Airborne Lidar Report

WVSA, PA – 2017 Impervious

Surface T3 Global Strategies, Inc.

Contractor: Woolpert, Inc.
Woolpert Project # 78066

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Section 1: Overview

TASK ORDER NAME: WVSA, PA – 2017 Impervious Surface

Project: # 78066

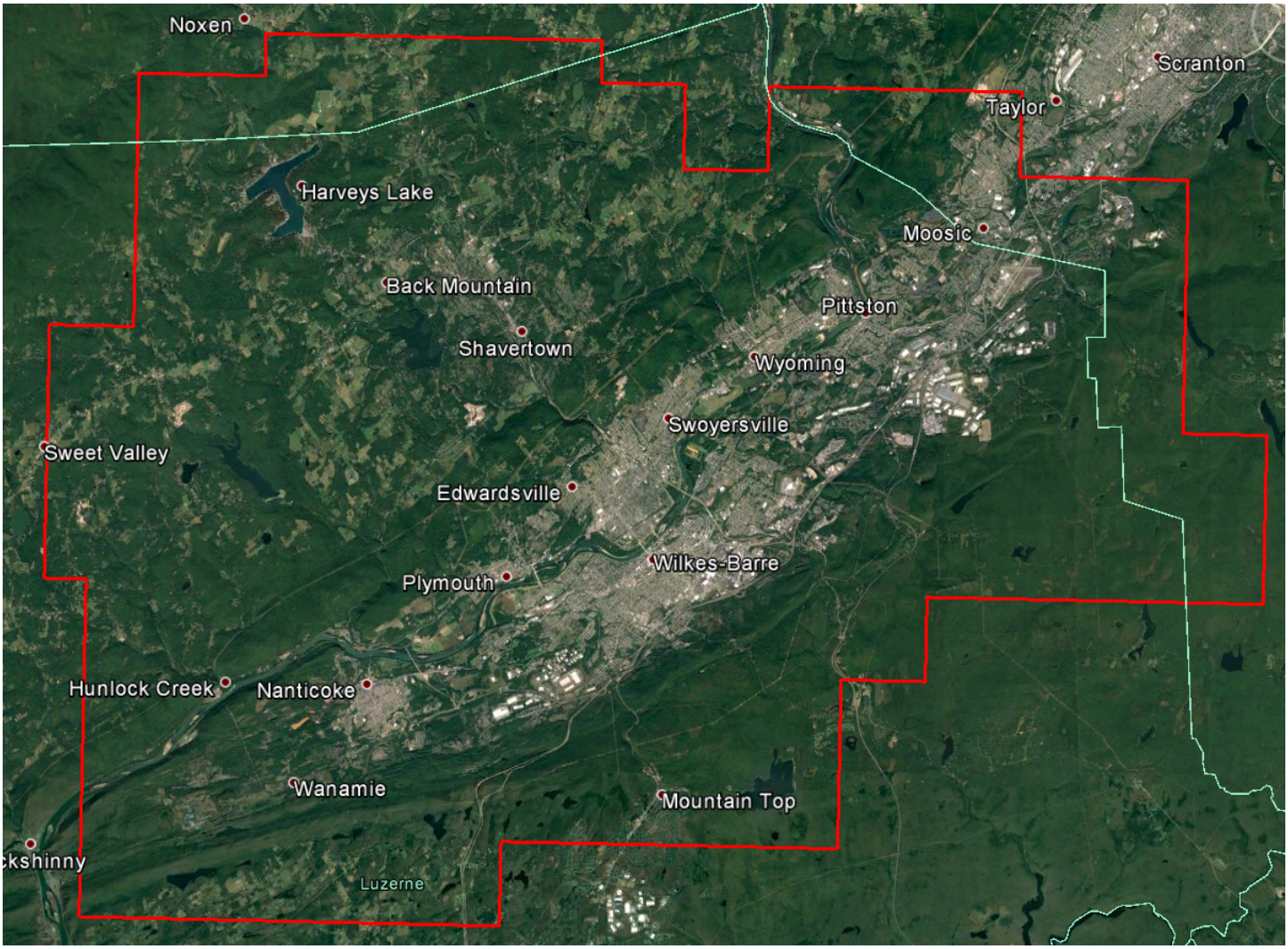
This report contains a comprehensive outline of the WVSA, PA Lidar task order. This task order requires lidar data to be acquired over an AOI surrounding Wilkes-Barre, PA (+/- 401.5 square miles). The lidar data for this AOI is collected at a nominal pulse spacing (NPS) of 0.35meters. The NPS assessment is made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath.

The aerial lidar was collected at the following sensor specifications:

Table 1.1 ALS80 Specifications	
Post Spacing	0.35 m
AGL (Above Ground Level) average flying height	5000 ft/1524 m
Average Ground Speed:	130 knots
Field of View (full)	20 degrees
Scan Rate	50 degrees
Pulse Rate	371 kHz
Side Lap	25%

The horizontal datum used for the task order was referenced to NAD83(2011) State Plane Pennsylvania North FIPS3701 Ft US. The vertical datum of NAVD88 Geoid12B Ft US.

Figure 1.1: WVSA, PA Lidar Task Order AOI



Section 2: Acquisition

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

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

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

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 nine (9) 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. Collection of lidar data took place from November 23, 2017 through December 8, 2017.

Table 2.2: Airborne Lidar Acquisition Flight Summary

Date of Acquisition	Lines Flown	Acquisition Time (UTC)
November 23, 2017_SH8194	**1-20**	**18:18 – 22:05**
November 24, 2017_SH8194_A	**21-35**	**11:17 – 17:51**
November 24, 2017_SH8194_B	**36-44**	**19:57 – 22:34**
December 2, 2017_ SH8194	**85-108**	**20:49 – 0:32**
December 3, 2017_ SH8191	**45-55, 60-65**	**20:34 – 1:01**
December 4, 2017_SH8191_A	**118-173**	**15:51 – 19:47**
December 4, 2017_SH8191_B	**20, 56-59, 66-84, 89, 109-117**	**21:42 – 3:11**
December 7, 2017_SH8194	**UL001-UL003, UL005, UL006, 69, 71, 73-77**	**14:55 – 16:39**
December 8, 2017_SH8194	**UL001-UL003, 75-84, 89**	**14:35 – 16:44**

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: 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: Proprietary Software, TerraMatch v. 17.
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.17.
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.17.

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

Equipment

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

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

Table 3.1: GNSS Base Station

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
WIL1_CORS	41° 18' 18.91302"	76° 00' 55.10021"	385.694

GPS / IMU 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.

- 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).

- 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.

- 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.

- The PDOP measures the precision of the GPS solution in regard 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.

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 Processed, but Unclassified (Class 1), Bare Earth Ground (Class 2), Low Noise (Class 7), Water (Class 9), Ignored Ground (Class 10), Bridge Decks (Class 17) and High Noise (Class 18) classifications.
- FGDC Compliant metadata was developed for the task order in .xml format per product.
- The horizontal datum used for the task order was referenced to NAD83(2011) State Plane Pennsylvania North FIPS3701 Ft US. The vertical datum of NAVD88 Geoid12B Ft US.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

WVSA, PA 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

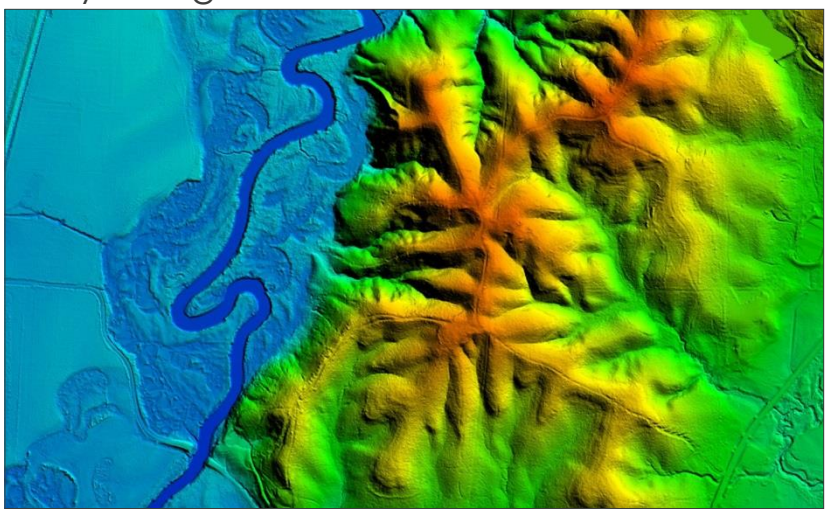


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the "tinning" across the lake surface.

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.

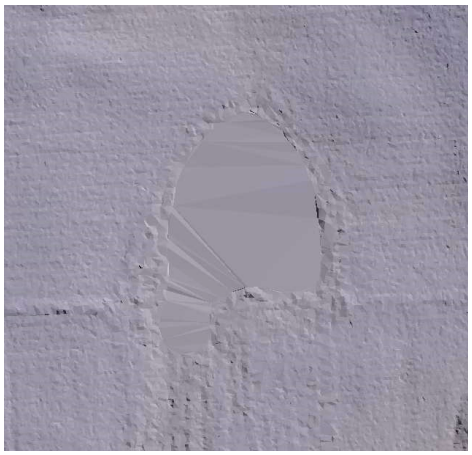


Figure 4.2

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

DATA QA/QC

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

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

Section 5: ACCURACY ASSESSMENT

Accuracy Assessment

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

Table 5.1: Overall Vertical Accuracy Statistics		
Average error	0.015	US Feet
Minimum error	-0.270	US Feet
Maximum error	0.280	US Feet
Average magnitude	0.108	US Feet
Root mean square	0.135	US Feet
Standard deviation	0.136	US Feet

Table 5.2: RAW Swath Quality Check Point Analysis NVA

Point ID	Easting (US Feet)	Northing (US Feet)	Elevation (US Feet)	TIN Elevation (US Feet)	Dz (US Feet)
2001	2420728.253	446001.108	1621.680	1621.700	0.020
2002	2541361.604	438584.877	1550.210	1550.300	0.090
2003	2411055.964	421246.966	1141.120	1141.200	0.080
2004	2468995.626	365115.401	1282.910	1282.700	-0.210
2005	2525878.437	399463.959	1927.170	1926.900	-0.270
2006	2523386.783	454224.947	837.330	837.500	0.170
2007	2496313.169	453272.245	592.790	592.600	-0.190
2008	2436326.793	444435.957	1263.060	1263.300	0.240
2009	2478406.831	440971.693	1342.280	1342.400	0.120
2010	2455228.161	427262.449	1175.720	1175.600	-0.120
2011	2521480.221	439572.753	637.890	637.800	-0.090
2012	2524734.744	416345.589	1497.410	1497.400	-0.010
2013	2507558.640	385305.210	1927.350	1927.400	0.050
2014	2498338.997	399594.293	948.690	948.600	-0.090
2015	2503894.854	404370.752	983.360	983.400	0.040
2016	2466607.021	392823.541	531.800	531.600	-0.200
2017	2432334.135	404645.677	1256.980	1257.000	0.020
2018	2413330.424	396299.791	1044.510	1044.600	0.090
2019	2431338.160	372932.481	669.820	670.100	0.280
2020	2420729.318	354970.556	1032.630	1032.600	-0.030
2021	2501198.478	415067.881	762.630	762.600	-0.030
2022	2474877.762	411324.832	704.360	704.400	0.040
2023	2473585.195	459788.845	1027.020	1027.000	-0.020

2024	2437345.450	456438.533	1311.000	1311.000	0.000
2025	2454552.730	448236.050	1182.730	1182.600	-0.130
2026	2457685.710	408574.574	1146.990	1147.200	0.210
2027	2464969.500	356235.962	1151.150	1151.100	-0.050
2028	2436621.459	423192.531	1263.950	1264.000	0.050
2029	2546273.183	401613.696	1983.490	1983.700	0.210
2030	2508923.287	406701.549	1016.630	1016.700	0.070
2031	2500775.344	441492.672	595.370	595.300	-0.070
2032	2417580.729	400552.141	1010.590	1010.500	-0.090
2033	2480173.630	429923.537	1086.270	1086.500	0.230
2034	2516262.365	429210.579	879.330	879.300	-0.030
2035	2416796.668	387807.610	903.960	904.100	0.140

VERTICAL ACCURACY CONCLUSIONS

Raw Swath 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) 0.041 meters x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using all lidar points against 35 NVA points.

LAS 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) 0.038 meters x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using lidar ground points against 35 NVA points.

Table 5.3: NVA Check Point Analysis DEM

Point ID	Easting (US Feet)	Northing (US Feet)	Elevation (US Feet)	DEM Elevation (US Feet)	Dz (US Feet)
2001	2420728.253	446001.108	1621.680	1621.706	0.026
2002	2541361.604	438584.877	1550.210	1550.306	0.096
2003	2411055.964	421246.966	1141.120	1141.105	-0.015
2004	2468995.626	365115.401	1282.910	1282.805	-0.105
2005	2525878.437	399463.959	1927.170	1926.908	-0.262
2006	2523386.783	454224.947	837.330	837.403	0.073
2007	2496313.169	453272.245	592.790	592.502	-0.288
2008	2436326.793	444435.957	1263.060	1263.205	0.145
2009	2478406.831	440971.693	1342.280	1342.405	0.125
2010	2455228.161	427262.449	1175.720	1175.605	-0.115
2011	2521480.221	439572.753	637.890	637.803	-0.087
2012	2524734.744	416345.589	1497.410	1497.306	-0.104

2013	2507558.640	385305.210	1927.350	1927.508	0.158
2014	2498338.997	399594.293	948.690	948.604	-0.086
2015	2503894.854	404370.752	983.360	983.304	-0.056
2016	2466607.021	392823.541	531.800	531.602	-0.198
2017	2432334.135	404645.677	1256.980	1257.005	0.025
2018	2413330.424	396299.791	1044.510	1044.504	-0.006
2019	2431338.160	372932.481	669.820	670.003	0.183
2020	2420729.318	354970.556	1032.630	1032.604	-0.026
2021	2501198.478	415067.881	762.630	762.603	-0.027
2022	2474877.762	411324.832	704.360	704.403	0.043
2023	2473585.195	459788.845	1027.020	1027.004	-0.016
2024	2437345.450	456438.533	1311.000	1310.905	-0.095
2025	2454552.730	448236.050	1182.730	1182.605	-0.125
2026	2457685.710	408574.574	1146.990	1147.205	0.215
2027	2464969.500	356235.962	1151.150	1151.205	0.055
2028	2436621.459	423192.531	1263.950	1263.905	-0.045
2029	2546273.183	401613.696	1983.490	1983.708	0.218
2030	2508923.287	406701.549	1016.630	1016.704	0.074
2031	2500775.344	441492.672	595.370	595.202	-0.168
2032	2417580.729	400552.141	1010.590	1010.504	-0.086
2033	2480173.630	429923.537	1086.270	1086.404	0.134
2034	2516262.365	429210.579	879.330	879.304	-0.026
2035	2416796.668	387807.610	903.960	904.304	0.344

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) 0.041 meters x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM against 35 NVA points.

Table 5.4: VVA Quality Check Point Analysis DEM

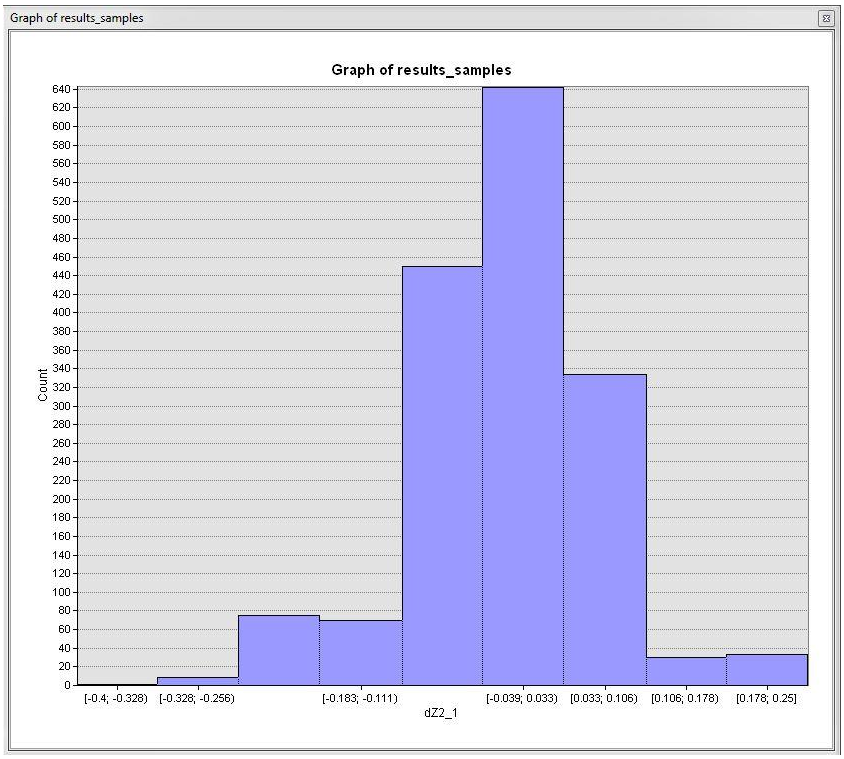
Point ID	Easting (US Feet)	Northing (US Feet)	Elevation (US Feet)	DEM Elevation (US Feet)	Dz (US Feet)
3001	2422094.778	436101.463	1332.910	1333.305	0.395
3002	2454285.855	447937.926	1162.340	1162.705	0.365
3003	2490053.185	445686.420	1213.850	1213.905	0.055
3004	2535089.744	398568.561	1872.180	1872.308	0.128
3005	2488445.869	370164.490	1695.300	1695.307	0.007
3006	2486389.045	384665.540	1272.050	1272.105	0.055

3007	2456476.463	409957.146	1091.190	1091.504	0.314
3008	2516219.149	429302.882	877.480	877.604	0.124
3009	2508666.605	407611.221	982.750	982.804	0.054
3010	2420705.949	354922.138	1028.590	1028.704	0.114
3011	2427600.533	389413.264	1035.640	1035.904	0.264
3012	2473589.594	459747.301	1027.230	1027.504	0.274
3013	2436686.543	423248.176	1260.610	1260.905	0.295
3014	2453452.070	379101.769	591.290	591.102	-0.188
3015	2478416.411	441011.209	1343.840	1344.005	0.165
3016	2539155.786	437751.469	1429.750	1429.906	0.156
3017	2447213.702	380205.122	578.860	579.102	0.242
3018	2542467.066	415745.880	1928.910	1929.208	0.298
3019	2468959.825	365033.276	1284.480	1284.505	0.025
3020	2437273.653	456392.511	1313.720	1313.905	0.185
3021	2432523.234	404958.386	1238.680	1238.905	0.225
3022	2411191.267	421319.252	1140.540	1140.605	0.065
3023	2444449.758	389277.663	523.320	523.602	0.282
3001	2422094.778	436101.463	1332.910	1333.305	0.395
3002	2454285.855	447937.926	1162.340	1162.705	0.365
3003	2490053.185	445686.420	1213.850	1213.905	0.055
3004	2535089.744	398568.561	1872.180	1872.308	0.128
3005	2488445.869	370164.490	1695.300	1695.307	0.007
3006	2486389.045	384665.540	1272.050	1272.105	0.055
3007	2456476.463	409957.146	1091.190	1091.504	0.314
3008	2516219.149	429302.882	877.480	877.604	0.124
3009	2508666.605	407611.221	982.750	982.804	0.054
3010	2420705.949	354922.138	1028.590	1028.704	0.114
3011	2427600.533	389413.264	1035.640	1035.904	0.264
3012	2473589.594	459747.301	1027.230	1027.504	0.274
3013	2436686.543	423248.176	1260.610	1260.905	0.295
3014	2453452.070	379101.769	591.290	591.102	-0.188
3015	2478416.411	441011.209	1343.840	1344.005	0.165
3016	2539155.786	437751.469	1429.750	1429.906	0.156
3017	2447213.702	380205.122	578.860	579.102	0.242
3018	2542467.066	415745.880	1928.910	1929.208	0.298
3019	2468959.825	365033.276	1284.480	1284.505	0.025
3020	2437273.653	456392.511	1313.720	1313.905	0.185
3021	2432523.234	404958.386	1238.680	1238.905	0.225
3022	2411191.267	421319.252	1140.540	1140.605	0.065
3023	2444449.758	389277.663	523.320	523.602	0.282

VERTICAL ACCURACY CONCLUSIONS

Vegetated Vertical Accuracy (VVA) Tested 0.118 Meters at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM against 23 VVA points. VVA Errors larger than 95th percentile include: Point 3001, Easting 2422094.78, Northing 436101.46, Z-Error 0.120 Meters

Figure 5.1: Lidar Relative Accuracy Histogram for WVSA, PA 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 WVSA, PA Lidar task measured at 0.028 meter RMSDz.

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

Section 6: Flight Logs

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

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	11/23/17	327	180066		WVSA 180066

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
BRAD Dellaca	475RC	1091.3	12:48	17:48	BASESTATION "NEW"
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RAY LABOLD	LIECA OC100	1095.1	5:14		MANUALLY SET POINT

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
	10 MI			3			HAZE	Departing	18:05
								Arriving	22:14

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	Mode	Threshold Values
20	37	50	99 %	Gain - Course/Up	Single	A
				Gain - Fine/Down	Multi	B

Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.
130 Kts	5300 Ft	Ft	Yes / No	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 17:40
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No
1	W	18:18	18:22	4 MIN			1.2	
2	E	18:25	18:29	4 MIN			1.1	
3	W	18:31	18:35	4 MIN			1.2	
4	E	18:38	18:42	4 MIN			1.2	
5	W	18:45	18:49	4 MIN			1.2	
6	E	18:52	19:00	8 MIN			1.2	
7	W	19:04	19:13	9 MIN			1.1	
8	E	19:16	19:23	7 MIN			1.1	
9	W	19:27	19:35	8 MIN			1.1	EYE SAFE AT END OF LINE
10	E	19:43	19:50	7 MIN			1.4	
11	W	19:54	20:03	9 MIN			1.3	EYE SAFE AT WEST END OF LINE
12	E	20:06	20:14	8 MIN			1.1	
13	W	20:17	20:26	8 MIN			1.1	
14	E	20:34	20:42	8 MIN			1.1	
15	W	20:45	20:54	9 MIN			1.2	
16	E	20:58	21:09	9 MIN			1.1	
17	W	21:11	21:21	9 MIN			1.0	
18	E	21:24	21:34	10 MIN			1.1	
~~19~~	~~W~~	~~21:37~~					1.2	went off line
19	W	21:42	21:53	11 MIN			1.2	
20	E	21:56	22:05	11 MIN			1.4	
↑ Times entered are Zulu / GMT ↑			Page		1			Verify S-Turns After Mission Yes ✓ No

Additional Comments: Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	11/24/17	328	180066		WVSA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
BRAD DeLANEY	975RC	1095.4	8:38	13:38	CORS
Pilot	**Senior Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RAY LABOURVE	DC6D	1099.5	1:09	18:09	AF9031

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
	10 MI			5			CLR	Departing	8:35
								Arriving	1:00

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	Mode	Threshold Values
20	371	50	99	Gain - Course/Up	Single	A
				Gain - Fine/Down	Multi	B

Air Speed	AGL	MSL	Waveform Used	Waveform Mode	Pre-Trigger Dist.
135 Kts	5300 Ft	Ft	Yes / No	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 13:35
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No
21	W	14:17	14:28	11 MIN			1.2	CORS CLEARED 14:04
22	E	14:31	14:48	17 MIN			1.3	CIRCLED BACK FOR 2ND PASS
23	W	14:53	15:05	12 MIN			1.0	
24	E	15:13	15:22	9 MIN			1.1	
25	W	15:26	15:37	11 MIN			1.3	REFLEW HALF LINE TO GOOD OFF LINE
26	E	15:40	15:50	10 MIN			1.2	
27	W	15:54	16:04	10 MIN			1.2	
28	E	16:08	16:17	9 MIN			1.2	
29	W	16:22	16:31	10 MIN			1.2	
30	E	16:34	16:44	10 MIN			1.2	
31	W	16:48	16:58	10 MIN			1.0	
32	E	17:01	17:11	10 MIN			1.1	
33	W	17:14	17:24	10 MIN			1.0	
34	E	17:28	17:38	10 MIN			1.0	
35	W	17:41	17:51	10 MIN			1.0	

↑ Times entered are Zulu / GMT ↑		Page	1	Verify S-Turns After Mission Yes ✓ No	
Additional Comments:					Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	11/24/17	328	78066		WVSA

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
BRAD DEMARY	475RL	1090.5	12:30	19:30	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RAY LAROCQUE	OCIED	1102.7	5 ~~PM~~ :06	23:06	AF9631

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
	10 MI			10			CLR	Departing	19:43
								Arriving	23:56

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	371	50	99	Gain - Course/Up		Single		A	1
				Gain - Fine/Down		Multi		B	

Air Speed	AGL		MSL		Waveform Used			Waveform Mode	Pre-Trigger Dist.
135	Kts 5300	Ft		Ft	Yes	No		@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 2:25
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes ✓ No
36	E	19:5~~8~~	20:0~~8~~	10			1.2	
37	W	20:10	20:21	11			1.2	
38	E	20:24	20:35	11			1.1	
39	W	20:39	20:49	10			1.2	
40	E	20:52	21:02	10			1.1	
41	W	21:06	21:17	11			1.0	
42	E	21:20	21:30	10			1.2	
43	W	21:33	21:44	11			1.2	
44	E	22:25	22:34	9			1.1	LINE BROKE TWICE DUE TO SAME ERROR I HAVE LEFT ON FAR EAST END
~~45~~	~~W~~							
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes ✓ No

Additional Comments: CAME ACROSS ERROR "SYSTEM CONTROLLER HAS NOT RECIEVED RECOVERY MESSAGE FROM TMAB" WOULD NOT RECORD DATA. Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/2/2017	336	78066	2	wvsa

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SMITH	N475RC	1119.3	3:35:00	20:35:00	
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
GEBHART	OTHER	1123.5	7:44:00	0:44:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	avp
280/4				8	-1	3020		Arriving	avp

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi	X	B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	5370	Ft	Yes		No		@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
108	w	20:49:00	20:55:00		18	0.6	1.2	
107	e	20:57:00	21:01:00		18	0.6	1.2	
106	w	21:04:00	21:09:00		19	0.6	1.2	
105	e	21:13:00	21:17:00		18	0.6	1.2	
104	w	21:20:00	21:25:00		17	0.6	1.2	
103	e	21:28:00	21:33:00		16	0.6	1.4	
102	w	21:36:00	21:41:00		16	0.6	1.4	
101	e	21:44:00	21:49:00		17	0.6	1.3	
100	w	21:52:00	21:57:00		17	0.6	1.2	
99	e	22:00:00	22:05:00		19	0.6	1.1	
98	w							eyesafe shutoff/refly
98	w	22:17:00	22:24:00		17	0.6	1.2	
97	e	22:27:00	22:33:00		17	0.6	1.1	
96	w	22:37:00	22:43:00		19	0.6	1	
95	e	22:47:00	22:54:00		17	0.6	1.1	
94	w	22:57:00	23:03:00		18	0.6	1.1	
93	e	23:07:00	23:14:00		16	0.6	1.2	
92	w	23:17:00	23:24:00		17	0.6	1.2	
91	e	23:27:00	23:34:00		18	0.6	1.2	
90	w	23:37:00	23:44:00		19	0.6	1.2	
89	e	23:47:00	23:54:00		18	0.6	1.3	power plant steam
88	w	23:57:00	0:03:00		19	0.6	1.2	
87	e	0:07:00	0:13:00		19	0.6	1.2	
86	w	0:16:00	0:22:00		20	0.6	1.1	
85	e	0:26:00	0:32:00		21	0.6	1	
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes X No

Additional Comments:

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/3/2017	337	78066	2	WVSA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N404CP	6318.7	14:57:00	19:57:00	Woolpert Pin
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8191	531348.0	20:24:00	1:24:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
230/5	6mi/Haze	clear	5	8	1	3016	HAZE	Departing	KAVP
								Arriving	KAVP

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	5000	Ft	5482	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	n/a	GPS Began Logging At: 9:15:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
				0:00:00					Take Off Time: 3:18
45	271.4	20:34:02	20:44:58	0:10:56	20	1.1	127	5400	
46	091.0	20:48:17	20:59:11	0:10:54	19	1.1	126	5391	
47	271.4	21:01:54	21:13:34	0:11:40	18	1.2	131	5393	
48	091.0	21:16:37	21:26:09	0:09:32	18	1.3	130	5390	Line aborted re eye shutter
55				0:00:00					Line aborted re eye shutter
60	271.4	21:34:08	21:43:29	0:09:21	17	1.3	130	5407	
61	091.0	21:46:06	21:55:06	0:09:00	18	1.1	130	5408	
62	271.4	21:57:00		##########					Line aborted re eye shutter
62	271.4	22:01:35	22:11:23	0:09:48	17	1.2	129	5444	Reflight
63	091.0	22:14:31		##########	18	1	133	5459	Line aborted re eye shutter error
64	271.4	22:27:57	22:37:48	0:09:51	19	1	129	5234	Traffic/changed alt to 5443
65	091.0	22:41:07	22:51:02	0:09:55	20	1	131	5388	
				0:00:00					
48	271.4	22:55:33	23:06:56	0:11:23	18	1.1	133	5365	Reflight
49	091.0	23:10:00	23:21:30	0:11:30	18	1.2	130	5382	
50	271.4	23:24:43	23:36:07	0:11:24	19	1.2	132	5362	
51	091.0	23:39:05	23:50:42	0:11:37	19	1.2	132	5362	
52	271.4	23:54:08	0:05:30	##########	19	1.3	131	5357	
53	091.0	0:08:10	0:19:40	0:11:30	19	1.2	131	5406	
54	271.4	0:22:34	0:34:08	0:11:34	19	1.1	131	5344	
55	091.0	0:37:13	0:48:23	0:11:10	21	1	130	5407	Reflight
				0:00:00					
63	271.4	0:51:28	1:01:10	0:09:42	20	1.1	135	5357	Reflight
				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 X No

Additional Comments: Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/4/2017	338	78066	2	WVSA FLT #2

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N404CP	6323.8	10:18:00	15:18:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8191	6328.2	15:05:00	20:05:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
260/3	4	CLR	0	1	-1	3041	HAZE	Departing	KAVP
								Arriving	KAVP

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	6000?	Ft	6782	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	n/a	GPS Began Logging At:	9:21:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission	Yes X No
173	001.3	15:51:55	15:53:47	0:01:52	19	1.2	130	6669	Take Off: 15:37	
172	181.3	15:56:09	15:58:05	0:01:56	19	1.2	126	6669		
171	001.3	16:00:32	16:02:15	0:01:43	20	1	131	6648		
170	181.3	16:04:45	16:06:32	0:01:47	20	1.1	125	6676		
169	001.3	16:09:03	16:10:44	0:01:41	18	1.1	130	6671		
168	181.3	16:13:06	16:14:42	0:01:36	18	1.1	127	6623		
167	001.3	16:17:04	16:18:33	0:01:29	18	1.1	128	6630		
166	181.3	16:21:19	16:23:20	0:02:01	18	1.1	127	6588		
165	001.3	16:25:32	16:29:15	0:03:43	17	1.3	128	6673		
164	181.3	16:31:15	16:35:01	0:03:46	19	1.1	125	6682		
163	001.3	16:37:11	16:40:56	0:03:45	21	1.1	127	6675		
162	181.3	16:43:22	16:47:00	0:03:38	21	1	127	6661		
161	001.3	16:49:25	16:51:33	0:02:08	21	1	129	6675		
160	181.3	16:53:37	15:55:51	###########	21	1	122	6638		
159	001.2	16:58:00	17:00:10	0:02:10	21	1.1	130	6645		
158	181.2	17:02:25	17:04:41	0:02:16	21	1.1	122	6666		
157	001.2	17:06:49	17:08:59	0:02:10	21	1.1	120	6651		
156	181.2	17:11:05	17:13:17	0:02:12	21	1	120	6651		
155	001.2	17:15:21	17:17:22	0:02:01	20	1.1	131	6653		
154	181.2	17:19:47	17:55:05	0:35:18	19	1.2	123	6649		
153	001.2	17:24:22	17:26:36	0:02:14	17	1.4	130	6665		
152	181.2	17:28:52	17:31:02	0:02:10	17	1.4	120	6650		
151	001.2	17:33:23	17:34:57	0:01:34	18	1.2	132	6664		
150	181.2	17:37:09	17:38:45	0:01:36	17	1.4	126	6646		
149	001.2	17:40:53	17:42:22	0:01:29	19	1.2	132	6646		
148	181.2	17:44:25	17:45:55	0:01:30	19	1.1	126	6643		
147	001.2	17:48:07	17:49:26	0:01:19	19	1.2	135	6648		
146	181.2	17:51:39	17:53:02	0:01:23	19	1.2	122	6656		
145	001.2	17:55:13	17:56:21	0:01:08	19	1.2	131	6630		
144	181.2	17:58:31	17:59:35	0:01:04	19	1.2	129	6649		
143	001.2	18:01:29	18:02:23	0:00:54	19	1.2	136	6662		
↑ Times entered are Zulu / GMT ↑				Page		1			Verify S-Turns After Mission	Yes X No

Additional Comments:	Drive #
Multiple AB/BG % and Range Gate notices.	

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/4/2017	338	78066	2	WVSA FLT #2 (PAGE 2)

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
SWAIN, J	N404CP	6323.8	10:18:00	15:18:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D	ALS-8191	6328.2	15:05:00	20:05:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
260/3	4	CLR	0	1	-1	3041	HAZE	Departing	KAVP
								Arriving	KAVP

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	6000?	Ft	6782	Ft	Yes		No		@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	n/a	GPS Began Logging At: 9:21:00
		↕ Times entered are Zulu / GMT ↕							Verify S-Turns Before Mission Yes / No
142	181.2	18:04:22	18:05:14	0:00:52	19	1.2	125	6676	
141	001.2	18:07:19	18:08:02	0:00:43	19	1.2	130	6658	
140	181.2	18:10:17	18:11:45	0:01:28	19	1.2	121	6664	
139	001.2	18:13:51	18:15:13	0:01:22	19	1.2	132	6668	
138	181.2	18:17:19	18:18:45	0:01:26	19	1.2	123	6652	
137	001.2	18:20:59	18:22:15	0:01:16	20	1.1	130	6676	
136	181.2	18:24:29	18:25:48	0:01:19	20	1.1	121	6697	
135	001.2	18:27:52	18:29:00	0:01:08	20	1.2	133	6667	
134	181.2	18:31:03	18:32:20	0:01:17	20	1.2	120	6667	
133	001.2	18:34:27	18:35:33	0:01:06	20	1.2	134	6681	
132	181.2	18:37:35	18:38:39	0:01:04	19	1.4	124	6671	
131	001.2	18:42:16	18:44:38	0:02:22	21	1.2	132	6690	
130	181.2	18:46:49	18:49:13	0:02:24	21	1.2	130	6676	
129	001.2	18:51:27	18:53:35	0:02:08	20	1.2	137	6697	
128	181.2	18:55:47	18:58:06	0:02:19	19	1.3	126	6662	
127	001.2	19:00:16	19:02:31	0:02:15	19	1.3	130	6667	
126	181.2	19:04:34	19:06:56	0:02:22	19	1.3	124	6697	
125	001.2	19:09:03	19:11:14	0:02:11	19	1.3	133	6708	
124	181.1	19:13:17	19:15:31	0:02:14	20	1.3	126	6690	
123	001.1	19:17:39	19:19:48	0:02:09	20	1.3	130	6672	
122	181.1	19:22:07	19:24:19	0:02:12	21	1.1	120	6624	
121	001.1	19:26:24	19:28:28	0:02:04	21	1.1	134	6675	
120	181.1	19:30:00		##########					Line aborted due to eye shutter error
120	181.1	19:36:53	19:39:04	0:02:11	21	1.1	124	6653	Reflight
119	001.1	19:41:26	19:43:10	0:01:44	21	1.1	135	6636	
118	181.1	19:45:33	19:47:20	0:01:47	21	1	126	6657	
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
↑ Times entered are Zulu / GMT ↑				Page		2			Verify S-Turns After Mission Yes / No

Additional Comments: Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/4/2017	338	78066	2	wvsa

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SMITH	N404CP	6328.2	4:29:00	21:29:00	
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
GEBHART	OTHER	6334.2	10:24:00	3:24:00	

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

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi	X	B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	5370	Ft	Yes		No		@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes X No
117	n	21:42:00	21:43:00		18	0.6	1.1	
116	s	21:46:00	21:48:00		18	0.6	1.1	
115	n	21:51:00	21:52:00		18	0.6	1.1	
114	s	21:55:00	21:56:00		17	0.6	1.2	
113	n	21:59:00	22:00:00		17	0.6	1.2	
112	s	22:03:00	22:04:00		17	0.6	1.1	
111	w	22:07:00	22:08:00		18	0.6	1	
110	e	22:11:00	22:12:00		18	0.6	1	
109	n	22:19:00	22:21:00		19	0.6	1	
20	e	22:26:00	22:37:00		19	0.6	1	
56	w	22:43:00	22:55:00		18	0.6	1.1	
57	e	22:58:00	23:10:00		17	0.6	1.2	
58	w	23:14:00	23:23:00		19	0.6	1.1	
59	e	23:27:00	23:36:00		19	0.6	1.2	
66	w	23:40:00	23:50:00		19	0.6	1.3	
67	e	23:53:00	0:03:00		20	0.6	1.2	
68	w	0:06:00	0:15:00		19	0.6	1.2	
69	e	0:18:00	0:25:00		20	0.6	1.1	
70	w	0:28:00	0:36:00		20	0.6	1.1	
71	e	0:39:00	0:46:00		22	0.6	1	
72	w	0:49:00	0:57:00		21	0.6	1.1	
73	e	0:59:00	1:07:00		21	0.6	1.1	
74	w	1:10:00	1:18:00		21	0.6	1.1	
75	e	1:21:00	1:28:00		21	0.6	1.3	
76	w	1:30:00	1:38:00		21	0.6	1.3	
77	e	1:41:00	1:48:00		21	0.6	1.1	
78	w	1:53:00	2:01:00		21	0.6	1	
79	e	2:04:00	2:10:00		21	0.6	1.1	
80	w	2:13:00	2:20:00		20	0.6	1.2	
81	e	2:23:00	2:29:00		19	0.6	1.2	
82	w	2:32:00	2:39:00		19	0.6	1.1	
↑ Times entered are Zulu / GMT ↑				Page	1			Verify S-Turns After Mission Yes X No

Additional Comments: Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/4/2017	338	78066	2	wvsa

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base

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

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

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

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

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission Yes No
83	e	2:41:00	2:48:00		18	0.6	1.3	
84	w	2:51:00	2:58:00		18	0.6	1.2	
89	e	3:00:00	3:03:00		19	0.6	1.2	reflt
89	e	3:11:00			20	0.6	1.1	eyesafe on ,ended flt
↑ Times entered are Zulu / GMT ↑				Page		2		Verify S-Turns After Mission Yes No

Additional Comments:

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/7/2017	341	78066	2	WVSA (reflights) FLT #7

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N475RC	1123.5	9:22:00	14:22:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8194	1125.7	11:58:00	16:58:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
240/11	10	CLR	5	1	-8	3000	CLOUDS	Departing	KAVP
								Arriving	KAVP

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	5000?	Ft	5482	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	n/a	GPS Began Logging At: 9:01:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
				0:00:00					TAKE OFF: 14:37:50
69	103.2	14:55:47	15:00:01	0:04:14	16	1.2	130	5411	Way Point 1-23
UL001	283.4			0:00:00					Line 70 Missed WP
UL002	283.4	15:09:29	15:15:34	0:06:05	17	1.2	121	5404	Line 70 WP 23-1
71	102.9	15:18:31	15:24:00	0:05:29	17	1.2	133	5382	WP 1-24
UL003	283.4	15:27:33	15:33:34	0:06:01	17	1.2	130	5352	Line 72 WP 1-23
73	102.9	15:36:43	15:42:12	0:05:29	18	1.2	130	5341	WP 1-23
UL005	283.3	15:45:22		##########					Line 74 ABORTED Eye Safety Error
75	102.9	15:54:15	15:59:43	0:05:28	18	1.3	134	5365	WP 1-23 WP 6 - cloud?
UL006	283.3	16:02:19		##########					Aborted - realized we needed to do enti
76	283.3	16:09:22	16:17:16	0:07:54	18	1.1	126	5287	WP 21 Clouds, clouds at end of line
77	102.9	16:20:15	16:27:59	0:07:44	18	1	132	5310	Clouds at WP 8, 14-17, 22
74	283.4	16:31:07	16:39:06	0:07:59	19	1	128	5294	Bumpy and cloudy. Will probably need t
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
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↑ Times entered are Zulu / GMT ↑				Page		1			Verify S-Turns After Mission: Yes X No

Additional Comments: Drive #

UL004 - Fat-fingered the start/stop. Attempted to skirt under the clouds during the mission. Started another mission later in the afternoon (creating FLT #8), however, the mission was aborted due to Wx/clouds.

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/8/2017	342	78066	2	WVSA FLT #8 Reflights

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
SWAIN, J.	N475RC	1125.9	9:05:00	14:05:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8194	1128.6	12:07:00	17:07:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
210/4	9	clr	90	-3	-9	30.03		Departing	KAVP
								Arriving	KAVP

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	5000?	Ft	5482	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	n/a	GPS Began Logging At:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
				0:00:00					Take Off 14:16:37
				0:00:00					Fly Over Cors 14:27:06
UL001	283.3	14:35:52	14:37:17	0:01:25	16	1.2	124	5394	Line 90 WP 6-1
89	102.9	14:40:57	14:42:39	0:01:42	16	1.2	132	5410	WP 1-7
84	283.2	14:48:34	14:55:02	0:06:28	17	1.2	125	5396	Full Line / Cld wp 21 Far left of web cam
83	102.9	14:58:16	15:04:35	0:06:19	17	1.2	130	5404	Full Line
82	283.3	15:07:23	15:14:01	0:06:38	16	1.2	125	5377	Full Line
81	102.9	15:17:08	15:23:36	0:06:28	16	1.2	130	5439	Full Line
80	283.3	15:26:21	15:33:04	0:06:43	16	1.2	126	5384	Full Line
79	102.9	15:35:49	15:42:30	0:06:41	18	1.2	132	5372	Full Line
78	283.4	15:46:23	15:54:20	0:07:57	18	1.2	130	5380	Full Line
77	102.9	15:57:20	16:05:17	0:07:57	17	1.1	134	5352	Full Line
76	283.4	16:09:10	16:16:28	0:07:18	16	1.2	130	5392	Full Line
75	102.9	16:21:26	16:26:55	0:05:29	19	1	129	5356	WP 1-23 (24)
UL002	283.3	16:30:30	16:36:18	0:05:48	19	1	132	5365	Line 74 WP 23-1 Missed start time
UL003	283.1	16:44:12	16:44:29	0:00:17	19	1	126	5383	Line 84 Reflight WP 21
				0:00:00					
				0:00:00					Flew over CORS 16:51:33
				0:00:00					
				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 S-Turns After Mission: Yes X No

Additional Comments:	Drive #

Section 7: Final Deliverables

The final lidar deliverables are listed below.

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