

Airborne LiDAR Report



ZION NATIONAL PARK QL1 AND QL2 LIDAR

Contract Number: G10PC00057

Task Number: G15PD00916

Contractor: Woolpert, Inc.
Woolpert Project # 75556

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Airborne LiDAR Report

UNITED STATES GEOLOGICAL SURVEY

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Section 1: Overview

TASK ORDER NAME: Zion National Park QL1 and QL2 Lidar

Project: # 75880

This report contains a comprehensive outline of the Zion QL1 and QL2 Lidar Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G10PC00057, Task Order No. G15PD00916. This task order requires lidar data to be acquired over Zion National Park in Utah (approximately 233 square miles) collected at a nominal pulse spacing (NPS) of 0.7 meters. An area within the AOI was required to be collected at a nominal post spacing (NPS) of 0.35 meters. The NPS assessment is made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath.

The data was collected using a Dual-Head DragonEye (DE) sensor. The sensor was mounted in a Leica PAV100 gyro-stabilized mount integrated with a NovAtel SPAN GNSS and LCI-100C IMU. This sensor collects up to four returns (echo) per pulse, as well as intensity data, for the first three returns. The aerial lidar was collected at the following sensor specifications:

Post Spacing	0.35 m
AGL (Above Ground Level) average flying height	1500 m
Average Ground Speed:	125 knots / 144 mph
Field of View (full)	40 degrees
Pulse Rate	320/360 kHz
Scan Rate	50 Hz
Side Lap	15%

LiDAR data was produced in NAD83(2011) UTM12N. Coordinate positions were specified in units of meters. The vertical datum used for the project was referenced to NAVD 1988, Meters, GEOID12B.

Figure 1.1: Zion National Park QL2 Lidar Task Order AOI

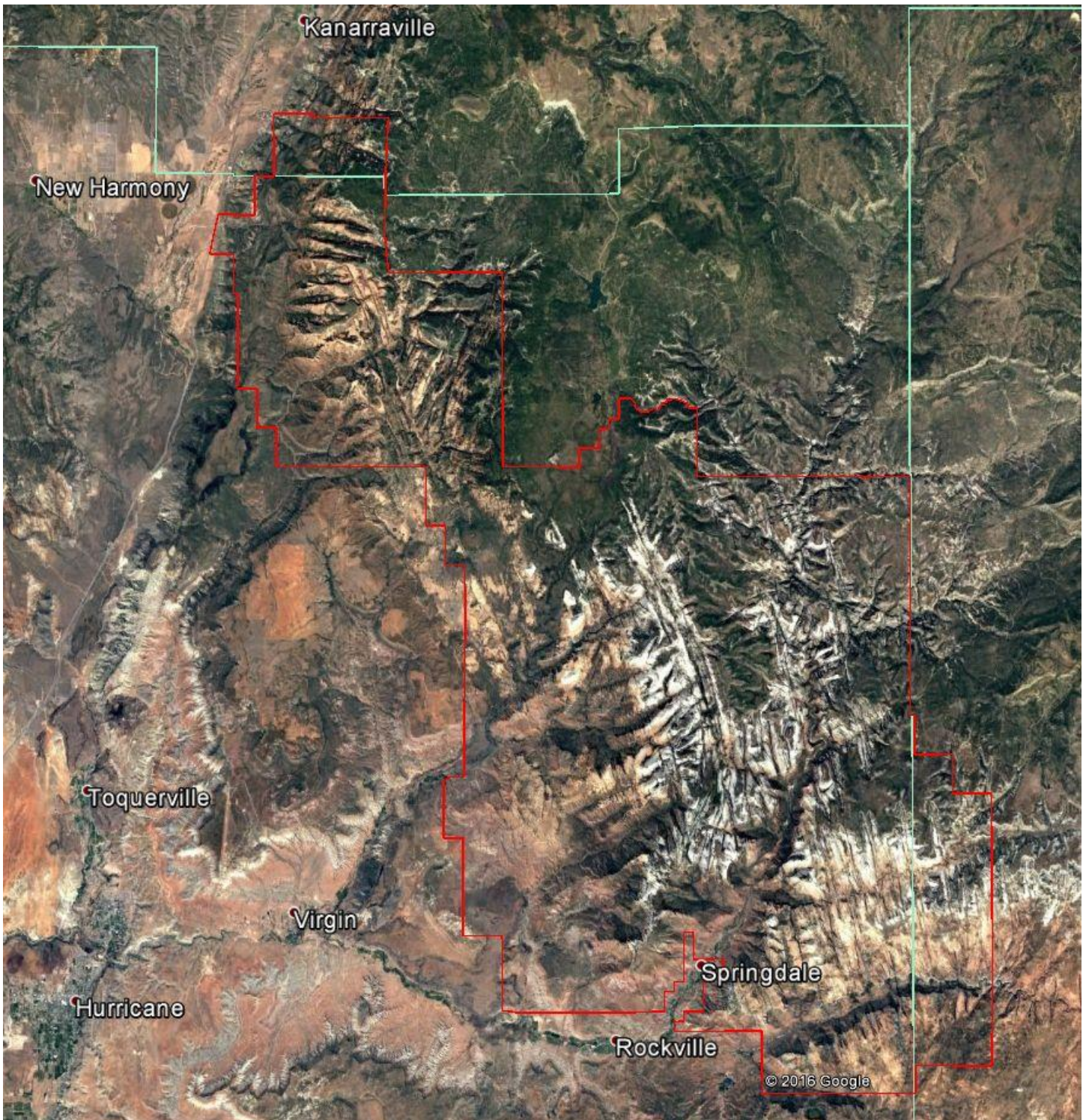
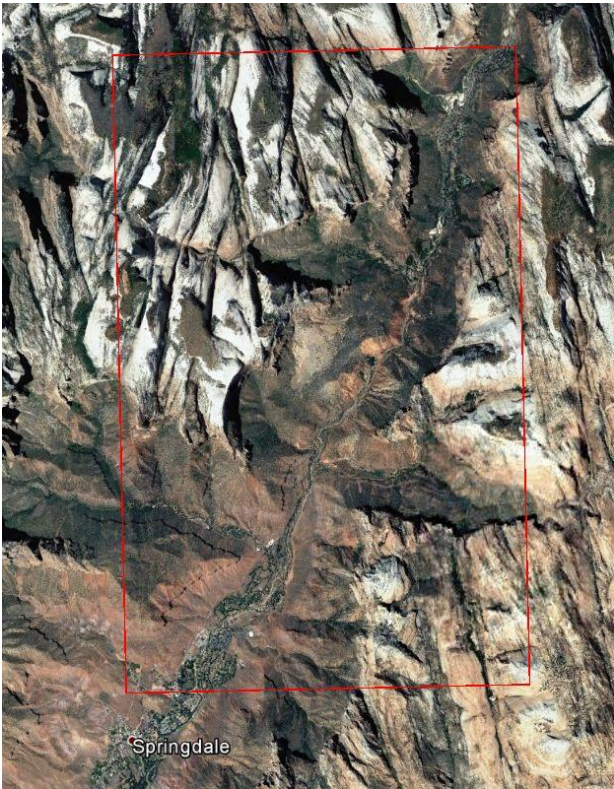


Figure 1.2: Zion National Park QL1 Lidar Task Order AOI



Section 2: Acquisition

The LiDAR data was acquired with a Leica Dual-Head DragonEye (DE) sensor, on board Woolpert's Cessna aircraft. The Leica system, developed by Leica of Herrburgg, Switzerland. The innovative dual scanner head design of the DragonEye features a unique oblique scan pattern. In one single pass, each ground target may be illuminated by four laser shots at multiple incidence angles from ± 8 to ± 20 degrees, maximizing vertical surface definition and minimizing shadows in the survey data. Each topographic laser operates in the infra-red spectrum at 1064nm. Up to 15 returns per pulse are acquired from each laser.

Table 2.1: The Leica DragonEye LiDAR System has the following specifications:

Laser Characterization	
Laser wavelength ⁶⁾	1064 nm
Laser divergence	0.5 mrad (1/e ²)
Pulse repetition frequency (PRF)	Up to 1 MHz
Return pulses	Programmable up to 15 returns, with full waveform record option
Operation altitude ¹⁾	300 – 1600 m AGL
Scanner pattern	Dual head oblique scanner
Scanner speed	Programmable up to 70 RPS per scanner (i.e., 280 scans/second)
Field of view	$\pm 8^\circ$ and $\pm 20^\circ$ front/back, $\pm 20^\circ$ left/right
Swath width	70% of AGL
Point density ²⁾	> 16 pts/m ²
Ranging accuracy ^{2), 3), 4)}	2 cm (1 σ)
Vertical accuracy ^{2), 3), 5)}	6 cm (1 σ)
Horizontal accuracy ^{2), 3), 5)}	25 cm (1 σ)

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 fourteen (14) missions, flown as close together as the weather permitted, to ensure consistent ground conditions across the project area. An initial quality control process was performed immediately on the LiDAR data to review the data coverage, airborne GPS data, and trajectory solution.

Table 2.2: Airborne Lidar Acquisition Flight Summary

Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down
November 14, 2015	70-87, 102-111	15:58 – 20:07
November 15, 2015	1-17, 23-40	17:36 – 22:32
November 17, 2015	1-17	20:22 – 22:35
November 20, 2015	18-23	17:50 – 19:36
June 28, 2016	9, 120-127	16:12 – 17:34
June 29, 2016	9-35	12:13 – 15:53
June 30, 2016	35-69	12:25 – 17:11
July 1, 2016	18-22, 88-101	17:23 – 20:06
July 2, 2016	1-8	12:30 – 14:00
July 2, 2016	7-25	17:48 – 20:27
July 6, 2016	1-6, 11-15	12:19 – 17:07
July 7, 2016	57-59, 62-67, 71, 72	12:36 – 17:00
July 8, 2016	1-6	12:32 – 14:00
July 20, 2016	4-20, 42, 43	12:35 – 16:01

Section 3: LiDAR Data Processing

Applications and Work Flow Overview

Initial data coverage analysis and quality checks to ensure there were no potential system issues were carried out in the field prior to demobilization of the sensor. In general, data were initially processed in Leica's Lidar Survey Studio (LSS) using final processed trajectory information. LAS files from LSS were imported to a Terrascan project where spatial algorithms were used to remove gross system noise and a basic ground classification was conducted per flight line for Terra Match use. TMatch was then run on the project, and a comparison to the lidar control points was conducted. Final trajectory data were post processed in NovAtel Inertial Explorer. Base station data were converted to GPB format and imported with aircraft GNSS and IMU data. Inertial Explorer accounts for the fixed offset between the reference point and IMU and uses a multi-pass algorithm to compute a tightly-coupled solution. Lidar processing was conducted using the Leica Lidar Survey Studio (LSS) software. Calibration information, along with processed trajectory information were combined with the raw laser data to create an accurately georeferenced lidar point cloud for the entire survey in LAS v1.2 format. All points from the topographic lasers include 16-bit intensity values. Additional QC steps were then performed in LSS prior to import to Terrascan. For example, spot checks were made on the data to ensure the front and back of the scans remained in alignment and no calibration or system issues were apparent prior to further data editing in Terrascan.

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

Equipment

Flight navigation during the LiDAR data acquisition mission is performed using IGI CCNS (Computer Controlled Navigation System). 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.

The aircraft is configured with a NovAtel SPAN GNSS and LCI-100C IMU.

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)
CDC1	37 42 2.18477	113 5 32.66306	1689.067
HO0410	37 10 17.76005	113 5 9.92983	1112.798
HO0487	37 31 54.29810	113 11 4.96229	1668.478
UTCE	37 42 15.17476	113 5 12.50246	1705.460
UTHN	37 11 8.50150	113 17 55.20862	1013.600

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 Vegetation (Class3), Medium Vegetation (Class4), High Vegetation (Class 5), Low noise (Class 7), Bridge Decks (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) UTM12N meters. The vertical datum used for the task order was referenced to NAVD 1988, meters, GEOID12B.

Section 4: Accuracy Assessment

Final Vertical Accuracy Assessment

The vertical accuracy statistics were calculated by comparison of the LiDAR bare earth points to the ground surveyed QA/QC points.

Table 4.1: Overall Vertical Accuracy Statistics

Average error	+0.027	meter
Minimum error	-0.135	meter
Maximum error	+0.355	meter
Average magnitude	0.058	meter
Root mean square	0.080	meter
Standard deviation	0.075	meter

Table 4.2: RAW Swath Quality Check Point Analysis NVA

Point ID	Easting (meter)	Northing (meter)	Elevation (meter)	TIN Elevation (meter)	Dz (meter)
2001	306733.081	4147612.753	1814.277	1814.315	0.038
2001A	306774.367	4147607.247	1815.656	1815.687	0.031
2002	312787.036	4134700.582	1946.583	1946.626	0.043
2002A	312787.952	4134704.921	1946.374	1946.490	0.116
2002B	312788.716	4134709.215	1946.155	1946.232	0.077
2003	328073.757	4126721.572	1328.564	1328.613	0.049
2003A	328067.374	4126726.834	1328.341	1328.426	0.085
2004	305342.575	4148392.065	1675.625	1675.490	-0.135
2004A	305337.119	4148435.253	1665.907	1666.262	0.355
2005	305210.073	4145465.823	1901.024	1901.023	-0.001
2005A	305242.204	4145448.113	1900.581	1900.608	0.027
2007	313673.198	4134908.784	1985.158	1985.186	0.028
2007A	313669.998	4134908.298	1985.032	1985.047	0.015
2007B	313674.950	4134908.078	1985.035	1985.105	0.070
2008	314803.374	4135545.065	1981.604	1981.647	0.043
2008A	314800.779	4135543.291	1981.825	1981.850	0.025
2008B	314797.354	4135541.706	1981.998	1982.059	0.061
2009	316132.827	4134593.482	2125.278	2125.350	0.072
2009A	316134.232	4134590.328	2125.202	2125.266	0.064
2010	316440.641	4136959.168	2276.199	2276.246	0.047
2010A	316443.158	4136950.570	2276.535	2276.623	0.088
2010B	316443.428	4136942.574	2276.306	2276.344	0.038
2011	313084.177	4129165.766	1566.388	1566.454	0.066
2011A	313089.670	4129160.444	1565.538	1565.525	-0.013

2011B	313095.453	4129157.652	1564.574	1564.573	-0.001
2012	313524.826	4126985.239	1385.684	1385.666	-0.018
2012A	313522.078	4126988.019	1385.536	1385.487	-0.049
2012B	313529.327	4126983.684	1385.987	1385.926	-0.061
2013	314808.796	4116097.211	1135.826	1135.817	-0.009
2013A	314809.721	4116093.878	1135.896	1135.774	-0.122
2014	322778.720	4117967.547	1190.989	1191.009	0.020
2014A	322777.512	4117971.216	1191.025	1191.095	0.070
2015	324680.771	4120858.550	1236.108	1236.102	-0.006
2015A	324681.141	4120862.869	1236.118	1236.024	-0.094
2016	326151.722	4120369.512	1399.201	1399.166	-0.035
2016A	326155.326	4120369.099	1398.755	1398.666	-0.089
2017	329774.345	4120585.765	1611.633	1611.700	0.067
2017A	329774.981	4120589.794	1611.870	1611.900	0.030
2018	332003.783	4121435.683	1681.086	1681.134	0.048
2018A	332001.246	4121438.730	1681.718	1681.740	0.022
2019	334598.303	4122616.367	1763.133	1763.214	0.081
2019A	334595.562	4122614.581	1762.830	1762.848	0.018
2019B	334590.862	4122613.199	1762.680	1762.737	0.057
2020	319314.827	4139915.766	2406.767	2406.883	0.116
2020A	319292.978	4139930.986	2402.961	2403.034	0.073
2021	322619.900	4139432.237	2192.553	2192.552	-0.001
2021A	322625.396	4139426.817	2192.169	2192.271	0.102
2022	320414.622	4139369.153	2403.830	2403.866	0.036
2022A	320410.439	4139367.615	2403.895	2403.989	0.094
2023	327035.742	4125404.830	1311.662	1311.656	-0.006
2023A	327031.765	4125408.533	1311.604	1311.601	-0.003
2024	325664.647	4122072.341	1260.719	1260.620	-0.099
2024A	325659.195	4122069.554	1260.692	1260.606	-0.086

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.156 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 0.123 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 4.3: NVA Check Point Analysis DEM

Point ID	Easting (meter)	Northing (meter)	Elevation (meter)	DEM Elevation (meter)	Dz (meter)
2001	306733.081	4147612.753	1814.277	1814.269	0.008
2001 A	306774.367	4147607.247	1815.656	1815.522	0.134
2002	312787.036	4134700.582	1946.583	1946.628	-0.045
2002A	312787.952	4134704.921	1946.374	1946.420	-0.046
2002B	312788.716	4134709.215	1946.155	1946.166	-0.011
2003	328073.757	4126721.572	1328.564	1328.572	-0.008
2003A	328067.374	4126726.834	1328.341	1328.303	0.038
2004	305342.575	4148392.065	1675.625	1675.273	0.352
2004 A	305337.119	4148435.253	1665.907	1665.816	0.091
2005	305210.073	4145465.823	1901.024	1901.017	0.007
2005 A	305242.204	4145448.113	1900.581	1900.459	0.122
2007	313673.198	4134908.784	1985.158	1985.157	0.001
2007A	313669.998	4134908.298	1985.032	1985.062	-0.030
2007B	313674.950	4134908.078	1985.035	1985.144	-0.109
2008	314803.374	4135545.065	1981.604	1981.614	-0.010
2008A	314800.779	4135543.291	1981.825	1981.868	-0.043
2008B	314797.354	4135541.706	1981.998	1982.028	-0.030
2009	316132.827	4134593.482	2125.278	2125.364	-0.086
2009A	316134.232	4134590.328	2125.202	2125.266	-0.064
2010	316440.641	4136959.168	2276.199	2276.151	0.048
2010A	316443.158	4136950.570	2276.535	2276.712	-0.177
2010B	316443.428	4136942.574	2276.306	2276.359	-0.053
2011	313084.177	4129165.766	1566.388	1566.377	0.011
2011A	313089.670	4129160.444	1565.538	1565.527	0.011
2011B	313095.453	4129157.652	1564.574	1564.485	0.089
2012	313524.826	4126985.239	1385.684	1385.597	0.087
2012A	313522.078	4126988.019	1385.536	1385.520	0.016
2012B	313529.327	4126983.684	1385.987	1385.939	0.048
2013	314808.796	4116097.211	1135.826	1135.837	-0.011
2013A	314809.721	4116093.878	1135.896	1135.791	0.105
2014	322778.720	4117967.547	1190.989	1190.972	0.017
2014A	322777.512	4117971.216	1191.025	1191.060	-0.035
2015	324680.771	4120858.550	1236.108	1236.092	0.016
2015A	324681.141	4120862.869	1236.118	1236.000	0.118
2016	326151.722	4120369.512	1399.201	1399.129	0.072
2016A	326155.326	4120369.099	1398.755	1398.725	0.030
2017	329774.345	4120585.765	1611.633	1611.613	0.020
2017A	329774.981	4120589.794	1611.870	1611.910	-0.040
2018	332003.783	4121435.683	1681.086	1681.122	-0.036
2018A	332001.246	4121438.730	1681.718	1681.717	0.001
2019	334598.303	4122616.367	1763.133	1763.227	-0.094
2019A	334595.562	4122614.581	1762.830	1762.779	0.051
2019B	334590.862	4122613.199	1762.680	1762.682	-0.002
2020	319314.827	4139915.766	2406.767	2406.840	-0.073
2020A	319292.978	4139930.986	2402.961	2402.960	0.001
2021	322619.900	4139432.237	2192.553	2192.599	-0.046
2021A	322625.396	4139426.817	2192.169	2192.185	-0.016
2022	320414.622	4139369.153	2403.830	2403.816	0.014

2022A	320410.439	4139367.615	2403.895	2403.880	0.015
2023	327035.742	4125404.830	1311.662	1311.659	0.003
2023A	327031.765	4125408.533	1311.604	1311.547	0.057
2024	325664.647	4122072.341	1260.719	1260.670	0.049
2024A	325659.195	4122069.554	1260.692	1260.618	0.074

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.152 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 4.4: VVA Quality Check Point Analysis DEM

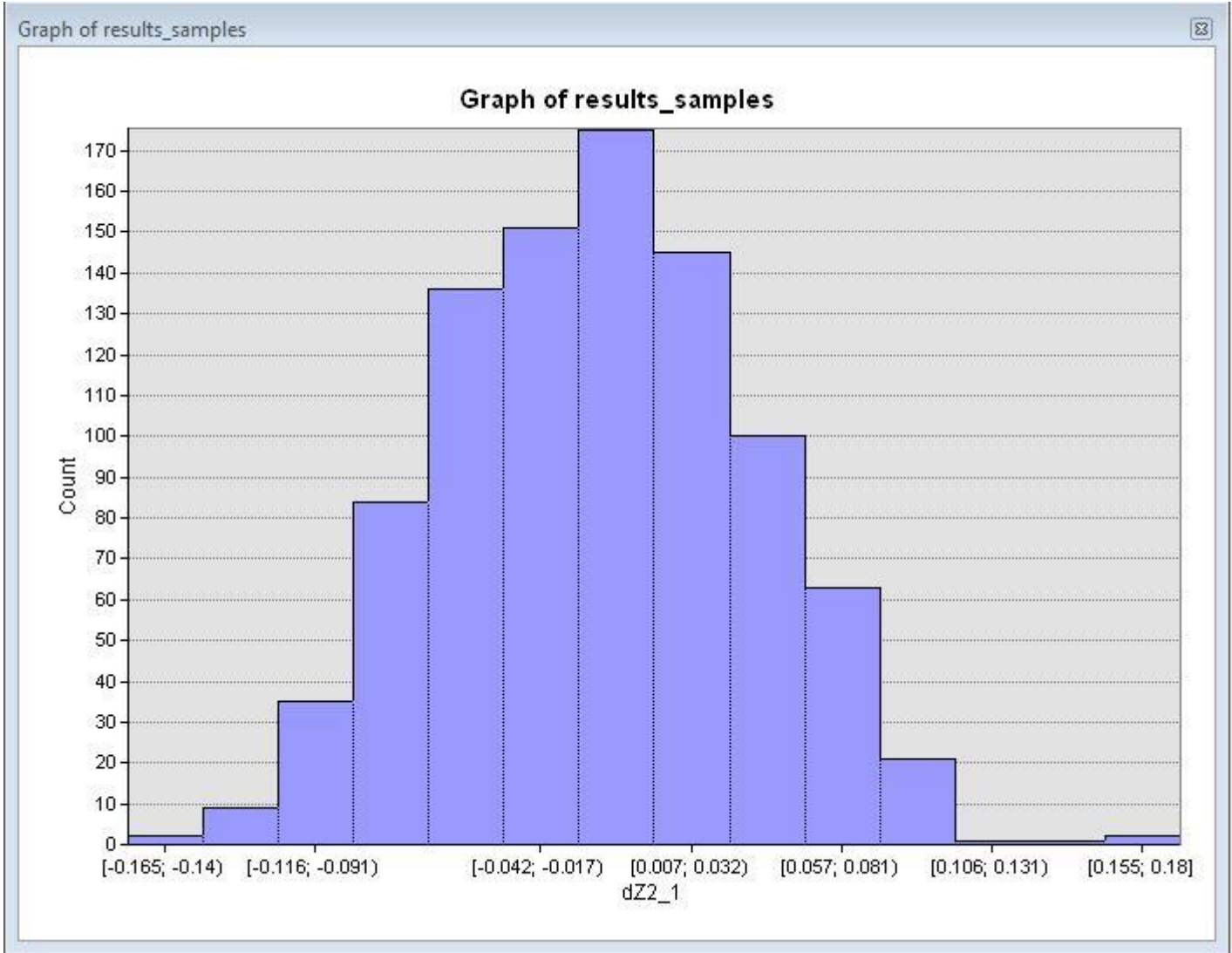
Point ID	Easting (meter)	Northing (meter)	Elevation (meter)	DEM Elevation (meter)	Dz (meter)
3001	306674.892	4147625.034	1813.638	1813.671	-0.033
3001 A	306643.898	4147614.217	1812.671	1812.662	0.009
3002	312811.940	4134680.789	1949.096	1949.182	-0.086
3002A	312813.924	4134683.760	1949.015	1949.076	-0.061
3002B	312808.972	4134687.168	1948.476	1948.547	-0.071
3003	328106.404	4126683.823	1326.750	1326.784	-0.034
3004	332023.409	4121430.085	1677.764	1677.813	-0.049
3004A	332026.510	4121426.954	1677.033	1677.018	0.015
3005	313717.721	4128020.186	1487.611	1487.461	0.150
3005A	313719.717	4128018.200	1487.587	1487.543	0.044
3006	321368.799	4139236.201	2245.828	2245.932	-0.104
3006A	321372.428	4139237.643	2245.806	2245.876	-0.070
3007	326146.300	4120376.725	1399.917	1399.870	0.047
3007A	326147.296	4120375.103	1399.977	1399.932	0.045
3008	323542.138	4119048.922	1202.062	1202.000	0.062
3008A	323544.038	4119049.806	1202.028	1201.925	0.103
3009	305965.463	4146299.160	1824.599	1824.557	0.042
3009 A	305958.580	4146245.097	1821.969	1822.244	-0.275
3010	314773.102	4116071.582	1133.556	1133.575	-0.019
3010A	314776.193	4116069.147	1133.670	1133.735	-0.065
3011	305224.840	4145444.944	1900.534	1900.568	-0.034
3011 A	305185.324	4145417.013	1899.956	1899.876	0.080
3012	316697.911	4138278.491	2335.618	2335.674	-0.056
3012A	316696.377	4138276.286	2335.179	2335.449	-0.270
3012B	316700.388	4138281.304	2335.440	2335.658	-0.218
3013	316114.260	4134615.306	2126.118	2126.255	-0.137
3013A	316109.141	4134615.858	2126.082	2126.224	-0.142
3013B	316117.135	4134617.742	2126.062	2126.116	-0.054
3001	306674.892	4147625.034	1813.638	1813.671	-0.033
3001 A	306643.898	4147614.217	1812.671	1812.662	0.009
3002	312811.940	4134680.789	1949.096	1949.182	-0.086
3002A	312813.924	4134683.760	1949.015	1949.076	-0.061
3002B	312808.972	4134687.168	1948.476	1948.547	-0.071

3003	328106.404	4126683.823	1326.750	1326.784	-0.034
3004	332023.409	4121430.085	1677.764	1677.813	-0.049
3004A	332026.510	4121426.954	1677.033	1677.018	0.015
3005	313717.721	4128020.186	1487.611	1487.461	0.150
3005A	313719.717	4128018.200	1487.587	1487.543	0.044
3006	321368.799	4139236.201	2245.828	2245.932	-0.104
3006A	321372.428	4139237.643	2245.806	2245.876	-0.070
3007	326146.300	4120376.725	1399.917	1399.870	0.047
3007A	326147.296	4120375.103	1399.977	1399.932	0.045
3008	323542.138	4119048.922	1202.062	1202.000	0.062
3008A	323544.038	4119049.806	1202.028	1201.925	0.103
3009	305965.463	4146299.160	1824.599	1824.557	0.042
3009 A	305958.580	4146245.097	1821.969	1822.244	-0.275
3010	314773.102	4116071.582	1133.556	1133.575	-0.019
3010A	314776.193	4116069.147	1133.670	1133.735	-0.065
3011	305224.840	4145444.944	1900.534	1900.568	-0.034
3011 A	305185.324	4145417.013	1899.956	1899.876	0.080
3012	316697.911	4138278.491	2335.618	2335.674	-0.056
3012A	316696.377	4138276.286	2335.179	2335.449	-0.270
3012B	316700.388	4138281.304	2335.440	2335.658	-0.218
3013	316114.260	4134615.306	2126.118	2126.255	-0.137
3013A	316109.141	4134615.858	2126.082	2126.224	-0.142
3013B	316117.135	4134617.742	2126.062	2126.116	-0.054

Vertical Accuracy Conclusions


Vegetated Vertical Accuracy (VVA) Tested 0.272 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 3009A, Easting 305965.463, Northing 4146299.16, Z-Error 0.275 Meters

Figure 4.1: LIDAR Relative Accuracy Histogram for Zion National Park QL1 and QL2 Lidar



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 Zion National Park QL1 and QL2 Lidar measured at 0.051 feet RMSDz.

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

Section 5: LiDAR Acquisition Flight Logs

This section contains the Flight Log(s) covering the project. Flight Logs list mission specific details such as crew members, airports, weather conditions, real time PDOP values and document any issues encountered during the mission. Flight Logs are filled out by the sensor operator during the acquisition flight.



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Block 11 & 13		DATE:	14 November 2015	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Ben H.	
MISSION ID:	P2015-025-ZionNP_QL2L		CLOUDS:	Clear	
BASE STATION:	CDC1 and HO0410		WIND:	10-15 kts @ 90°	
ENGINE START:	15:45	ENGINE OFF:	20:16	ENGINE TIME:	04:31
GNSS START:	15:49	GNSS START:	20:10		
TAKEOFF:	15:58	TOUCHDOWN:	20:07	AIR TIME	04:09

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
						Overfly northern blocks on transit
						Significant snow in Blocks 1-7
						Least snow in Blocks 4-6
						Some dusting in north of Blocks 8-10
	16:12:00					At HO0410 base station
						Begin Block 11
000_FL87	16:17:34	16:22:10	160	63	N	Will clip higher elevations on all lines
001_FL86	16:25:23	16:30:34	160	63	S	
002_FL85	16:33:33	16:38:29	160	63	N	Aircraft control hard, sinks/lifts on
003_FL84	16:41:24	16:46:35	160	63	S	all lines. Shadowing of data in MPIA
004_FL83	16:49:10	16:54:16	160	63	N	range will also be an issue
005_FL82	16:56:54	17:02:00	160	63	S	
006_FL81	17:04:41	17:09:26	160	63	N	Rerun from south start to frame 20
007_FL80	17:12:26	17:17:01	160	63	S	Fast at SOL
008_FL79	17:19:58	17:24:49	160	63	N	
009_FL78	17:27:55	17:33:00	160	63	S	
010_FL77	17:35:45	17:40:44	160	63	N	
011_FL76	17:43:40	17:48:38	160	63	S	
012_FL75	17:51:23	17:56:10	160	63	N	
013_FL74	17:59:10	18:04:03	160	63	S	
014_FL73	18:06:48	18:11:34	160	63	N	
015_FL72	18:14:29	18:18:39	160	63	S	
016_FL71	18:21:54	18:26:06	160	63	N	
017_FL70	18:33:45	18:37:08	160	63	S	
						End Block 11 / Begin Block 13
018_FL111	18:40:36	18:43:23	160	63	E	
019_FL110	18:47:16	18:50:49	160	63	W	



FLIGHT LOG

PROJECT NAME: P2015.025 - Zion National Park **BASE AIRPORT:** Cedar City (CDC)
LOCATION / AREA: Zion National Park, UT / Block 11 & 13 **DATE:** 14 November 2015
AIRCRAFT: Cessna 401 - N6255Q **PILOT:** Ray L.
SYSTEM: Dual DragonEye **OPERATOR:** Ben H.

MISSION ID: P2015-025-ZionNP_QL2L **CLOUDS:** Clear
BASE STATION: CDC1 and HO0410 **WIND:** 10-15 kts @ 90°

ENGINE START: 15:45 **ENGINE OFF:** 20:16 **ENGINE TIME:** 04:31
GNSS START: 15:49 **GNSS START:** 20:10
TAKEOFF: 15:58 **TOUCHDOWN:** 20:07 **AIR TIME:** 04:09

FL #	START TIME	END TIME	TOPO		BATHY PWR CHII	REMARKS
			PRF	PWR		
020_FL109	18:54:05	18:57:45	160	63	E	
021_FL108	19:00:38	19:05:10	160	63	W	
022_FL107	19:08:16	19:12:43	160	63	E	
023_FL106	19:15:36	19:20:13	160	63	W	
024_FL105	19:23:07	19:27:34	160	63	E	
025_FL104	19:30:35	19:34:56	160	63	W	
026_FL103	19:37:54	19:42:12	160	63	E	
027_FL102	19:45:15	19:49:40	160	63	W	
	19:51:00					Over base station at HO0410
						Return to CDC



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Block 11 & 13		DATE:	15 November 2015	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Ben H.	
MISSION ID:	P2015-025-ZionNP_QL2H		CLOUDS:	Clear	
BASE STATION:	CDC1 and HO0410		WIND:	15-20 kts @ 200°	
ENGINE START:	17:25	ENGINE OFF:	22:40	ENGINE TIME:	05:15
GNSS START:	17:28	GNSS START:	22:34		
TAKEOFF:	17:36	TOUCHDOWN:	22:32	AIR TIME	04:56

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	17:52:00					At HO0410 base station
						Begin Block 13
						Will clip lower elevations on all lines
						Dataset: 20151115_175526
000_FL40	17:55:26	17:56:07	160	63	E	Abort line- Reject. Off track at SOL.
						Dataset: 20151115_180230
000_FL40	18:02:30	18:05:19	160	63	E	
001_FL39	18:08:54	18:12:31	160	63	W	
002_FL38	18:15:36	18:19:13	160	63	E	
003_FL37	18:22:18	18:26:51	160	63	W	
004_FL36	18:29:44	18:34:24	160	63	E	
005_FL35	18:37:15	18:41:57	160	63	W	
006_FL34	18:44:55	18:49:21	160	63	E	
007_FL33	18:52:13	18:56:32	160	63	W	
008_FL32	18:59:22	19:03:55	160	63	E	
009_FL31	19:08:30	19:11:12	160	63	W	Forced stop error. Rerun to frame 20
						End Block 13 / Begin Block 11
010_FL17	19:16:54	19:21:12	160	63	N	
011_FL16	19:24:38	19:29:13	160	63	S	
012_FL15	19:32:02	19:36:48	160	63	N	
013_FL14	19:39:42	19:44:25	160	63	S	
014_FL13	19:47:18	19:52:07	160	63	N	
015_FL12	19:55:05	19:59:43	160	63	S	
016_FL11	20:02:18	20:07:01	160	63	N	
017_FL10	20:09:55	20:14:35	160	63	S	
018_FL9	20:17:28	20:22:11	160	63	N	
019_FL8	20:25:12	20:29:34	160	63	S	



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Block 11 & 13		DATE:	15 November 2015	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Ben H.	
MISSION ID:	P2015-025-ZionNP_QL2H		CLOUDS:	Clear	
BASE STATION:	CDC1 and HO0410		WIND:	15-20 kts @ 200°	
ENGINE START:	17:25	ENGINE OFF:	22:40	ENGINE TIME:	05:15
GNSS START:	17:28	GNSS START:	22:34		
TAKEOFF:	17:36	TOUCHDOWN:	22:32	AIR TIME	04:56

FL #	START TIME	END TIME	TOPO		BATHY PWR CHII	REMARKS
			PRF	PWR		
020_FL7	20:33:16	20:36:56	160	63	N	
021_FL6	20:40:00	20:43:27	160	63	S	
022_FL5	20:46:29	20:49:53	160	63	N	
023_FL4	20:52:33	20:55:52	160	63	S	
024_FL3	20:58:46	21:02:02	160	63	N	
025_FL2	21:04:54	21:08:03	160	63	S	
026_FL1	21:10:54	21:13:55	160	63	N	
						End Block 11 / Rerun line in Block 13
027_FL31	21:19:35	21:24:03	160	63	E	
						Begin Block 12
028_FL30	21:28:09	21:31:00	160	63	N	
029_FL29	21:33:52	21:36:46	160	63	S	
030_FL28	21:40:02	21:43:18	160	63	N	
031_FL27	21:46:44	21:50:00	160	63	S	
032_FL26	21:52:57	21:56:16	160	63	N	
033_FL25	21:58:57	22:02:18	160	63	S	
034_FL24	22:04:57	22:08:16	160	63	N	
035_FL23	22:11:25	22:14:43	160	63	S	
						Weather moving into the area.
	22:18:00					Over base HO0410
						Return to CDC below rain clouds



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Block 14		DATE:	17 November 2015	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Ben H.	
MISSION ID:	P2015-025-ZionNP_QL1L		CLOUDS:	Clear	
BASE STATION:	CDC1 and HO0410		WIND:	20-25 kts @ 0°	
ENGINE START:	20:09	ENGINE OFF:	22:45	ENGINE TIME:	02:36
GNSS START:	20:16	GNSS START:	22:39		
TAKEOFF:	20:22	TOUCHDOWN:	22:35	AIR TIME	02:13

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	20:41:00					At HO0410 base station
						Begin Block 14A
						Dataset: 20151117_204508
						Will clip lower elevations on all lines
000_FL1	20:45:08	20:47:41	160	63	N	Turbulent air difficult to keep steady
001_FL2	20:50:47	20:53:13	160	63	S	
002_FL3	20:56:08	20:58:37	160	63	N	
003_FL4	21:02:21	21:04:53	160	63	S	
004_FL5	21:07:55	21:10:43	160	63	N	
005_FL6	21:13:30	21:16:18	160	63	S	
006_FL7	21:19:36	21:22:25	160	63	N	
007_FL8	21:25:17	21:28:01	160	63	S	
						Begin Block 14B
008_FL17	21:31:24	21:33:47	160	63	W	
009_FL16	21:36:30	21:38:54	160	63	E	
010_FL15	21:41:45	21:44:09	160	63	W	
011_FL14	21:46:48	21:49:19	160	63	E	
012_FL13	21:51:50	21:54:12	160	63	W	
013_FL12	21:56:40	21:59:03	160	63	E	
014_FL11	22:01:33	22:03:52	160	63	W	
015_FL10	22:07:05	22:09:30	160	63	E	
016_FL9	22:12:10	22:14:25	160	63	W	
						End survey - still need lines in BL14C
						Too turbulent.
	22:16:00					Over base HO0410
						Returning to CDC



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park	BASE AIRPORT:	Cedar City (CDC)
LOCATION / AREA:	Zion National Park, UT / Block 14	DATE:	20 November 2015
AIRCRAFT:	Cessna 401 - N6255Q	PILOT:	Ray L.
SYSTEM:	Dual DragonEye	OPERATOR:	Dushan A.

MISSION ID:	P2015-025-ZionNP_QL1L and QL2H	CLOUDS:	Clear
BASE STATION:	CDC1 and HO0410	WIND:	10 kts @ 0°

ENGINE START:	17:36	ENGINE OFF:	19:40	ENGINE TIME:	02:04
GNSS START:	17:40	GNSS START:	19:40		
TAKEOFF:	17:50	TOUCHDOWN:	19:36	AIR TIME	01:46

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	18:05:00					At HO0410 base station
						Begin Block 14C
						Dataset: QL1L_20151120_181302
						Will clip lower elevations on all lines
000_FL23	18:13:02	18:15:45	160	63		
001_FL22	18:18:30	18:21:21	160	63		
002_FL21	18:24:23	18:27:10	160	63		
003_FL20	18:30:00	18:32:55	160	63		
004_FL19	18:35:49	18:37:37	160	63		
005_FL18	18:40:27	18:42:22	160	63		
						End Block 14C
						QL1L Completed
						Dataset: QL2H_20151120_184711
000_FL22	18:47:11	18:50:25	160	63		Abort due to snow in area
	18:55:00					Over base HO0410
						Returning to CDC



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Block 1		DATE:	28 June 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Eric L.	
MISSION ID:	P2015-025-ZionNP_QL2L		CLOUDS:	Overcast	
BASE STATION:	HO0487		WIND:	11 kts @ 224°	
ENGINE START:	15:57	ENGINE OFF:	17:36	ENGINE TIME:	01:39
GNSS START:	16:00	GNSS START:	17:36		
TAKEOFF:	16:12	TOUCHDOWN:	17:34	AIR TIME	01:22

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
						Delayed start - aircraft oil change
	16:18:00					Initialize over HO0478
						Dataset: QL2L_20160628_162703
000_FL120	16:24:20	16:25:57	180	55	-	Line 1 (Begin BL01)
001_FL121	16:29:09	16:32:09	180	55	-	Line 2
002_FL122	16:35:49	16:39:17	180	55	-	Line 3
003_FL123	16:42:19	16:45:52	180	55	-	Line 4
004_FL124	16:48:44	16:52:52	180	55	-	Line 5
005_FL125	16:56:20	17:00:25	180	55	-	Line 6
006_FL126	17:03:25	17:07:27	180	55	-	Line 7
007_FL127	17:10:36	17:14:36	180	55	-	Line 8
008_FL9	17:17:33	17:21:44	180	55	-	Out of pitch - re-run tomorrow
	17:22:00					Close over base HO0478
						Returning to CDC



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Block 2, 3, 4, 5, 6		DATE:	29 June 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Eric L.	
MISSION ID:	P2015-025-ZionNP_QL2L		CLOUDS:	Overcast/rainy	
BASE STATION:	HO0487		WIND:	12 kts @ 220°	
ENGINE START:	12:03	ENGINE OFF:	15:56	ENGINE TIME:	03:53
GNSS START:	12:03	GNSS START:	15:48		
TAKEOFF:	12:13	TOUCHDOWN:	15:53	AIR TIME	03:40

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	12:18:00					Initialize over HO0478
						Dataset: QL2L_20160629_122819
000_FL9	12:25:36	12:29:25	180	55	-	Begin BL02
001_FL10	12:32:23	12:36:20	180	55	-	
002_FL11	12:39:28	12:43:08	180	55	-	
003_FL12	12:46:23	12:49:39	180	55	-	Flew too low: re-run (Begin BL03)
004_FL13	12:54:40	12:57:50	180	55	-	
005_FL14	13:01:02	13:04:05	180	55	-	
006_FL12	13:06:53	13:10:10	180	55	-	Re-run at correct altitude
007_FL15	13:18:34	13:20:39	180	55	-	Begin BL04
008_FL16	13:23:52	13:26:10	180	55	-	
009_FL17	13:29:09	13:31:26	180	55	-	
010_FL18	13:34:53	13:37:18	180	55	-	
011_FL19	13:40:11	13:42:41	180	55	-	
012_FL20	13:45:59	13:48:22	180	55	-	
013_FL21	13:51:57	13:53:58	180	55	-	Begin BL05
014_FL22	13:56:57	13:59:25	180	55	-	
015_FL23	14:02:40	14:05:32	180	55	-	
016_FL24	14:08:31	14:11:36	180	55	-	
017_FL25	14:14:45	14:18:01	180	55	-	
018_FL26	14:20:59	14:24:15	180	55	-	
019_FL27	14:27:23	14:30:38	180	55	-	
020_FL28	14:33:40	14:37:30	180	55	-	
021_FL29	14:40:38	14:44:34	180	55	-	
022_FL30	14:48:13	14:52:06	180	55	-	
023_FL31	14:55:08	14:59:39	180	55	-	Flew too low: re-run (Begin BL06)
024_FL31	15:03:45	15:08:00	180	55	-	Re-run at correct altitude



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park	BASE AIRPORT:	Cedar City (CDC)		
LOCATION / AREA:	Zion National Park, UT / Block 2, 3, 4, 5, 6	DATE:	29 June 2016		
AIRCRAFT:	Cessna 401 - N6255Q	PILOT:	Ray L.		
SYSTEM:	Dual DragonEye	OPERATOR:	Eric L.		
MISSION ID:	P2015-025-ZionNP_QL2L	CLOUDS:	Overcast/rainy		
BASE STATION:	HO0487	WIND:	12 kts @ 220°		
ENGINE START:	12:03	ENGINE OFF:	15:56	ENGINE TIME:	03:53
GNSS START:	12:03	GNSS START:	15:48		
TAKEOFF:	12:13	TOUCHDOWN:	15:53	AIR TIME	03:40

FL #	START TIME	END TIME	TOPO		BATHY PWR CHII	REMARKS
			PRF	PWR		
025_FL32	15:11:00	15:15:16	180	55	-	
026_FL33	15:19:13	15:23:23	180	55	-	
027_FL34	15:26:38	15:30:26	180	55	-	
028_FL35	15:36:37	15:37:20	180	55	-	Aborted line due to rain storm ahead
						Close over base HO0478
						Returning to CDC



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Blocks 7, 8, 9, 10		DATE:	30 June 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Eric L.	
MISSION ID:	P2015-025-ZionNP_QL2L		CLOUDS:	Overcast/prtly cloudy	
BASE STATION:	HO0410		WIND:	10 kts @ 230°	
ENGINE START:	12:14	ENGINE OFF:	17:14	ENGINE TIME:	05:00
GNSS START:	12:15	GNSS START:	17:13		
TAKEOFF:	12:25	TOUCHDOWN:	17:11	AIR TIME	04:46

FL #	START TIME	END TIME	TOPO PRF PWR	BATHY PWR CHII	REMARKS
	12:40:00				Initialize over HO0410
					Dataset: QL2L_20160630_125208
000_FL35	12:49:25	12:51:31	180 55	-	Begin BL07
001_FL36	12:54:50	12:56:58	180 55	-	
002_FL37	12:59:45	13:01:54	180 55	-	
003_FL38	13:05:00	13:07:23	180 55	-	
004_FL39	13:11:00	13:14:10	180 55	-	
005_FL40	13:17:26	13:20:39	180 55	-	
006_FL41	13:23:46	13:27:01	180 55	-	
007_FL42	13:30:07	13:33:25	180 55	-	
008_FL43	13:36:36	13:40:03	180 55	-	
009_FL44	13:46:41	13:50:10	180 55	-	Begin BL08
010_FL45	13:53:23	13:56:57	180 55	-	
011_FL46	14:00:17	14:03:49	180 55	-	
012_FL47	14:06:57	14:10:36	180 55	-	
013_FL48	14:13:53	14:17:26	180 55	-	
014_FL49	14:20:34	14:24:09	180 55	-	
015_FL50	14:27:14	14:30:54	180 55	-	
016_FL51	14:33:59	14:37:43	180 55	-	
017_FL52	14:40:50	14:44:26	180 55	-	
018_FL53	14:47:25	14:51:02	180 55	-	
019_FL54	14:56:19	15:00:30	180 55	-	Begin BL09
020_FL55	15:03:41	15:07:52	180 55	-	
021_FL56	15:11:08	15:15:26	180 55	-	
022_FL57	15:18:40	15:23:06	180 55	-	
023_FL58	15:26:26	15:30:39	180 55	-	
024_FL59	15:35:21	15:39:43	180 55	-	Begin BL10



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park	BASE AIRPORT:	Cedar City (CDC)
LOCATION / AREA:	Zion National Park, UT / Blocks 7, 8, 9, 10	DATE:	30 June 2016
AIRCRAFT:	Cessna 401 - N6255Q	PILOT:	Ray L.
SYSTEM:	Dual DragonEye	OPERATOR:	Eric L.

MISSION ID:	P2015-025-ZionNP_QL2L	CLOUDS:	Overcast/prtly cloudy
BASE STATION:	HO0410	WIND:	10 kts @ 230°

ENGINE START:	12:14	ENGINE OFF:	17:14	ENGINE TIME:	05:00
GNSS START:	12:15	GNSS START:	17:13		
TAKEOFF:	12:25	TOUCHDOWN:	17:11	AIR TIME	04:46

FL #	START TIME	END TIME	TOPO		BATHY PWR CHII	REMARKS
			PRF	PWR		
025_FL60	15:42:52	15:47:01	180	55	-	
026_FL61	15:50:06	15:54:25	180	55	-	
027_FL62	15:57:19	16:01:33	180	55	-	
028_FL63	16:04:25	16:08:47	180	55	-	
029_FL64	16:11:46	16:15:59	180	55	-	
030_FL65	16:18:53	16:23:04	180	55	-	
031_FL66	16:26:02	16:30:11	180	55	-	
032_FL67	16:33:04	16:37:18	180	55	-	Beginning of daily rough air
033_FL68	16:40:17	16:44:22	180	55	-	
034_FL69	16:47:28	16:51:30	180	55	-	Air increasingly rough
						Close over base HO0410
						Returning to CDC



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Blocks 12		DATE:	01 July 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Eric L.	
MISSION ID:	P2015-025-ZionNP_QL2L		CLOUDS:	Overcast/prtly cloudy	
BASE STATION:	HO0410		WIND:	10 kts @ 300°	
ENGINE START:	17:16	ENGINE OFF:	20:10	ENGINE TIME:	02:54
GNSS START:	17:16	GNSS START:	19:53		
TAKEOFF:	17:23	TOUCHDOWN:	20:06	AIR TIME	02:43

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	17:36:00					Initialize over HO0410
						Dataset: QL2L_20160701_174626
000_FL88	17:43:43	17:46:27	180	55	-	Begin BL12
001_FL89	17:49:20	17:52:01	180	55	-	
002_FL90	17:54:59	17:58:08	180	55	-	
003_FL91	18:01:05	18:04:16	180	55	-	
004_FL92	18:07:08	18:10:10	180	55	-	
005_FL93	18:13:05	18:16:09	180	55	-	
006_FL94	18:19:11	18:22:21	180	55	-	
007_FL95	18:25:04	18:28:10	180	55	-	
008_FL96	18:31:15	18:34:20	180	55	-	
009_FL97	18:37:17	18:40:15	180	55	-	
010_FL98	18:43:27	18:46:33	180	55	-	
011_FL99	18:49:40	18:52:47	180	55	-	
012_FL100	18:56:02	18:59:04	180	55	-	
013_FL101	19:02:19	19:05:22	180	55	-	
	19:08:00				-	Close over base HO0410
	19:14:00				-	Initialize over HO0410
					-	Dataset: QL2H_20160701_192049
000_FL18	19:18:06	19:21:13	180	55	-	Begin BL12
001_FL19	19:24:14	19:27:25	180	55	-	
002_FL20	19:30:33	19:33:38	180	55	-	
003_FL21	19:36:45	19:39:54	180	55	-	
004_FL22	19:43:04	19:46:14	180	55	-	
						Close over base HO0410
						Returning to CDC



FLIGHT LOG

PROJECT NAME: P2015.025 - Zion National Park
LOCATION / AREA: Zion National Park, UT / Blocks 14
AIRCRAFT: Cessna 401 - N6255Q
SYSTEM: Dual DragonEye

BASE AIRPORT: Cedar City (CDC)
DATE: 02 July 2016
PILOT: Ray L.
OPERATOR: Eric L.

MISSION ID: P2015-025-ZionNP_QL1H
BASE STATION: HO0410

CLOUDS: Overcast/rainy
WIND: 16 kts @ 190°

ENGINE START: 12:21 **ENGINE OFF:** 14:03 **ENGINE TIME:** 01:42
GNSS START: 12:24 **GNSS START:** 13:50
TAKEOFF: 12:30 **TOUCHDOWN:** 14:00 **AIR TIME** 01:30

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	12:46:00					Initialize over HO0410
						Dataset: QL1H_20160702_125305
000_FL1	12:50:22	12:52:04	180	55	-	Begin BL14
001_FL2	13:00:15	13:02:01	180	55	-	
002_FL3	13:05:11	13:07:02	180	55	-	
003_FL4	13:09:54	13:11:46	180	55	-	
004_FL5	13:14:59	13:16:54	180	55	-	(Light rain) Rejected
005_FL6	13:19:46	13:20:46	180	55	-	Forced Stop mid-line (light rain) Rejected
006_FL6	13:21:07	13:21:17	180	55	-	BAD: No Data
007_FL8	13:38:12	13:38:23	180	55	-	BAD: No Data, Missed FL7
	13:41:00					Close over base HO0410
						Returning to CDC due to weather



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Blocks 12, 14, 15, 16		DATE:	02 July 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Eric L.	
MISSION ID:	P2015-025-ZionNP_QL1H and QL2H		CLOUDS:	Overcast/prtly cloudy	
BASE STATION:	HO0410		WIND:	9 kts @ 270°	
ENGINE START:	17:41	ENGINE OFF:	20:30	ENGINE TIME:	02:49
GNSS START:	17:43	GNSS START:	20:16		
TAKEOFF:	17:48	TOUCHDOWN:	20:27	AIR TIME	02:39

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	18:02:00					Initialize over HO0410
						Dataset: QL1H_20160702_180914
000_FL7	18:06:31	18:08:26	180	55	-	Begin BL14
						Dataset: QL1H_20160702_181744
000_FL9	18:15:01	18:17:22	180	55	-	Begin BL15 (shutter speed to 1/800)
001_FL10	18:20:31	18:22:59	180	55	-	
002_FL11	18:25:58	18:28:18	180	55	-	
003_FL12	18:31:26	18:33:51	180	55	-	
004_FL13	18:36:50	18:39:09	180	55	-	
005_FL14	18:42:12	18:44:34	180	55	-	
006_FL15	18:47:50	18:50:11	180	55	-	
007_FL16	18:53:17	18:55:43	180	55	-	
008_FL17	18:58:54	19:01:12	180	55	-	
009_FL18	19:04:51	19:06:55	180	55	-	Start BL16
010_FL19	19:10:31	19:12:47	180	55	-	
011_FL20	19:15:38	19:18:08	180	55	-	
012_FL21	19:21:33	19:23:57	180	55	-	
013_FL22	19:26:49	19:29:16	180	55	-	
014_FL23	19:32:34	19:34:56	180	55	-	
015_FL24	19:37:51	19:40:14	180	55	-	
016_FL25	19:43:38	19:46:00	180	55	-	
						Dataset: QL2H_20160702_200452
000_FL21	20:02:09	20:04:51	180	55	-	Begin BL12 (lost some lidar @ SOL)
001_FL22	20:07:52	20:11:00	180	55	-	
						Close over base HO0410
						Returning to CDC



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Reflights		DATE:	06 July 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Dushan A.	
MISSION ID:	P2015-025-ZionNP_QL2R		CLOUDS:	Clear	
BASE STATION:	HO0487 & UTCE		WIND:	20-25 kts @ 215°	
ENGINE START:	12:09	ENGINE OFF:	17:09	ENGINE TIME:	05:00
GNSS START:	-	GNSS START:	-		
TAKEOFF:	12:19	TOUCHDOWN:	17:07	AIR TIME	04:48

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	12:26:00					Initialize over HO0487
	12:32:00					Dataset: QL2R_20160706_123510
000_FL6	12:32:08	12:35:40	180	55	-	
001_FL5	12:39:11	12:42:54	180	55	-	
002_FL4	12:45:51	12:49:34	180	55	-	
003_FL3	12:52:59	12:56:24	180	55	-	
004_FL2	12:58:58	12:59:03	180	55	-	BAD: Force Stop (Laser)
005_FL2	12:59:08	13:01:55	180	55	-	
006_FL1	13:05:44	13:05:47	180	55	-	BAD: Force Stop (Scanner)
007_FL1	13:05:51	13:05:56	180	55	-	BAD: Force Stop (Scanner)
008_FL1	13:05:59	13:06:04	180	55	-	BAD: Force Stop (Scanner)
009_FL1	13:06:24	13:06:30	180	55	-	BAD: Force Stop (Scanner)
	13:08:00					Reboot Lidar System
	13:14:00					Dataset: QL2R_20160706_131743
000_FL1	13:14:41	13:16:54	180	55	-	
001_FL11	13:20:37	13:24:24	180	55	-	
002_FL12	13:27:56	13:32:01	180	55	-	
003_FL13	13:35:19	13:39:25	180	55	-	
004_FL14	13:42:15	13:46:19	180	55	-	
005_FL15	13:49:51	13:53:37	180	55	-	



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Re flights		DATE:	07 July 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Dushan A.	
MISSION ID:	P2015-025-ZionNP_QL2R & QL1R		CLOUDS:	Clear	
BASE STATION:	HO0410 & UTHN		WIND:	10-15 kts @ 220°	
ENGINE START:	12:26	ENGINE OFF:	17:03	ENGINE TIME:	04:37
GNSS START:	12:29	GNSS START:	-		
TAKEOFF:	12:36	TOUCHDOWN:	17:00	AIR TIME	04:24

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	12:52:00					Initialize over UTHN
	13:00:00					Dataset: QL2R_20160707_130334
000_FL63	13:00:32	13:02:12	180	55	-	
001_FL64	13:05:27	13:07:08	180	55	-	
002_FL65	13:10:14	13:11:54	180	55	-	
003_FL62	13:17:02	13:18:19	180	55	-	
004_FL58	13:25:32	13:28:10	180	55	-	
005_FL59	13:31:20	13:33:49	180	55	-	
006_FL71	13:38:48	13:41:04	180	55	-	
007_FL72	13:44:25	13:46:47	180	55	-	
008_FL57	13:51:13	13:53:39	180	55	-	
009_FL67	13:55:11	13:56:27	180	55	-	
010_FL66	14:02:17	14:03:43	180	55	-	
011_FL70	14:08:34	14:08:36	180	55	-	BAD: Force Stop (Scanner)
012_FL70	14:08:46	14:08:49	180	55	-	BAD: Force Stop (Scanner)
013_FL70	14:08:55	14:08:57	180	55	-	BAD: Force Stop (Scanner)
014_FL70	14:09:01	14:09:03	180	55	-	BAD: Force Stop (Scanner)
015_FL70	14:09:10	14:09:12	180	55	-	BAD: Force Stop (Scanner)
	14:10:00					Reboot Lidar System
	14:13:00					Dataset: QL2R_20160707_141645



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Re flights		DATE:	08 July 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Ray L.	
SYSTEM:	Dual DragonEye		OPERATOR:	Dushan A.	
MISSION ID:	P2015-025-ZionNP_QL1R		CLOUDS:	Clear	
BASE STATION:	HO0410		WIND:	15 kts @ 210°	
ENGINE START:	12:20	ENGINE OFF:	14:04	ENGINE TIME:	01:44
GNSS START:	-	GNSS START:	-		
TAKEOFF:	12:32	TOUCHDOWN:	14:00	AIR TIME	01:28

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
	12:45:00					Initialize over HO0410
	13:00:00					Dataset: QL1R_20160708_125422
000_FL1	12:51:20	12:54:09	180	55	-	
001_FL2	12:57:35	13:00:17	180	55	-	
002_FL3	13:03:50	13:03:53	180	55	-	BAD: Force Stop (Scanner)
	13:05:00					Reboot Lidar System
	13:11:00					Dataset: QL1R_20160708_131434
000_FL3	13:11:32	13:14:21	180	55	-	
001_FL4	13:18:25	13:18:28	180	55	-	BAD: Force Stop (Scanner)
	13:20:00					Reboot Lidar System
	13:28:00					Dataset: QL1R_20160708_133154
000_FL4	13:28:52	13:31:05	180	55	-	DO NOT PROCESS
001_FL5	13:34:43	13:34:46	180	55	-	BAD: Force Stop (Scanner)
002_FL5	13:35:09	13:35:11	180	55	-	BAD: Force Stop (Scanner)
	13:37:00					Reboot Lidar System
	13:42:00					Dataset: QL1R_20160708_134600
000_FL5	13:42:58	13:45:18	180	55	-	DO NOT PROCESS
001_FL6	13:48:49	13:48:51	180	55	-	BAD: Force Stop (Scanner)
	13:55:00					Abort Mission due to Scanner Issue
	13:46:00					Close over HO0410 & UTHN



FLIGHT LOG

PROJECT NAME:	P2015.025 - Zion National Park		BASE AIRPORT:	Cedar City (CDC)	
LOCATION / AREA:	Zion National Park, UT / Re flights		DATE:	20 July 2016	
AIRCRAFT:	Cessna 401 - N6255Q		PILOT:	Dave S.	
SYSTEM:	Dual DragonEye		OPERATOR:	Dushan A.	
MISSION ID:	P2015-025-ZionNP_QL1R & QL2R		CLOUDS:	Clear	
BASE STATION:	CDC1 & UTHN		WIND:	15-20 kts @ 220°	
ENGINE START:	12:20	ENGINE OFF:	16:07	ENGINE TIME:	03:47
GNSS START:	12:24	GNSS START:	16:07		
TAKEOFF:	12:35	TOUCHDOWN:	16:01	AIR TIME	03:26

FL #	START TIME	END TIME	TOPO PRF PWR		BATHY PWR CHII	REMARKS
						Initialize over UTHN
						Dataset: QL1R_20160720_130236
000_FL4	12:59:34	12:59:34	180	55	-	
001_FL5	13:04:58	13:04:58	180	55	-	
002_FL6	13:10:19	13:10:19	180	55	-	
003_FL7	13:15:30	13:15:30	180	55	-	
004_FL8	13:20:21	13:20:21	180	55	-	
005_FL9	13:25:25	13:25:25	180	55	-	
006_FL10	13:30:23	13:30:23	180	55	-	
007_FL11	13:36:11	13:36:11	180	55	-	
008_FL16	13:41:06	13:41:06	180	55	-	
009_FL17	13:45:44	13:45:44	180	55	-	
010_FL16	13:50:01	13:50:01	180	55	-	
011_FL18	13:54:47	13:54:47	180	55	-	
012_FL19	13:59:25	13:59:25	180	55	-	
013_FL20	14:03:41	14:03:41	180	55	-	
						Dataset: QL2R_20160720_141014
000_FL42	14:07:12	14:07:12	180	55	-	
001_FL43	14:13:59	14:13:59	180	55	-	

Section 6: 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.
- **Bridge Breaklines as ESRI shapefile**
- Digital Elevation Model in ERDAS .IMG format
- 8-bit intensity images in .TIF format
- Tile Index 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