Airborne Lidar Report

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CO San Juan 2017 D17

Contract Number: G16PC00022
Task Number: G17PD01197

Contractor: Woolpert, Inc.
Woolpert Project # 77866

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Section 1: Overview

TASK ORDER NAME: CO San Juan 2017 D17

Project: # 77866

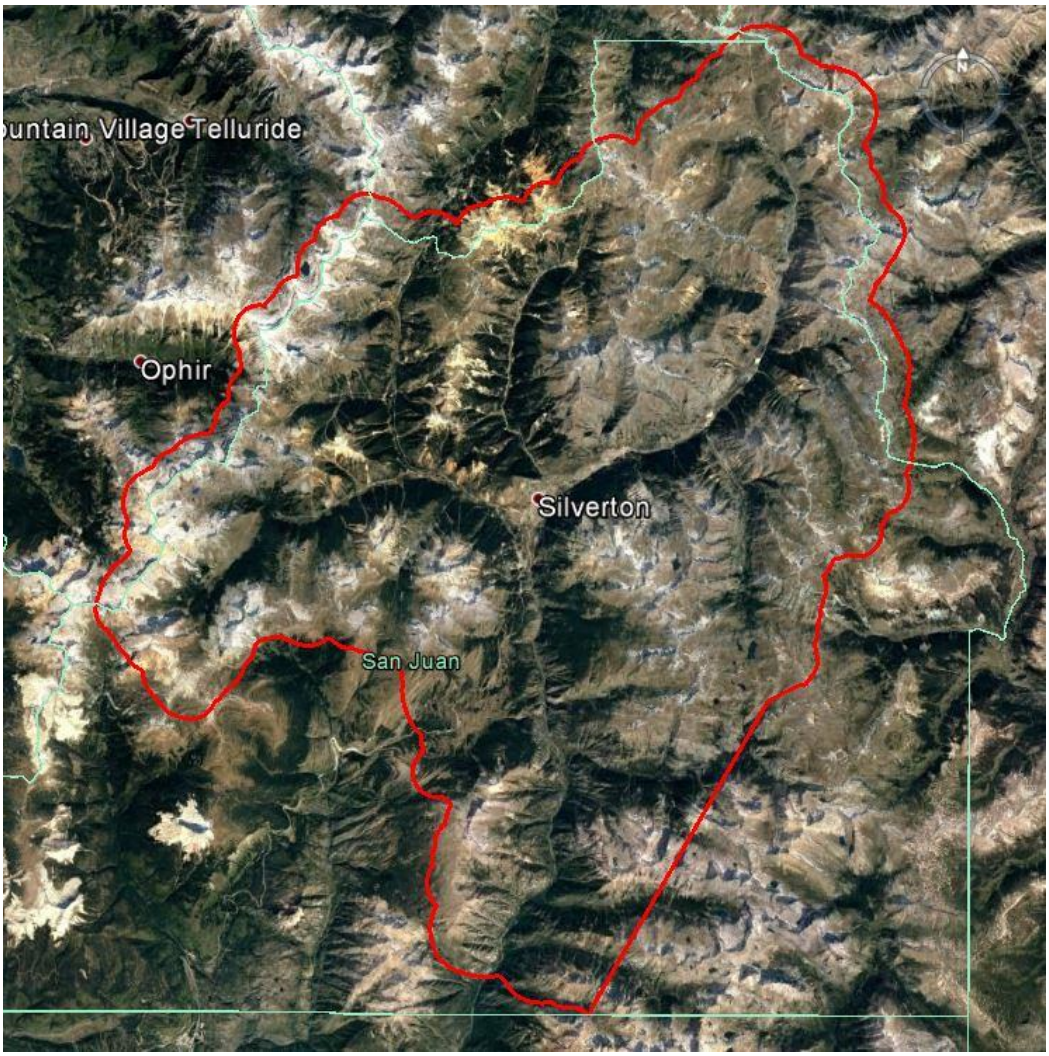
This report contains a comprehensive outline of the CO San Juan 2017 D17 Lidar task order for the United States Geological Survey (USGS) issued under USGS Contract No. G16PC00022, Task Order No. G17PD01197. This task consists of lidar data acquisition, and processing over an area of highly varied and rugged terrain located in southwest Colorado (+/- 232 sq. mi) of USGS V.1.2 lidar. The data were acquired at a NPS of no greater than 0.35 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 a single Optech Galaxy lidar sensor on board a Cessna 310Q aircraft. The Galaxy sensor collects up to eight 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: Optech Galaxy Specifications	
Post Spacing	0.35 m
AGL (Above Ground Level) average flying height	1,250 m
Average Ground Speed:	140 knots
Field of View (full)	28 degrees
Pulse Rate	500 kHz
Scan Rate	72 Hz
Side Lap	40%

The horizontal datum used for the task order was referenced to NAD83 (2011), Zone 13, Meters. The vertical datum used for the task order was referenced to NAVD 1988 (GEOID12B), Meters.

Figure 1.1: CO San Juan 2017 D17 - Task Order AOI



Section 2: Acquisition

The lidar data was acquired with one Optech Galaxy lidar sensor system. The Galaxy lidar system, developed by Teledyne Optech of Vaughan, Ontario, Canada.

Table 2.1: Galaxy Lidar System Specifications

Parameter	Specification
Sensor Performance	
Performance envelope [1, 2, 3, 4]	150-4700 m AGL, nominal
Absolute horizontal accuracy [2, 3]	1/10,000 x altitude; 1 σ
Absolute elevation accuracy [2, 3]	< 0.03-0.20 m RMSE from 150-4700 m A
Laser Configuration	
Topographic laser	1064-nm near-infrared
Laser classification	Class IV (US FDA 21 CFR 1040.10 and 1040.11; IEC/EN 60825-1)
Pulse repetition frequency (effective)	Programmable, 50-1000 kHz
Beam divergence	0.25 mrad (1/e)
Laser range precision [5]	< 0.008 m, 1 σ
Minimum target separation distance	< 0.7 m (discrete)
Range capture	Up to 8 range measurements, including last
Intensity capture	Up to 8 intensity measurements, including last (12-bit)
Sensor Configuration	
Position and orientation system	POS AV™ AP60 (OEM); 220-channel dual frequency GNSS receiver; GNSS airborne antenna with Iridium filters; high-accuracy AIMU (Type 57); non-ITAR
Scan angle (FOV)	10-60°
Swath width	10-115% of altitude AGL
Scan frequency	0-120 Hz advertised (0-240 scan lines/sec)
Scan product	2000 maximum
Flight management system	Optech FMS (Airborne Mission Manager and Nav) with operator console
SwathTRAK™	Dynamic FOV for fixed-width data swaths in variable terrain
PulseTRAK™	Multipulse tracking algorithm with no density loss across PIA transition zones
Roll compensation	±5° minimum
Data storage	Internal solid-state drive (SSD)
Power requirements	28 V; 300 W
Dimensions and weight	Sensor: 0.34 x 0.34 x 0.25 m, 27 kg — PDU: 0.42 x 0.33 x 0.10 m, 6.5 kg
Operating temperature	0 to +35°C

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 12 (twelve) missions. An initial quality control process was performed immediately on the lidar data to review the data coverage, airborne GPS data, and trajectory solution. Collection of lidar data took place between September 16, 2017 and October 24, 2017.

Table 2.3: Airborne Lidar Acquisition Flight Summary

Date of Acquisition	Lines Flown	Acquisition Time (UTC)
September 16, 2017_A	**42, 43**	**1:58 – 2:25**
September 17, 2017_A	**36, 37, 40, 41**	**13:48 – 14:50**
September 18, 2017_A	**1, 2**	**13:48 – 14:05**
September 18, 2017_B	**39**	**2:09 – 2:26**
September 19, 2017_A	**34, 35, 38, 45, 69-81**	**15:35 – 18:29**
September 20, 2017_A	**1-8, 51-68**	**13:23 – 17:30**
September 20, 2017_B	**9-17**	**23:56 – 1:49**
September 21, 2017_A	**32, 33, 37, 41, 42, 44-50**	**14:13 – 17:07**
September 25, 2017_A	**18-31**	**18:42 – 21:42**
September 26, 2017_A	**82-91**	**16:41 – 17:49**
October 8, 2017_A	**96-106**	**17:09 – 18:12**
October 24, 2017_A	**1-12**	**15:34 – 17:19**

Section 3: Lidar Data Processing

Applications and Work Flow Overview

Raw lidar data is imported into LMS 4.1 as well as the processed SBET. The final output coordinate system is chosen. The correct .las format is then selected. The data is processed thru a standard process and then a refined process, which incorporates a bundle adjustment to the entire block of data. Once complete, the data is imported into the MARS8 software. A DZ ortho is produced to verify that flight line to flight line separation is meeting specifications and also to make sure there are no data gaps. Ground control points are then imported and a check point report is produced. Once all ground control points are meeting spec, a ground control point report is exported.

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)
DP6610	37° 57’ 13.23328 "	107° 54’ 16.62412 "	2740.490
HL0671	37° 09’ 31.83433"	107° 45’ 10.11433"	2014.163

Data Processing

GPS and IMU processing is done using POSPac MMS 8.0 software. The raw POS data is imported and the correct type of antenna is selected. The base station data is imported and the coordinates are modified to either an OPUS solution or an NGS datasheet. The correct antenna type and height are inputted. The coordinate system in which the base station data coordinates were inputted is chosen (ie NAD83 2011 or ITRF). The data is then processed in the "IN-Fusion Single Base" mode. The display plots are then reviewed for spec/quality criteria.

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:

- 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/Processed but not classified (Class 1), Bare earth ground (Class 2), Low Noise (Class 7), Water (Class 9), Ignored ground (Class10), Bridge Decks (Class 17), and High Noise (Class 18) classifications.
- FGDC CSDGM USGS MetaParser-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 13, Meters. The vertical datum used for the task order was referenced to NAVD 1988 (GEOID12B), Meters.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

The CO San Juan 2017 D17 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

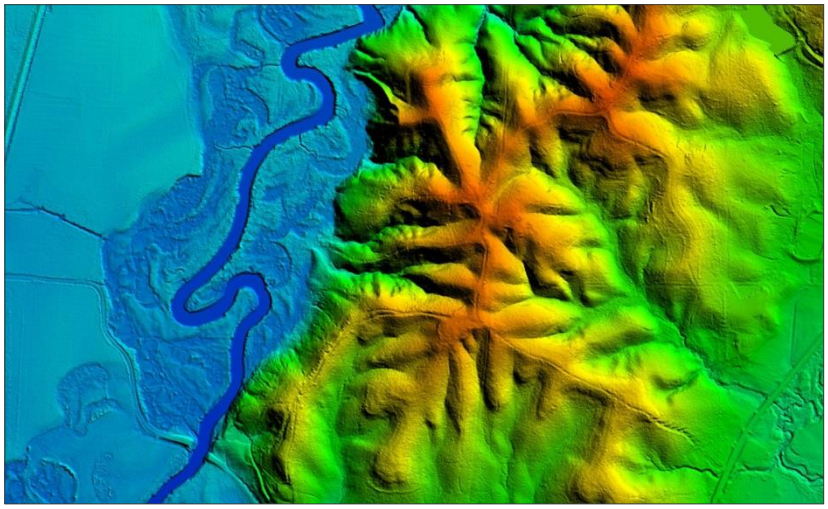


Figure 4.2: Reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the “tinning” across the lake surface.

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.

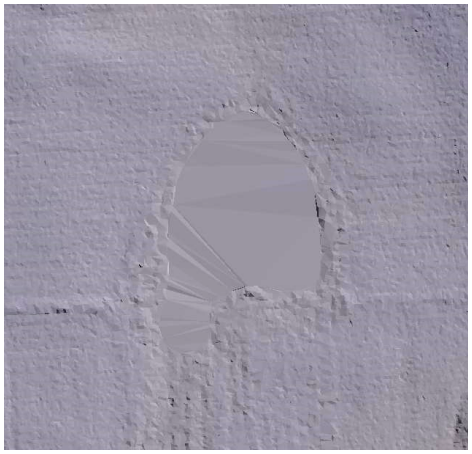


Figure 4.2

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 GDB format. The breaklines defining the water bodies greater than 2-acre were provided in shapefile format as Polygon-Z shapefiles. No rivers and streams, at a nominal minimum width of 30 meters (100 feet), were found.

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	-0.018	Meter
Minimum error	-0.111	Meter
Maximum error	0.116	Meter
Average magnitude	0.038	Meter
Root mean square	0.049	Meter
Standard deviation	0.046	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	261948.261	4198815.954	3340.535	3340.520	-0.015
2001_A	261910.116	4198788.696	3342.194	3342.190	-0.004
2001_B	261967.168	4198826.918	3339.753	3339.730	-0.023
2002	260779.240	4179870.150	3226.061	3226.050	-0.011
2002_A	260751.940	4179840.537	3223.243	3223.190	-0.053
2003	254493.077	4193701.236	3335.866	3335.810	-0.056
2003_A	254523.373	4193687.333	3339.499	3339.450	-0.049
2004	264914.237	4187508.280	2821.548	2821.580	0.032
2004_A	264751.522	4187497.209	2822.843	2822.880	0.037
2004_B	265040.658	4187467.303	2820.172	2820.230	0.058
2005	270169.584	4190064.822	2933.890	2933.920	0.030
2005_A	270218.149	4190026.556	2916.475	2916.500	0.025
2006	274342.437	4196075.883	3073.476	3073.450	-0.026
2007	273211.013	4201493.425	3471.845	3471.790	-0.055
2008	276105.316	4185746.746	3768.572	3768.480	-0.092
2009	260148.357	4192793.234	3047.524	3047.640	0.116
2009_A	260115.630	4192814.436	3050.529	3050.630	0.101
2010	267445.026	4199163.635	3507.805	3507.770	-0.035
2010_A	267432.544	4199209.573	3511.402	3511.410	0.008
2011	264408.859	4192491.556	3022.072	3022.090	0.018
2012	265563.519	4196331.729	3143.042	3143.020	-0.022
2012_A	265578.272	4196367.444	3144.229	3144.220	-0.009
2013	276705.086	4192672.452	3393.416	3393.420	0.004

2013_A	275893.825	4193562.867	3264.447	3264.410	-0.037
2014	253149.629	4185153.366	3253.516	3253.520	0.004
2014_A	253137.491	4185195.084	3252.239	3252.250	0.011
2014_B	253125.914	4185149.556	3254.612	3254.610	-0.002
2015	255092.315	4190198.536	3648.167	3648.150	-0.017
2015_A	255071.975	4190158.702	3639.273	3639.220	-0.053
2016	256877.213	4187817.812	2980.298	2980.270	-0.028
2017	258529.992	4188616.155	2950.454	2950.440	-0.014
2017_A	258497.451	4188584.401	2950.699	2950.680	-0.019
2018	270197.989	4197977.983	3746.999	3746.950	-0.049
2018_A	270102.550	4198004.170	3738.504	3738.510	0.006
2019	273668.839	4198177.755	3821.654	3821.560	-0.094
2020	274152.382	4199671.590	3644.917	3644.840	-0.077
2020_A	274120.392	4199683.282	3650.732	3650.660	-0.072
2021	275393.253	4201518.663	3626.921	3626.810	-0.111
2022	272930.226	4188509.133	3052.741	3052.740	-0.001
2023	270027.710	4187405.689	3231.411	3231.400	-0.011
2023_A	270025.542	4187416.679	3230.565	3230.550	-0.015
2024	271938.123	4196671.775	3373.004	3372.920	-0.084
2025	258833.013	4197058.208	3758.646	3758.620	-0.026
2025_A	258877.659	4197082.607	3752.685	3752.660	-0.025
2025_B	258965.878	4197069.445	3750.233	3750.180	-0.053

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.096 Meters Non- vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using 0.049 Meters (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using all lidar points against 45 NVA points.

LAS 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 0.050 Meters (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using lidar ground points against 45 NVA points.

Table 5.3: NVA Check Point Analysis DEM

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	DEM Elevation (Meter)	Dz (Meter)
2001	261948.261	4198815.954	3340.535	3340.550	0.015
2001_A	261910.116	4198788.696	3342.194	3342.230	0.036
2001_B	261967.168	4198826.918	3339.753	3339.770	0.017

2002	260779.24	4179870.15	3226.061	3226.060	-0.001
2002_A	260751.94	4179840.537	3223.243	3223.140	-0.103
2003	254493.077	4193701.236	3335.866	3335.840	-0.026
2003_A	254523.373	4193687.333	3339.499	3339.450	-0.049
2004	264914.237	4187508.28	2821.548	2821.580	0.032
2004_A	264751.522	4187497.209	2822.843	2822.900	0.057
2004_B	265040.658	4187467.303	2820.172	2820.220	0.048
2005	270169.584	4190064.822	2933.89	2933.900	0.010
2005_A	270218.149	4190026.556	2916.475	2916.490	0.015
2006	274342.437	4196075.883	3073.476	3073.450	-0.026
2007	273211.013	4201493.425	3471.845	3471.740	-0.105
2008	276105.316	4185746.746	3768.572	3768.460	-0.112
2009	260148.357	4192793.234	3047.524	3047.610	0.086
2009_A	260115.63	4192814.436	3050.529	3050.640	0.111
2010	267445.026	4199163.635	3507.805	3507.720	-0.085
2010_A	267432.544	4199209.573	3511.402	3511.400	-0.002
2011	264408.859	4192491.556	3022.072	3022.030	-0.042
2012	265563.519	4196331.729	3143.042	3143.020	-0.022
2012_A	265578.272	4196367.444	3144.229	3144.200	-0.029
2013	276705.086	4192672.452	3393.416	3393.490	0.074
2013_A	275893.825	4193562.867	3264.447	3264.340	-0.107
2014	253149.629	4185153.366	3253.516	3253.540	0.024
2014_A	253137.491	4185195.084	3252.239	3252.220	-0.019
2014_B	253125.914	4185149.556	3254.612	3254.610	-0.002
2015	255092.315	4190198.536	3648.167	3648.130	-0.037
2015_A	255071.975	4190158.702	3639.273	3639.190	-0.083
2016	256877.213	4187817.812	2980.298	2980.250	-0.048
2017	258529.992	4188616.155	2950.454	2950.430	-0.024
2017_A	258497.451	4188584.401	2950.699	2950.680	-0.019
2018	270197.989	4197977.983	3746.999	3746.970	-0.029
2018_A	270102.55	4198004.17	3738.504	3738.520	0.016
2019	273668.839	4198177.755	3821.654	3821.520	-0.134
2020	274152.382	4199671.59	3644.917	3644.820	-0.097
2020_A	274120.392	4199683.282	3650.732	3650.680	-0.052
2021	275393.253	4201518.663	3626.921	3626.830	-0.091
2022	272930.226	4188509.133	3052.741	3052.760	0.019
2023	270027.71	4187405.689	3231.411	3231.370	-0.041
2023_A	270025.542	4187416.679	3230.565	3230.550	-0.015
2024	271938.123	4196671.775	3373.004	3372.880	-0.124
2025	258833.013	4197058.208	3758.646	3758.590	-0.056
2025_A	258877.659	4197082.607	3752.685	3752.670	-0.015

2025_B	258965.878	4197069.445	3750.233	3750.180	-0.053

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.120 Meters Non-Vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using 0.061 Meters (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM against 45 NVA points.

Table 5.4: VVA Quality Check Point Analysis DEM

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	DEM Elevation (Meter)	Dz (Meter)
3001	261940.375	4198824.022	3339.231	3339.28	0.049
3001_A	261867.079	4198728.228	3341.692	3341.92	0.228
3001_B	261900.287	4198816.855	3342.369	3342.43	0.061
3002	253213.938	4185220.74	3249.611	3249.54	-0.071
3002_A	253105.049	4185224.311	3251.665	3251.63	-0.035
3002_B	253125.932	4185123.349	3254.354	3254.52	0.166
3003	260809.788	4179873.899	3227.821	3227.79	-0.031
3003_A	260794.544	4179823.282	3217.37	3217.47	0.100
3004	274078.288	4193726.641	2997.899	2997.88	-0.019
3004_A	273993.424	4193744.263	2991.507	2991.47	-0.037
3005	257926.988	4188239.255	2965.924	2966.02	0.096
3005_A	257968.742	4188276.352	2964.706	2964.95	0.244
3006	271620.576	4190721.871	2949.202	2949.22	0.018
3006_A	271581.651	4190749.807	2946.857	2947	0.143
3007	265079.245	4187545.905	2820.298	2820.39	0.092
3007_A	265105.35	4187570.627	2820.696	2820.92	0.224
3008	260204.535	4192323.782	3071.273	3071.34	0.067
3008_A	260179.209	4192302.358	3067.1	3067.19	0.090
3009	259212.602	4195213.143	3199.292	3199.28	-0.012
3009_A	259180.04	4195205.294	3200.965	3200.9	-0.065
3009_B	259185.333	4195245.655	3203.112	3203.1	-0.012
3010	267343.275	4198622.108	3429.249	3429.12	-0.129
3010_A	267360.195	4198652.644	3430.593	3430.3	-0.293
3011	265936.046	4196704.628	3158.768	3158.78	0.012
3011_A	265999.22	4196727.95	3160.752	3160.72	-0.032
3012	264401.102	4192437.057	3014.446	3014.63	0.184
3013	274701.644	4200760.455	3345.007	3344.93	-0.077
3013_A	274676.485	4200737.92	3339.258	3339.2	-0.058

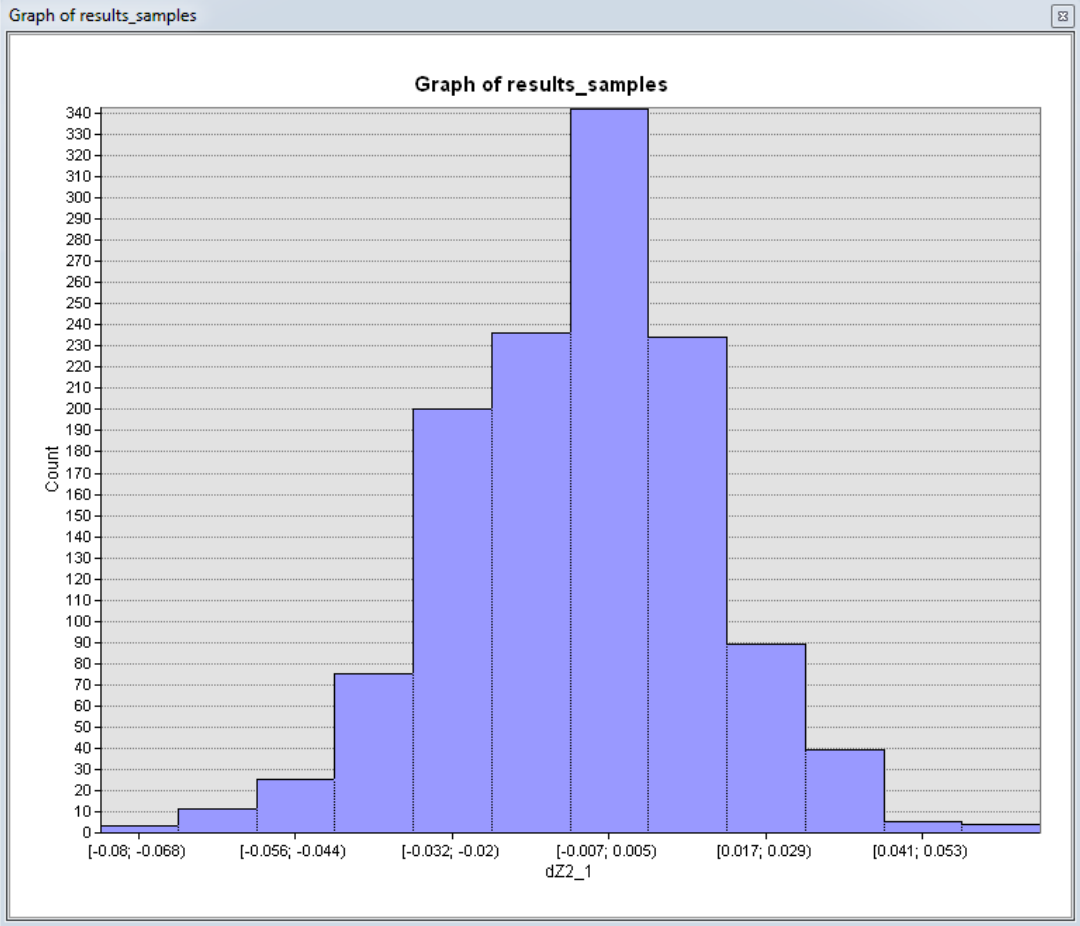
3014	264507.268	4183303.997	3176.251	3176.17	-0.081
3014_A	264488.841	4183389.046	3176.818	3176.84	0.022

VERTICAL ACCURACY CONCLUSIONS

Vegetated Vertical Accuracy (VVA) Tested 0.257 Meters at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM against 30 VVA points. VVA Errors larger than 95th percentile include:

Point 3010_A, Easting 267360, Northing 4198652, Z-Error 0.290 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 lidar measured at 0.020 Meters RMSDz.

Approved by:	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		May 2018

Section 6: Flight Logs

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

Woolpert

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/16/2017 A		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
140	Kts	4100	Ft	15000	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:	
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission	Yes X No
42	S	1:58:00	2:07:00		20		1		
43	N	2:11:00	2:18:00	0:00:00	19		1		
TL	W	2:23:00	2:25:00	0:00:00	19		1		
				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

MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
9/17/2017 A		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					
Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used		Waveform Mode	Pre-Trigger Dist.
140	Kts	4100	Ft	15000	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:
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No
40	N	13:48:00	13:56:00		16		1	
41	S	14:05:00	14:13:00	0:00:00	13		1.1	
36	N	14:18:00	14:26:00	0:00:00	13		1.3	
*37	S	14:31:00	14:39:00	0:00:00	14		1.3	2.5 miles eol remain/refly/tie line
TL	E	14:45:00	14:47:00	0:00:00	13		1.3	
TL	W	14:49:00	14:50:00	0:00:00	13		1.3	
				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

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/18/2017 A		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
1	N	13:48:00	13:52:00		16		0.9	trace snow above tree line
2	S	13:56:00	13:59:00	0:00:00	15		1	1.75 miles remain eol/laser off 13:59
TL	W	14:03:00	14:05:00	0:00:00	13		1.2	
				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

MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
9/18/2017 B		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
39	S	2:09:00	2:18:00		21		0.99	
TL	W	2:25:00	2:26:00	0:00:00	21		1	
				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:	Drive #

Woolpert

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/19/2017 A		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
38	N	15:35:00	15:44:00		17		1	crab reached 20
35	S	15:48:00	15:57:00	0:00:00	18		1.1	refly first 1.5 miles fse
34	N	16:01:00	16:10:00	0:00:00	18		1.2	refly first 1.5 miles fse
81	S	16:20:00	16:22:00	0:00:00	18		1.1	
80	N	16:27:00	16:28:00	0:00:00	17		1.1	
79	S	16:34:00	16:37:00	0:00:00	18		1	
78	N	16:41:00	16:44:00	0:00:00	18		1	crab reached 23
77	S	16:49:00	16:52:00	0:00:00	18		1	
76	N	16:56:00	16:59:00	0:00:00	20		1.7	
75*	S	17:04:00	17:08:00	0:00:00	19		1	turb first mile fne
74	N	17:13:00	17:16:00	0:00:00	17		1.1	
75*	S	17:22:00	17:26:00	0:00:00	17		1.1	*reflight
73	N	17:30:00	17:34:00	0:00:00	17		1.1	
72	S	17:39:00	17:44:00	0:00:00	16		1.2	
71	N	17:47:00	17:52:00	0:00:00	16		1.2	
70	S	17:56:00	18:00:00	0:00:00	16		1.2	
69	N	18:03:00	18:07:00	0:00:00	16		1.2	
45	S	18:12:00	18:12:00	0:00:00	17		1.1	stopped laser 1 mile fne/refly
TL	W	18:18:00	18:29:00	0:00:00	17		1	
				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

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/20/2017 A		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
*68	N	13:23:00	13:28:00		17		1	
67	S	13:34:00	13:39:00	0:00:00	18		0.94	
66	N	13:42:00	13:47:00	0:00:00	18		0.9	
65	S	13:52:00	13:57:00	0:00:00	15		1	
64	N	14:01:00	14:06:00	0:00:00	15		1.1	
63	S	14:11:00	14:16:00	0:00:00	14		1.1	
62	N	14:19:00	14:24:00	0:00:00	15		1	
61	S	14:28:00	14:34:00	0:00:00	15		1	
60	N	14:37:00	14:43:00	0:00:00	15		1.1	
59	S	14:47:00	14:52:00	0:00:00	15		1.1	
58	N	14:56:00	15:01:00	0:00:00	16		1.1	
57	S	15:05:00	15:11:00	0:00:00	16		1.1	
56	N	15:14:00	15:19:00	0:00:00	16		1.1	
55	S	15:25:00	15:30:00	0:00:00	16		1.2	
54	N	15:33:00	15:39:00	0:00:00	17		1.2	
53	S	15:43:00	15:48:00	0:00:00	18		1.1	
52	N	15:52:00	15:57:00	0:00:00	18		1.2	
51	S	16:01:00	16:06:00	0:00:00	18		1.2	
*1	N	16:13:00	16:16:00	0:00:00	17		1.1	reflight from 9/18/17 (trace snow)
*2	S	16:19:00	16:23:00	0:00:00	19		1	reflight from 9/18/17 (trace snow)
3	N	16:26:00	16:29:00	0:00:00	19		1	
4	S	16:33:00	16:37:00	0:00:00	18		1	
5	N	16:40:00	16:44:00	0:00:00	18		1	
6	S	16:48:00	16:53:00	0:00:00	18		1	
7	N	16:56:00	17:01:00	0:00:00	16		1.2	
8	S	17:04:00	17:10:00	0:00:00	18		1	
TL	E	17:12:00	17:14:00	0:00:00	17		1.1	500 kHz
TL	W	17:21:00	17:26:00	0:00:00	17		1.1	100 kHz
TL	E	17:29:00	17:30:00	0:00:00	17		1.1	
				0:00:00				
				0:00:00				
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes No

Additional Comments:

Drive #

Woolpert

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/20/2017 B		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
140	Kts	4100	Ft	15000	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:	
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission	Yes X No
9	S	23:56:00	0:03:01		16		1.3		
10	N	0:06:19	0:12:56	0:00:00	16		1.3		
11	S	0:17:28	0:24:27	0:00:00	19		1		
12	N	0:27:13	NA	0:00:00	18		1	Speed was too fast, refly	
12	N	0:34:21	0:40:43	0:00:00	18		1		
13	S	0:45:07	0:52:48	0:00:00	19		1		
14	N	0:55:25	1:02:00	0:00:00	20		1		
15	S	1:06:00	1:14:00	0:00:00	20		0.9		
16	N	1:17:00	1:25:00	0:00:00	19		1		
17	S	1:29:00	1:38:00	0:00:00	18		1.1		
TL	W	1:43:00	1:49:00	0:00:00	18		1.1	100 kHz	
				0:00:00					
				0:00:00					
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				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

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/21/2017 B		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
50	N	14:13:00	14:18:00		14		1.2	
49	S	14:24:00	14:32:00	0:00:00	15		1.1	
48	N	14:35:00	14:40:00	0:00:00	16		1	
47	S	14:46:00	14:55:00	0:00:00	16		1.1	
46	N	14:58:00	15:05:00	0:00:00	16		1.1	
45	S	15:12:00	15:21:00	0:00:00	15		1.2	reflight (9/19/17)
44	N	15.25:00	15:33:00	0:00:00	16		1.1	
33	S	15:36:00	15:46:00	0:00:00	17		1.1	
41	N	15:48:00	15:56:00	0:00:00	17		1.2	reflight (9/17/17)
42	S	16:02:00	16:11:00	0:00:00	18		1	reflight (9/16/17)
37	S	16:17:00	16:22:00	0:00:00	17		1.1	reflight (9/17/17)
TL	W	16:26:00	16:32:00	0:00:00	17		1	tie line for line 37 *reflight*
32	N	16:40:00	16:48:00	0:00:00	17		1	speed a little high toward eol
TL	W	16:57:00	17:07:00	0:00:00	19		0.94	
				0:00:00				
				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:

Drive #

Woolpert

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/25/2017 B		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
31	S	18:42:00	18:51:00		19		0.99	trace snow north facing slopes above t
30	N	18:55:00	19:04:00	0:00:00	19		0.99	
29	S	19:08:00	19:17:00	0:00:00	18		0.97	
28	N	19:21:00	19:30:00	0:00:00	17		1	
27	S	19:36:00	19:45:00	0:00:00	16		1	
26	N	19:49:00	19:58:00	0:00:00	17		0.9	
25	S	20:02:00	20:11:00	0:00:00	16		1	
24	N	20:15:00	20:24:00	0:00:00	16		1	
23	S	20:27:00	20:36:00	0:00:00	15		1.1	
22	N	20:39:00	20:48:00	0:00:00	16		1.1	
21	S	20:52:00	21:01:00	0:00:00	16		1.2	
20	N	21:04:00	21:12:00	0:00:00	16		1.1	
19	S	21:16:00	21:24:00	0:00:00	17		0.99	
18	N	21:28:00	21:35:00	0:00:00	16		1	
tl	W	21:41:00	21:42:00	0:00:00	17		0.92	100khz
				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

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	9/26/2017 B		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
82	W	16:41:00	16:43:00		17		1.1	no snow
83	E	16:46:00	16:48:00	0:00:00	17		1.1	no snow
84	W	16:51:00	16:53:00	0:00:00	17		1.1	no snow
85	E	16:58:00	17:00:00	0:00:00	17		1.1	no snow
86	W	17:03:00	17:05:00	0:00:00	18		1.1	no snow
tl	S	17:08:00	17:10:00	0:00:00	17		1.1	100 khz
				0:00:00				
91	E	17:15:00	17:17:00	0:00:00	16		1.2	
90	W	17:21:00	17:24:00	0:00:00	16		1.2	
89	E	17:27:00	17:30:00	0:00:00	16		1	
88	W	17:33:00	17:36:00	0:00:00	16		1	
87	E	17:41:00	17:44:00	0:00:00	16		1	
tl	S	17:48:00	17:49:00	0:00:00	17		1	
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↑ Times entered are Zulu / GMT ↑			Page		1			Verify S-Turns After Mission Yes No

Additional Comments:

Drive #

Woolpert

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/8/2017 A		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
102	S	17:09:00	17:10:00	0:00:00	13		1.4	
103	N	17:16:00	17:17:00	0:00:00	13		1.2	
104	S	17:20:00	17:22:00	0:00:00	14		1.2	
105	N	17:26:00	17:28:00	0:00:00	14		1.2	
106	S	17:31:00	17:32:00	0:00:00	14		1.3	
TL	W	17:36:00	17:38:00	0:00:00	14		1.3	
TL	E	17:41:00	17:42:00	0:00:00	14		1.3	
96	N	17:45:00	17:47:00	0:00:00	15		1.3	
97	S	17:49:00	17:51:00	0:00:00	16		1.2	
98	N	17:54:00	17:55:00	0:00:00	16		1.1	
99	S	18:00:00	18:02:00	0:00:00	17		1.1	
100	N	18:05:00	18:06:00	0:00:00	17		1.2	
101	S	18:11:00	18:12:00	0:00:00	17		1.2	
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes No

Additional Comments:

Drive #

Woolpert

	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/24/2017 A		77866		CO San Juan 2017 D17

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Other					

Pilot	Sensor Type	HOBBS END	Local End Time	Zulu End Time	PID
Other	OTHER				

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
28	72	500	High	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
140	Kts	4100	Ft	15000	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:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
9	S	15:34:00	15:35:00	0:00:00	13		1.5	
9	N	15:44:00	15:44:00	0:00:00	13		1.7	
10	W	15:57:00	15:57:00	0:00:00	13		1.4	
6	E	16:04:00	16:05:00	0:00:00	12		1.4	
5	N	16:12:00	16:13:00	0:00:00	14		1.2	
11	N	16:15:00	16:16:00	0:00:00	14		1.3	
12	N	16:23:00	16:23:00	0:00:00	15		1.3	
8	W	16:25:00	16:26:00	0:00:00	15		1.3	
7	W	16:30:00	16:32:00	0:00:00	15		1.3	
4	SW	16:43:00	16:44:00	0:00:00	15		1.3	
3	NE	16:49:00	16:51:00	0:00:00	15		1.3	
1	N	16:58:00	16:59:00	0:00:00	17		1.1	
2	W	17:04:00	17:05:00	0:00:00	17		1.2	
2	W	17:12:00	17:13:00	0:00:00	16		1.2	
2	E	17:18:00	17:19:00	0:00:00	16		1.2	
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↑ 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.

- Unclassified lidar point data swaths in LAS v1.4 format
- Classified point cloud data tiles in LAS v1.4 format
- Breaklines in Esri GDB
- 1-meter digital elevation model (DEM) tiles in ERDAS IMG format
- 1-meter, 8-bit gray-scale intensity image tiles in GeoTIF format
- Tile layout in Esri shapefile format
- Boundary in Esri shape file format
- Control and QA/QC checkpoints in Esri shapefile format
- Flight line boundaries in Esri shapefile format
- Task level FGDC compliant metadata in XML format
- Lidar processing report in PDF format
- Survey report in PDF format