

Airborne LiDAR Report



SOUTH PLATTE NE QL2 LIDAR

Contract Number: G10PC00057

Task Number: G15PD01037

Contractor: Woolpert, Inc.
Woolpert Project # 75955

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Section 1: Overview

TASK ORDER NAME: South Platte NE QL2 Lidar

Project: # 75955

This report contains a comprehensive outline of the South Platte NE QL2 Lidar Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G10PC00057, Task Order No. G15PD01037. This task order requires lidar data to be acquired over Banner, Kimball, Cheyenne, Deuel, Keith, and Lincoln Counties (approximately 4,988 square miles) 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 a Leica ALS80 HP 1000 kHz Multiple Pulses in Air (MPIA) lidar systems on board Woolpert 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

Post Spacing	0.70 m
AGL (Above Ground Level) average flying height	1981m
Average Ground Speed:	150 knots
Field of View (full)	40 degrees
Pulse Rate	320/360 kHz
Scan Rate	50 Hz
Side Lap	25%

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

Table 1.1: ALS70 Specifications - PAR

Post Spacing	0.70 m
AGL (Above Ground Level) average flying height	1813 m
Average Ground Speed:	150 knots
Field of View (full)	40 degrees
Pulse Rate	272 kHz
Scan Rate	46 Hz
Side Lap	25%

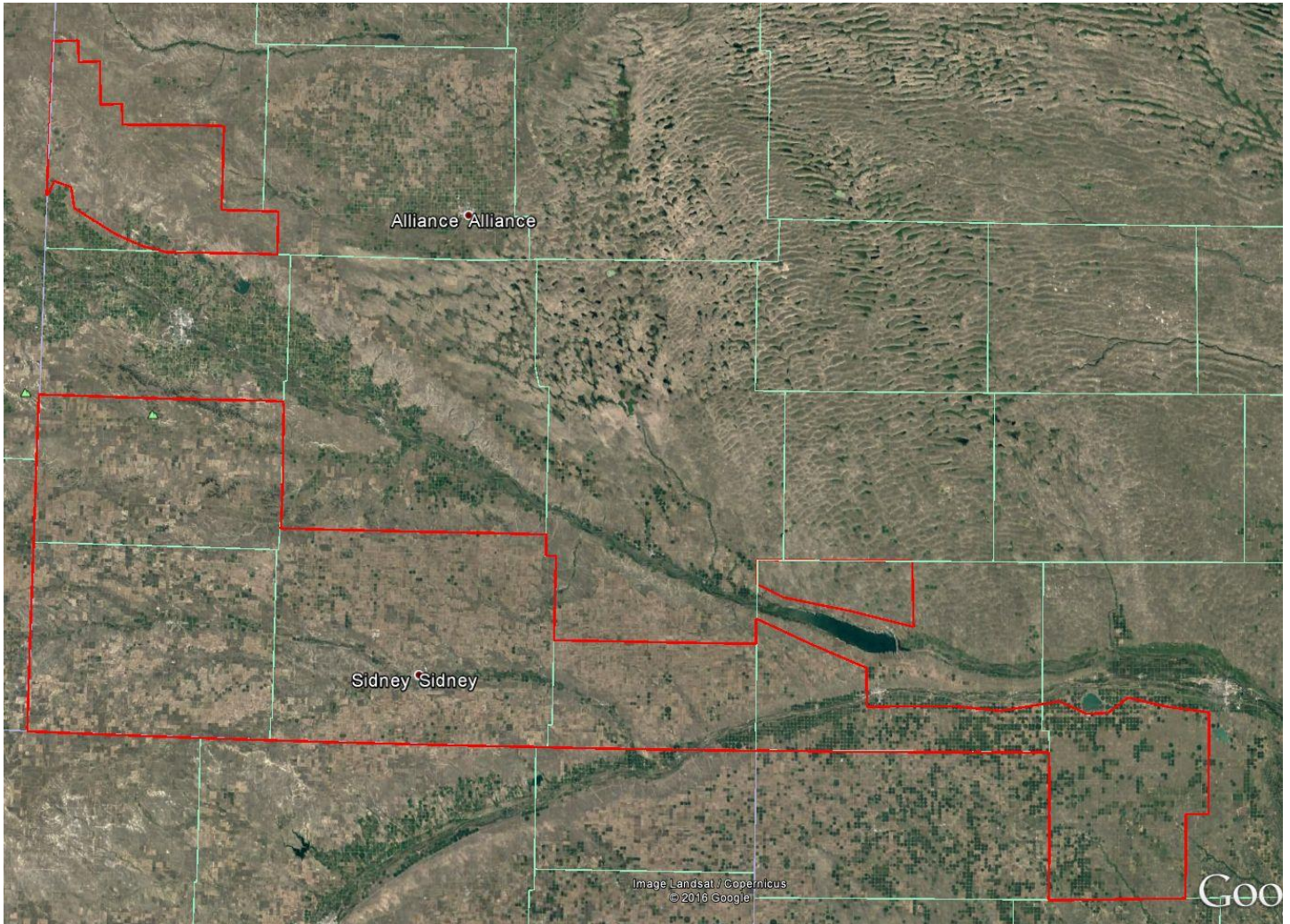
- One Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) lidar sensor owned and operated by **ASI**. The sensor was mounted in ASI aircraft. The aerial lidar was collected at the following sensor specifications:

Table 1.1: ALS70 Specifications - ASI

Post Spacing	0.70 m
AGL (Above Ground Level) average flying height	1828 m
Average Ground Speed:	150 knots
Field of View (full)	40degrees
Pulse Rate	272 kHz
Scan Rate	41 Hz
Side Lap	25%

LiDAR data was produced in NAD 1983(2011) UTM Zone 13 North, NAVD88 Geoid12B meters. A portion of the project area falls in UTM Zone 14 North. This data was reprojected from UTM 13N and products were generated for delivery.

Figure 1.1: South Platte NE QL2 Lidar Task Order AOI



Section 2: Acquisition

The lidar data was acquired with a Leica ALS80HP 1000 kHz Multiple Pulses in Air (MPiA) Lidar Sensor System. 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
Power Requirements	28 VDC @ 25A
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 two (22) mission, 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.

Figure 2.1: LiDAR Flight Layout, South Platte NE QL2 Lidar

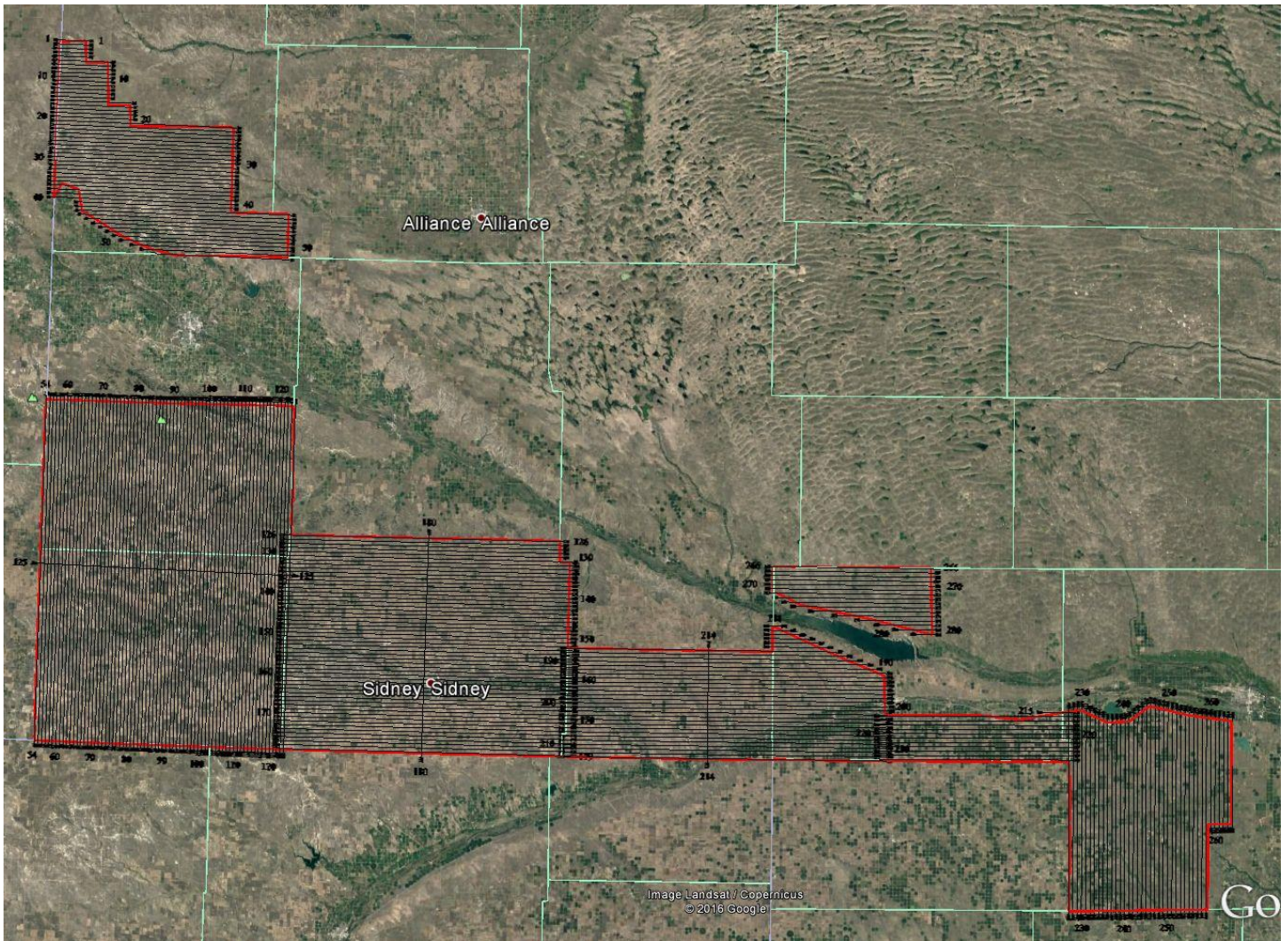


Table 2.2: Airborne Lidar Acquisition Flight Summary

Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down
March 15, 2016	263-265	10:33- 11:31
March 20, 2016	1-42	14:40- 22:05
March 21, 2016	43-63	15:00- 21:45
March 22, 2016	252-263	22:29- 0:51
April 8, 2016_PAR_A	64-72, 125	16:18 – 16:34
April 8, 2016_PAR_B	73-82	22:48 -3:94
April 9, 2016_PAR	83-92	14:24 – 19:38
April 12, 2016_PAR	93-102	13:46 – 18:53
April 13, 2016_PAR_A	102-112	13:18 – 18:56
April 13, 2016_PAR_B	113-118	19:27 – 23:14
April 14, 2016_PAR	119-124	13:15 – 16:57
April 21, 2016_PAR	176-180	13:12 - 15:58
April 22, 2016_PAR_A	164-176	11:16 – 16:55
April 22, 2016_PAR_B	152-163	11:16 – 16:55
April 23, 2016_PAR_A	139-151	12:26 – 18:17
April 23, 2016_PAR_B	126-138	19:16 - 0:52
April 24, 2016_PAR	205-214	14:20 – 19:11
April 25, 2016_PAR	194-204	14:30 - 18:49
May 2, 2016	213, 252, 266-281	15:54 – 19:10
May 3, 2016	181-187, 215-230	18:07- 22:25
May 4, 2016	187-196, 231-246	15:28- 22:00
May 5, 2016	247-263	15:48- 17:05

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:

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
NGS PID MM0352	41°07'59.89396"	100°42'31.23925"	825.471
KBFF Airport Base	41°52'12.81249"	103°35'38.41986"	1184.148
NGS PID AB4161	41°11'13.37354"	103°40'30.38505"	1478.526
NGS PID MN0080	41°06'14.14929"	102°59'16.75625"	1288.409
NGS PID MN0657	41°04'32.56343"	102°27'39.19769"	1100.984
KOGA Airport Base	41°07'08.54162"	101°45'36.68271"	967.253

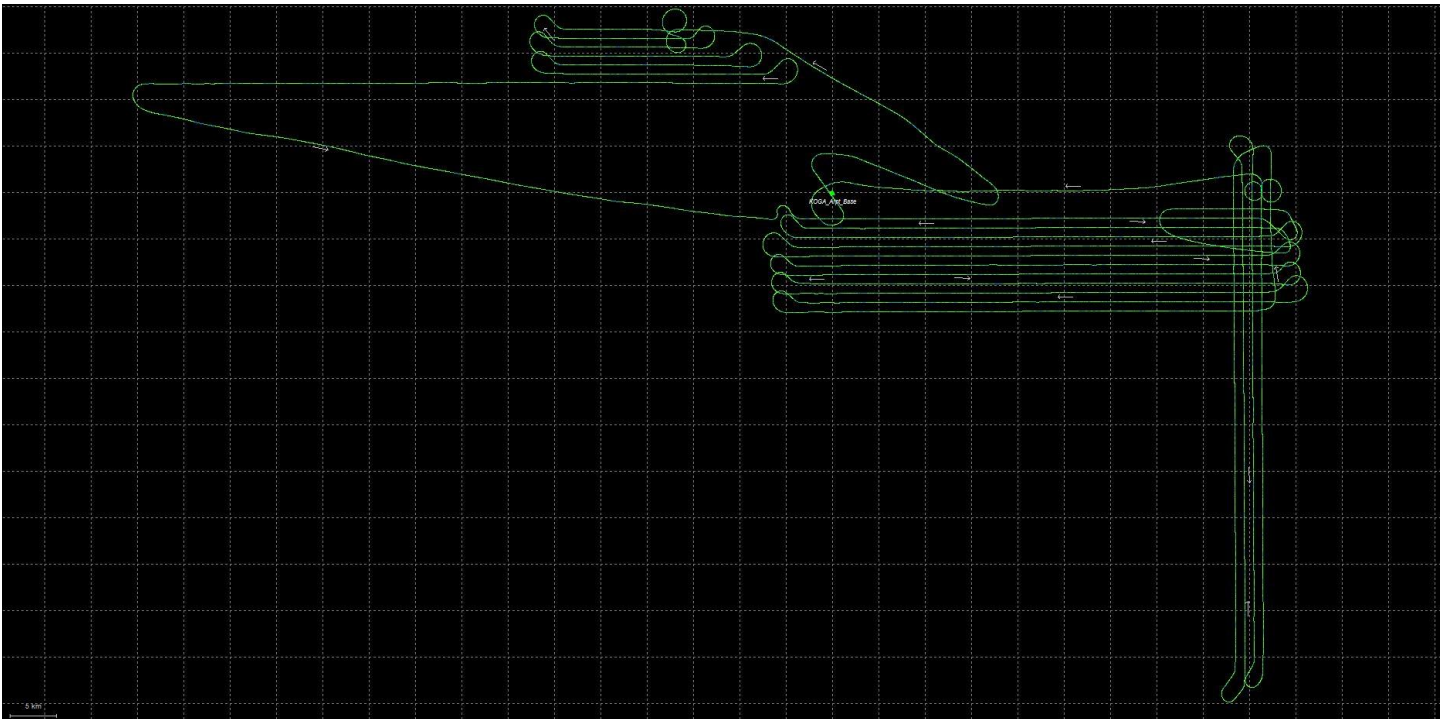
Data Processing

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).

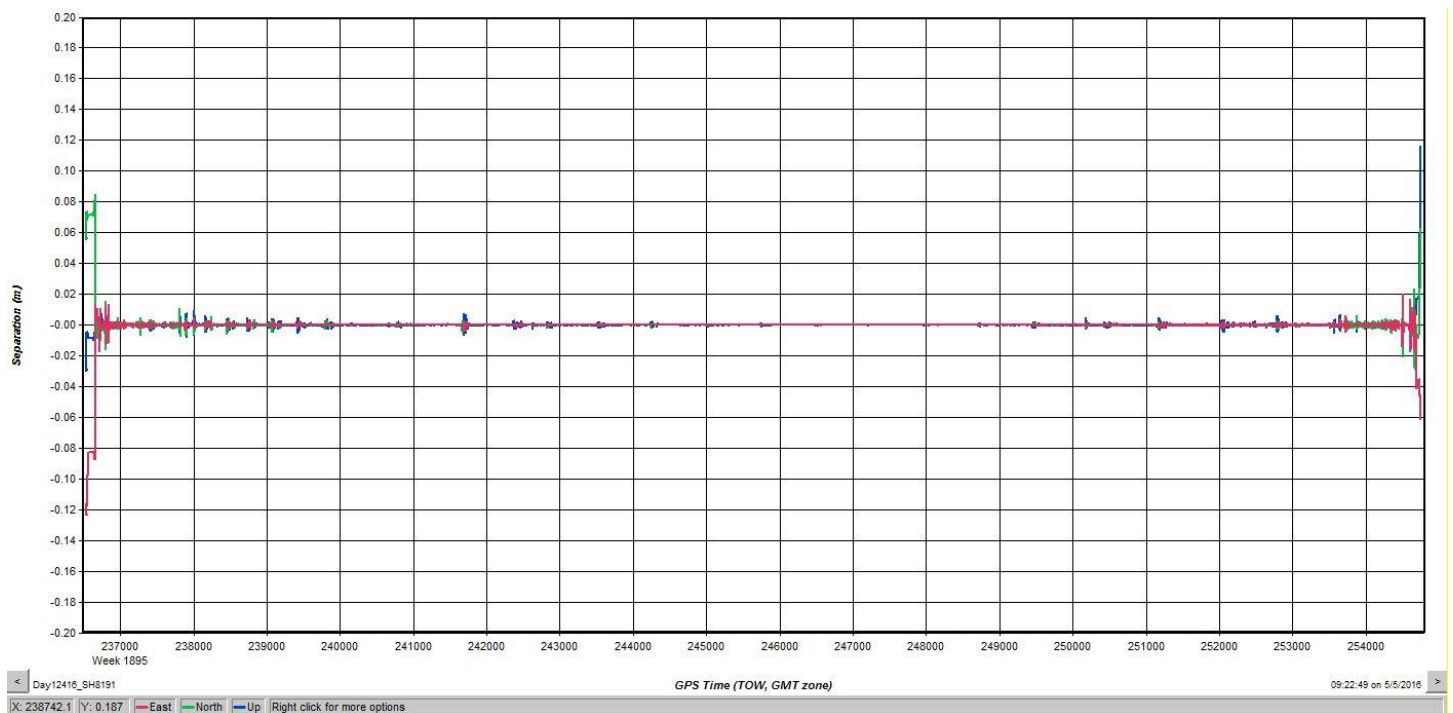
Figure 3.1: Trajectory, Day12416_SH8191



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, Day12416_SH8191

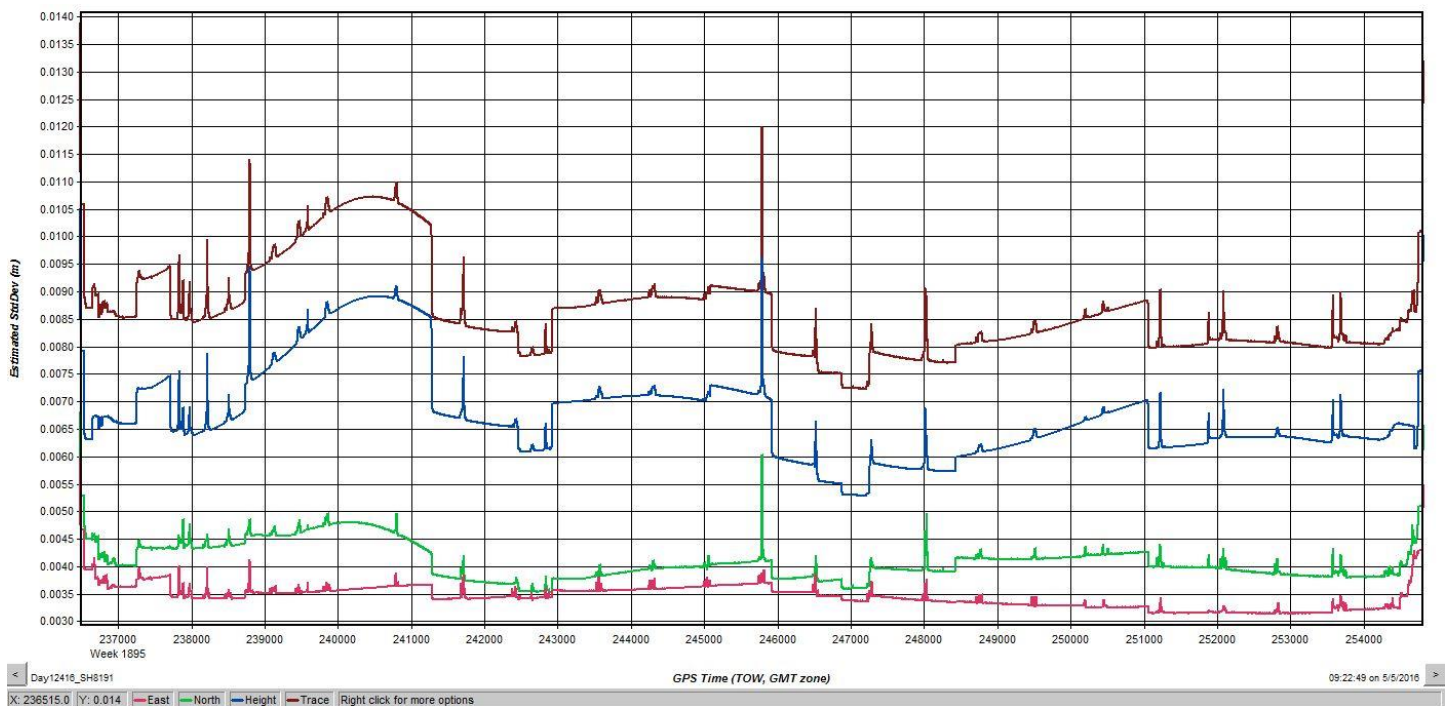


Estimated Positional Accuracy

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, Day12416_SH8191

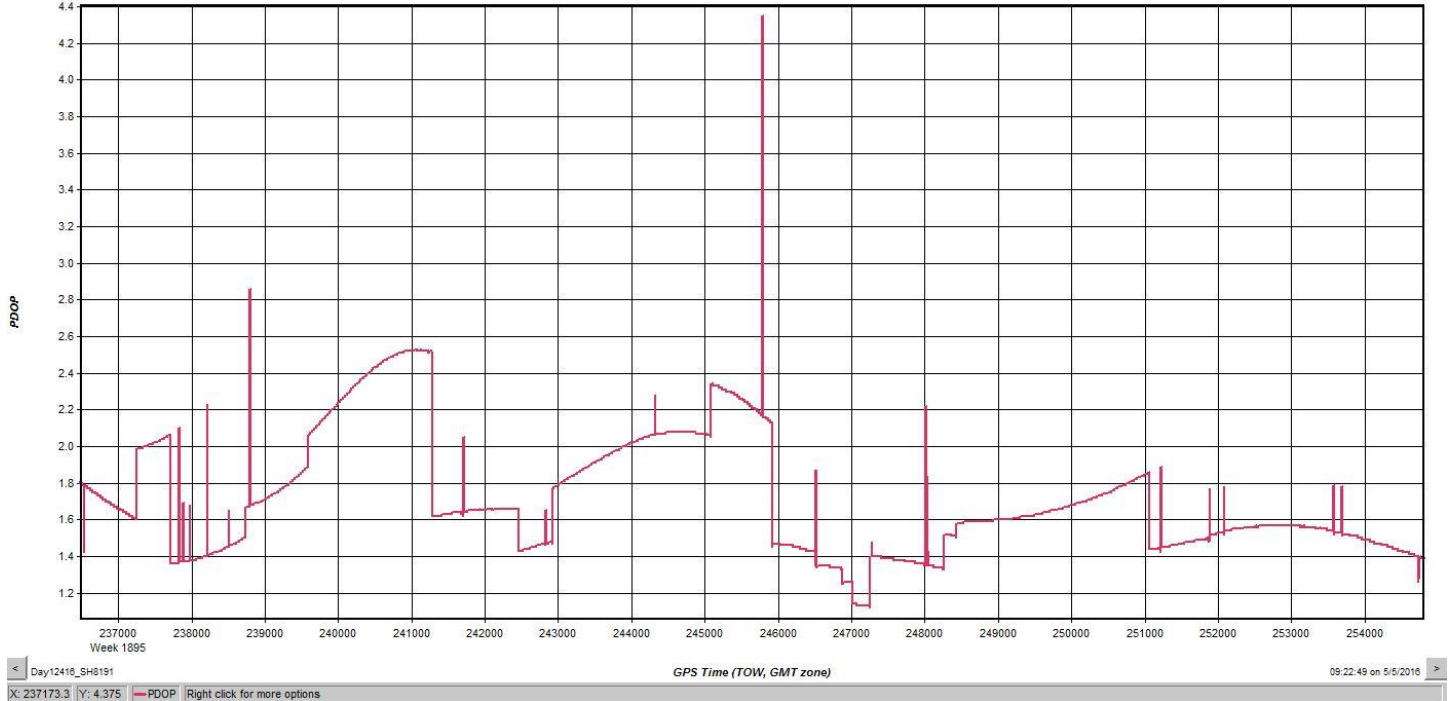


PDOP

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, Day12416_SH8191



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 (Class 17), High Noise (Class 18) classifications.
- Although hydro flattening was a requirement for this task order no hydro features satisfied the USGS LBS version 1.2 criteria for hydro collection. Bridge breaklines were also compiled in efforts to generate an accurate DEM product. The bridge breakline product was delivered in ESRI shapefile format and was also used in the processing of the DEM deliverable.
- 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) UTM13N meters. The vertical datum used for the task order was referenced to NAVD 1988, meters, GEOID12B. A portion of the project area falls in UTM Zone 14 North. This data was reprojected from UTM 13N and products were generated for delivery.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

South Platte NE QL2 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

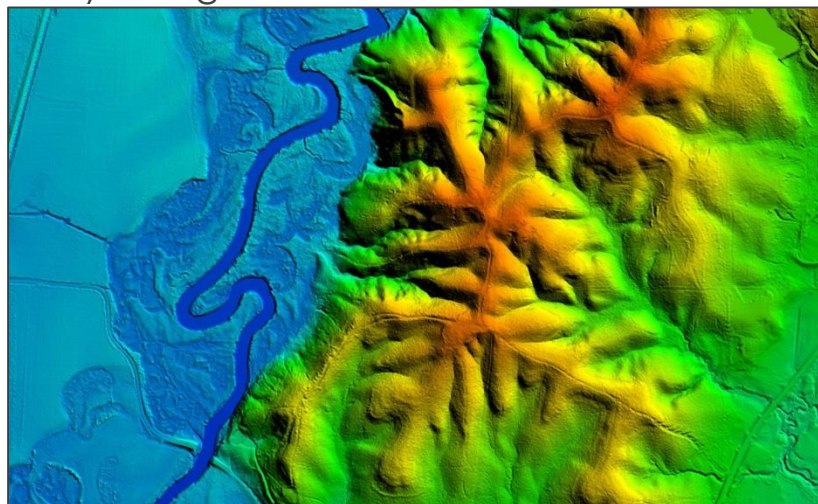


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the “tinning” across the lake surface.

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 as an ESRI Shapefile. 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 v15, 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	0.004	Meter
Minimum error	-0.119	Meter
Maximum error	+0.140	Meter
Average magnitude	0.031	Meter
Root mean square	0.039	Meter
Standard deviation	0.039	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	579901.735	4697814.933	1460.898	1460.830	-0.068
2002	580388.401	4694855.289	1440.954	1440.940	-0.014
2003	580547.252	4690784.479	1418.417	1418.420	0.003
2004	579700.398	4685747.479	1394.744	1394.740	-0.004
2005	578905.654	4681792.760	1358.377	1358.340	-0.037
2006	599682.714	4674349.562	1520.869	1520.830	-0.039
2007	609113.907	4668709.073	1422.436	1422.420	-0.016
2008	609193.469	4662644.853	1422.324	1422.340	0.016
2009	597979.619	4658442.856	1282.712	1282.720	0.008
2010	609328.815	4653730.450	1293.971	1294.010	0.039
2011	609414.121	4651070.368	1326.107	1326.150	0.043
2012	598559.329	4668685.984	1460.268	1460.250	-0.018
2013	579500.630	4559842.324	1534.569	1534.520	-0.049
2014	585625.153	4610310.751	1387.280	1387.250	-0.030
2015	587999.637	4539675.332	1620.205	1620.240	0.035
2016	593095.418	4564947.990	1483.615	1483.630	0.015
2017	596040.918	4586288.845	1540.506	1540.560	0.054
2018	600604.806	4579611.563	1538.463	1538.500	0.037
2019	606311.845	4562053.713	1508.499	1508.380	-0.119
2020	608423.145	4610803.618	1295.618	1295.610	-0.008
2021	614940.527	4604371.088	1348.660	1348.800	0.140
2022	620428.074	4580205.639	1465.916	1466.010	0.094

2023	626149.977	4543514.765	1466.503	1466.540	0.037
2024	636655.570	4564463.944	1355.597	1355.590	-0.007
2025	628797.379	4604690.331	1261.698	1261.740	0.042
2026	668503.520	4588838.736	1295.934	1295.980	0.046
2027	645800.038	4584000.236	1379.483	1379.480	-0.003
2028	655016.034	4580085.926	1350.487	1350.530	0.043
2029	669604.839	4576694.299	1305.538	1305.490	-0.048
2030	686862.930	4572203.274	1248.033	1248.060	0.027
2031	698647.442	4568066.048	1199.400	1199.390	-0.010
2032	702172.888	4556668.121	1156.482	1156.470	-0.012
2033	695921.032	4585282.819	1215.388	1215.420	0.032
2034	701213.433	4546859.531	1222.472	1222.520	0.048
2035	682528.379	4552772.314	1258.612	1258.640	0.028
2036	657425.593	4561038.864	1286.704	1286.720	0.016
2037	640229.034	4555082.653	1408.394	1408.420	0.026
2038	656538.894	4548932.337	1350.280	1350.250	-0.030
2039	643382.647	4545446.533	1350.897	1350.980	0.083
2040	668008.214	4541484.389	1335.318	1335.320	0.002
2041	733377.588	4543226.873	1050.141	1050.160	0.019
2042	719235.382	4544276.211	1095.596	1095.640	0.044
2043	712375.651	4551132.869	1121.634	1121.670	0.036
2044	723139.141	4555512.961	1152.267	1152.180	-0.087
2045	707627.154	4563158.160	1200.942	1200.960	0.018
2046	727793.756	4561506.561	1152.293	1152.250	-0.043
2047	736912.527	4551103.389	1103.771	1103.790	0.019
2048	748342.500	4569175.649	1154.832	1154.780	-0.052
2049	760552.467	4564749.537	1128.119	1128.110	-0.009
2050	768936.949	4562400.589	1102.457	1102.440	-0.017
2051	743830.670	4561005.289	1111.096	1111.080	-0.016
2052	759976.981	4558653.102	1103.619	1103.600	-0.019
2053	751661.828	4554779.962	1085.518	1085.550	0.032
2054	745826.892	4549577.151	1026.840	1026.820	-0.020
2055	757492.536	4544471.277	1082.928	1082.880	-0.048
2056	772846.335	4549117.944	1053.128	1053.170	0.042
2057	775143.398	4544648.254	1043.839	1043.790	-0.049
2058	781128.571	4553394.331	1022.013	1022.000	-0.013
2059	796286.887	4551632.324	1007.562	1007.590	0.028
2060	787961.590	4547956.493	1018.262	1018.220	-0.042
2061	806044.540	4547187.039	989.530	989.490	-0.040
2062	806046.030	4554942.500	953.772	953.690	-0.082
2063	815014.294	4552425.520	965.102	965.110	0.008

2064	820262.039	4526632.281	957.991	958.050	0.059
2065	825042.475	4514261.970	981.058	981.070	0.012
2066	830313.994	4523980.712	933.453	933.440	-0.013
2067	831819.220	4541852.161	967.716	967.690	-0.026
2068	826603.922	4554530.398	946.079	946.060	-0.019
2069	842218.021	4556795.105	910.304	910.350	0.046
2070	851840.628	4537881.408	931.678	931.680	0.002
2071	846290.886	4528682.278	904.058	904.040	-0.018
2072	836924.787	4551759.949	940.323	940.300	-0.023
2073	847690.850	4550574.931	923.101	923.080	-0.021
2074	836858.525	4535600.488	959.798	959.750	-0.048
2075	821305.249	4539681.142	969.634	969.630	-0.004
2076	831433.580	4535368.888	959.967	959.960	-0.007
2077	837640.323	4527663.741	956.551	956.520	-0.031
2078	835980.834	4520671.330	929.985	929.990	0.005
2079	841123.588	4513552.161	923.183	923.190	0.007
2080	845951.917	4546070.110	937.114	937.090	-0.024
2081	823649.902	4546639.783	962.269	962.280	0.011
2082	812174.416	4546221.131	997.676	997.670	-0.006
2083	766781.425	4555056.479	995.806	995.790	-0.016
2084	676299.931	4566997.448	1276.995	1277.040	0.045
2085	645518.655	4574167.635	1374.294	1374.250	-0.044
2086	585376.257	4595827.608	1587.603	1587.650	0.047
2087	615331.583	4552998.963	1496.345	1496.320	-0.025
2088	596393.960	4549428.691	1574.898	1574.960	0.062
2089	589437.429	4579744.142	1571.992	1571.960	-0.032
2090	601496.357	4600878.758	1406.937	1407.020	0.083
2091	611991.327	4593571.032	1509.357	1509.400	0.043
2092	579984.094	4666394.955	1319.224	1319.200	-0.024
2093	658435.433	4573125.513	1330.596	1330.630	0.034
2094	682233.827	4583326.273	1263.572	1263.570	-0.002
2095	628180.274	4593372.505	1423.701	1423.770	0.069
2096	622534.554	4655660.941	1397.233	1397.250	0.017
2097	690752.263	4564265.855	1221.789	1221.820	0.031
2098	714976.985	4558543.870	1183.023	1183.010	-0.013
2099	735908.137	4559116.242	1137.635	1137.640	0.005
2100	761416.729	4552570.124	1003.426	1003.480	0.054
2101	781453.029	4549433.108	1030.398	1030.390	-0.008
2102	799289.399	4545211.586	1005.277	1005.230	-0.047
2103	810184.437	4552225.443	979.961	979.940	-0.021
2104	832807.233	4551575.222	945.410	945.400	-0.010

2105	818256.965	4520217.667	1006.536	1006.520	-0.016
2106	833815.305	4514483.873	945.651	945.650	-0.001
2107	843861.174	4523100.640	938.345	938.390	0.045
2108	836385.982	4545261.480	955.778	955.750	-0.028
2109	787559.359	4553726.892	1008.761	1008.710	-0.051
2110	802374.235	4550247.469	1005.631	1005.670	0.039
2111	722779.363	4566787.571	1158.492	1158.490	-0.002
2112	684741.976	4546404.284	1270.331	1270.360	0.029
2113	671558.877	4559475.518	1278.095	1278.070	-0.025
2114	612313.574	4546483.048	1507.026	1507.080	0.054
2115	623334.107	4565969.411	1399.443	1399.460	0.017
2116	583104.466	4574885.546	1583.054	1583.100	0.046
2117	589705.340	4557363.149	1570.169	1570.150	-0.019
2118	611865.110	4572250.396	1484.091	1484.150	0.059
2119	622599.546	4651313.343	1316.573	1316.630	0.057
2120	589536.733	4676683.952	1471.844	1471.860	0.016
2121	589562.674	4673682.464	1442.649	1442.620	-0.029
2122	591237.806	4664575.645	1352.778	1352.800	0.022
2123	579486.828	4671960.130	1312.290	1312.310	0.020
2001_A	579899.314	4697832.225	1460.666	1460.570	-0.096
2002_A	580384.377	4694867.025	1440.943	1440.930	-0.013
2003_A	580533.551	4690748.049	1417.968	1417.940	-0.028
2004_A	579700.260	4685761.831	1394.805	1394.800	-0.005
2005_A	578908.866	4681812.233	1358.426	1358.410	-0.016
2006_A	599689.753	4674350.135	1520.837	1520.830	-0.007
20078_A	781887.083	4575132.095	1016.367	1016.420	0.053
2007_A	609106.772	4668708.838	1422.446	1422.450	0.004
20087_A	773863.094	4584997.118	1080.185	1080.190	0.005
2008_A	609205.586	4662644.075	1422.516	1422.530	0.014
2009_A	597986.118	4658444.799	1282.706	1282.750	0.044
20108_A	749606.551	4580002.891	1046.184	1046.110	-0.074
2010_A	609321.683	4653730.675	1293.993	1293.990	-0.003
2011_A	609403.242	4651077.210	1326.388	1326.390	0.002
2012_A	598565.559	4668683.262	1460.240	1460.260	0.020
2013_A	579500.836	4559850.001	1534.415	1534.360	-0.055
2014_A	585623.551	4610303.913	1387.283	1387.270	-0.013
2015_B	587999.593	4539659.220	1620.607	1620.620	0.013
2016_A	593092.176	4564954.276	1483.610	1483.640	0.030
2017_A	596040.179	4586304.087	1540.620	1540.680	0.060
2018_A	600623.026	4579611.328	1538.321	1538.320	-0.001
2019_A	606274.920	4562039.962	1508.537	1508.470	-0.067

2020_A	608421.117	4610810.446	1295.598	1295.590	-0.008
2021_A	614939.978	4604378.357	1348.725	1348.800	0.075
2022_A	620351.954	4580204.076	1467.361	1467.330	-0.031
2023_B	626158.000	4543514.420	1466.473	1466.400	-0.073
2024_A	636650.038	4564472.565	1355.612	1355.650	0.038
2025_A	628798.391	4604697.644	1261.664	1261.730	0.066
2026_A	668493.005	4588849.418	1296.017	1296.040	0.023
2027_A	645801.704	4584021.383	1379.339	1379.400	0.061
2028_A	655014.918	4580151.394	1348.964	1348.910	-0.054
2029_A	669614.837	4576679.158	1305.576	1305.580	0.004
2030_A	686921.467	4572203.855	1247.832	1247.890	0.058
2031_B	698646.825	4568079.495	1199.424	1199.430	0.006
2032_B	702159.935	4556674.200	1156.641	1156.660	0.019
2033_A	695884.119	4585281.345	1215.563	1215.600	0.037
2034_B	701223.673	4546859.828	1222.419	1222.410	-0.009
2036_A	657407.474	4561049.542	1286.394	1286.410	0.016
2037_B	640244.156	4555082.951	1407.954	1407.970	0.016
2038_B	656524.685	4548932.427	1350.245	1350.230	-0.015
2039_B	643398.361	4545446.842	1351.009	1351.060	0.051
2040_B	668008.205	4541498.802	1335.332	1335.330	-0.002
2041_B	733369.873	4543237.654	1049.255	1049.250	-0.005
2042_B	719230.200	4544283.469	1095.681	1095.680	-0.001
2043_B	712372.722	4551126.290	1121.676	1121.700	0.024
2044_A	723120.828	4555511.758	1152.328	1152.280	-0.048
2045_B	707637.450	4563158.010	1200.869	1200.850	-0.019
2046_A	727792.967	4561525.326	1152.412	1152.350	-0.062
2047_B	736912.200	4551094.867	1103.667	1103.730	0.063
2048_A	748395.855	4569187.294	1155.590	1155.550	-0.040
2049_A	760539.254	4564739.237	1128.144	1128.100	-0.044
2050_A	768918.823	4562417.315	1102.745	1102.730	-0.015
2051_A	743829.502	4561029.922	1110.532	1110.540	0.008
2052_A	759972.264	4558667.702	1103.725	1103.730	0.005
2053_A	751721.117	4554782.397	1085.380	1085.420	0.040
2054_B	745826.313	4549588.991	1026.899	1026.920	0.021
2055_B	757493.028	4544464.261	1082.944	1082.980	0.036
2056_B	772855.733	4549118.049	1053.141	1053.150	0.009
2057_B	775143.442	4544658.530	1043.765	1043.750	-0.015
2058_B	781128.630	4553401.368	1021.902	1021.900	-0.002
2059_B	796294.899	4551632.103	1007.266	1007.280	0.014
2060_B	787961.321	4547961.103	1018.219	1018.220	0.001
2061_B	806054.952	4547187.070	989.356	989.330	-0.026

2062_A	806046.886	4554918.621	953.652	953.640	-0.012
2063_A	815012.391	4552453.543	964.347	964.360	0.013
2064_A	820268.758	4526632.246	957.842	957.900	0.058
2065_B	825034.616	4514260.892	980.553	980.540	-0.013
2066_B	830305.416	4523979.951	933.662	933.620	-0.042
2067_A	831797.038	4541851.465	968.931	968.990	0.059
2068_A	826638.421	4554532.179	945.793	945.770	-0.023
2069_A	842196.375	4556793.797	910.107	910.100	-0.007
2070_B	851826.319	4537880.219	932.390	932.400	0.010
2072_A	836904.223	4551758.627	940.031	940.060	0.029
2073_A	847670.504	4550581.151	922.792	922.770	-0.022
2075_A	821271.220	4539678.964	968.880	968.910	0.030
2076_B	831431.047	4535359.207	959.877	959.890	0.013
2077_A	837646.225	4527664.336	956.559	956.550	-0.009
2078_B	835980.610	4520678.690	930.075	930.060	-0.015
2079_B	841123.060	4513561.273	922.996	923.000	0.004
2080_A	845953.475	4546047.479	937.191	937.210	0.019
2081_A	823656.300	4546658.662	962.101	962.060	-0.041
2082_B	812174.914	4546210.946	997.747	997.730	-0.017
2083_A	766787.086	4555050.085	995.854	995.820	-0.034
2084_A	676299.310	4567017.993	1276.752	1276.800	0.048
2085_A	645509.575	4574140.428	1374.601	1374.570	-0.031
2086_A	585358.787	4595827.098	1587.768	1587.820	0.052
2087_A	615283.551	4552997.637	1496.666	1496.610	-0.056
2088_B	596406.729	4549428.706	1574.906	1574.880	-0.026
2089_A	589453.072	4579746.284	1571.314	1571.300	-0.014
2090_A	601477.485	4600878.627	1407.992	1408.080	0.088
2091_A	611974.953	4593570.301	1509.216	1509.330	0.114
2092_A	579983.841	4666380.810	1319.249	1319.250	0.001

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.076 Meters Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using $(RMSEz) \times 1.96000$ 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 points.

LAS Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.078 Meters Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using $(RMSEz) \times 1.96000$ 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 ground points.

Table 5.3: NVA Check Point Analysis DEM

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	DEM Elevation (Meter)	Dz (Meter)
2001	579901.735	4697814.933	1460.898	1460.840	0.058
2002	580388.401	4694855.289	1440.954	1440.940	0.014
2003	580547.252	4690784.479	1418.417	1418.400	0.017
2004	579700.398	4685747.479	1394.744	1394.740	0.004
2005	578905.654	4681792.760	1358.377	1358.330	0.047
2006	599682.714	4674349.562	1520.869	1520.810	0.059
2007	609113.907	4668709.073	1422.436	1422.480	-0.044
2008	609193.469	4662644.853	1422.324	1422.340	-0.016
2009	597979.619	4658442.856	1282.712	1282.680	0.032
2010	609328.815	4653730.450	1293.971	1294.010	-0.039
2011	609414.121	4651070.368	1326.107	1326.150	-0.043
2012	598559.329	4668685.984	1460.268	1460.300	-0.032
2013	579500.630	4559842.324	1534.569	1534.510	0.059
2014	585625.153	4610310.751	1387.280	1387.260	0.020
2015	587999.637	4539675.332	1620.205	1620.220	-0.015
2016	593095.418	4564947.990	1483.615	1483.540	0.075
2017	596040.918	4586288.845	1540.506	1540.600	-0.094
2018	600604.806	4579611.563	1538.463	1538.470	-0.007
2019	606311.845	4562053.713	1508.499	1508.360	0.139
2020	608423.145	4610803.618	1295.618	1295.570	0.048
2021	614940.527	4604371.088	1348.660	1348.800	-0.140
2022	620428.074	4580205.639	1465.916	1465.920	-0.004
2023	626149.977	4543514.765	1466.503	1466.520	-0.017
2024	636655.570	4564463.944	1355.597	1355.580	0.017
2025	628797.379	4604690.331	1261.698	1261.710	-0.012
2026	668503.520	4588838.736	1295.934	1295.920	0.014
2027	645800.038	4584000.236	1379.483	1379.480	0.003
2028	655016.034	4580085.926	1350.487	1350.490	-0.003
2029	669604.839	4576694.299	1305.538	1305.460	0.078
2030	686862.930	4572203.274	1248.033	1248.060	-0.027
2031	698647.442	4568066.048	1199.400	1199.390	0.010
2032	702172.888	4556668.121	1156.482	1156.460	0.022
2033	695921.032	4585282.819	1215.388	1215.400	-0.012
2034	701213.433	4546859.531	1222.472	1222.500	-0.028
2035	682528.379	4552772.314	1258.612	1258.640	-0.028
2036	657425.593	4561038.864	1286.704	1286.730	-0.026
2037	640229.034	4555082.653	1408.394	1408.410	-0.016
2038	656538.894	4548932.337	1350.280	1350.230	0.050

2039	643382.647	4545446.533	1350.897	1350.910	-0.013
2040	668008.214	4541484.389	1335.318	1335.310	0.008
2041	733377.588	4543226.873	1050.141	1050.130	0.011
2042	719235.382	4544276.211	1095.596	1095.580	0.016
2043	712375.651	4551132.869	1121.634	1121.650	-0.016
2044	723139.141	4555512.961	1152.267	1152.160	0.107
2045	707627.154	4563158.160	1200.942	1200.920	0.022
2046	727793.756	4561506.561	1152.293	1152.250	0.043
2047	736912.527	4551103.389	1103.771	1103.740	0.031
2048	748342.500	4569175.649	1154.832	1154.780	0.052
2049	760552.467	4564749.537	1128.119	1128.100	0.019
2050	768936.949	4562400.589	1102.457	1102.420	0.037
2051	743830.670	4561005.289	1111.096	1111.070	0.026
2052	759976.981	4558653.102	1103.619	1103.560	0.059
2053	751661.828	4554779.962	1085.518	1085.530	-0.012
2054	745826.892	4549577.151	1026.840	1026.830	0.010
2055	757492.536	4544471.277	1082.928	1082.870	0.058
2056	772846.335	4549117.944	1053.128	1053.120	0.008
2057	775143.398	4544648.254	1043.839	1043.780	0.059
2058	781128.571	4553394.331	1022.013	1021.980	0.033
2059	796286.887	4551632.324	1007.562	1007.620	-0.058
2060	787961.590	4547956.493	1018.262	1018.220	0.042
2061	806044.540	4547187.039	989.530	989.490	0.040
2062	806046.030	4554942.500	953.772	953.690	0.082
2063	815014.294	4552425.520	965.102	965.120	-0.018
2064	820262.039	4526632.281	957.991	958.030	-0.039
2065	825042.475	4514261.970	981.058	981.050	0.008
2066	830313.994	4523980.712	933.453	933.460	-0.007
2067	831819.220	4541852.161	967.716	967.670	0.046
2068	826603.922	4554530.398	946.079	946.060	0.019
2069	842218.021	4556795.105	910.304	910.290	0.014
2070	851840.628	4537881.408	931.678	931.680	-0.002
2071	846290.886	4528682.278	904.058	904.010	0.048
2072	836924.787	4551759.949	940.323	940.320	0.003
2073	847690.850	4550574.931	923.101	923.060	0.041
2074	836858.525	4535600.488	959.798	959.750	0.048
2075	821305.249	4539681.142	969.634	969.630	0.004
2076	831433.580	4535368.888	959.967	959.970	-0.003
2077	837640.323	4527663.741	956.551	956.530	0.021
2078	835980.834	4520671.330	929.985	929.980	0.005
2079	841123.588	4513552.161	923.183	923.190	-0.007

2080	845951.917	4546070.110	937.114	937.100	0.014
2081	823649.902	4546639.783	962.269	962.280	-0.011
2082	812174.416	4546221.131	997.676	997.670	0.006
2083	766781.425	4555056.479	995.806	995.750	0.056
2084	676299.931	4566997.448	1276.995	1277.030	-0.035
2085	645518.655	4574167.635	1374.294	1374.250	0.044
2086	585376.257	4595827.608	1587.603	1587.640	-0.037
2087	615331.583	4552998.963	1496.345	1496.280	0.065
2088	596393.960	4549428.691	1574.898	1574.860	0.038
2089	589437.429	4579744.142	1571.992	1571.960	0.032
2090	601496.357	4600878.758	1406.937	1406.900	0.037
2091	611991.327	4593571.032	1509.357	1509.420	-0.063
2092	579984.094	4666394.955	1319.224	1319.200	0.024
2093	658435.433	4573125.513	1330.596	1330.570	0.026
2094	682233.827	4583326.273	1263.572	1263.490	0.082
2095	628180.274	4593372.505	1423.701	1423.750	-0.049
2096	622534.554	4655660.941	1397.233	1397.270	-0.037
2097	690752.263	4564265.855	1221.789	1221.840	-0.051
2098	714976.985	4558543.870	1183.023	1183.030	-0.007
2099	735908.137	4559116.242	1137.635	1137.670	-0.035
2100	761416.729	4552570.124	1003.426	1003.400	0.026
2101	781453.029	4549433.108	1030.398	1030.390	0.008
2102	799289.399	4545211.586	1005.277	1005.220	0.057
2103	810184.437	4552225.443	979.961	979.960	0.001
2104	832807.233	4551575.222	945.410	945.390	0.020
2105	818256.965	4520217.667	1006.536	1006.510	0.026
2106	833815.305	4514483.873	945.651	945.680	-0.029
2107	843861.174	4523100.640	938.345	938.370	-0.025
2108	836385.982	4545261.480	955.778	955.730	0.048
2109	787559.359	4553726.892	1008.761	1008.700	0.061
2110	802374.235	4550247.469	1005.631	1005.650	-0.019
2111	722779.363	4566787.571	1158.492	1158.480	0.012
2112	684741.976	4546404.284	1270.331	1270.340	-0.009
2113	671558.877	4559475.518	1278.095	1278.050	0.045
2114	612313.574	4546483.048	1507.026	1507.050	-0.024
2115	623334.107	4565969.411	1399.443	1399.450	-0.007
2116	583104.466	4574885.546	1583.054	1583.100	-0.046
2117	589705.340	4557363.149	1570.169	1570.090	0.079
2118	611865.110	4572250.396	1484.091	1484.120	-0.029
2119	622599.546	4651313.343	1316.573	1316.650	-0.077
2120	589536.733	4676683.952	1471.844	1471.850	-0.006

2121	589562.674	4673682.464	1442.649	1442.620	0.029
2122	591237.806	4664575.645	1352.778	1352.800	-0.022
2123	579486.828	4671960.130	1312.290	1312.300	-0.010
2001A	579899.314	4697832.225	1460.666	1460.560	0.106
2002A	580384.377	4694867.025	1440.943	1440.930	0.013
2003A	580533.551	4690748.049	1417.968	1417.950	0.018
2004A	579700.260	4685761.831	1394.805	1394.800	0.005
2005A	578908.866	4681812.233	1358.426	1358.420	0.006
2006A	599689.753	4674350.135	1520.837	1520.800	0.037
20078A	781887.083	4575132.095	1016.367	1016.440	-0.073
2007A	609106.772	4668708.838	1422.446	1422.420	0.026
20087A	773863.094	4584997.118	1080.185	1080.180	0.005
2008A	609205.586	4662644.075	1422.516	1422.530	-0.014
2009A	597986.118	4658444.799	1282.706	1282.710	-0.004
20108A	749606.551	4580002.891	1046.184	1046.110	0.074
2010A	609321.683	4653730.675	1293.993	1293.980	0.013
2011A	609403.242	4651077.210	1326.388	1326.410	-0.022
2012A	598565.559	4668683.262	1460.240	1460.290	-0.050
2013A	579500.836	4559850.001	1534.415	1534.320	0.095
2014A	585623.551	4610303.913	1387.283	1387.240	0.043
2015 B	587999.593	4539659.220	1620.607	1620.600	0.007
2016A	593092.176	4564954.276	1483.610	1483.560	0.050
2017A	596040.179	4586304.087	1540.620	1540.660	-0.040
2018A	600623.026	4579611.328	1538.321	1538.330	-0.009
2019A	606274.920	4562039.962	1508.537	1508.480	0.057
2020A	608421.117	4610810.446	1295.598	1295.570	0.028
2021A	614939.978	4604378.357	1348.725	1348.770	-0.045
2022A	620351.954	4580204.076	1467.361	1467.270	0.091
2023 B	626158.000	4543514.420	1466.473	1466.430	0.043
2024A	636650.038	4564472.565	1355.612	1355.630	-0.018
2025A	628798.391	4604697.644	1261.664	1261.730	-0.066
2026A	668493.005	4588849.418	1296.017	1296.020	-0.003
2027A	645801.704	4584021.383	1379.339	1379.350	-0.011
2028A	655014.918	4580151.394	1348.964	1348.930	0.034
2029A	669614.837	4576679.158	1305.576	1305.550	0.026
2030A	686921.467	4572203.855	1247.832	1247.810	0.022
2031 B	698646.825	4568079.495	1199.424	1199.410	0.014
2032 B	702159.935	4556674.200	1156.641	1156.620	0.021
2033A	695884.119	4585281.345	1215.563	1215.570	-0.007
2034 B	701223.673	4546859.828	1222.419	1222.360	0.059
2036A	657407.474	4561049.542	1286.394	1286.350	0.044

2037 B	640244.156	4555082.951	1407.954	1407.960	-0.006
2038 B	656524.685	4548932.427	1350.245	1350.200	0.045
2039 B	643398.361	4545446.842	1351.009	1351.080	-0.071
2040 B	668008.205	4541498.802	1335.332	1335.290	0.042
2041 B	733369.873	4543237.654	1049.255	1049.230	0.025
2042 B	719230.200	4544283.469	1095.681	1095.670	0.011
2043 B	712372.722	4551126.290	1121.676	1121.610	0.066
2044A	723120.828	4555511.758	1152.328	1152.240	0.088
2045 B	707637.450	4563158.010	1200.869	1200.840	0.029
2046A	727792.967	4561525.326	1152.412	1152.340	0.072
2047 B	736912.200	4551094.867	1103.667	1103.630	0.037
2048A	748395.855	4569187.294	1155.590	1155.540	0.050
2049A	760539.254	4564739.237	1128.144	1128.130	0.014
2050A	768918.823	4562417.315	1102.745	1102.720	0.025
2051A	743829.502	4561029.922	1110.532	1110.540	-0.008
2052A	759972.264	4558667.702	1103.725	1103.700	0.025
2053A	751721.117	4554782.397	1085.380	1085.380	0.000
2054 B	745826.313	4549588.991	1026.899	1026.910	-0.011
2055 B	757493.028	4544464.261	1082.944	1082.920	0.024
2056 B	772855.733	4549118.049	1053.141	1053.120	0.021
2057 B	775143.442	4544658.530	1043.765	1043.760	0.005
2058 B	781128.630	4553401.368	1021.902	1021.860	0.042
2059 B	796294.899	4551632.103	1007.266	1007.290	-0.024
2060 B	787961.321	4547961.103	1018.219	1018.220	-0.001
2061 B	806054.952	4547187.070	989.356	989.320	0.036
2062A	806046.886	4554918.621	953.652	953.640	0.012
2063A	815012.391	4552453.543	964.347	964.320	0.027
2064 A	820268.758	4526632.246	957.842	957.900	-0.058
2065 B	825034.616	4514260.892	980.553	980.550	0.003
2066 B	830305.416	4523979.951	933.662	933.620	0.042
2067A	831797.038	4541851.465	968.931	968.970	-0.039
2068A	826638.421	4554532.179	945.793	945.760	0.033
2069A	842196.375	4556793.797	910.107	910.110	-0.003
2070 B	851826.319	4537880.219	932.390	932.370	0.020
2072A	836904.223	4551758.627	940.031	940.070	-0.039
2073A	847670.504	4550581.151	922.792	922.780	0.012
2075A	821271.220	4539678.964	968.880	968.900	-0.020
2076 B	831431.047	4535359.207	959.877	959.900	-0.023
2077 A	837646.225	4527664.336	956.559	956.560	-0.001
2078 B	835980.610	4520678.690	930.075	930.060	0.015
2079 B	841123.060	4513561.273	922.996	922.990	0.006

2080A	845953.475	4546047.479	937.191	937.200	-0.009
2081A	823656.300	4546658.662	962.101	962.070	0.031
2082 B	812174.914	4546210.946	997.747	997.730	0.017
2083A	766787.086	4555050.085	995.854	995.830	0.024
2084A	676299.310	4567017.993	1276.752	1276.780	-0.028
2085A	645509.575	4574140.428	1374.601	1374.540	0.061
2086A	585358.787	4595827.098	1587.768	1587.820	-0.052
2087A	615283.551	4552997.637	1496.666	1496.600	0.066
2088 B	596406.729	4549428.706	1574.906	1574.830	0.076
2089A	589453.072	4579746.284	1571.314	1571.280	0.034
2090A	601477.485	4600878.627	1407.992	1408.010	-0.018
2091A	611974.953	4593570.301	1509.216	1509.290	-0.074
2092A	579983.841	4666380.810	1319.249	1319.250	-0.001

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.080 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 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	579896.811	4697799.297	1461.048	1460.830	0.218
3002	580247.213	4695260.015	1442.895	1442.980	-0.085
3003	580529.366	4690779.054	1418.787	1418.800	-0.013
3004	579687.740	4686226.339	1399.922	1399.910	0.012
3005	578869.345	4681452.278	1357.161	1357.150	0.011
3006	599675.240	4674359.522	1519.149	1519.210	-0.061
3007	609124.984	4668729.101	1421.911	1421.930	-0.019
3008	609191.356	4662665.458	1421.587	1421.680	-0.093
3009	597965.583	4658463.734	1281.369	1281.420	-0.051
3010	609327.911	4653993.698	1293.959	1294.090	-0.131
3011	609419.067	4651054.887	1325.621	1325.690	-0.069
3012	598560.190	4668703.912	1459.988	1460.040	-0.052
3013	579337.554	4559833.528	1533.428	1533.400	0.028
3014	585225.671	4610310.368	1387.243	1387.400	-0.157
3015	588106.246	4539483.924	1622.344	1622.410	-0.066
3016	592804.803	4564792.345	1481.393	1481.360	0.033
3017	595902.379	4586276.394	1539.474	1539.570	-0.096

3018	600816.321	4579596.449	1537.820	1537.850	-0.030
3019	605982.694	4561944.084	1508.390	1508.390	0.000
3020	607871.215	4610795.255	1301.007	1301.100	-0.093
3021	615143.230	4604368.752	1349.072	1349.170	-0.098
3022	619774.700	4580182.576	1468.159	1468.190	-0.031
3023	625766.308	4543501.759	1470.993	1471.020	-0.027
3024	636203.540	4564547.886	1356.367	1356.480	-0.113
3025	629174.122	4604691.027	1259.837	1259.870	-0.033
3026	668476.868	4589390.556	1301.516	1301.530	-0.014
3027	645407.318	4583967.346	1374.336	1374.410	-0.074
3028	655018.503	4580400.317	1345.407	1345.460	-0.053
3029	669604.662	4576275.689	1305.379	1305.440	-0.061
3030	687260.085	4572215.331	1245.919	1246.100	-0.181
3031	698671.413	4567704.031	1195.470	1195.500	-0.030
3032	701613.812	4556825.602	1159.450	1159.460	-0.010
3033	695062.545	4585275.336	1218.997	1219.020	-0.023
3034	701484.319	4546881.882	1220.406	1220.480	-0.074
3035	682078.882	4552751.142	1262.067	1262.090	-0.023
3036	657654.381	4561373.690	1285.692	1285.780	-0.088
3037	641154.428	4555088.289	1399.928	1399.940	-0.012
3038	655743.438	4548942.068	1352.809	1352.800	0.009
3039	642964.961	4545457.507	1351.987	1352.130	-0.143
3040	668030.735	4541139.607	1333.594	1333.640	-0.046
3041	732798.570	4542753.257	1051.201	1051.250	-0.049
3042	719073.038	4544542.892	1095.788	1095.850	-0.062
3043	712295.441	4550923.551	1124.402	1124.480	-0.078
3044	723125.702	4555178.303	1150.547	1150.520	0.027
3045	708448.185	4563160.221	1198.479	1198.550	-0.071
3046	727791.688	4561108.574	1147.902	1147.990	-0.088
3047	736926.797	4550884.250	1102.727	1102.810	-0.083
3048	748351.006	4569169.596	1154.589	1154.600	-0.011
3049	759765.177	4564724.876	1122.069	1122.240	-0.171
3050	768983.298	4562384.622	1101.206	1101.190	0.016
3051	743822.013	4561505.338	1109.226	1109.310	-0.084
3052	759995.383	4558299.305	1101.012	1101.050	-0.038
3053	752053.599	4554785.889	1083.918	1083.890	0.028
3054	745835.180	4549311.939	1026.500	1026.590	-0.090
3055	757488.803	4544967.000	1084.480	1084.490	-0.010
3056	772360.207	4549107.702	1050.874	1050.910	-0.036
3057	775136.458	4544259.023	1045.822	1045.880	-0.058
3058	781134.518	4553059.341	1029.162	1029.200	-0.038

3059	795714.566	4551626.869	1011.439	1011.600	-0.161
3060	787990.830	4547330.745	1015.552	1015.560	-0.008
3061	805707.467	4547194.167	989.427	989.520	-0.093
3062	806037.418	4554945.601	952.799	952.920	-0.121
3063	815401.712	4552448.081	958.200	958.320	-0.120
3064	819689.676	4526613.320	963.035	963.100	-0.065
3065	825171.121	4513975.279	976.171	976.360	-0.189
3066	829434.173	4523923.573	936.224	936.230	-0.006
3067	832660.842	4541895.504	957.997	958.140	-0.143
3068	826228.555	4554503.212	949.002	949.040	-0.038
3069	841872.553	4556777.081	913.280	913.250	0.030
3070	852612.313	4537948.177	932.058	932.240	-0.182
3071	845870.680	4528566.180	910.947	911.050	-0.103
3072	837635.223	4551785.086	942.134	942.180	-0.046
3073	848128.531	4550608.023	939.187	939.140	0.047
3074	836849.565	4535617.810	958.456	958.450	0.006
3075	820891.928	4539682.754	971.932	971.940	-0.008
3076	830883.414	4535368.117	957.796	957.770	0.026
3077	837151.586	4527617.925	949.018	949.260	-0.242
3078	835982.108	4521074.613	937.949	937.980	-0.031
3079	840865.269	4513303.639	923.765	923.840	-0.075
3080	845943.897	4546068.946	938.940	938.920	0.020
3081	823683.355	4546337.358	961.990	962.110	-0.120
3082	812140.972	4546540.024	999.741	999.800	-0.059
3083	766957.984	4555113.573	994.493	994.470	0.023
3084	676300.686	4567260.215	1276.195	1276.330	-0.135
3085	645437.528	4573888.427	1374.819	1374.900	-0.081
3086	584607.213	4595801.389	1592.389	1592.430	-0.041
3087	615107.064	4552980.382	1496.547	1496.570	-0.023
3088	596203.355	4549439.649	1574.053	1574.120	-0.067
3089	589430.464	4579527.301	1568.195	1568.240	-0.045
3090	601134.220	4600885.448	1414.883	1415.000	-0.117
3091	612056.320	4592931.490	1506.770	1506.940	-0.170
3092	579994.178	4666156.518	1319.942	1320.060	-0.118
30016A	773615.536	4585028.738	1073.267	1073.320	-0.053
3001A	579912.553	4697799.658	1462.103	1461.920	0.183
3002A	580231.029	4695253.221	1441.939	1442.010	-0.071
30032A	746364.130	4581965.019	1085.640	1085.770	-0.130
3003A	580549.863	4690773.835	1418.562	1418.590	-0.028
3004A	579702.778	4686226.823	1400.164	1400.170	-0.006
3005A	578854.234	4681456.677	1357.026	1357.040	-0.014

3006A	599695.304	4674351.072	1519.963	1520.020	-0.057
30072A	773800.850	4576575.172	1048.858	1049.040	-0.182
3007A	609125.034	4668719.892	1421.631	1421.700	-0.069
3008A	609213.435	4662645.716	1421.557	1421.630	-0.073
3009A	597986.712	4658468.580	1281.174	1281.340	-0.166
3010A	609302.623	4653977.224	1293.522	1293.600	-0.078
3011A	609397.418	4651055.452	1324.524	1324.610	-0.086
3012A	598577.128	4668697.653	1459.822	1459.880	-0.058
3013A	579360.848	4559839.367	1533.271	1533.370	-0.099
3014A	585224.459	4610287.945	1387.769	1387.830	-0.061
3015 B	588089.775	4539485.097	1622.400	1622.440	-0.040
3016A	592833.261	4564805.400	1481.398	1481.460	-0.062
3017A	595901.257	4586294.956	1539.390	1539.480	-0.090
3018A	600810.386	4579624.403	1537.911	1537.940	-0.029
3019A	605988.130	4561919.701	1508.506	1508.550	-0.044
3020A	607864.956	4610770.689	1300.280	1300.310	-0.030
3021A	615145.222	4604391.633	1348.725	1348.840	-0.115
3022A	619786.207	4580207.489	1467.911	1467.950	-0.039
3023 B	625771.323	4543485.924	1470.717	1470.750	-0.033
3024A	636207.533	4564572.157	1356.666	1356.720	-0.054
3025A	629184.520	4604713.035	1259.317	1259.390	-0.073
3026A	668501.736	4589383.996	1301.216	1301.240	-0.024
3027A	645398.243	4583998.354	1375.006	1375.110	-0.104
3028A	655002.922	4580410.492	1345.694	1345.770	-0.076
3029A	669606.485	4576255.976	1305.395	1305.400	-0.005
3030A	687261.660	4572198.620	1245.659	1245.780	-0.121
3031 B	698667.862	4567713.392	1195.656	1195.740	-0.084
3032 B	701626.957	4556821.553	1159.361	1159.370	-0.009
3033A	695078.228	4585242.584	1218.686	1218.740	-0.054
3034 B	701470.328	4546880.691	1220.394	1220.440	-0.046
3035 B	682070.040	4552750.836	1262.073	1262.090	-0.017
3036A	657650.673	4561356.060	1283.591	1283.780	-0.189
3037 B	641155.222	4555071.524	1399.903	1400.000	-0.097
3038 B	655750.899	4548949.983	1352.678	1352.690	-0.012
3039 B	642980.111	4545457.081	1351.708	1351.740	-0.032
3040 B	668030.526	4541152.925	1333.648	1333.670	-0.022
3041 B	732809.456	4542760.035	1051.030	1051.130	-0.100
3042 B	719070.965	4544553.673	1095.718	1095.790	-0.072
3043 B	712296.866	4550913.600	1123.707	1123.800	-0.093
3044A	723150.345	4555178.684	1150.362	1150.290	0.072
3045 B	708457.431	4563160.507	1198.455	1198.630	-0.175

3046A	727816.836	4561110.851	1147.512	1147.530	-0.018
3047 B	736926.448	4550893.023	1102.750	1102.800	-0.050
3048A	748359.889	4569189.825	1154.835	1154.880	-0.045
3049A	759760.595	4564695.752	1123.757	1123.870	-0.113
3050A	768952.733	4562410.034	1101.594	1101.650	-0.056
3051A	743804.693	4561504.752	1109.453	1109.650	-0.197
3052A	759972.596	4558280.063	1100.814	1100.800	0.014
3053A	752034.325	4554808.952	1083.924	1083.920	0.004
3054 B	745840.428	4549297.440	1026.308	1026.370	-0.062
3055 B	757487.447	4544974.242	1084.487	1084.520	-0.033
3056 B	772348.191	4549108.989	1050.825	1050.810	0.015
3057 B	775136.686	4544248.804	1045.761	1045.790	-0.029
3058 B	781134.234	4553068.219	1029.192	1029.180	0.012
3059 B	795715.383	4551634.710	1011.140	1011.270	-0.130
3060 B	787990.726	4547342.010	1015.452	1015.470	-0.018
3061 B	805695.168	4547198.871	989.459	989.460	-0.001
3062A	806038.022	4554918.629	952.708	952.740	-0.032
3063A	815402.168	4552433.379	957.992	958.080	-0.088
3064 A	819692.233	4526619.598	963.179	963.240	-0.061
3066 B	829441.533	4523923.429	937.114	937.150	-0.036
3067 B	825170.731	4513982.383	976.591	976.870	-0.279
3067A	832665.462	4541881.682	958.971	959.020	-0.049
3068A	826227.431	4554526.193	950.239	950.340	-0.101
3069A	841877.180	4556802.505	912.818	912.820	-0.002
3070 B	852603.971	4537950.790	931.827	931.980	-0.153
3072A	837642.056	4551804.637	941.256	941.380	-0.124
3073A	848129.729	4550592.687	940.224	940.270	-0.046
3074 B	836848.025	4535606.040	958.859	958.900	-0.041
3075A	820899.432	4539651.201	971.541	971.650	-0.109
3077 A	837157.663	4527618.495	949.274	949.340	-0.066
3078 B	835982.075	4521084.388	938.069	938.160	-0.091
3079 B	840857.321	4513298.419	923.823	924.050	-0.227
3080A	845946.947	4546047.069	937.982	938.150	-0.168
3081A	823657.783	4546325.019	961.917	961.980	-0.063
3082 B	812133.876	4546540.521	999.851	999.900	-0.049
3083A	766977.634	4555118.012	994.462	994.470	-0.008
3084A	676285.958	4567260.851	1276.172	1276.200	-0.028
3085A	645421.643	4573892.957	1374.675	1374.720	-0.045
3086A	584600.132	4595818.281	1592.303	1592.150	0.153
3087A	615110.856	4553004.590	1496.447	1496.490	-0.043
3088 B	596215.603	4549452.536	1574.057	1574.110	-0.053

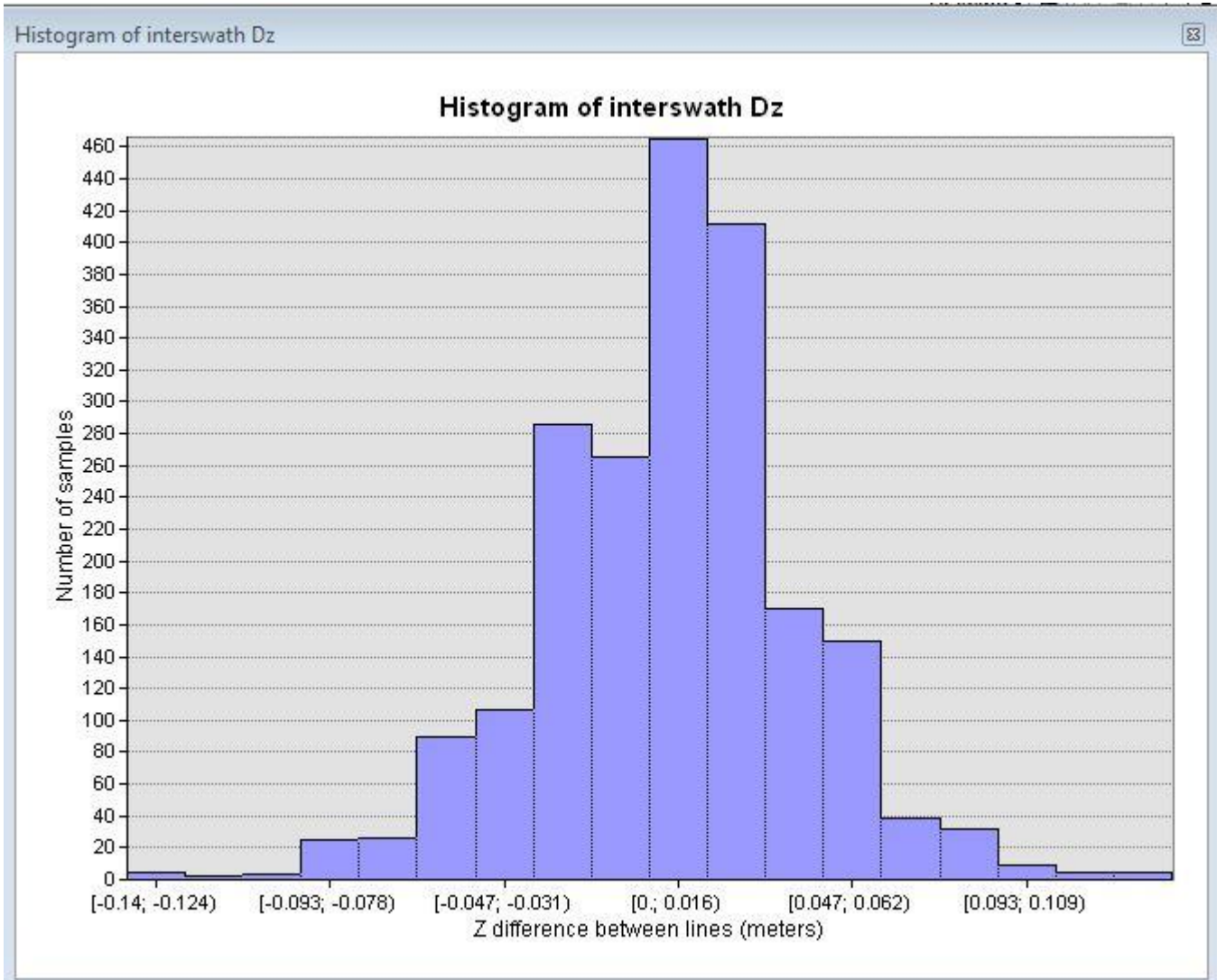
3089A	589448.478	4579529.174	1568.755	1568.770	-0.015
3090A	601145.786	4600865.417	1415.585	1415.710	-0.125
3091A	612054.420	4592950.693	1506.732	1506.840	-0.108
3092A	579977.273	4666157.195	1319.216	1319.300	-0.084

VERTICAL ACCURACY CONCLUSIONS

Vegetated Vertical Accuracy (VVA) Tested 0.182 Meters at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. VVA Errors larger than 95th percentile include:


Point 3001, Easting 579896.811, Northing 579896.811, Z-Error 0.218 Meters
Point 3065, Easting 825171.121, Northing 4513975.279, Z-Error 0.189 Meters
Point 3077, Easting 837151.586, Northing 4527617.925, Z-Error 0.242 Meters
Point 3001A, Easting 579912.553, Northing 4697799.658, Z-Error 0.183 Meters
Point 3036A, Easting 657650.673, Northing 4561356.060, Z-Error 0.189 Meters
Point 3051A, Easting 743804.693, Northing 4561504.752, Z-Error 0.191 Meters
Point 3067B, Easting 825170.731, Northing 4513982.383, Z-Error 0.279 Meters
Point 3079B, Easting 840857.321, Northing 4513298.419, Z-Error 0.227 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 South Platte NE QL2 Lidar measured at 0.036 Meter RMSDz.

Approved by:	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		December 2016


Section 6: Flight Logs

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

Woolpert													
Leica LIDAR													
M/M/DD/YYYY		Day of Year		Project #		Phase #		Project Name					
3/15/2016		75		16-6602-09-102		1		North Platte NE					
Operator		Aircraft		HOBS Start		Local Start Time		ZULU Start Time		Base			
Other				6699.5				10:33:00					
Pilot		Sensor Type		HOBS END		Local End Time		Zulu End Time		PID			
Other		OTHER		6701.5				11:31:00					
Wind Dir/Speed	Visibility	Clouds	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fine/Cloud	Departing	LBF	Arriving	LBF		
10							none						
Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	Gain - Course/Up	Gain - Fine/Down	Mode	Threshold Values					
40	41	272	100		Single	Multi	A	B					
Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.								
130	Kts	6000	Ft	9364	Ft	Yes	No	@	NS	Pt			
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:					
								Verify S-Turns Before Mission		Yes	<input checked="" type="checkbox"/>		
265	s	10:33:34	10:39:24	21:38:17									
265	n	10:46:07	10:52:10	0:00:00									
265	s	10:57:07	11:03:00	0:00:00									
264	n	11:08:52	11:14:59	0:00:00									
263	s	11:20:13	11:20:44	0:00:00				started line, aborted					
263	s	11:26:06	11:31:52	0:00:00				clouds in line					
				0:00:00									
				0:00:00									
				0:00:00									
				0:00:00									
				0:00:00									
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				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	<input type="checkbox"/>		
Additional Comments:										Drive #			

WOOLPERT FLIGHT LOG SHEET #1										
Leica ALS-70		MM/DD/YYYY 3/20/2016		Day of Year 80		Mission Name / Job # SouthPlatte 75955				
Operator Annen		Aircraft N47SRC N404CP N7079F N47SCP N1107Q		Sensor SH-8170 SH_6157 SH-7108		Hobbs Start 370.9		Local Start Time 8:40		Zulu Start Time 14:40
Pilot Gebhart						Hobbs End 377.9		Local End Time 16:05		Zulu End Time 22:05
Passengers		Using or Relying on CORS Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>				GPS Base #1 Operator Annen		PID KBFF		
Wind Dir/Speed Calm		Visibility 10		Ceiling 0		Cloud Cover % 0		Temp -6		Dew Point -11
						Pressure 30.28		Haze/Fire/Cloud		Departing ICAO KBFF
										Arriving ICAO KBFF
Scan Angle (FOV) 40		Scan Frequency (Hz) 51		Pulse Rate (kHz) 272		Laser Power % 100		Gain Course/Up Fine/Down		Mode Single <input type="checkbox"/> 2+2 <input type="checkbox"/> Multi <input type="checkbox"/> 4+3 <input type="checkbox"/>
Air Speed 150 Kts		AGL 6,500 Ft		MSL 10,571 Ft		Threshold /		Waveform Mode @ NS		Pre-Trigger Dist. 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 ↓										
1	W	15:09:00	15:15:00		19	0.7	1.2	Verify 5-Turns Before Mission Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>		
2	E	13:15:00	15:15:00							
3	W	15:19:00	15:20:00							
4	E	15:24:00	15:25:00							
5	W	15:28:00	15:30:00							
6	E	15:33:00	15:36:00							
7	W	15:39:00	15:42:00							
8	E	15:45:00	15:48:00							
9	W	15:51:00	15:54:00							
10	E	15:57:00	16:00:00							
11	W	16:03:00	16:06:00							
12	E	16:09:00	16:12:00							
13	W	16:16:00	16:18:00							
14	E	16:22:00	16:25:00							
15	W	16:28:00	16:31:00							
16	E	16:34:00	16:38:00							
17	W	16:41:00	16:45:00							
18	E	16:48:00	16:52:00							
19	W	16:54:00	16:59:00							
20	E	17:02:00	17:07:00							
21	W	17:14:00	17:23:00							
22	E	17:26:00	17:35:00							
23	W	17:38:00	17:47:00							
24	E	17:50:00	18:00:00							
25	W	18:03:00	18:12:00							
26	E	18:15:00	18:24:00							
		CONTINUED PAGE 2								
↑ Times entered are Zulu / GMT ↑										
				0:00:00		Total Time On Line		Verify 5-Turns After Mission		Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Additional Comments: System worked well, no issues.										
Drive #										

WOOLPERT FLIGHT LOG SHEET #1										
Leica ALS-70		MM/DD/YYYY		Day of Year		Mission Name / Job #				
		3/21/2016		81		75955 USGS SouthPlatte NE				
Operator Annen		Aircraft N475RC N404CP N7079F N475CP N1107Q		Sensor SH-8170 SH_6157 SH-7108		Hobbs Start 377.9		Local Start Time 9:00		Zulu Start Time 15:00
Pilot Gebhart						Hobbs End 384.2		Local End Time 15:45		Zulu End Time 21:45
Passengers		Using or Relying on CORS Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>		GPS Base #1 Operator Annen		PID KBFF				
Wind Dir/Speed Var/3		Visibility 10		Ceiling 16k		Cloud Cover % 83		Temp 7		Dew Point -4
						Pressure 29.86		Haze/Fire/Cloud		Departing ICAO KBFF
										Arriving ICAO KBFF
Scan Angle (FOV) 40		Scan Frequency (Hz) 51		Pulse Rate (kHz) 272		Laser Power % 100		Gain Course/Up Fine/Down		Mode Single <input type="checkbox"/> 2+2 <input type="checkbox"/> Multi <input type="checkbox"/> 4+3 <input type="checkbox"/>
Air Speed 150 Kts		AGL 6,500 Ft		MSL 10,571 Ft		Threshold /		Waveform Mode @ NS		Pre-Trigger Dist. 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 <input checked="" type="checkbox"/> No <input type="checkbox"/>										
43	W	15:33:00	15:45:00		22	0.6	1			
44	E	15:48:00	15:58:00							
45	W	16:01:00	16:12:00							
46	E	16:15:00	16:25:00							
47	W	16:29:00	16:38:00							
48	E	16:42:00	16:51:00							
49	W	16:54:00	17:03:00							
50	E	17:06:00	17:14:00							
51	W	17:17:00	17:26:00							
52	E	17:29:00	17:36:00							
53	W	17:39:00	17:46:00							
54	S	17:58:00	18:15:00							
55	N	18:18:00	18:35:00							
56	S	18:38:00	18:56:00							
57	N	18:58:00	19:15:00							
58	S	19:19:00	19:37:00							
59	N	19:40:00	19:58:00							
60	S	20:01:00	20:19:00							
61	N	20:21:00	20:39:00							
62	S	20:42:00	21:01:00							
63	N	21:04:00	21:22:00							
↑ Times entered are Zulu / GMT ↑				0:00:00		Total Time On Line		Verify S-Turns After Mission		Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Additional Comments: System worked well, no issues.								Drive #		



Flight Crew		Project #		Project Description		Level Adj		GPS (ft)		Level Adj		GPS Base Station Information		Miscellaneous Conditions																																																																																																																												
MISSION 1		PROJECT 13		Windsor South Platte		A. 0.10		B. 0.70		C. -1.20		ELEVATION		TEMP																																																																																																																												
MISSION 1		PROJECT 13		Windsor South Platte		A. 0.10		B. 0.70		C. -1.20		ELEVATION		TEMP																																																																																																																												
125	171	182	188	194	200	206	212	218	224	230	236	242	248	254	260	266	272	278	284	290	296	302	308	314	320	326	332	338	344	350	356	362	368	374	380	386	392	398	404	410	416	422	428	434	440	446	452	458	464	470	476	482	488	494	500	506	512	518	524	530	536	542	548	554	560	566	572	578	584	590	596	602	608	614	620	626	632	638	644	650	656	662	668	674	680	686	692	698	704	710	716	722	728	734	740	746	752	758	764	770	776	782	788	794	800	806	812	818	824	830	836	842	848	854	860	866	872	878	884	890	896	902	908	914	920	926	932	938	944	950	956	962	968	974	980	986	992	998
125	171	182	188	194	200	206	212	218	224	230	236	242	248	254	260	266	272	278	284	290	296	302	308	314	320	326	332	338	344	350	356	362	368	374	380	386	392	398	404	410	416	422	428	434	440	446	452	458	464	470	476	482	488	494	500	506	512	518	524	530	536	542	548	554	560	566	572	578	584	590	596	602	608	614	620	626	632	638	644	650	656	662	668	674	680	686	692	698	704	710	716	722	728	734	740	746	752	758	764	770	776	782	788	794	800	806	812	818	824	830	836	842	848	854	860	866	872	878	884	890	896	902	908	914	920	926	932	938	944	950	956	962	968	974	980	986	992	998

X PAR LLC PRECISION AERIAL PHOTOGRAPHY										LIDAR DAILY LOG										
Project #			Project Description			GPS (m)			Laser Aim			GPS Information			GPS Information			Weather		
402016			2015CAGL_234413			-0.15 0.210 -1.220			1 0 0			27-46-48 3-4828			27-46-48 3-4828			Partly Cloudy		
FIELD CREW										OPERATOR										
MISSEY 2					MISSEY 2					MISSEY 2					MISSEY 2					
AL230					AL230					AL230					AL230					
Line	Date	Start	Stop	Operator	Time	Scan Rate	Pulse Rate	Ball Comp	Ball Comp %	Altitude	Altitude	Altitude	Altitude	Altitude	Altitude	Altitude	Altitude	Altitude	Altitude	Altitude
74	11/15/2015	07:52:56	08:02:29	MISSEY 2	08:02:29	48.0	275000	1855	Y	1821	5135									
75	11/15/2015	08:02:29	08:12:02	MISSEY 2	08:12:02	48.0	275000	1855	Y	1821	5135									
76	11/15/2015	08:12:02	08:21:35	MISSEY 2	08:21:35	48.0	275000	1855	Y	1821	5135									
77	11/15/2015	08:21:35	08:31:08	MISSEY 2	08:31:08	48.0	275000	1855	Y	1821	5135									
78	11/15/2015	08:31:08	08:40:41	MISSEY 2	08:40:41	48.0	275000	1855	Y	1821	5135									
79	11/15/2015	08:40:41	08:50:14	MISSEY 2	08:50:14	48.0	275000	1855	Y	1821	5135									
80	11/15/2015	08:50:14	09:00:00	MISSEY 2	09:00:00	48.0	275000	1855	Y	1821	5135									
81	11/15/2015	09:00:00	09:10:00	MISSEY 2	09:10:00	48.0	275000	1855	Y	1821	5135									
82	11/15/2015	09:10:00	09:20:00	MISSEY 2	09:20:00	48.0	275000	1855	Y	1821	5135									
83	11/15/2015	09:20:00	09:30:00	MISSEY 2	09:30:00	48.0	275000	1855	Y	1821	5135									
84	11/15/2015	09:30:00	09:40:00	MISSEY 2	09:40:00	48.0	275000	1855	Y	1821	5135									
85	11/15/2015	09:40:00	09:50:00	MISSEY 2	09:50:00	48.0	275000	1855	Y	1821	5135									
86	11/15/2015	09:50:00	10:00:00	MISSEY 2	10:00:00	48.0	275000	1855	Y	1821	5135									
87	11/15/2015	10:00:00	10:10:00	MISSEY 2	10:10:00	48.0	275000	1855	Y	1821	5135									
88	11/15/2015	10:10:00	10:20:00	MISSEY 2	10:20:00	48.0	275000	1855	Y	1821	5135									
89	11/15/2015	10:20:00	10:30:00	MISSEY 2	10:30:00	48.0	275000	1855	Y	1821	5135									
90	11/15/2015	10:30:00	10:40:00	MISSEY 2	10:40:00	48.0	275000	1855	Y	1821	5135									
91	11/15/2015	10:40:00	10:50:00	MISSEY 2	10:50:00	48.0	275000	1855	Y	1821	5135									
92	11/15/2015	10:50:00	11:00:00	MISSEY 2	11:00:00	48.0	275000	1855	Y	1821	5135									
93	11/15/2015	11:00:00	11:10:00	MISSEY 2	11:10:00	48.0	275000	1855	Y	1821	5135									
94	11/15/2015	11:10:00	11:20:00	MISSEY 2	11:20:00	48.0	275000	1855	Y	1821	5135									
95	11/15/2015	11:20:00	11:30:00	MISSEY 2	11:30:00	48.0	275000	1855	Y	1821	5135									
96	11/15/2015	11:30:00	11:40:00	MISSEY 2	11:40:00	48.0	275000	1855	Y	1821	5135									
97	11/15/2015	11:40:00	11:50:00	MISSEY 2	11:50:00	48.0	275000	1855	Y	1821	5135									
98	11/15/2015	11:50:00	12:00:00	MISSEY 2	12:00:00	48.0	275000	1855	Y	1821	5135									
99	11/15/2015	12:00:00	12:10:00	MISSEY 2	12:10:00	48.0	275000	1855	Y	1821	5135									
100	11/15/2015	12:10:00	12:20:00	MISSEY 2	12:20:00	48.0	275000	1855	Y	1821	5135									

X PARALIC		PARALIC		LIDAR Daily Log										METEOROLOGICAL CONDITIONS									
P.O. Box 72387 Boulder City, NV 72387 MISSION AIRBORNE TECHNOLOGIES				Project #		Project Description		Level Arm		GPS (m)		Level Arm		GPS Information		Elevation		Temp		Pressure			
Flight Date (UTC)		Flight Operator		Sensor		Scan Rate		Rate Rate (Hz)		Rate Rate (Hz)		Rate Rate (Hz)		Rate Rate (Hz)		Rate Rate (Hz)		Rate Rate (Hz)		Rate Rate (Hz)			
4/20/16		Parker		AL370		FOV		48.0		27000		YES		Y		187		5452		101.9857 Pa			
Height	Line	Dir	Start	Stop	Total Time	Scan Rate	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)	Rate Rate (Hz)		
85.131	182620	185.20	14.14.14	14.14.14	0:03:13	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	15.33.23	15.33.23	0:22:41	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	18.24.08	18.24.08	0:23:26	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	19.47.34	19.47.34	0:20:21	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	17.14.26	17.14.26	0:23:17	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	17.42.04	17.42.04	0:23:31	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	18.20.12	18.20.12	0:23:01	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	18.44.32	18.44.32	0:27:38	42	48.0	27000	YES	Y	187	5452											
85.131	182620	185.20	18.44.32	18.44.32	0:27:38	42	48.0	27000	YES	Y	187	5452											
LIDAR FLIGHT SUMMARY																							
Average Horizontal Line Miles Per Mission Year		3194.2		3199.5		3199.5		3199.5		3199.5		3199.5		3199.5		3199.5		3199.5		3199.5			
Average Vertical Line Miles Per Mission Year		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0			
Sensor (Scan Rate)		AL370		AL370		AL370		AL370		AL370		AL370		AL370		AL370		AL370		AL370			
# of Flight Lines		53		53		53		53		53		53		53		53		53		53			
Mission Name		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs			
Average Horizontal Line Miles Per Flight Hour		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0			
Average Vertical Line Miles Per Flight Hour		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0			
# of Flight Lines		53		53		53		53		53		53		53		53		53		53			
Mission Name		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs			
Average Horizontal Line Miles Per Flight Hour		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0			
Average Vertical Line Miles Per Flight Hour		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0			
# of Flight Lines		53		53		53		53		53		53		53		53		53		53			
Mission Name		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs		Mission Hobbs			
Average Horizontal Line Miles Per Flight Hour		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0			
Average Vertical Line Miles Per Flight Hour		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0			



P.O. Box 72837
 Precursor Aerial Reconnaissance


LIDAR Daily Log									
Field Crew		Project Description		Location		Level Arm		GPS Information	
Operator	Surveyor	Project #	Project Description	Recipient Email Path	Location	Level Arm	GPS (m)	Start Time	Stop Time
Operator	Surveyor	20150413_131255	PRECUSOR AERIAL RECONNAISSANCE			0.0	0.0	13:12:55	13:56:25
101	102	103	104	105	106	107	108	109	110
111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130
131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170
171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190
191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210
211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230
231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250
251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270
271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290
291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310
311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330
331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350
351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370
371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390
391	392	393	394	395	396	397	398	399	400
401	402	403	404	405	406	407	408	409	410
411	412	413	414	415	416	417	418	419	420
421	422	423	424	425	426	427	428	429	430
431	432	433	434	435	436	437	438	439	440
441	442	443	444	445	446	447	448	449	450
451	452	453	454	455	456	457	458	459	460
461	462	463	464	465	466	467	468	469	470
471	472	473	474	475	476	477	478	479	480
481	482	483	484	485	486	487	488	489	490
491	492	493	494	495	496	497	498	499	500
501	502	503	504	505	506	507	508	509	510
511	512	513	514	515	516	517	518	519	520
521	522	523	524	525	526	527	528	529	530
531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550
551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570
571	572	573	574	575	576	577	578	579	580
581	582	583	584	585	586	587	588	589	590
591	592	593	594	595	596	597	598	599	600
601	602	603	604	605	606	607	608	609	610
611	612	613	614	615	616	617	618	619	620
621	622	623	624	625	626	627	628	629	630
631	632	633	634	635	636	637	638	639	640
641	642	643	644	645	646	647	648	649	650
651	652	653	654	655	656	657	658	659	660
661	662	663	664	665	666	667	668	669	670
671	672	673	674	675	676	677	678	679	680
681	682	683	684	685	686	687	688	689	690
691	692	693	694	695	696	697	698	699	700
701	702	703	704	705	706	707	708	709	710
711	712	713	714	715	716	717	718	719	720
721	722	723	724	725	726	727	728	729	730
731	732	733	734	735	736	737	738	739	740
741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760
761	762	763	764	765	766	767	768	769	770
771	772	773	774	775	776	777	778	779	780
781	782	783	784	785	786	787	788	789	790
791	792	793	794	795	796	797	798	799	800
801	802	803	804	805	806	807	808	809	810
811	812	813	814	815	816	817	818	819	820
821	822	823	824	825	826	827	828	829	830
831	832	833	834	835	836	837	838	839	840
841	842	843	844	845	846	847	848	849	850
851	852	853	854	855	856	857	858	859	860
861	862	863	864	865	866	867	868	869	870
871	872	873	874	875	876	877	878	879	880
881	882	883	884	885	886	887	888	889	890
891	892	893	894	895	896	897	898	899	900
901	902	903	904	905	906	907	908	909	910
911	912	913	914	915	916	917	918	919	920
921	922	923	924	925	926	927	928	929	930
931	932	933	934	935	936	937	938	939	940
941	942	943	944	945	946	947	948	949	950
951	952	953	954	955	956	957	958	959	960
961	962	963	964	965	966	967	968	969	970
971	972	973	974	975	976	977	978	979	980
981	982	983	984	985	986	987	988	989	990
991	992	993	994	995	996	997	998	999	1000

PARALIC PRECISION AERIAL TELEMETRY										LIDAR DAILY LOG												
Flight Data (UTC)					Sensor					GPS Information					Miscellaneous Conditions							
Line	Dir	Start	Stop	Operator	Plane	Altitude	Scan Rate	Plane Rate Hz	Rail Comp	Roll	Yaw	Pitch	Roll	Yaw	Pitch	Roll	Yaw	Pitch	Roll	Yaw	Pitch	
1	L	13:45:15	13:47:00	FW	FW	40	48.0	275000	Y	Y	Y	Y	171	171	171	171	171	171	171	171	171	171
2	L	14:03:52	14:05:36	FW	FW	40	48.0	275000	Y	Y	Y	Y	171	171	171	171	171	171	171	171	171	171
3	L	14:29:25	14:31:09	FW	FW	40	48.0	275000	Y	Y	Y	Y	171	171	171	171	171	171	171	171	171	171
4	L	15:31:28	15:33:12	FW	FW	40	48.0	275000	Y	Y	Y	Y	171	171	171	171	171	171	171	171	171	171
5	L	15:46:25	15:48:09	FW	FW	40	48.0	275000	Y	Y	Y	Y	171	171	171	171	171	171	171	171	171	171
6	L	16:37:42	16:39:26	FW	FW	40	48.0	275000	Y	Y	Y	Y	171	171	171	171	171	171	171	171	171	171


LIDAR FLIGHT SUMMARY									
Accrual Blk Time	Source Collection Time	File Name	Avg Flight Line Speed	Rolls Start	Rolls Stop	Rolls Total	Rolls Percent	Rolls Min	Rolls Max
3:41:37	2:17:27	3:1	0.78	3:41:37	2:17:27	3:1	0.78	3:41:37	2:17:27

DATA COLLECTION									
Total Lines	# Height Lines	# Points	Rolls % Complete	Total Flight Lines	Line Completion	Rolls % Done			
0	0	0	0.0	0	0	0.0			

Comments									
Cloud Cover	Clear	Partly Cloudy	Cloudy						
X									



LIDAR Daily Log														
Field Code	Project #	Project Description	Location	GPS (ft)	X	Y	Z	Altitude (ft)	Speed	Altitude (ft)	Altitude (ft)	Map Points (T/M)	Return	Notes
95026.11		Workpoint South Platte	South Platte		-4.110	0.710	-1.720							
MISSEON 8			South Platte											
Flight Date (UTC)	Flight Date (LST)	File No.	Operator	Start	Stop	Total Time	FOV	Scan Rate	Pulse Rate (Hz)	Rfl Comp	Min. Power (dBm)	Max. Power (dBm)	Min. Range (m)	Max. Range (m)
4/21/2018			Perce	13:52:52	15:20:18	1:27:26	45	48 Hz	272000	YES	1657	8053	0	1500
			Perce	13:57:44	14:13:39	1:15:55	45	48 Hz	272000	YES	1657	8053	0	1500
			Perce	14:13:39	14:31:22	1:17:43	45	48 Hz	272000	YES	1657	8053	0	1500
			Perce	14:31:22	14:57:14	1:25:52	45	48 Hz	272000	YES	1657	8053	0	1500
			Perce	14:57:14	15:19:44	1:22:30	45	48 Hz	272000	YES	1657	8053	0	1500
			Perce	15:19:44	15:37:32	1:17:48	45	48 Hz	272000	YES	1657	8053	0	1500
LIDAR FLIGHT SUMMARY														
Account ID/Zone	2-02-03	Noble Start				5273.1								
Return Collection Time	1:25:55	Noble Stop				5275.9								
Line filter Flown	0.0	Return Holder				0								
Average Flight Lines Speed	0.0	Outlier Ratio				0.0								
DATA COLLECTION														
Total Lines	0	Project % Complete				0								
# Flight Lines	0	Total Flight Lines				0								
Flight Percent	0	Line Completions				0								
Scanner On/Flight Miles	0.0	Mission Lines				0								
Comments														
														Cloud Cover
														Clear
														Fair
														Partly Cloudy
														Cloudy



P.O. Box 72337
Denver City, LA 72337
75000
75000

Field Crew		Project #		Project Description		Sensor Navigation File Name		Location						
DOONE 11				Woodport South Platte		WOODPORT		Woodport, NE						
MISSION 9		N7964C		WOODPORT		WOODPORT		WOODPORT						
Sensor		AL070		WOODPORT		WOODPORT		WOODPORT						
Operator		Parker		WOODPORT		WOODPORT		WOODPORT						
Flight Line	Dir	Start	Stop	Total Time	PCV	Scan Rate	Rate Rate - In	Rate Rate - Out	Mid Pulse	Altitude	Altitude	Speed	Operator	Conditions/Comments
11001	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11002	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11003	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11004	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11005	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11006	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11007	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11008	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11009	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11010	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11011	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11012	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11013	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11014	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11015	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11016	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11017	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11018	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11019	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11020	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11021	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11022	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11023	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11024	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11025	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11026	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11027	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11028	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11029	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	
11030	L200106020	11:56:13	11:56:13	0:00:14	40	46.0	27000	27000	Y	1742	5776		PCOP	

LIDAR FLIGHT SUMMARY

Accrpt 360 Time	32:05	Hobby Stop	32:05
Search Collection Time	3:36:24	Hobby Stop	3:36:24
Line Name Flow	4:06:07	Mission Hobbs	4:06:07
Average Flight Line Speed	0.0	Mission Hobbs	0.0
	0.0	Mission Hobbs	0.0

DATA COLLECTION

Total Lines	0	Project 3, Complete	#C/V02
# Flight Lines	0	Take Flight Lines	0
Flight Percent	0.0	Line Complete	0
Search Flight Line	0.0	Mission Lines	0

Comments

Cloud Cover

Clear	X
Partly Cloudy	
Cloudy	

X PAR LLC Aerial & Geospatial Technology			LIDAR Daily Log										METEOROLOGICAL CONDITIONS							
Project Information			Flight Information			GPS Information			Miscellaneous			Weather								
P.O. Box 72327 Denver, CO, LA 72327	Project #	4232018	Area	Operator	Pilot	Start	Stop	Total Time	FOV	Scan Rate	Rain Rate (in)	Rel Comp	Mult Pulse	Altitude (ft)	Speed	Altitude (ft)	Wind	Temp	Humidity	Pressure
Project Description: South Platte			GPS: LA72327			GPS: 4232018			Miscellaneous: LA72327			Weather: Cloudy								
Project #	4232018	Area	Operator	Pilot	Start	Stop	Total Time	FOV	Scan Rate	Rain Rate (in)	Rel Comp	Mult Pulse	Altitude (ft)	Speed	Altitude (ft)	Wind	Temp	Humidity	Pressure	
4232018	4232018	South Platte	LA72327	LA72327	19:39:32	19:44:13	0:04:41	40	46.0	27:000	Y	Y	1774	5000	1774	5000	52.0	100.00	1013.27	
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150

FLIGHT LINE		OPERATOR		START		STOP		TOTAL TIME		FOY		SCAN RATE		PULSE RATE (Hz)		ROT COMP		MIS PULSE (%)		ALTIMETER		SPEED		GPS INFORMATION		METEOROLOGICAL CONDITIONS		
Line	Div	Plane	Operator	Start	Stop	Start	Stop	Total Time	Altim	Altim	Height	Scan Rate	Pulse Rate (Hz)	Rot Comp	Mis Pulse (%)	Altimeter	Altimeter	Speed	Start Time	Stop Time	Void Yr	Operator	Conditions	Comments	Cloud Cover			
1001	1001A	465286	Fair	14:51:11	14:56:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605										Clear	X
1002	1002A	465286	Fair	15:01:11	15:06:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1003	1003A	465286	Fair	15:11:11	15:16:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1004	1004A	465286	Fair	15:21:11	15:26:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1005	1005A	465286	Fair	15:31:11	15:36:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1006	1006A	465286	Fair	15:41:11	15:46:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1007	1007A	465286	Fair	15:51:11	15:56:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1008	1008A	465286	Fair	16:01:11	16:06:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1009	1009A	465286	Fair	16:11:11	16:16:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1010	1010A	465286	Fair	16:21:11	16:26:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1011	1011A	465286	Fair	16:31:11	16:36:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1012	1012A	465286	Fair	16:41:11	16:46:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1013	1013A	465286	Fair	16:51:11	16:56:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1014	1014A	465286	Fair	17:01:11	17:06:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1015	1015A	465286	Fair	17:11:11	17:16:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1016	1016A	465286	Fair	17:21:11	17:26:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1017	1017A	465286	Fair	17:31:11	17:36:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1018	1018A	465286	Fair	17:41:11	17:46:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1019	1019A	465286	Fair	17:51:11	17:56:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1020	1020A	465286	Fair	18:01:11	18:06:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1021	1021A	465286	Fair	18:11:11	18:16:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1022	1022A	465286	Fair	18:21:11	18:26:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1023	1023A	465286	Fair	18:31:11	18:36:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1024	1024A	465286	Fair	18:41:11	18:46:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1025	1025A	465286	Fair	18:51:11	18:56:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear
1026	1026A	465286	Fair	19:01:11	19:06:42	0:10:29	0:00:00	46.0	277000	1000	1000	46.0	277000	1000	1000	1798	5605											Clear

Woolpert														
Leica LIDAR		MM/DD/YYYY	Day of Year	Project #	Phase #	Project Name								
		5/2/2016	123	75955	2	USGS South Platte Basin								
Operator		Altitude		Elevation Start		Elev Start Time		Zulu Start Time		Date				
GALAMBOS		NAD83		5461.2		9:54:00		15:54:00		WOOLPERT PIN				
Pilot		Sensor Type		Elevation End		Local End Time		Zulu End Time		PID				
FLOYD		OTHER		5465.1		1:10:00		19:10:00		KOGA				
Wind Dir/Speed		Visibility	Ceiling	Cloud Cover %	Temp	Deer Point	Pressure			Haze/Fire/Cloud		Departing	KOGA	
240 6		10	Clear		7	3	30.19					Arriving	KOGA	
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain		255	Mode	Threshold Values		
40		50		272		100		Gain - Course/Up			Single	A		
								Gain - Fine/Down			Multi	X B		
Air Speed		AGL		MSL		Waveform Used		Waveform Mode				Pre-Trigger Dist.		
150		Kts		6500		Ft		Varies		Ft		Yes		No x
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:		15:29:48				
		↑ Times entered are Zulu / GMT ↓						Verify 5-Turns before Mission		Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>				
266	E	15:54:26	16:02:41		16	0.9	1.5	SENSOR: 8191						
267	W	16:05:59	16:13:57	0:00:00	14	1	1.8	Dusting of snow on the peaks						
268	E	16:16:52	16:25:04	0:00:00	14	1	1.8							
269	W	16:28:15	16:36:36	0:00:00	16	0.7	1.2							
270	E	16:39:50	16:48:09	0:00:00	16	0.7	1.2							
271	W	16:51:10	16:59:06	0:00:00	16	0.7	1.2							
272	E	17:02:05	17:10:05	0:00:00	16	0.7	1.2							
273	W	17:13:08	17:20:45	0:00:00	16	0.7	1.2							
274	E	17:23:17	17:30:35	0:00:00	18	0.6	1.1							
275	W	17:33:54	17:40:51	0:00:00	16	0.7	1.3							
276	E	17:43:38	17:49:30	0:00:00	18	0.7	1.3							
277	W	17:52:31	17:57:29	0:00:00	19	0.7	1.2							
278	E	18:00:34	18:04:12	0:00:00	19	0.7	1.2							
279	W	18:07:23	18:10:14	0:00:00	19	0.7	1.2							
280	E	18:13:16	18:15:10	0:00:00	19	0.7	1.2							
281	W	18:18:04	18:19:09	0:00:00	19	0.7	1.2							
252	S	18:33:37	18:43:22	0:00:00	19	0.7	1.2							
213	W	19:03:18	19:10:00	0:00:00	19	0.7	1.2	wrong line...stopped						
				0:00:00				Checked out another are 196 and it						
				0:00:00				had snow on it.						
				0:00:00				Ending Static: 19:36:54						
				0:00:00										
				0:00:00										
				0:00:00										
				0:00:00										
				0:00:00										
				0:00:00										
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				0:00:00										
				0:00:00										
				0:00:00										
↑ Times entered are Zulu / GMT ↑				Page		1		Verify 5-Turns After Mission		Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>				
Additional Comments:										Drive #				
										00133				

Woolpert																	
Leica LIDAR		MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name											
		5/3/2016	124	75955	2	USGS South Platte Basin											
Operator		Aircraft		HOBBS Start		Local Start Time		ZULU Start Time		Date							
GALAMBOS		N404CP		5465.1		12:07:00		18:07:00		WOOLPERT PIN							
Pilot		Sensor Type		HOBBS END		Local End Time		ZULU End Time		PID							
FLOYD		OTHER		5470.1		4:25:00		22:25:00		KOGA							
Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KOGA								
350 8	10	clear		15	3	30.13		Arriving	KOGA								
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain	255	Mode	Threshold Values						
40		50		272		100		Gain - Course/Up	Single	A							
								Gain - Fine/Down	Multi	X	B						
Air Speed		AGL	MSL	Waveform Used		Waveform Made		Pre-Trigger Dist:									
150		Kts	6500	Ft	Varies	Ft	Yes	No	X	@	NS	Rt					
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:		17:41:48							
↑ Times entered are Zulu / GMT ↑										Verify S-Turns Before Mission Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>							
181	W	18:07:47	18:08:29		17	0.7	1.3	SENSOR: 8191									
182.03	E	18:11:26	18:12:42	0:00:00	17	0.7	1.3	Snow in Ditches and furrows									
183.03	W	18:16:30	18:18:10	0:00:00	17	0.7	1.3										
184.03	E	18:21:11	18:23:12	0:00:00	17	0.7	1.3										
185.03	W	18:02:00	18:29:29	0:00:00	17	0.7	1.3										
186.03	E	18:32:25	18:35:17	0:00:00	16	0.7	1.5										
187.03	W	18:38:58	18:52:24	0:00:00	17	0.6	1.5	10% snow?									
216	E	19:09:16	19:18:56	0:00:00	19	0.6	1.2										
215	W	19:21:53	19:23:32	0:00:00	20	0.6	1.1										
217	W	19:28:23	19:38:00	0:00:00	21	0.7	1.3										
218	E	19:40:24	19:49:54	0:00:00	21	0.7	1.3										
219	W	19:52:49	20:02:16	0:00:00	22	0.6	1										
220	E	20:05:31	20:14:54	0:00:00	22	0.6	1										
221	W	20:17:40	20:27:09	0:00:00	22	0.6	1										
222	E	20:29:58	20:39:24	0:00:00	22	0.6	1.1										
223	W	20:42:20	20:51:57	0:00:00	22	0.6	1										
224	E	20:54:39	21:04:11	0:00:00	22	0.6	1										
225	W	21:07:18	21:16:45	0:00:00	19	0.7	1.3										
226	E	21:19:33	21:29:23	0:00:00	19	0.7	1.3										
227	S	21:35:29	21:45:25	0:00:00	19	0.7	1.3										
228	N	21:48:23	21:59:36	0:00:00	19	0.7	1.3										
229	S	22:02:39	22:12:45	0:00:00	19	0.7	1.3										
230	N	22:14:54	22:25:40	0:00:00	18	0.7	1.4										
				0:00:00				STATIC: 22:44:30									
				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 <input checked="" type="checkbox"/> No <input type="checkbox"/>			
Additional Comments:										Drive #				00132			

Woolpert															
Leica LIDAR		MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name									
		5/4/2016	125	75955	2	USGS South Platte Basin									
Operator		Aircraft		HOBS Start		Local Start Time		ZULU Start Time		Date					
GALAMBOS		N404CP		5470.1		9:28:00		15:28		WOOLPERT PIN					
Pilot		Sensor Type		HOBS END		Local End Time		ZULU End Time		PID					
GEBHART		OTHER		5477.2		4:00:00		22:00:00		KOGA					
Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KOGA						
calm	10	clear		17	5	30.19		Arriving	KOGA						
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain	255	Mode	Threshold Values				
40		50		272		100		Gain - Course/Up	Single	A					
								Gain - Fine/Down	Multi	X	B				
Air Speed		AGL	MSL	Waveform Used		Waveform Made		Pre-Trigger Dist:							
150		Kts	6500	Ft	Varies	Ft	Yes	No	X	@	NS	Rt			
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:		17:41:48					
↑ Times entered are Zulu / GMT ↑										Verify S-Turns Before Mission Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>					
187	W	15:28:51	15:42:34		16	0.7	1.1	SENSOR: 8191							
188	E	15:45:42	15:55:09	0:00:00	13	0.9	1.9	trace of snow in furrows w end							
189	W	16:02:50	16:17:23	0:00:00	13	0.9	1.9								
190	E	16:20:12	16:34:48	0:00:00	16	0.7	1.2								
191	W	16:38:03	16:53:22	0:00:00	16	0.7	1.2								
192	E	16:56:43	17:12:12	0:00:00	16	0.7	1.2								
193	W	17:15:26	17:31:18	0:00:00	18	0.7	1.3								
194	E	17:34:16	17:49:40	0:00:00	17	0.7	1.3								
195	W	17:52:52	18:08:29	0:00:00	17	0.7	1.3								
196	E	18:11:33	18:26:49	0:00:00	21	0.7	1.3								
231	S	18:37:37	18:47:44	0:00:00	21	0.7	1.3								
232	N	18:50:24	19:01:12	0:00:00	22	0.6	1								
233	S	19:04:19	19:14:17	0:00:00	21	0.6	1								
234	N	19:17:10	19:27:34	0:00:00	22	0.6	1								
235	S	19:30:45	19:40:29	0:00:00	22	0.6	1.1								
236	N	19:43:19	19:53:07	0:00:00	22	0.6	1								
237	S	19:56:11	20:05:51	0:00:00	22	0.6	1								
238	N	20:08:54	20:18:33	0:00:00	19	0.7	1.3								
239	S	20:21:50	20:31:03	0:00:00	19	0.7	1.3								
240	N	20:33:31	20:43:36	0:00:00	19	0.7	1.3								
241	S	20:46:29	20:55:57	0:00:00	19	0.7	1.2								
242	N	20:58:42	21:08:44	0:00:00	19	0.7	1.2								
243	S	21:11:43	21:21:40	0:00:00	18	0.7	1.4								
244	N	21:23:22	21:33:25	0:00:00	18	0.7	1.4								
245	S	21:36:11	21:46:45	0:00:00	18	0.7	1.4								
246	N	21:48:48	21:59:20	0:00:00	18	0.7	1.3								
				0:00:00				Static: 22:19:00							
				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 <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Additional Comments:										Drive #					
										00132					

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
- 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