As a QC measure, Woolpert has developed a routine to generate accuracy statistical reports by comparisons against the TIN and the DEM using surveyed ground control of higher accuracy. The lidar is adjusted accordingly to meet or exceed the vertical accuracy requirements.
- The lidar tiles were reviewed using a series of proprietary QA/QC procedures to ensure it fulfills the task order requirements. A portion of this requires a manual step to ensure anomalies have been removed from the ground class.
- The lidar LAS files are classified into the Default (Class 1), Ground (Class 2), Low Noise (Class 7), Water (Class 9), Ignored ground (Class10), Bridge Decks (Class 17), High Noise (Class 18) classifications.
- FGDC Compliant metadata was developed for the task order in .xml format per product.
- The horizontal datum used for the task order was referenced to NAD83 (2011), Zone 15, Meters. The vertical datum used for the task order was referenced to NAVD 1988, Meters, GEOID12B
- Please note that tiles 15RXQ330320 and 15RXQ405950 do not contain lidar points. The data boundary intersects these tiles and a hydro breakline was digitized based on this boundary. For this reason a hydro-flattened DEM IMG and Intensity Image was generated. There will be no LAS 1.4 for tiles 15RXQ330320 and 15RXQ405950. The DEM IMG/Intensity tiff file count is 5903. The LAS 1.4 count is 5901.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

Mississippi NRCS FY16 Lidar processing task order required the compilation of breaklines defining water bodies and rivers. The breaklines were used to perform the hydrologic flattening of water bodies, and gradient hydrologic flattening of double line streams and rivers. Lakes, reservoirs and ponds, at a minimum size of 2-acre or greater, were compiled as closed polygons. The closed water bodies were collected at a constant elevation. Rivers and streams, at a nominal minimum width of 30 meters (100 feet), were compiled in the direction of flow with both sides of the stream maintaining an equal gradient elevation.

LIDAR DATA REVIEW AND PROCESSING

Woolpert utilized the following steps to hydrologically flatten the water bodies and for gradient hydrologic flattening of the double line streams within the existing lidar data.

1. Woolpert used the newly acquired lidar data to manually draw the hydrologic features in a 2D environment using the lidar intensity and bare earth surface. Open Source imagery was used as reference when necessary.
2. Woolpert utilizes an integrated software approach to combine the lidar data and 2D breaklines. This process “drapes” the 2D breaklines onto the 3D lidar surface model to assign an elevation. A monotonic process is performed to ensure the streams are consistently flowing in a gradient manner. A secondary step within the program verifies an equally matching elevation of both stream edges. The breaklines that characterize the closed water bodies are draped onto the 3D lidar surface and assigned a constant elevation at or just below ground elevation.
3. The lakes, reservoirs and ponds, at a minimum size of 2-acre or greater and streams at a minimum size of 30 meters (100 feet) nominal width, were compiled to meet task order requirements. **Figure 4.1** illustrates an example of 30 meters (100 feet) nominal streams identified and defined with hydrologic breaklines. The breaklines defining rivers and streams, at a nominal minimum width of 30 meters (100 feet), were draped with both sides of the stream maintaining an equal gradient elevation.
4. All ground points were reclassified from inside the hydrologic feature polygons to water, class nine (9).
5. All ground points were reclassified from within a buffer along the hydrologic feature breaklines to buffered ground, class ten (10).
6. The lidar ground points and hydrologic feature breaklines were used to generate a new digital elevation model (DEM).

Figure 4.1: Example Hydrologic Breaklines

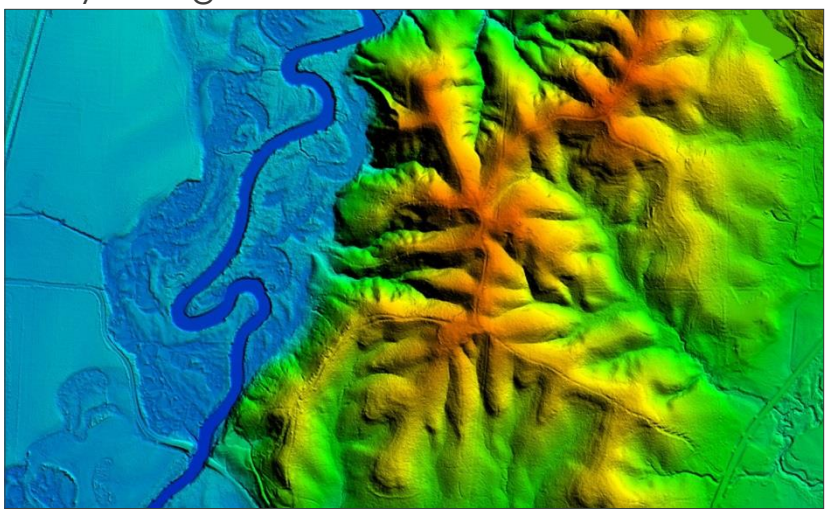


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the "tinning" across the lake surface.

Figure 4.3 reflects a DEM generated from lidar with breaklines compiled to define the hydrologic features. This figure illustrates the results of adding the breaklines to hydrologically flatten the DEM data. Note the smooth appearance of the lake surface in the DEM.

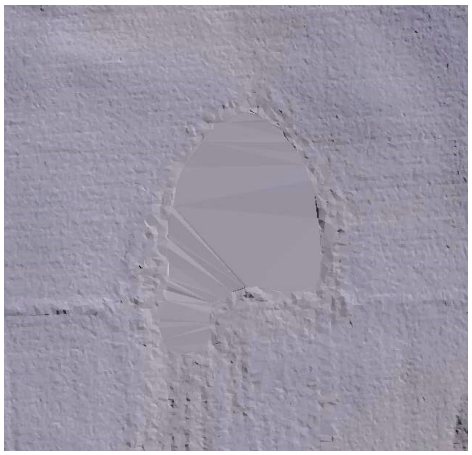


Figure 4.2

Figure 4.3

Terrascan was used to add the hydrologic breakline vertices and export the lattice models. The hydrologically flattened DEM data was provided to USGS in ERDAS .IMG format.

The hydrologic breaklines compiled as part of the flattening process were provided to the USGS in ESRI shapefile format. The breaklines defining the water bodies greater than 2-acre and for the gradient flattening of all rivers and streams at a nominal minimum width of 30 meters (100 feet) were provided as a Polygon-Z and Polyline-Z shape file, respectively.

DATA QA/QC

Initial QA/QC for this task order was performed in Global Mapper v17, by reviewing the grids and hydrologic breakline features. Additionally, ESRI software and proprietary methods were used to review the overall connectivity of the hydrologic breaklines.

Edits and corrections were addressed individually by tile. If a water body breakline needed to be adjusted to improve the flattening of the DEM data, the area was cross referenced by tile number, corrected accordingly, a new DEM file was regenerated and reviewed.

Section 5: ACCURACY ASSESSMENT

Accuracy Assessment

The vertical accuracy statistics were calculated by comparison of all lidar points to the ground surveyed QC points.

Table 5.1: Overall Vertical Accuracy Statistics		
Average error	+0.009	Meter
Minimum error	-0.156	Meter
Maximum error	+0.231	Meter
Average magnitude	0.036	Meter
Root mean square	0.050	Meter
Standard deviation	0.050	Meter

Table 5.2: RAW Swath Quality Check Point Analysis NVA

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	TIN Elevation (Meter)	Dz (Meter)
2001	642432.381	3438393.705	115.051	115.020	-0.031
2002	638385.709	3440023.583	17.356	17.410	0.054
2003	652290.806	3473582.584	50.296	50.200	-0.096
2004	646164.916	3447423.767	28.544	28.550	0.006
2005	647970.254	3489983.281	25.234	25.260	0.026
2006	664846.881	3498250.453	92.452	92.470	0.018
2007	658981.983	3480705.583	113.098	113.100	0.002
2008	658363.172	3459498.909	38.270	38.370	0.100
2009	667355.856	3440939.046	109.956	109.920	-0.036
2010	681333.281	3431790.400	104.406	104.370	-0.036
2011	676458.158	3459977.263	95.106	95.120	0.014
2012	680203.510	3480805.061	66.770	66.720	-0.050
2013	710868.729	3449771.485	124.206	124.260	0.054
2014	688156.591	3451963.539	116.909	117.000	0.091
2015	699907.069	3437597.322	103.726	103.740	0.014
2016	719017.750	3441559.752	99.971	99.980	0.009
2017	726652.143	3458232.013	136.849	136.830	-0.019
2018	707536.837	3466683.338	125.165	125.200	0.035
2019	706235.884	3484251.510	80.084	80.100	0.016
2020	691631.583	3495179.292	108.801	108.810	0.009
2021	721969.050	3489259.563	99.603	99.630	0.027
2022	711198.368	3508683.330	128.673	128.700	0.027
2023	678028.521	3504757.690	95.540	95.540	0.000

2024	704570.182	3499001.319	149.854	149.860	0.006
2025	686690.216	3511623.007	65.297	65.340	0.043
2026	699035.141	3507682.736	113.972	113.940	-0.032
2027	706448.237	3516278.277	87.175	87.190	0.015
2028	691487.689	3518924.516	81.940	81.970	0.030
2029	701752.231	3527896.000	69.904	69.900	-0.004
2030	677029.349	3528145.891	76.017	75.990	-0.027
2031	673047.760	3513900.262	45.674	45.690	0.016
2032	667140.188	3509606.984	69.205	69.120	-0.085
2033	656050.372	3500284.945	81.203	81.130	-0.073
2034	696478.166	3471309.988	82.318	82.360	0.042
2035	701589.063	3542389.874	38.147	38.070	-0.077
2036	690398.333	3536218.226	54.689	54.590	-0.099
2037	684695.223	3544043.766	53.448	53.510	0.062
2038	693899.416	3559571.981	39.460	39.570	0.110
2039	712774.707	3558409.109	76.408	76.410	0.002
2040	704399.634	3580300.097	77.127	77.180	0.053
2041	712619.193	3599279.386	89.478	89.470	-0.008
2042	719736.491	3583858.885	50.684	50.700	0.016
2043	712078.485	3569826.361	34.074	34.100	0.026
2044	733690.663	3568973.673	59.442	59.470	0.028
2045	724437.494	3574326.930	54.778	54.840	0.062
2046	715075.571	3594362.599	105.535	105.520	-0.015
2047	735698.082	3596830.814	85.019	85.010	-0.009
2048	738776.295	3559050.136	104.283	104.270	-0.013
2049	723610.421	3564541.570	105.669	105.700	0.031
2050	747605.469	3554580.224	131.984	131.960	-0.024
2051	742751.315	3552614.055	99.400	99.470	0.070
2052	757420.828	3550522.377	99.998	99.950	-0.048
2053	750131.878	3567394.817	132.916	132.760	-0.156
2054	735448.366	3590035.000	81.552	81.510	-0.042
2055	738209.191	3583323.610	63.274	63.330	0.056
2056	749961.528	3581870.454	93.456	93.410	-0.046
2057	746988.008	3593602.296	82.222	82.190	-0.032
2058	757424.391	3597269.585	83.538	83.470	-0.068
2059	760665.508	3586930.470	108.742	108.730	-0.012
2060	753352.254	3592483.833	71.626	71.610	-0.016
2061	743856.577	3588523.507	98.990	99.010	0.020
2062	767785.549	3581316.974	89.423	89.440	0.017
2063	759661.588	3579032.011	97.197	97.200	0.003
2064	762424.844	3571725.225	103.333	103.370	0.037

2065	759216.816	3563827.865	79.734	79.730	-0.004
2066	684291.381	3442663.140	116.149	116.170	0.021
2067	700139.647	3460689.259	130.001	130.030	0.029
2068	729531.075	3449393.654	127.632	127.620	-0.012
2069	716735.235	3464052.834	136.758	136.770	0.012
2070	663795.418	3475764.136	58.089	58.120	0.031
2071	679381.788	3473256.555	51.875	51.900	0.025
2072	677622.112	3491250.743	119.850	119.860	0.010
2073	692486.659	3504953.819	136.929	136.950	0.021
2074	694569.157	3512875.806	86.789	86.780	-0.009
2075	680416.395	3518476.329	45.956	45.930	-0.026
2076	670723.005	3526521.722	36.888	36.820	-0.068
2077	695960.870	3548932.977	51.864	51.940	0.076
2078	710148.274	3551577.402	99.139	99.370	0.231
2079	703194.722	3569748.354	79.370	79.360	-0.010
2080	706093.624	3563719.978	47.572	47.570	-0.002
2081	709129.205	3588411.333	84.541	84.530	-0.011
2082	717382.937	3587202.699	92.255	92.270	0.015
2083	723654.830	3592980.517	73.388	73.350	-0.038
2084	732550.301	3586847.238	95.669	95.680	0.011
2085	732746.183	3595089.841	53.813	53.790	-0.023
2086	726166.522	3555648.307	88.022	88.060	0.038
2087	747374.714	3562093.816	122.309	122.250	-0.059
2088	743872.844	3575718.365	82.441	82.540	0.099
2089	755555.013	3574118.344	142.427	142.460	0.033
2090	732459.546	3581088.495	77.088	77.270	0.182
2091	768269.491	3588327.542	95.811	95.820	0.009
2092	759190.693	3568711.641	102.674	102.640	-0.034
2093	754626.879	3559331.792	115.725	115.730	0.005
2094	734278.451	3550008.197	83.537	83.530	-0.007
2095	732104.215	3559277.980	70.111	70.140	0.029
2096	741154.602	3566420.797	73.785	73.840	0.055
2097	713325.181	3576589.542	51.634	51.610	-0.024
2098	720114.259	3573101.520	38.926	38.940	0.014
2099	717874.292	3567821.718	39.322	39.390	0.068
2100	724441.983	3569385.049	58.942	59.000	0.058
2101	726254.669	3580610.706	80.573	80.610	0.037
2102	726698.796	3588291.704	78.964	78.960	-0.004
2103	717268.868	3560553.155	81.282	81.270	-0.012
2104	717340.961	3554814.216	78.273	78.310	0.037
2105	714090.816	3542740.359	57.348	57.380	0.032

2106	704117.180	3537891.357	55.503	55.510	0.007
2107	708074.233	3524378.300	80.973	80.980	0.007
2108	721752.913	3497641.494	141.658	141.690	0.032
2109	717125.490	3479902.220	102.808	102.840	0.032
2110	711980.329	3458314.094	130.290	130.340	0.050
2111	711983.566	3432318.767	106.051	106.110	0.059
2112	733390.757	3439405.021	102.643	102.630	-0.013
2113	719031.796	3453028.141	99.695	99.710	0.015
2114	697601.328	3447107.902	114.948	114.930	-0.018
2115	687340.078	3462033.300	75.227	75.260	0.033
2116	688723.097	3486192.781	125.684	125.670	-0.014
2117	667815.002	3455553.676	40.787	40.800	0.013
2118	667947.153	3486013.422	116.500	116.520	0.020
2119	684895.357	3501439.328	141.568	141.570	0.002
2120	678364.897	3451911.845	113.413	113.350	-0.063

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.098 Meters Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported against 120 NVA points using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using all points.

LAS Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.086 Meters Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported against 120 NVA points using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using ground points.

Table 5.3: NVA Check Point Analysis DEM

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	DEM Elevation (Meter)	Dz (Meter)
2001	642432.381	3438393.705	115.051	115.010	0.041
2002	638385.709	3440023.583	17.356	17.410	-0.054
2003	652290.806	3473582.584	50.296	50.200	0.096
2004	646164.916	3447423.767	28.544	28.520	0.024
2005	647970.254	3489983.281	25.234	25.270	-0.036
2006	664846.881	3498250.453	92.452	92.480	-0.028
2007	658981.983	3480705.583	113.098	113.060	0.038
2008	658363.172	3459498.909	38.270	38.370	-0.100
2009	667355.856	3440939.046	109.956	109.960	-0.004
2010	681333.281	3431790.400	104.406	104.370	0.036
2011	676458.158	3459977.263	95.106	95.120	-0.014

2012	680203.510	3480805.061	66.770	66.680	0.090
2013	710868.729	3449771.485	124.206	124.250	-0.044
2014	688156.591	3451963.539	116.909	117.000	-0.091
2015	699907.069	3437597.322	103.726	103.750	-0.024
2016	719017.750	3441559.752	99.971	100.020	-0.049
2017	726652.143	3458232.013	136.849	136.840	0.009
2018	707536.837	3466683.338	125.165	125.210	-0.045
2019	706235.884	3484251.510	80.084	80.120	-0.036
2020	691631.583	3495179.292	108.801	108.800	0.001
2021	721969.050	3489259.563	99.603	99.630	-0.027
2022	711198.368	3508683.330	128.673	128.700	-0.027
2023	678028.521	3504757.690	95.540	95.530	0.010
2024	704570.182	3499001.319	149.854	149.840	0.014
2025	686690.216	3511623.007	65.297	65.350	-0.053
2026	699035.141	3507682.736	113.972	113.950	0.022
2027	706448.237	3516278.277	87.175	87.180	-0.005
2028	691487.689	3518924.516	81.940	81.970	-0.030
2029	701752.231	3527896.000	69.904	69.870	0.034
2030	677029.349	3528145.891	76.017	76.030	-0.013
2031	673047.760	3513900.262	45.674	45.650	0.024
2032	667140.188	3509606.984	69.205	69.130	0.075
2033	656050.372	3500284.945	81.203	81.130	0.073
2034	696478.166	3471309.988	82.318	82.380	-0.062
2035	701589.063	3542389.874	38.147	38.080	0.067
2036	690398.333	3536218.226	54.689	54.600	0.089
2037	684695.223	3544043.766	53.448	53.470	-0.022
2038	693899.416	3559571.981	39.460	39.610	-0.150
2039	712774.707	3558409.109	76.408	76.410	-0.002
2040	704399.634	3580300.097	77.127	77.150	-0.023
2041	712619.193	3599279.386	89.478	89.490	-0.012
2042	719736.491	3583858.885	50.684	50.710	-0.026
2043	712078.485	3569826.361	34.074	34.090	-0.016
2044	733690.663	3568973.673	59.442	59.470	-0.028
2045	724437.494	3574326.930	54.778	54.850	-0.072
2046	715075.571	3594362.599	105.535	105.520	0.015
2047	735698.082	3596830.814	85.019	85.010	0.009
2048	738776.295	3559050.136	104.283	104.290	-0.007
2049	723610.421	3564541.570	105.669	105.710	-0.041
2050	747605.469	3554580.224	131.984	131.970	0.014
2051	742751.315	3552614.055	99.400	99.440	-0.040
2052	757420.828	3550522.377	99.998	99.950	0.048

2053	750131.878	3567394.817	132.916	132.820	0.096
2054	735448.366	3590035.000	81.552	81.510	0.042
2055	738209.191	3583323.610	63.274	63.320	-0.046
2056	749961.528	3581870.454	93.456	93.410	0.046
2057	746988.008	3593602.296	82.222	82.190	0.032
2058	757424.391	3597269.585	83.538	83.470	0.068
2059	760665.508	3586930.470	108.742	108.730	0.012
2060	753352.254	3592483.833	71.626	71.600	0.026
2061	743856.577	3588523.507	98.990	99.010	-0.020
2062	767785.549	3581316.974	89.423	89.440	-0.017
2063	759661.588	3579032.011	97.197	97.200	-0.003
2064	762424.844	3571725.225	103.333	103.390	-0.057
2065	759216.816	3563827.865	79.734	79.710	0.024
2066	684291.381	3442663.140	116.149	116.180	-0.031
2067	700139.647	3460689.259	130.001	130.030	-0.029
2068	729531.075	3449393.654	127.632	127.620	0.012
2069	716735.235	3464052.834	136.758	136.780	-0.022
2070	663795.418	3475764.136	58.089	58.100	-0.011
2071	679381.788	3473256.555	51.875	51.900	-0.025
2072	677622.112	3491250.743	119.850	119.870	-0.020
2073	692486.659	3504953.819	136.929	136.940	-0.011
2074	694569.157	3512875.806	86.789	86.780	0.009
2075	680416.395	3518476.329	45.956	45.930	0.026
2076	670723.005	3526521.722	36.888	36.850	0.038
2077	695960.870	3548932.977	51.864	51.920	-0.056
2078	710148.274	3551577.402	99.139	99.360	-0.221
2079	703194.722	3569748.354	79.370	79.360	0.010
2080	706093.624	3563719.978	47.572	47.570	0.002
2081	709129.205	3588411.333	84.541	84.510	0.031
2082	717382.937	3587202.699	92.255	92.270	-0.015
2083	723654.830	3592980.517	73.388	73.350	0.038
2084	732550.301	3586847.238	95.669	95.700	-0.031
2085	732746.183	3595089.841	53.813	53.790	0.023
2086	726166.522	3555648.307	88.022	88.060	-0.038
2087	747374.714	3562093.816	122.309	122.310	-0.001
2088	743872.844	3575718.365	82.441	82.540	-0.099
2089	755555.013	3574118.344	142.427	142.460	-0.033
2090	732459.546	3581088.495	77.088	77.080	0.008
2091	768269.491	3588327.542	95.811	95.820	-0.009
2092	759190.693	3568711.641	102.674	102.630	0.044
2093	754626.879	3559331.792	115.725	115.740	-0.015

2094	734278.451	3550008.197	83.537	83.560	-0.023
2095	732104.215	3559277.980	70.111	70.150	-0.039
2096	741154.602	3566420.797	73.785	73.820	-0.035
2097	713325.181	3576589.542	51.634	51.600	0.034
2098	720114.259	3573101.520	38.926	38.930	-0.004
2099	717874.292	3567821.718	39.322	39.400	-0.078
2100	724441.983	3569385.049	58.942	59.010	-0.068
2101	726254.669	3580610.706	80.573	80.590	-0.017
2102	726698.796	3588291.704	78.964	78.970	-0.006
2103	717268.868	3560553.155	81.282	81.280	0.002
2104	717340.961	3554814.216	78.273	78.280	-0.007
2105	714090.816	3542740.359	57.348	57.370	-0.022
2106	704117.180	3537891.357	55.503	55.490	0.013
2107	708074.233	3524378.300	80.973	81.000	-0.027
2108	721752.913	3497641.494	141.658	141.700	-0.042
2109	717125.490	3479902.220	102.808	102.810	-0.002
2110	711980.329	3458314.094	130.290	130.340	-0.050
2111	711983.566	3432318.767	106.051	106.100	-0.049
2112	733390.757	3439405.021	102.643	102.650	-0.007
2113	719031.796	3453028.141	99.695	99.710	-0.015
2114	697601.328	3447107.902	114.948	114.930	0.018
2115	687340.078	3462033.300	75.227	75.240	-0.013
2116	688723.097	3486192.781	125.684	125.680	0.004
2117	667815.002	3455553.676	40.787	40.800	-0.013
2118	667947.153	3486013.422	116.500	116.520	-0.020
2119	684895.357	3501439.328	141.568	141.580	-0.012
2120	678364.897	3451911.845	113.413	113.350	0.063

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.090 Meters Non-Vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported against 120 NVA points using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM.

Table 5.4: VVA Quality Check Point Analysis DEM

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	DEM Elevation (Meter)	Dz (Meter)
3001	642191.591	3438327.564	121.596	121.580	0.016
3002	638622.094	3440260.727	19.075	18.960	0.115
3003	652463.609	3472730.752	34.908	34.860	0.048

3004	647106.283	3447526.145	32.921	32.840	0.081
3005	648165.691	3489740.144	21.111	21.230	-0.119
3006	664951.646	3498651.432	91.793	91.910	-0.117
3007	659395.369	3481067.478	111.328	111.370	-0.042
3008	658812.466	3459888.404	48.381	48.440	-0.059
3009	667185.089	3440665.052	113.309	113.410	-0.101
3010	681417.958	3431348.956	91.036	91.080	-0.044
3011	675825.520	3459581.594	91.273	91.490	-0.217
3012	680340.929	3480308.561	62.251	62.240	0.011
3013	709066.888	3449257.946	107.782	107.850	-0.068
3014	688934.350	3453228.600	121.108	121.120	-0.012
3015	700384.312	3437629.715	88.664	88.730	-0.066
3016	719787.301	3441018.691	106.762	106.790	-0.028
3017	727097.676	3458525.288	136.965	137.030	-0.065
3018	706829.208	3466532.573	139.153	139.250	-0.097
3019	705231.814	3483782.870	89.936	89.990	-0.054
3020	692267.587	3495080.371	101.294	101.280	0.014
3021	722546.554	3489460.743	97.073	97.110	-0.037
3022	711576.214	3509134.542	119.076	119.120	-0.044
3023	678046.406	3505057.761	102.848	102.830	0.018
3024	704563.550	3499382.420	148.040	148.070	-0.030
3025	686797.299	3511311.755	68.590	68.650	-0.060
3026	699437.911	3507816.836	115.391	115.360	0.031
3027	706858.177	3516318.137	76.363	76.430	-0.067
3028	692071.686	3518443.429	89.396	89.420	-0.024
3029	702290.492	3527542.081	62.410	62.560	-0.150
3030	677242.155	3527405.096	72.035	72.010	0.025
3031	672795.469	3514105.945	32.133	32.150	-0.017
3032	666916.744	3510332.913	63.723	63.720	0.003
3033	656656.185	3500707.272	82.165	82.170	-0.005
3034A	696559.360	3470932.781	73.751	73.770	-0.019
3035	701703.913	3541477.207	49.958	50.030	-0.072
3036	690216.961	3536292.956	53.654	53.600	0.054
3037	684400.191	3544380.906	58.912	59.070	-0.158
3038	694111.292	3559179.754	69.453	69.500	-0.047
3039	712311.243	3558425.294	73.366	73.530	-0.164
3040	704548.192	3580680.973	68.840	68.950	-0.110
3041	712149.376	3600318.611	44.378	44.480	-0.102
3042	719521.794	3583856.173	51.120	51.200	-0.080
3043	711765.463	3570092.722	35.500	35.560	-0.060
3044	733067.281	3568882.454	58.574	58.700	-0.126

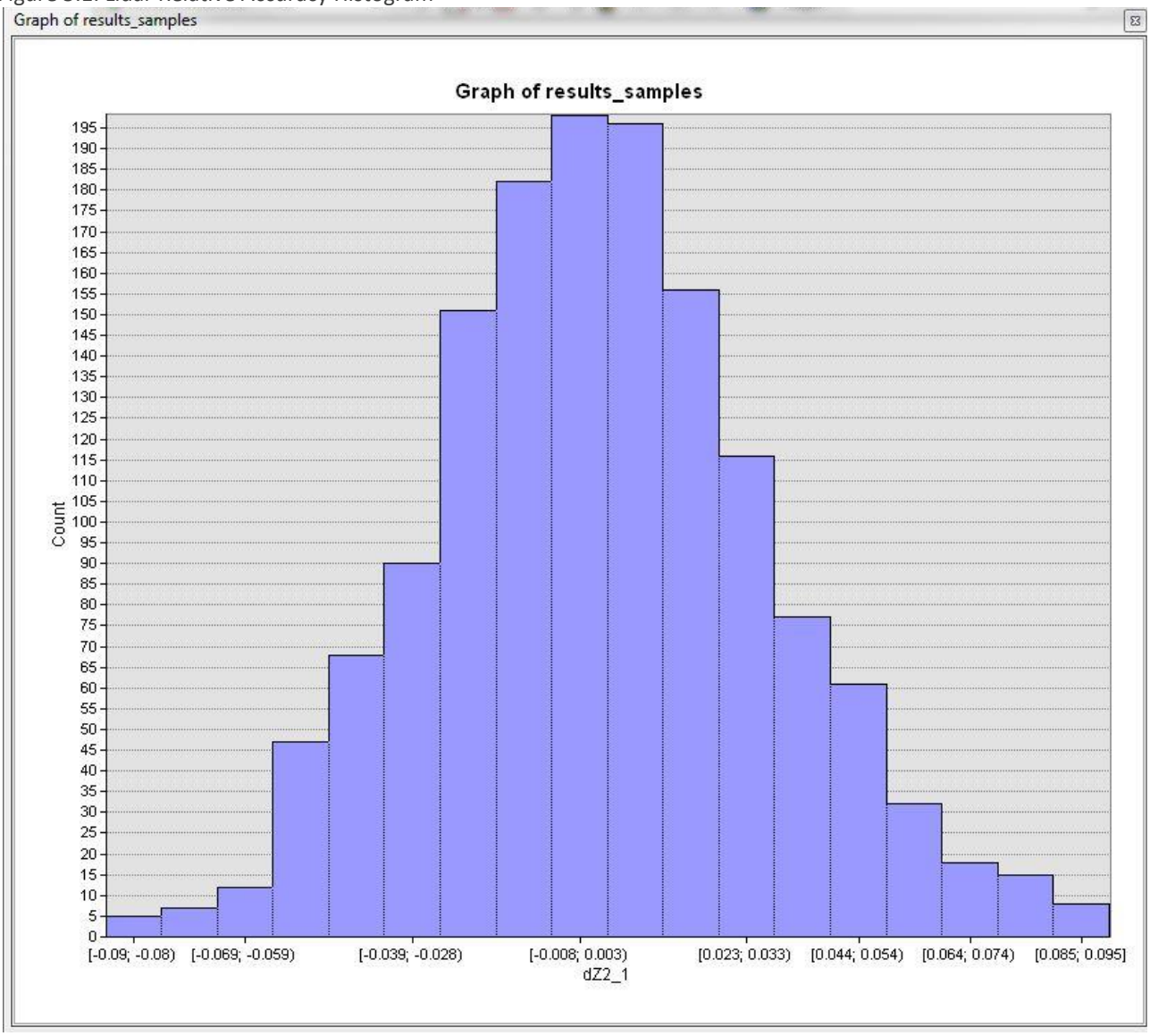
3045	723890.329	3573982.526	52.562	52.670	-0.108
3046	714932.765	3594141.883	106.579	106.620	-0.041
3047	736050.480	3596725.680	94.441	94.550	-0.109
3048	738347.751	3559310.954	92.251	92.310	-0.059
3049	724037.574	3564539.753	106.438	106.500	-0.062
3050	747866.782	3554473.460	121.626	121.610	0.016
3051	742820.318	3552934.695	102.773	102.770	0.003
3052	756650.231	3550591.996	94.123	94.140	-0.017
3053	750122.454	3567613.767	135.485	135.410	0.075
3054	735331.603	3589858.478	80.160	80.210	-0.050
3055	738632.212	3583497.315	63.890	63.950	-0.060
3056	749633.838	3581871.476	101.643	101.550	0.093
3057	746759.331	3593488.945	84.894	84.960	-0.066
3058	757408.441	3597001.177	75.206	75.280	-0.074
3059	760588.123	3586645.248	105.176	105.230	-0.054
3060	752973.037	3592262.292	70.679	70.700	-0.021
3061	744164.641	3588351.117	95.452	95.530	-0.078
3062	767952.046	3581221.124	88.282	88.310	-0.028
3063	759261.035	3579180.627	99.288	99.220	0.068
3064	762443.707	3571469.393	100.209	100.180	0.029
3065	759685.655	3563636.079	79.657	79.910	-0.253
3066	684311.460	3443001.365	115.665	115.780	-0.115
3067	700165.714	3460370.634	127.221	127.260	-0.039
3068	729591.503	3449707.600	130.804	130.880	-0.076
3069	716373.470	3464148.076	134.462	134.500	-0.038
3070	663603.927	3476075.430	59.687	59.830	-0.143
3071A	678947.011	3473384.100	42.707	42.720	-0.013
3072	677280.435	3491387.522	117.043	117.110	-0.067
3073	693024.198	3505017.644	145.363	145.400	-0.037
3074	694719.288	3512473.366	95.082	95.130	-0.048
3075	680696.829	3518567.464	48.307	48.330	-0.023
3076	670295.340	3526483.925	24.889	24.890	-0.001
3077	696013.838	3549277.376	39.171	39.130	0.041
3078	710493.234	3551227.209	102.631	102.640	-0.009
3079	702562.412	3569732.166	77.350	77.420	-0.070
3080	706023.602	3564096.586	48.972	48.990	-0.018
3081	708545.312	3588549.641	100.485	100.530	-0.045
3082	716803.448	3586933.044	88.848	89.030	-0.182
3083	723720.652	3592543.530	77.306	77.480	-0.174
3084	732222.380	3586731.462	87.868	87.950	-0.082
3085	732576.005	3594472.954	68.148	68.150	-0.002

3086	725862.813	3555438.977	93.971	94.020	-0.049
3087	747401.130	3561913.259	119.096	119.080	0.016
3088	744221.954	3575863.555	82.770	82.830	-0.060
3089	755745.938	3573935.386	135.127	135.150	-0.023
3090	731657.679	3580770.611	69.167	69.250	-0.083

VERTICAL ACCURACY CONCLUSIONS

Vegetated Vertical Accuracy (VVA) Tested 0.168 Meters at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM using 90 VVA points. VVA Errors larger than 95th percentile include:
Point 3011, Easting 675825.520, Northing 3459581.594, Z-Error 0.217 Meters
Point 3065, Easting 759685.655, Northing 3563636.079, Z-Error 0.253 Meters
Point 3082, Easting 716803.448, Northing 3586933.044, Z-Error 0.182 Meters
Point 3083, Easting 723720.652, Northing 3592543.530, Z-Error 0.174 Meters

Figure 5.1: Lidar Relative Accuracy Histogram



RELATIVE ACCURACY ASSESSMENT AND CONCLUSION

Relative accuracy also known as "between swath" accuracy was tested through a series of well distributed flight line overlap locations. The relative accuracy for the Mississippi NRCS FY16 Lidar measured at 0.030 Meters RMSDz.

Approved by:	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		March 2017

Section 6: Flight Logs

Flight logs for the project are shown on the following pages:

YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: S 20160118 – 145231 DATE: 1/18/2016 F1 LEICA ALS80

PILOT: Darin Moody OPERATOR: Gary Tao AIRCRAFT: N 208 NR SN 8227

PROJECT NUMBER	LINE NO. & Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	ALT (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
28212_USGS							2000	18:19	18:24		Postline Fig8
MS		147					2100m	18:31	18:34		Flyover MSBL
											Landing in Natchez for
											fuel (KHEZ), Natchez, MS
											rolling ~30° on landing

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP		NOTES:
○										See Page 1
○						WX clear				
○										

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YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

1/2

MISSION: S 20160118 - 145231 DATE: 1/18/2016 F1 LEICA ALS80

PILOT: Darin Moody OPERATOR: Gary Tao AIRCRAFT: N208NR SN 8227

PROJECT NUMBER	LINE NO. & Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	ALT (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
28212_USGS											MSJ and MSVC clouded over
_MS											
								15:40	15:43		S turn — before CORS
AOI MSBU											to wake up IMU
CORS								15:45	15:48		flyover of MSBU CORS
							2000	15:52	15:57		Pre-line Figure 8
	954 181°	168	39	40	269		1970	16:00	16:08		
	953 0°	156					2000m	16:09	16:18		
	952 180°	163					2000m	16:19	19:27		
	951 0°	146					2000m	16:28	16:37		
	950 180°	166					1950m	16:38	16:46		
	949 0°	155					2015m	16:47	16:56		
	948 180°	165					1965	16:57	17:06		
	947 0°	150					1990	17:07	17:16		
	946 180°	157					1940	17:23	17:37		
	945 0°	160					2000	17:38	17:53		
	944 180°	157	✓	✓	✓		1960	17:54	18:08		
	XTIE	146					2014	18:15	18:18		Using eastern 999 as X TIE

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	NOTES
⊘ MSBU AOI	55	11	44	2.3	1.3		14:55	18:56	3688.6 - 3692.2
○						WX Clear in South			15:10up 18:47down
○									KHSK → KHEZ for refuel
									No Back up Base Available

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YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: 8 20160118–193356 DATE: 1/18/2016 F2 LEICA ALS80

PILOT: Darin Moody OPERATOR: Gary Tao AIRCRAFT: N208NR SN 8227

PROJECT NUMBER	LINE NO. & Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	ALT (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
28212-USGS		167					2000m	20:00	20:04		Fly over MSBU
MS								20:18	20:22		Preline fig 8
AOI MSBU	943 0°	154	39	40	269		2000m	20:24	20:38		
	942 180°	167					1950	20:40	20:54		
	941 0°	157					2012	20:55	21:10		
	940 180°	165					2000	21:11	21:25		
	939 0°	140					2000	21:26	21:41		
	938 180°	164					2000	21:42	21:56		
	937 0°	139					2000	21:57	22:20		29° Roll into line
	936 180°	166					2000	22:21	22:41		
	HL001 270°						ASB	22:55	22:59		Cross Tie
							1970m	22:59	23:02		Postline fig 8
	MSBU CORS 327°	127						23:04	23:08		Closeout flyover of MSBU

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	NOTES: No base station available
Ø MSBU AOI	55	8	36	2.4	1.3		19:34	23:40	19:48 wheelsup from KHEZ, Natchez, MS
○						WX Clear			23:31 downQ KHKS
○									3692.2 – 3695.9

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YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: S 20160119- 151839 DATE: 1/19/2016 LEICA ALS80

PILOT: Darin Moody OPERATOR: Gary Tao AIRCRAFT: N 208 NR SN 8227

PROJECT NUMBER	LINE NO. & Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	ALT (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
	927 180°	152	39	40	269		2000	17:21	17:43		
	926 0°	164	↑	↑	↑		2000	17:44	18:04		31° roll on turn in
	925 180°	150	↓	↓	↓		2000	18:05	18:27		
	924 0°	168	↓	↓	↓		2000	18:28	18:49		a little high @ start
	ULOO2 90°	159	↓	↓	↓		2000	19:02	19:06		Cross Tie
	XTIE							19:06	19:10		Post line fig 8
	200°	136						19:13	19:19		close out flyover of MSBU CORS
											RTB KHKS for refuel and
											crew swap

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	NOTES:
⊗ NSJKAOI	40	40	0	3.4	1.4				
⊘ MSBU AOI	56	24	28			WX Clear			See page 1
○									

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YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

1/2

MISSION: S 20160119_151839 DATE: 1/19/2016 LEICA ALS-80 SN 8227

PILOT: Darin Moody OPERATOR: Gary Tuo AIRCRAFT: N 202NR

PROJECT NUMBER	LINE NO. & Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	ALT (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
28212_USGS											
_MS											Lost Coupled Solution on takeoff
		117	39	40	269						
								15:16			Pilot Display went out had
											to reboot system in air to
											get it back up
	195°	104					2000m	15:25	15:30		Reinitializing over MSJK
											3.5NM in, 3.5NM out
Block50 MSJK							2000	15:34	15:39		Preline fig8
AOI	517 180°	158					2000	15:43	15:54		25° turns
	516 0°	168					2000	15:55	16:05		25° turns
	515 180°	153					2000	16:06	16:16		
	4001 270°	143						16:20	16:23		CROSSTIE, Block 50 finished
	XTIE										Going to 900 Blockline (MSBU)
								16:40	16:43		S turn to wake up IMU
								16:43	16:49		flyover MSBU CORS
	928 0°	151					2000	16:59	17:20		

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP	NOTES:
⊘ MSJK AOI	40	40	0	3.4	1.4		14:44		14:55 up @ KHKS, 19:42 down
⊘ MSBU AOI	56	24	28			WX Clear			3695.9 3770.7
○									

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Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/20/2017	20	76268	2	USGS MISSISSIPPI, Natchez

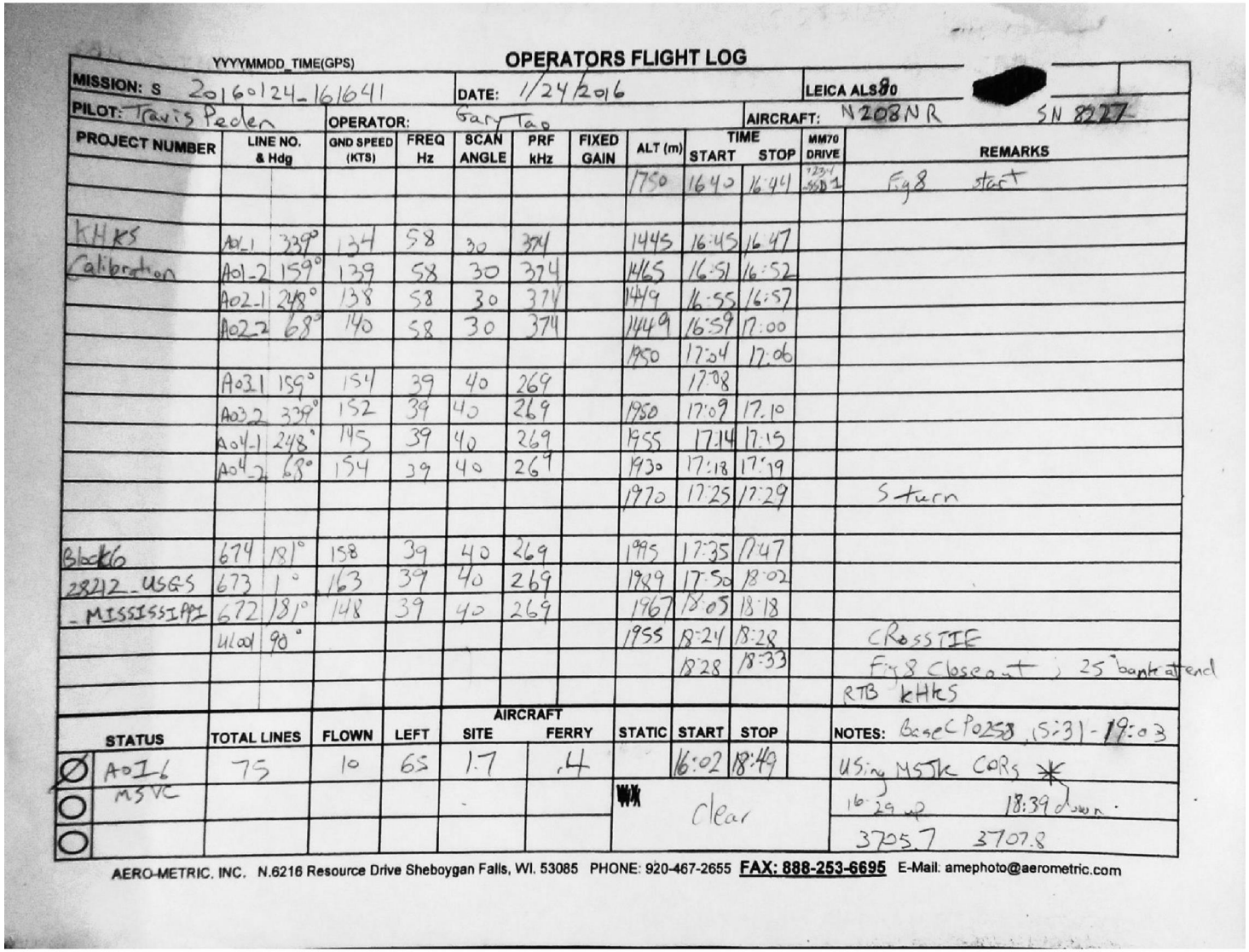
Operator	Aircraft	HOBBS Start	Local Start Time IMU	ZULU Start Time IMU	Base
Linville	N111SD	361..3	1:30:00	19:30:00	WOOLPERT PIN
Pilot	**Sensor Type**				**PID**
LaROCQUE	OTHER	362.3	2:43:00	20:43:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
200@11g17	10	clr	0	21	16	29.78		Departing	kvks
								Arriving	kvks

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	PreSet
				Gain - Fine/Down		Multi		B	PreSet

Air Speed	AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	6500	agl	6,500	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	Base GPS Began Logging At: 1:20:00
								Figure 8-Turns Before Mission Yes X No
8	359.2	19:58:35	20:06:57		17	0.7	1.3	wind at altitude 247@38kt
25	179.2	20:12:58	20:23:51		17	0.7	1.3	



YYYYMMDD_TIME(GPS)

OPERATORS FLIGHT LOG

MISSION: S 20160124_161641 DATE: 1/24/2016 LEICA ALS80

PILOT: Travis Peden OPERATOR: Gary Tao AIRCRAFT: N208NR SN 8227

PROJECT NUMBER	LINE NO. & Hdg	GND SPEED (KTS)	FREQ Hz	SCAN ANGLE	PRF kHz	FIXED GAIN	ALT (m)	TIME START	TIME STOP	MM70 DRIVE	REMARKS
							1750	16:40	16:44	1234 SSD 1	Fig 8 start
KHKS	A01 339°	134	58	30	374		1445	16:45	16:47		
Calibration	A01-2 159°	139	58	30	374		1465	16:51	16:52		
	A02-1 248°	138	58	30	374		1449	16:55	16:57		
	A02-2 68°	140	58	30	374		1449	16:59	17:00		
							1950	17:04	17:06		
	A03-1 159°	154	39	40	269			17:08			
	A03-2 339°	152	39	40	269		1950	17:09	17:10		
	A04-1 248°	145	39	40	269		1955	17:14	17:15		
	A04-2 68°	154	39	40	269		1930	17:18	17:19		
							1970	17:25	17:29		Sturn
Block6	674 181°	158	39	40	269		1995	17:35	17:47		
28242_USGS	673 1°	163	39	40	269		1989	17:50	18:02		
_MISSISSIPPI	672 181°	148	39	40	269		1967	18:05	18:18		
	ULcal 90°						1955	18:24	18:28		CROSSTIE
								18:28	18:33		Fig 8 Closeout ; 25° bank at end
											RTB KHKS

STATUS	TOTAL LINES	FLOWN	LEFT	AIRCRAFT SITE	AIRCRAFT FERRY	STATIC	START	STOP
⊘ A01-6	75	10	65	1.7	.4		16:02	18:49
○ MSVC						clear		
○								

NOTES: Base CP0253 (5:31) - 19:03
Using MSVC CORS *
16:29 up 18:39 down.
3705.7 3707.8

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Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/30/2016	30	76268	2	USGS 2016 MS

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other	N7079F	251.2	8:30:00	14:30:00	
Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
GEBHART	OTHER	253.5	11:01:00	17:01:00	Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	HEZ
180@ 10	>10	1200		14	9	3001		Arriving	HEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
150	Kts	6500	Ft	6500	Ft	Yes		No		@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
196	s	14:42:00	15:08:00	6:38:00	19	0.6	1.1	
195	N	15:11:00	15:27:00	0:00:00	19	0.6	1.2	
194	s	15:30:00	15:45:00	0:00:00	20	0.6	1.1	
193	N	15:48:00	16:04:00	0:00:00	20	0.6	1.1	Clouds near the end of line
192	S	16:12:00	16:27:00	0:00:00	20	0.7	1.3	Clouds near the start of line
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes No

Additional Comments:	Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	02/03/16	033			

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
Starbuck	N0709F	7.53.5	10:04	16:04	Woolpert
Pilot	**Sensor Type**	**HOBBS End**	**Local End Time**	**Zulu End Time**	**PID**
	ALS 80/8170	260.7	4:36	22:36	Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Daw Point	Pressure	Haze/Fire/Cloud		
340/6	<10		B	11	3	3006		Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi	✓	B	

Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.
150 Kts	6,500 Ft	6,500 Ft	Yes [ ] No [ ]	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 15:09
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No
191	N	16:04	16:20	0:00:00	17	0.7	1.3	
190	S	16:23	16:38	0:00:00	19	0.6	1.1	
189	N	16:42	16:57	0:00:00	20	0.5	1.1	
188	S	17:00	17:15	0:00:00	22	0.6	1.0	
187	N	17:19	17:34	0:00:00	22	0.6	1.1	Low Return over lake
186	S	17:37	17:53	0:00:00	23	0.5	1.0	Low Return over lake
185	N	17:56	18:11	0:00:00	21	0.6	1.1	Low Return over lake
184	S	18:15	18:30	0:00:00	22	0.6	1.0	
183	N	18:33	18:49	0:00:00	18	0.7	1.2	
182	S	18:53	19:08	0:00:00	19	0.6	1.0	
181	N	19:11	19:28	0:00:00	18	0.6	1.0	
180	S	19:31	19:46	0:00:00	16	0.7	1.2	
179	N	19:49	20:05	0:00:00	16	0.7	1.2	
178	S	20:08	20:23	0:00:00	17	0.6	1.1	
177	N	20:27	20:42	0:00:00	15	0.7	1.3	
176	S	20:46	21:01	0:00:00	16	0.7	1.2	
175	N	21:05	21:21	0:00:00	14	0.8	1.6	
174	S	21:24	21:40	0:00:00	15	0.7	1.3	
173	N	21:43	21:59	0:00:00	14	0.9	1.5	
172	S	22:02	22:18	0:00:00	15	0.8	1.3	
171	N	22:21	22:36	0:00:00	15	0.7	1.1	
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes ✓ No

Additional Comments:

Drive #

Woolpert

Leica LIDAR

MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
02/04/16	034	07626	02	USGS 2016 Mississippi

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
		260.7			Woolpert

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
	ALS80 / 8170	262.5			Woolpest

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing / Arriving
360/6	+10	1200	C	5	0	3039		Departing: ; Arriving:

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.
150 Kts	6,500 Ft	6,500 Ft	Yes / No	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 8:30
⇕ Times entered are Zulu / GMT ⇕								Verify S-Turns Before Mission Yes ✓ No
170	S	15:31	15:47	0:00:00	18	0.6	1.1	
169	N	15:50	16:07	0:00:00	17	0.7	1.3	
168	S	16:10	16:26	0:00:00	18	0.7	1.3	Few clouds
167	N	16:29	16:45	0:00:00	19	0.6	1.1	Clouds
166	S	21:50	22:05	0:00:00	16	0.7	1.1	
165	N	22:09	22:26	0:00:00	16	0.7	1.1	
164	S	22:29	22:44	0:00:00	16	0.7	1.3	
163	N	22:48	23:05	0:00:00	17	0.7	1.3	
162	S	23:08	23:23	0:00:00	19	0.6	1.2	
161	N	23:27	23:43	0:00:00	19	0.6	1.1	
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes No

Additional Comments:

First mission line 170 – 167 Start 15:31 End 16:45

Second mission Same day line 166 – 161 Start 21:50 End 23:43

Drive #: 264.8

Woolpert

Leica LIDAR

MM/DD/YEAR: 02/04/16
Day of Year: 034
Project #: 07626
Phase #: 02
Project Name: USGS 2016 Mississippi
Operator:
Aircraft:
HOBBS Start: 260.7
Local Start Time:
ZULU Start Time:
Base: Woolpert
Pilot:
Sensor Type: ALS80 / 8170
HOBBS END: 262.5
Local End Time:
Zulu End Time:
PID: Woolpest

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
360/6	+10	1200	C	5	0	3039		Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	Kts	6,500	Ft	6,500	Ft	Yes		No		@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	8:30
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission	Yes ✓ No
170	S	15:31	15:47	0:00:00	18	0.6	1.1		
169	N	15:50	16:07	0:00:00	17	0.7	1.3		
168	S	16:10	16:26	0:00:00	18	0.7	1.3	Few clouds	
167	N	16:29	16:45	0:00:00	19	0.6	1.1	Clouds	
166	S	21:50	22:05	0:00:00	16	0.7	1.1		
165	N	22:09	22:26	0:00:00	16	0.7	1.1		
164	S	22:29	22:44	0:00:00	16	0.7	1.3		
163	N	22:48	23:05	0:00:00	17	0.7	1.3		
162	S	23:08	23:23	0:00:00	19	0.6	1.2		
161	N	23:27	23:43	0:00:00	19	0.6	1.1		
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
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				0:00:00					
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes ☐ No ☐

Additional Comments:
First mission line 170 - 167 Start 15:31 End 16:45
Second mission Sameday line 166 - 161 Start 21:50 End 23:43

Drive #: 264.8

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
Operator	02/05/16	035	076268	02	SW Mississippi USGS
	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
Pilot	N 7079F	264.8			Woolpert
	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
	ALS 80 / 8170	272.1			Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
—	+10			7	-4	3053		Departing	KHEZ
								Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	Mode	Threshold Values
40	50	272	100	Gain - Course/Up	Single	A
				Gain - Fine/Down	Multi	B

Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.
150 Kts	6,500 Ft	6,500 Ft	Yes / No	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 9:06am
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No
160	S	15:57	16:13	0:00:00	20	0.7	1.3	
159	N	16:16	16:32	0:00:00	21	0.6	1.1	
158	S	16:36	16:51	0:00:00	22	0.5	1.1	
157	N	16:55	17:10	0:00:00	21	0.6	1.1	Cloud
156	S	17:14	17:29	0:00:00	22	0.5	1.0	
155	N	17:32	17:47	0:00:00	22	0.5	1.0	
154	S	17:51	18:07	0:00:00	19	0.6	1.1	
153	N	18:09	18:24	0:00:00	18	0.6	1.1	
152	S	18:28	18:43	0:00:00	17	0.7	1.2	Flood.ng ?
151	N	18:47	19:02	0:00:00	17	0.7	1.1	Low Return over Lake
150	S	19:05	19:21	0:00:00	18	0.6	1.0	Low Return over Lake
149	N	19:24	19:38	0:00:00	16	0.7	1.2	
148	S	19:42	19:57	0:00:00	16	0.7	1.2	
147	N	20:00	20:15	0:00:00	17	0.6	1.1	
146	S	20:19	20:34	0:00:00	15	0.7	1.3	
145	N	20:37	20:52	0:00:00	16	0.7	1.2	
144	S	20:55	21:11	0:00:00	15	0.7	1.2	
143	N	21:14	21:28	0:00:00	14	0.8	1.4	
142	S	21:32	21:47	0:00:00	15	0.7	1.1	
141	N	21:50	22:05	0:00:00	15	0.7	1.2	
140	S	22:08	22:23	0:00:00	15	0.7	1.1	Low Return over Lake
139	N	22:31	22:46	0:00:00	16	0.7	1.2	Smoke
				0:00:00				
				0:00:00				
				0:00:00				
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				0:00:00				
↑ Times entered are Zulu / GMT ↑				Page	1			Verify S-Turns After Mission Yes No

Additional Comments:

Drive #

Woolpert

Leica LIDAR

MM/DD/YEAR: 02/06/16
Day of Year: 036
Project #: 076268 .
Phase #: 02
Project Name: SW Mississippi USGS 2016
Operator:
Pilot:
Aircraft: N707F
Sensor Type: ALS80 / 8170
HOBBS Start: 272.1
HOBBS END: 275.7
Local Start Time: 2! 10
Local End Time: 5:58
ZULU Start Time: 20!10
Zulu End Time: 23:58
Base: Woolpert
PID: Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud
360/10	+10	12000	—	13	-5	3026	

Departing: HEZ
Arriving: HEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %
40	50	272	100

Fixed Gain:
Gain - Course/Up:
Gain - Fine/Down:
Mode: Single / Multi
Threshold Values: A / B

Air Speed: 150 Kts
AGL: 6,500 Ft
MSL: 6,500 Ft
Waveform Used: Yes No
Waveform Mode: @ NS
Pre-Trigger Dist.: Ft

GPS Began Logging At: 11:11
Verify S-Turns Before Mission: Yes ✓ No

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	
⇕ Times entered are Zulu / GMT ⇕								
198	W	20:41	20:52	0:00:00	16	0.7	1.2	
197	W	20:56	21:08	0:00:00	14	0.8	1.21	
138	S	21:24	21:40	0:00:00	15	0.7	1.2	Low Return over Rives
137	N	21:42	21:58	0:00:00	15	0.7	1.2	
136	S	22:00	22!15	0:00:00	15	0.7	1.2	
135	N	22:18	22:33	0:00:00	16	0.7	1.1	
134	S	22:36	22:51	0:00:00	16	0.7	1.2	Water in fields
133	N	22:54	23:08	0:00:00	16	0.7	1.3	Water in fields
107	E	23:12	23:26	0:00:00	18	0.6	1.1	
106	W	23:29	23:42	0:00:00	17	0.6	1.2	Low Return over water
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
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↑ Times entered are Zulu / GMT ↑				Page	1			

Verify S-Turns After Mission: Yes ✓ No

Additional Comments:
Lots of flood still along the mississippi lines 132- 109

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	02/07/16		076268	02	SW Mississippi USGS 2016

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
Starbuck	N7079F	275.7	9:47	15:47	Woolpert
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PIC**
		282.8	5:06	23:06	Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
350/4	+10	12,000		9	1	30.31		Departing	KHEZ
								Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single	A	
				Gain - Fine/Down		Multi	B	

Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.
150 Kts	6,500 Ft	6,500 Ft	Yes ☐ No ☐	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 9:15
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No
105	E	16:07	16:21	0:00:00	20	0.6	1.1	
104	W	16:24	16:39	0:00:00	21	0.6	1.1	
103	E	16:42	16:56	0:00:00	23	0.6	1.0	
102	W	16:59	17:13	0:00:00	21	0.6	1.1	
101	E	16:56	17:31	0:00:00	21	0.6	1.0	
100	W	17:34	17:48	0:00:00	21	0.6	1.1	
99	E	1752	18:05	0:00:00	21	0.6	1.1	
98	W	18:08	18:23	0:00:00	19	0.7	1.2	
97	E	18:26	18:40	0:00:00	19	0.7	1.2	
96	W	18:43	18:57	0:00:00	19	0.7	1.1	
95	E	19:00	19:14	0:00:00	20	0.6	1.0	
94	W	19:17	1931	0:00:00	17	0.6	1.2	Flooded fields
93	E	19:34	19:48	0:00:00	17	0.7	1.2	
92	W	19:51	20:04	0:00:00	18	0.6	1.1	
91	E	20:07	20:21	0:00:00	16	0.7	1.3	
90	W	20:24	20:37	0:00:00	16	0.7	1.2	
89	E	20:40	20:53	0:00:00	15	0.7	1.3	
88	W	20:57	21:10	0:00:00	15	0.7	1.2	
87	E	21:13	21:26	0:00:00	15	0.7	1.2	
86	W	21:30	21:42	0:00:00	14	0.7	1.3	
85	E	21:46	21:59	0:00:00	15	0.7	1.2	
84	W	22:02	22:16	0:00:00	16	0.7	1.1	
83	E	22:19	22:32	0:00:00	17	0.7	1.3	
82	W	22:35	22:48	0:00:00	17	0.7	1.3	
				0:00:00				
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				0:00:00				
↑ Times entered are Zulu / GMT ↑				Page	1			Verify S-Turns After Mission Yes ✓ No

Additional Comments: Drive #

Woolpert

Leica LiDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	02/08/16	038	076268	02	SW Mississippi USGS

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
	N7079F	287.8	9:53	15:53	Woolpert
Pilot	**Sensor Type**	**HOBBS End**	**Local End Time**	**Zulu End Time**	**PID**
	ALS 80/8170	287.6	2:50	20:50	Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
290/14	+10	12,000		11	-4	3013		Departing	KHEZ
								Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used			Waveform Mode		Pre-Trigger Dist.	
150	Kts	6,500	Ft	6,500	Ft	Yes		No	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 9:00
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes ✓ No
108	N	16:09	16:17	0:00:00	19	0.6	1.1	
81	E	16:28	16:41	0:00:00	20	0.6	1.1	
80	W	16:45	16:58	0:00:00	20	0.6	1.0	
79	E	17:01	17:14	0:00:00	20	0.6	1.0	
78	W	17:17	17:29	0:00:00	22	0.6	1.0	
77	E	17:33	17:43	0:00:00	20	0.6	1.1	
76	E	17:57	18:13	0:00:00	19	0.6	1.1	min range error
65	S	18:27	18:39	0:00:00	18	0.8	1.3	min range error
64	N	18:42	18:55	0:00:00	18	0.7	1.1	
63	S	18:58	19:10	0:00:00	19	0.6	1.0	
62	N	19:14	19:26	0:00:00	17	0.7	1.2	
61	S	19:29	19:42	0:00:00	17	0.7	1.2	Snow
37	N	19:51	20:04	0:00:00	17	0.7	1.2	
38	S	20:07	20:21	0:00:00	16	0.7	1.3	Snow
				0:00:00				
				0:00:00				
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↑ Times entered are Zulu / GMT ↑			Page		1			Verify S-Turns After Mission Yes ✓ No

Additional Comments: Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	2/11/16	042	076268	02	SW Mississippi USGS

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
	N7079F	288.2	11:48	17:48	Woolpert
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PIC**
	ALS80 / CM70	295.8	1:38	1:38	Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
230/16	+10	1200	C	21	8	3016		Departing	HEZ
								Arriving	HEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	Mode		Threshold Values	
40	50	272	100	Gain - Course/Up	Single		A	
				Gain - Fine/Down	Multi	✓	B	

Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.
150 Kts	6,500 Ft	6,500 Ft	Yes ☐ No ☐	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 11:21
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No ☐
39	N	18:33	18:47	0:00:00	18	0.6	1.1	
40	S	18:51	19:04	0:00:00	18	0.6	1.0	
41	N	19:07	19:21	0:00:00	16	0.7	1.2	
42	S	19:25	19:40	0:00:00	17	0.6	1.1	
43	N	19:43	19:59	0:00:00	16	0.7	1.2	Smoke
44	S	20:02	20:18	0:00:00	16	0.7	1.2	Smoke
45	N	20:21	20:37	0:00:00	16	0.7	1.1	
46	S	20:40	20:56	0:00:00	15	0.7	1.2	Smoke
47	N	20:59	21:16	0:00:00	15	0.7	1.2	
48	S	21:19	21:35	0:00:00	16	0.7	1.2	
49	N	21:38	21:54	0:00:00	16	0.7	1.2	
50	S	21:58	22:11	0:00:00	16	0.7	1.2	
51	N	22:15	22:27	0:00:00	16	0.7	1.3	Smoke
52	S	22:30	22:42	0:00:00	17	0.6	1.2	
53	N	22:44	22:57	0:00:00	19	0.6	1.1	
54	S	22:59	23:11	0:00:00	20	0.6	1.1	
55	N	23:14	23:27	0:00:00	17	0.6	1.4	
56	S	23:30	23:42	0:00:00	17	0.6	1.4	
57	N	23:45	23:57	0:00:00	18	0.6	1.3	
58	S	00:00	00:12	0:00:00	17	0.6	1.2	
59	N	00:15	00:27	0:00:00	17	0.6	1.2	
60	S	00:30	00:42	0:00:00	17	0.6	1.3	
66	N	00:45	00:57	0:00:00	18	0.6	1.2	
				0:00:00				
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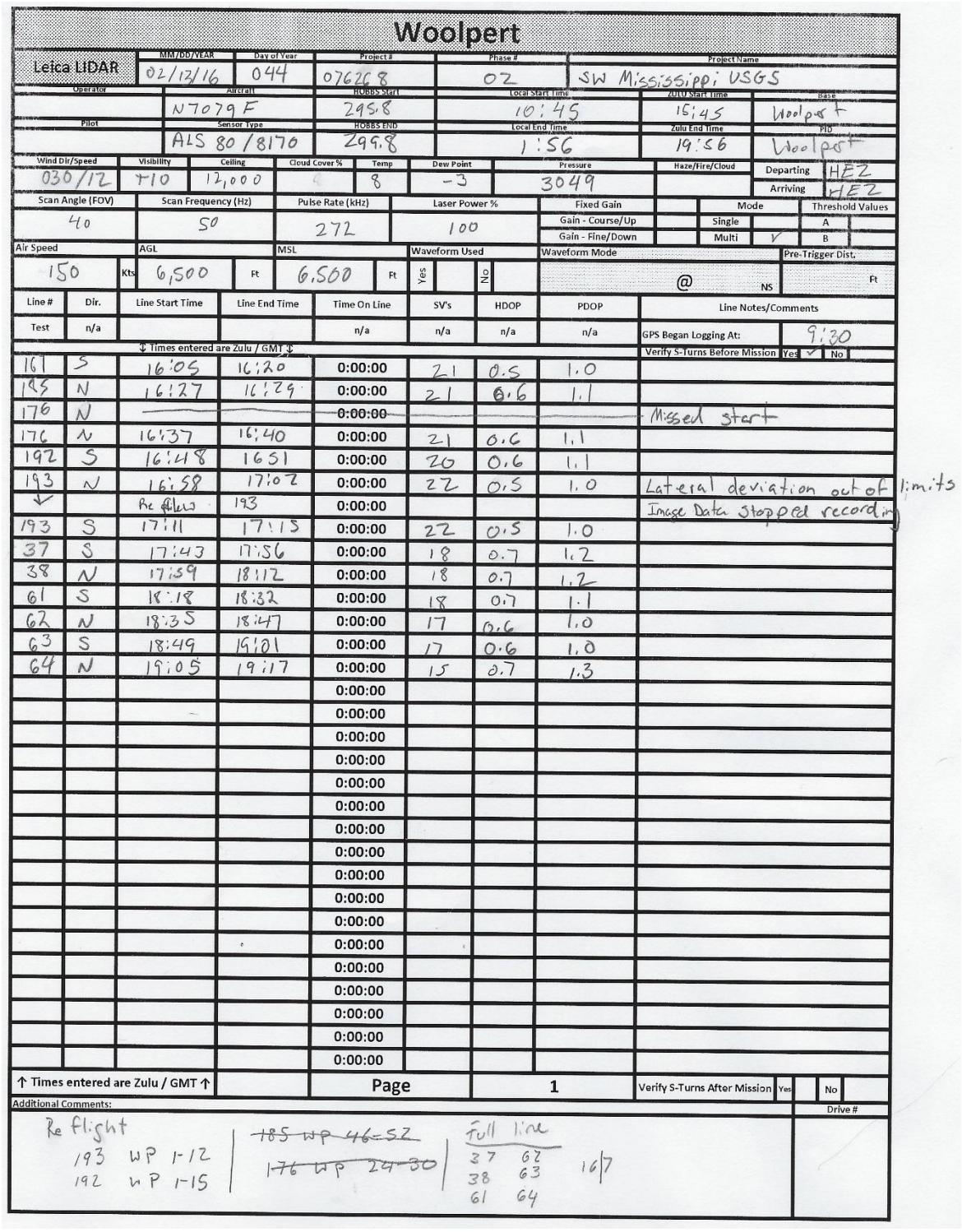
↑ Times entered are Zulu / GMT ↑				Page	1			Verify S-Turns After Mission Yes ☐ No ☐

Additional Comments:

39-60, 66

Drive #



Woolpert

Leica LIDAR

MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name	
02/13/16	044	076268	02	SW Mississippi USGS	
Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
	N7079F	295.8	10:45	15:45	Woolpert
Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
	ALS 80 / 8170	299.8	1:56	19:56	Woolpert

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing: HEZ
030/12	+10	12,000		8	-3	3049		Arriving: HEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode	Threshold Values
40	50	272	100	Gain - Course/Up		Single	A
				Gain - Fine/Down		Multi ✓	B

Air Speed		AGL		MSL		Waveform Used		Waveform Mode	Pre-Trigger Dist.
150	Kts	6,500	Ft	6,500	Ft	Yes	No	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 9:30
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No
161	S	16:05	16:20	0:00:00	21	0.5	1.0	
185	N	16:27	16:29	0:00:00	21	0.6	1.1	
176	N			~~0:00:00~~				Missed start
176	N	16:37	16:40	0:00:00	21	0.6	1.1	
192	S	16:48	1651	0:00:00	20	0.6	1.1	
193	N	16:58	17:02	0:00:00	22	0.5	1.0	Lateral deviation out of limits
↓		Re flew	193	0:00:00				Image Data stopped recording
193	S	17:11	17:15	0:00:00	22	0.5	1.0	
37	S	17:43	17:56	0:00:00	18	0.7	1.2	
38	N	17:59	18:12	0:00:00	18	0.7	1.2	
61	S	18:18	18:32	0:00:00	18	0.7	1.1	
62	N	18:35	18:47	0:00:00	17	0.6	1.0	
63	S	18:49	19:01	0:00:00	17	0.6	1.0	
64	N	19:05	19:17	0:00:00	15	0.7	1.3	
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes No

Additional Comments:

Re flight
193 WP 1-12
192 WP 1-15

~~185 WP 46-52~~
~~176 WP 24-30~~

Full line
37 62
38 63
61 64

16|7

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/8/2017	8	77025	2	USGS MISSIPPI, Natchez

Operator	Aircraft	HOBBS Start	Local Start Time IMU	ZULU Start Time IMU	Base
Linville	N111SD	339.7	11:11:00	17:11:00	WOOLPERT PIN
Pilot	**Sensor Type**				**PID**
LaROCQUE	OTHER	344.8	4:38:00	22:38:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
090@4	10	clr	0	1	-11	30.76		Departing	KHEZ
								Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	PreSet
				Gain - Fine/Down		Multi		B	PreSet

Air Speed	AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	6500	agl	6,500	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	Base GPS Began Logging At:	11:00:00
								Figure 8-Turns Before Mission	Yes X No
109	179.5	17:48:39	17:49:36		23	0.6	1.1		
110	179.3	17:54:48	18:01:24		21	0.6	1.1		
111	359.3	18:04:44	18:11:16		22	0.6	1.1		
112	179.4	18:14:32	18:21:17		25	0.6	1.1		
113	359.4	18:24:39	18:31:08		23	0.6	1		
114	179.4	18:34:10	18:40:48		22	0.6	1.1		
115	359.4	18:44:21	18:54:27		22	0.6	1.1		
116	179.4	18:57:50	19:08:24		22	0.6	1.1		
117	359.4	19:11:54	19:22:14		19	0.7	1.3		
118	179.5	19:25:35	19:36:23		20	0.7	1.3		
119	359.4	19:39:43	19:50:10		21	0.6	1.1		
120	179.5	19:55:19	20:08:28		20	0.6	1.1		
121	359.5	20:11:43	20:26:46		21	0.6	1.1		
122	179.5	20:30:12	20:46:19		20	0.7	1.3		
123	359.5	20:49:32	21:04:41		19	0.7	1.3		
124	179.6	21:08:04	21:23:54		19	0.7	1.3		
125	359.5	21:27:26	21:42:30		19	0.7	1.3		
126	179.6	21:45:02	22:00:57		19	0.7	1.2		
127	359.5	22:04:26	22:19:16		17	0.8	1.4		

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Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/9/2017	9	77025	2	USGS MISSIPPI, Natchez

Operator	Aircraft	HOBBS Start	Local Start Time IMU	ZULU Start Time IMU	Base
Linville	N111SD	344.8	4:49:00	22:49:00	WOOLPERT PIN
Pilot	**Sensor Type**				**PID**
LaROCQUE	OTHER	346.8	7:00:00	1:00:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
160@11g20	10	clr	0	14	6	30.37		Departing	KHEZ
								Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	PreSet
				Gain - Fine/Down		Multi		B	PreSet

Air Speed	AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	6500	agl	6,500	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	Base GPS Began Logging At:	4:40:00
								Figure 8-Turns Before Mission	Yes X No
128	179.6	23:09:31	23:24:28		18	0.7	1.2	could not capture ladt 5 miles of line	
								128 due to clouds	
1	358.9	23:42:20	23:43:00		23	0.6	1.1	all flights are right at base of clounds	
2	179.0	23:46:54	23:47:53		23	0.6	1.1		
3	359.0	23:51:26	23:52:31		24	0.5	1.1		
4	179.0	23:57:30	23:59:53		24	0.5	1.1		
5	359.0	0:03:22	0:05:49		24	0.5	1.1		
6	359.0	0:13:56	0:21:10		21	0.6	1.2		
7	179.1	0:24:55	0:33:58		20	0.6	1.2		
9	230.4	0:39:47	0:41:39		19	0.6	1.3	Line 9 is an F flight	

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Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/13/2017	13	76268	2	USGS MISSIPPI, Natchez

Operator	Aircraft	HOBBS Start	Local Start Time IMU	ZULU Start Time IMU	Base
Linville	N6255Q	346.8	3:19:00	21:19:00	WOOLPERT PIN
Pilot	**Sensor Type**				**PID**
Larocque	Leica 8170	351.6	8:23:00	2:23:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KHEZ
070@07kts	10	80	OVC	22	18	30.39		Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	50	272	100	Gain - Course/Up		Single		A	PreSet
				Gain - Fine/Down		Multi		B	PreSet

Air Speed	AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	6500	agl	6,500	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	Base GPS Began Logging At: 4:40:00
								Figure 8-Turns Before Mission Yes X No
8	359.0	21:40:25	21:48:49		15	0.8	1.5	Cld @ 11 m to 9 m
9	179.1	21:51:44	22:00:53		16	0.7	1.3	
10	359.1	22:04:07	22:12:44		16	0.7	1.2	
11	179.1	22:15:41	22:25:01		16	0.8	1.4	
12	359.1	22:28:26	22:37:00		16	0.8	1.3	
13	179.1	22:40:00	22:49:11		16	0.8	1.2	
14	359.1	22:52:22	23:01:16		17	0.7	1.2	
15	179.2	23:04:15	23:13:40		18	0.6	1.1	
16	359.1	23:16:52	23:25:50		20	0.6	1.1	
17	179.2	23:28:53	23:38:10		20	0.6	1.1	
18	359.2	23:41:38	23:50:53		21	0.6	1.1	
19	179.2	23:54:07	00:03:45		18	0.6	1.3	
20	359.2	00:07:04	00:16:29		19	0.6	1.2	
21	179.2	00:19:36	00:29:03		19	0.6	1.3	
22	359.2	00:32:32	00:41:45		17	0.6	1.3	
23	179.3	00:44:54	00:53:54		17	0.6	1.4	
24	359.2	00:57:13	01:07:33		22	0.6	1.1	cld @ 19m - 20m
25	179.3	01:11:00	01:21:38		21	0.6	1.3	cld @ 10m - 11m
F	Flts							
10	271.6	01:27:32	01:29:34		20	0.6	1.3	
11	042.2	01:34:29	01:37:04		20	0.6.	1.3	
12	185.5	01:40:36	01:42:56		20	0.6	1.3	
13	205.0	01:49:12	01:52:42		20	0.6	1.3	
14	183.0	01:58:23	02:01:43		21	0.6	1.2	

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Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/14/2017	14	76268	0.02	USGS Natchez, Mississippi

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Justin Linville	N6255Q	351.6	9:11:00	15:11:00	woolpert pin
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Ray Larocque	Leica 8170	355.5	1:23:00	19:23	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KHEZ
150@6kts	10sm		clear	17	15	30.45		Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	50	272	100%	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150 kts	Kts	6500	Ft	6500	Ft	Yes		No	x	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 8:47:00
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes No
26	359.1	15:46:31	15:57:10		19	0.6	1.1	
27	179.3	16:00:26	16:10:57		20	0.6	1.1	
28	359.3	16:14:02	16:24:31		18	0.6	1.3	
29	179.3	16:27:34	16:37:33		18	0.7	1.3	
30	359.3	16:41:07	16:51:42		19	0.6	1.2	
31	179.4	16:54:57	17:05:17		20	0.6	1.1	
32	359.3	17:08:46	17:19:35		21	0.5	1.1	
33	179.4	17:22:54	17:33:26		22	0.6	1.1	
34	359.4	17:36:48	17:48:20		21	0.6	1.1	
35	179.4	17:51:47	18:03:11		23	0.6	1.1	
36	359.4	18:06:34	18:18:52		22	0.6	1.1	
8	179.3	18:29:22	18:30:32		24	0.6	1	Patch for clouds
24	359.2	18:35:53	18:37:55		23	0.6	1	Patch for clouds
25	179.3	18:40:27	18:41:24		21	0.7	1.2	Patch for clouds
F	Flights							
6	181.0	18:56:01	18:57:11		22	0.7	1.2	
5	001.0	18:59:57	19:01:10		22	0.7	1.1	
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes No

Additional Comments: Drive #

Notes: Patch flights 8, 24, and 25 for clouds. Two missions were flown this day. This is the first mission,labelled as Day014A

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/14/2017	14	76268	0.02	USGS Natchez, Mississippi

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Justin Linville	N6255Q	355.8	2:42:00	20:42:00	woolpert pin
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Ray Larocque	Leica 8170	357	4:03.00	22:03	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
220@6kts	10sm		clear	23	11	3035		Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	50	272	100%	Gain - Course/Up		Single		A	pre-set
				Gain - Fine/Down		Multi		B	pre-set

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.
150	Kts	6500	Ft	6500	Ft	Yes		No	X	@ NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	2:30 - 4:30
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission	Yes / No
2	263	21:09:24	21:10:16		18	0.7	1.2		
3	083.6	21:13:28	21:14:26		18	0.7	1.2		
4	222.6	21:17:40	21:18:16		18	0.7	1.2		
1	272	21:37:42	21:38:14		18	0.7	1.2		

↑ Times entered are Zulu / GMT ↑		Page	1	Verify S-Turns After Mission	Yes / No

Additional Comments: Drive #

This is the second mission of this day, also known as Day014B. Flights in F Block

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/15/2017	15	76268	0.02	USGS Natchez, Mississippi

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Justin Linville	N6255Q	357.3	6:43:00	0:48:00	woolpert pin
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Ray Larocque	Leica 8170	359.7	9:33	03:26:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
100@4kts	10sm		clear	18	14	30.13		Departing	KHEZ
								Arriving	KHEZ

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
40	50	272	100%	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	Kts	6500	Ft	6500	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	6:43 - 9:33
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission	Yes / No
129	359.6	01:23:14	01:37:58		19	0.6	1.2		
130	179.6	01:41:16	01:56:53		19	0.6	1.3		
131	359.6	02:00:07	02:14:53		23	0.6	1		
132	179.6	02:18:12	02:33:31		22	0.6	1.1		
128	359.5	02:36:58	02:39:57		20	0.6	1.3		
7	001.5	02:55:29	02:56:11		21	0.6	1.1		
8	180.3	02:59:27	03:00:31		21	0.6	1.1		

↑ Times entered are Zulu / GMT ↑		Page	1	Verify S-Turns After Mission	Yes / No

Additional Comments: Drive #

Section 7: Final Deliverables

The final lidar deliverables are listed below.

- LAS v1.4 classified point cloud
- LAS v1.4 raw unclassified point cloud flight line strips.
- Hydro Breaklines as ESRI shapefile
- Bridge Breaklines as ESRI shapefile
- Digital Elevation Model in ERDAS .IMG format
- 8-bit gray scale intensity images in .TIF format
- 0.3 meters contours
- Tile layout provided as ESRI shapefile
- Control Points provided as ESRI shapefile
- FGDC compliant metadata per product in XML format
- Lidar processing report in pdf format
- Survey report in pdf format