LiDAR Project Report

140G0218F0069, EASTERN TX QL2 LiDAR

Prepared For:

United States Geological Survey

Prepared By:

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TASK ORDER: # 140G0218F0069

Project Report
LiDAR Collection, Processing, and QA/QC

140G0218F0069, EASTERN TX QL2 LiDAR

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EASTERN TX QL2 LiDAR AOI

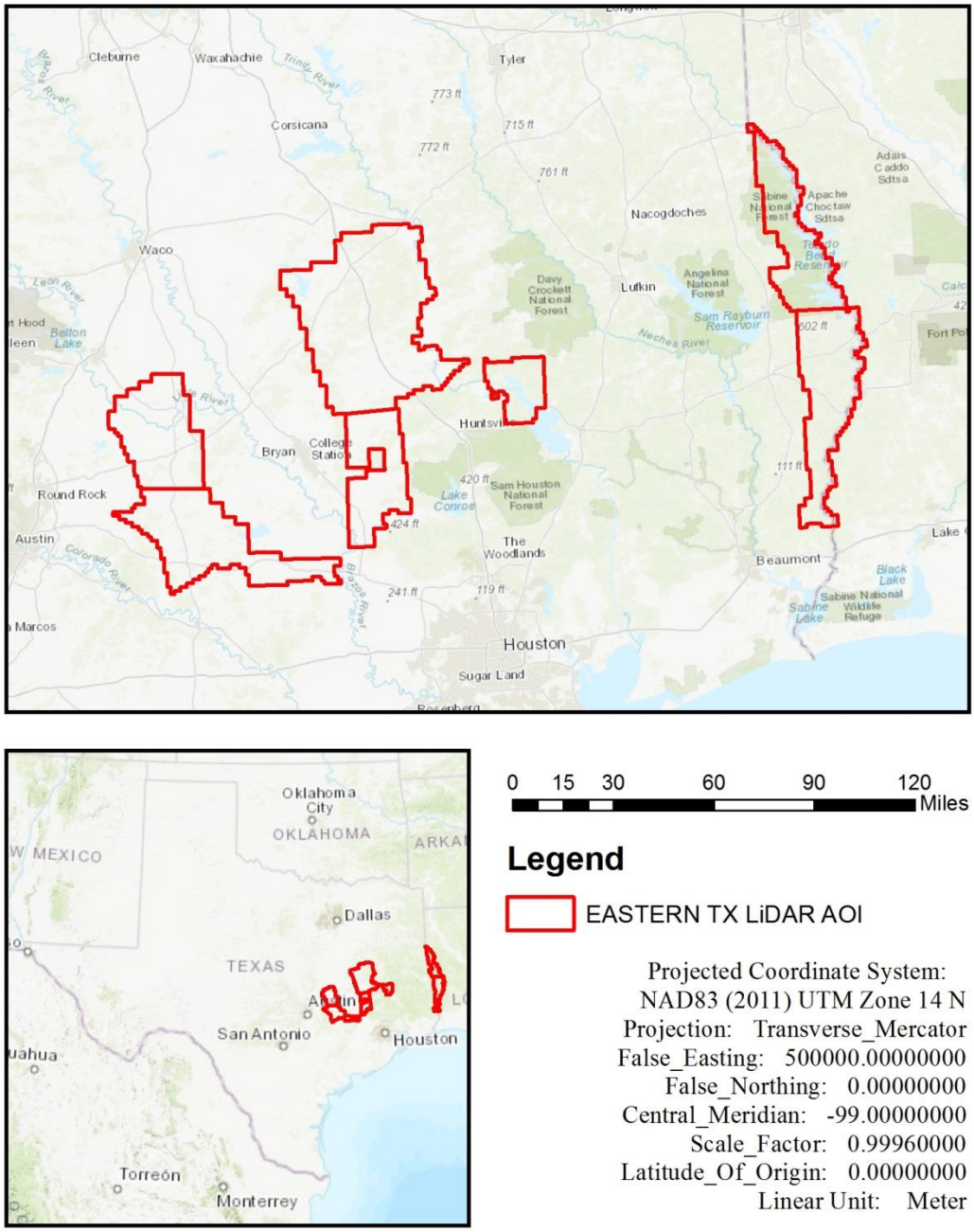

Image 1: EASTERN TX QL2 LiDAR AOI

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1 Introduction and Specifications

Digital Aerial Solutions, LLC (DAS) was tasked to collect and process a Light Detection and Ranging (LiDAR) derived elevation dataset for the 140G0218F0069, EASTERN TX QL2 LiDAR. The area encompasses approximately 5,755 square miles; Aerial LiDAR data was collected utilizing a Leica ALS80. The ALS80 is a discrete return topographic LiDAR mapping system manufactured by Leica Geosystems. LiDAR data collected for the 140G0218F0069, EASTERN TX QL2 LiDAR survey has an Aggregate Nominal Pulse (ANPS) spacing of (QL2 0.7 meters), and includes up to 2 discrete returns per pulse, along with intensity values for each return.

LiDAR datasets were post processed to generate elevation point cloud swaths for each flight line. Deliverables include the point cloud swaths, tiled point clouds classified by land cover type, breaklines to support hydro-flattening of digital elevation models (DEM), intensity tiles, and bare-earth DEM tiles. The point cloud deliverables are stored in the LAS version 1.4, point data record format 6. The tiling scheme for tiled deliverables is a 1,500 meter x 1,500 meter grid. Tile number is the appropriate cell number values found in the USNG index. All deliverables were generated in conformance with the U.S. Geological Survey National Geospatial Program Guidelines and Base Specifications, Version 1.3.

2 Spatial Reference System

The project is divided by the boarder of the UTM 14N and UTM 15N based on which side the project lies. The spatial reference of the data is as follows:

Horizontal Spatial Reference

- Coordinates: UTM Zone 14 N and UTM Zone 15 N, Meters (to 2 decimal places)
- Datum: North American Datum 1983 (2011), Meters (to 2 decimal places)

Vertical Spatial Reference

All datasets are available with orthometric elevation; point cloud datasets are also available with ellipsoid heights.

- Datum: North American Vertical Datum of 1988 (GEOID12B)

3 LiDAR Acquisition

3.1 Survey Area

The EASTERN TX QL2 LiDAR survey covers approximately 5,755 square miles for the QL2 area of interest: covering all of Leon, Washington, Sabine, San Jacinto, Shelby, Grimes, Lee, Madison, Milam, Trinity and Newton counties in TX. The flight plan consisted of 405 survey lines and 11 control lines.

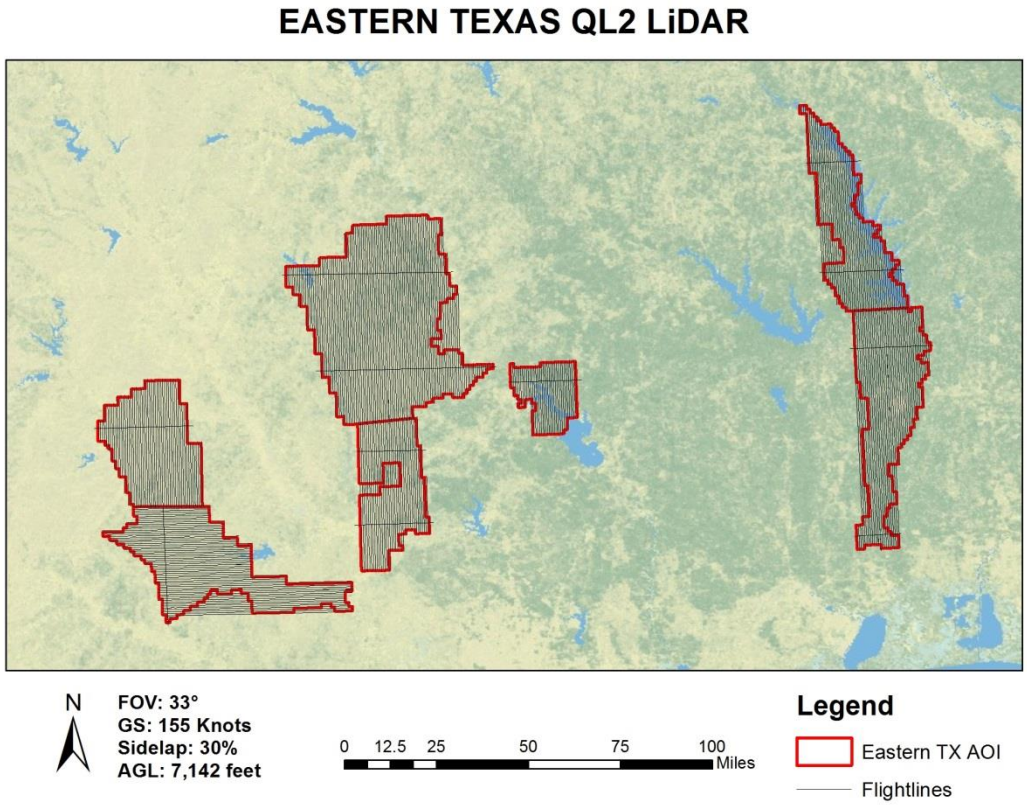


Image 2: EASTERN TX QL2 LiDAR Flightlines

3.2 Acquisition Parameters

Acquisition parameters include the sensor configuration, the flight plan characteristics, and are selected based on a number of project specific criteria. Criteria reviewed included the required accuracies for the final dataset, the land cover types within the project survey area, and the required nominal pulse spacing. Aggregate Nominal Pulse Density (ANPD) for QL2 AOIs is no less than 2ppsm. The project parameters are summarized below.

Parameter	QL2
Flying Height Above Ground Level:	7,142 feet
Nominal Sidelap:	30%
Nominal Speed Over Ground:	155 Knots
Field of View:	33°
Laser Rate:	257.0 kHz
Scan Rate:	52.5 Hz
Maximum Across Track Spacing:	1.52 meters
Maximum Along Track Spacing:	0.76 meters
Average point Spacing:	0.63 meters

Table 1: Flight Parameters

3.3 Acquisition Mission

The acquisition mission for the 140G0218F0069, EASTERN TX QL2 LiDAR survey was coordinated for optimal collection conditions and was acquired within 2 weeks. Collection began on March 06, 2018 and was completed on March 21, 2018.

3.4 Airborne GPS/IMU

Airborne global positioning system (GPS) and inertial measurement unit (IMU) data was collected on the aircraft during the acquisition mission, providing sensor position and orientation information for geo- referencing the LiDAR data. Airborne GPS observations were collected at a frequency of 2Hz, and IMU observations are collected at a frequency of 200Hz.

Aircraft	Sensor	GPS Lever Arm (m)	IMU Lever Arm (m)
	ALS80 SN# 8235	X: -0.182, Y: -0.056, Z: -1.371	X: -0.450, Y: 0.164, Z: -0.169
C421-N12RF	ALS80 SN# 8137	X: -0.176, Y: -0.050, Z: -1.373	X: -0.450, Y: 0.164, Z: -0.169
C421-N12RF	ALS80 SN# 8235	X: -0.154, Y: -0.051, Z: -1.378	X: -0.450, Y: 0.164, Z: -0.169

Table 2: Aircraft and Lever Arms

GPS data was collected with ground base stations during the acquisition missions, providing corrections to support differential post-processing of the airborne GPS. Base stations were setup at DeQuincy Industrial Airpark, Coulter Airfield and Angelina County Airport in TX. Ground GPS observations were collected at a frequency of 2Hz. The use of three CORS stations was also employed to support data acquisition for the project area. The following table's list the positions used in to post-process the airborne GPS.

Name	Latitude	Longitude	Ellipsoid (m)
DeQuincy Industrial Airpark - 5R8	30° 26' 08.25702"	-93° 28' 07.85054"	-5.086
DeQuincy Industrial Airpark - 5R81	30° 26' 08.30674"	-93° 28' 07.69740"	-5.079
Coulter Airfield - KCDF1	30° 43' 04.25442"	-96° 20' 08.24193"	82.484
Coulter Airfield - KFCD	30° 43' 04.38293"	-96° 20' 08.08616"	82.482
Angelina County Airport - LFK	31° 13' 57.23361"	-94° 45' 09.99642"	58.16
Angelina County Airport - LFK1	31° 13' 56.95597"	-94° 45' 09.87681"	58.212

Table 3: Base Stations locations

4 LiDAR Processing

4.1 Acquisition Post-Processing

For each mission, airborne GPS was differentially corrected using the ground base station GPS for the corresponding day in Leica's IPAS software. The resulting solution is check to assure an accuracy of +/- 3 cm combined separation for north, east and height position difference between the forward and reverse processing solutions.

Differentially corrected airborne GPS data was merged with the airborne IMU dataset in Leica's IPAS software through Kalman filtering techniques. IPAS applies the reference lever arms for the GPS and IMU measurement systems during processing to determine the trajectory (position and orientation) of the LiDAR sensor during the acquisition mission. Estimated lever arm values reported posteriori, validating the measurements made during sensor installation in the aircraft.

Raw LiDAR sensor ranging data and the final sensor trajectory from IPAS were processed in Leica's ALSPP software to produce the LiDAR elevation point cloud swaths for each flight line, stored in LAS version 1.4 file format. Quality control of the swath point clouds was performed to validate proper function of the sensor systems, full coverage of the project AOI, and point density consistent with the planned nominal pulse spacing.

Swath point clouds were assigned a unique File Source ID within the LAS file format before further processing. Swath files for the 140G0218F0069, EASTERN TX QL2 LiDAR project were numbered in chronological order of acquisition.

4.2 Geometric Calibration

Geometric and positional accuracy of the LiDAR swath point clouds is highly dependent on accurate calibration of the various subsystems within the LiDAR sensor system. Sensor calibration parameters fall into two categories, one being those parameters proprietary to the manufacturer's sensor design, and the other being parameters common to most commercial airborne LiDAR sensors, the IMU to laser reference system alignment angles (bore-site), and mirror deformation constants (scaling).

The manufacturer specific calibration parameters are applied in Leica's ALSPP software for the Leica ALS80 sensor system. Terrasolid's Terramatch software was used to calculate the IMU bore-site and mirror scale parameters for the 140G0218F0069, EASTERN TX QL2 LiDAR. Within the TerraMatch software, the Tie- line workflow was used to solve for the parameters. The Tie-line workflow involves automated selection of numerous 'tie-lines', which represent a linear segment fit to the data that should have the same slope, azimuth, position and elevation, within the overlap sections of the survey lines and control lines. The tie- lines provide observations for algorithms within TerraMatch to solve for the bore-site and mirror scale parameters for the lift.

The Tie-line workflow is dependent upon well distributed tie-lines throughout the swath point clouds to effectively solve for bore-site and mirror scale parameters with the automated algorithms.

Manual estimation of the bore-site and mirror scale parameters was performed using the observed tie-lines in overlap areas.

The final step of geometric calibration is to determine elevation (z) offset corrections to be applied to the swath point clouds. The Z values calculated during the course of the acquisition mission can vary at the centimeter level as the GPS satellite constellation observed in the survey area changes with satellites moving through their orbits over the course of the mission. Baseline length from the ground base station GPS to the airborne GPS can also impact the z values calculated for the swath point clouds. The Z offset corrections are calculated in two steps; a relative step, where individual lines are corrected one to another using the adjusted tie-lines from the bore-site and mirror scale calculation step; and an absolute step, where groups of lines are leveled to project ground control.

For 140G0218F0069, EASTERN TX QL2 LiDAR project, the control lines were used to determine relative z offset corrections in areas of discernible ground. The ground control points listed below were used to adjust the LiDAR by an average of -0.180 cm.

Point Id	Easting	Northing	Orth. Height
04.01.GCP.BG	842313.305	3433712.339	81.100
04.03.GCP.BG	846335.377	3429016.171	69.672
04.05.GCP.BG	846387.194	3425699.260	58.533
06.23.GCP.BG	1002172.755	3360765.160	10.203
1.2.GCP.BG	705027.516	3399743.146	152.963
2.56.GCP.BG	782071.475	3447849.998	126.578
2.69.GCP.BG	776111.473	3431860.067	112.510
5.10.GCP.BG	994697.256	3481207.022	84.729
5.18.GCP.BG	1002450.162	3463003.408	81.670
5.6.GCP.BG	996074.489	3489647.970	63.356
5.8.GCP.BG	996377.469	3485359.756	71.609
04.04.HCP.HP	842981.425	3430096.974	71.204
04.09.GCP.HP	858606.490	3417368.615	46.076
04.20.GVP.HP	847701.349	3429689.646	63.381
04.24.GCP.HP	863261.877	3429926.974	78.751
06.27.GCP.HP	1005085.041	3349713.340	4.929
06.34.GCP.HP	998102.427	3388352.485	16.359
06.36.GCP.HP	999938.271	3391660.901	18.837
06.40.GCP.HP	1005547.420	3399948.601	17.783
1.1.GCP.HP	691008.536	3392516.638	139.245
1.11.GCP.HP	673673.916	3394754.950	142.605
1.11.GCP.HP2	675557.378	3389465.351	124.653
1.12.GCP.HP	673673.915	3394754.952	142.606
1.13.GCP.HP	672115.680	3403760.861	159.371
1.16.GCP.HP	679476.541	3416897.951	158.528
1.19.GCP.HP	692749.717	3422403.625	110.730
1.21.GCP.HP	693315.870	3406694.869	110.024
1.5.GCP.HP	697038.563	3383367.232	129.287
1.6.GCP.HP	690649.529	3388925.039	143.259
1.9.GCP.HP	683079.473	3390678.431	138.330
1A.10.GCP.HP	728684.942	3342576.915	162.664
1A.11.GCP.HP	749914.864	3334554.271	111.328
1A.15.GCP.HP	719908.291	3349981.585	93.806

Point Id	Easting	Northing	Orth. Height
1A.17.GCP.HP	714848.387	3345631.081	103.334
1A.25.GCP.HP	710041.645	3350772.375	119.125
1A.3.GCP.HP	749468.960	3340175.914	90.271
1A.31.GCP.HP	695864.014	3352439.888	111.210
1A.32.GCP.HP	693004.086	3348027.499	129.739
1A.35.GCP.HP	684479.224	3360388.767	126.410
1A.37.GCP.HP	694166.243	3360007.588	107.104
1A.4.GCP.HP	745059.399	3340871.090	116.655
1A.5.GCP.HP	740141.348	3342317.260	107.900
1A.6.GCP.HP	737312.324	3342537.868	116.806
1A.7.GCP.HP	733025.533	3341788.859	139.183
1A.8.GCP.HP	731016.459	3340877.446	138.149
1A.GCP.HP	751241.232	3340486.638	92.566
2.1.GCP.HP	758753.797	3452921.829	105.774
2.12.GCP.HP	802704.051	3494786.684	92.699
2.13.GCP.HP	807990.190	3486663.907	70.056
2.16.GCP.HP	814263.844	3471527.621	59.690
2.4.GCP.HP	765919.083	3468451.769	136.491
2.50.GCP.HP	814243.411	3471513.856	59.935
2.52.GCP.HP	787766.572	3462139.051	107.954
2.6.GCP.HP	772087.915	3473966.527	150.406
2.61.GCP.HP	807008.792	3438139.694	82.707
2.65.GCP.HP	801599.972	3431945.950	84.486
2.66.GCP.HP	795443.206	3428377.246	86.104
3.1.GCP.HP	779964.971	3408207.545	101.519
3.11.GCP.HP	798716.190	3368118.581	97.920
3.12.GCP.HP	795615.792	3373703.000	113.062
3.16.GCP.HP	802958.497	3382579.029	97.092
3.19.GCP.HP	792098.380	3408736.287	102.134
3.2.GCP.HP	777937.384	3398715.619	94.645
3.6.GCP.HP	782413.887	3373398.968	90.944
5.13.GCP.HP	990618.744	3476636.672	78.614
5.19.GCP.HP	973461.247	3542011.300	67.558

Point Id	Easting	Northing	Orth. Height
5.4.GCP.HP	990108.790	3489224.062	102.279
5.53.GCP.HP	1021725.889	3449804.629	32.856
5.81.GCP.HP	981668.956	3529570.050	84.904
6.1.GCP.HP	990313.665	3495980.689	70.592
6.12.GCP.HP	1004468.826	3432878.375	105.000
6.15.GCP.HP	1001367.972	3424534.240	55.238
6.21.GCP.HP	1007679.795	3412660.457	33.622
6.5.GCP.HP	1004899.465	3447317.088	99.712
6.7.GCP.HP	1006404.651	3442819.152	59.706
04.28.GCP.PS	863552.701	3436817.381	78.644
04.31.GCP.PS	854686.461	3417072.320	81.662
06.40.GCP.PS	1005547.426	3399948.594	17.808
06.40.GCP.PS2	1005547.413	3399948.599	17.769
1A.36.GCP.PS	691078.957	3367120.679	137.461
3.23.GCP.PS	787257.825	3406613.423	107.988
3.8.GCP.PS	783821.604	3359320.937	65.118

Table 5: Ground Control Points

The final geometrically calibrated swath point clouds were compared to the bare-earth profile survey data. The LAS data was found to fit the profile surveys within the vertical accuracy tolerance specified for the project. Full documentation of the vertical accuracy checks maybe found in section 5.1.

4.3 Point Cloud Classification

Georeference information was applied to the swath point cloud LAS files. Geometrically calibrated swath point clouds were cut into USNG index, 1,500 meter x 1,500 meter LAS 1.2 format tiles for point cloud classification and derived in LAS 1.4 format for product creation.

Tiled point cloud data was processed in Terrasolid's Terrascan software to assign initial classification values. The Terrascan software provides a number of routines to algorithmically detect and assign points to their appropriate class. Points left unclassified by the algorithmic routine remain as Class 1.

- Automated classification routines assigned points to one of the following classes:

```
Class 1 – Processed, but unclassified
Class 2 – Bare-earth ground
Class 7 – Low Noise (low, manually identified, if necessary)
Class 9 — Water
Class 17 — Bridge Decks
Class 18 – High Noise (high, manually identified, if necessary)
Class 20 — Ignored Ground (Breakline Proximity)
```

Automated classification results were reviewed for each tiled point cloud, and manual edits made where necessary to correct for misclassified points. Points remaining in Class 1 after the automated classification routines were run and manual classification completed were left in Class 1. Points falling outside of a 100 meter buffer of the project AOI polygon were excluded from the tiled point clouds.

4.4 Breakline Collection

Manual breakline collection were performed to support the hydro-flattening requirements of the project's DEM deliverables. Breaklines were collected directly from the classified point clouds and from triangulated irregular network (TIN) surface models built from the classified point clouds, in Terrasolid's Terrascan and Terramodeler software. Breakline features were collected as a design file elements in Bentley's Microstation software. Breaklines were converted to ESRI 3D shapefile format for the breakline deliverable, and tiled to USNG index.

The data collected for the 140G0218F0069, EASTERN TX QL2 LiDAR LiDAR survey maintained significant point density in the water, marsh, and swamp, limiting the usefulness of point density as guiding factor in breakline placement.

Points classified as Class 2 – Bare-earth ground, falling within a one meter buffer of the collected breaklines, were reassigned to Class 20 – Ignored Ground. These points are excluded from the surface model during DEM generation to preserve the hydro-flattening characteristics of the breaklines.

4.5 DEM Generation

The final classified point clouds and collected breaklines were reviewed for completeness and conformance to the task order scope of work. Within the Terramodeler software, points in Class 2 – Bare- earth ground and the breaklines were combined to generate TIN elevation models for each tile, from which the bare-earth DEM tiles were interpolated and exported as ERDAS Imagine 32-bit floating point raster format ".img" format.

5 Quality Control

5.1 Point Clouds

Accuracy and completeness of the LiDAR point clouds directly impacts the quality of all other derived LiDAR derived products. Ensuring a quality LiDAR dataset begins with proper mission planning and execution. Ground GPS base stations are located such that GPS baselines between the ground and airborne receivers do not exceed 30km. For the 140G0218F0069, EASTERN TX QL2 LiDAR project, two base stations were run to meet this requirement, one at the field operations airport and one within the survey area. Static alignment is performed both before take-off and after landing to allow for GPS integer ambiguity resolution. Sensor operators carefully monitor the LiDAR unit and its various subsystems during the acquisition mission to ensure proper function. Airborne GPS positional dilution of precision (PDOP) estimates are monitored to ensure they remain less than 3.The optical system is monitored to ensure there are no ranging errors encountered during the flight lines.

During acquisition post-processing estimates of the trajectory data accuracy are reviewed to ensure they will support the required accuracy tolerances of the point cloud data. The trajectory accuracy is a function of the differentially corrected GPS data and the IMU data.

The raw swath point clouds generated from ALSPP are reviewed as another check for proper sensor function. The point clouds are reviewed for full coverage of the AOI, required point density and nominal pulse spacing, clustering, proper intensity values, full swath coverage within the planned field of view, and planned survey line overlap.

Geometric calibration quality control validates that the positional accuracy requirements of the project are met, and includes relative accuracy assessments for intra-swath (within) and inter-swath (between) accuracy, along with absolute accuracy assessments against project ground control.

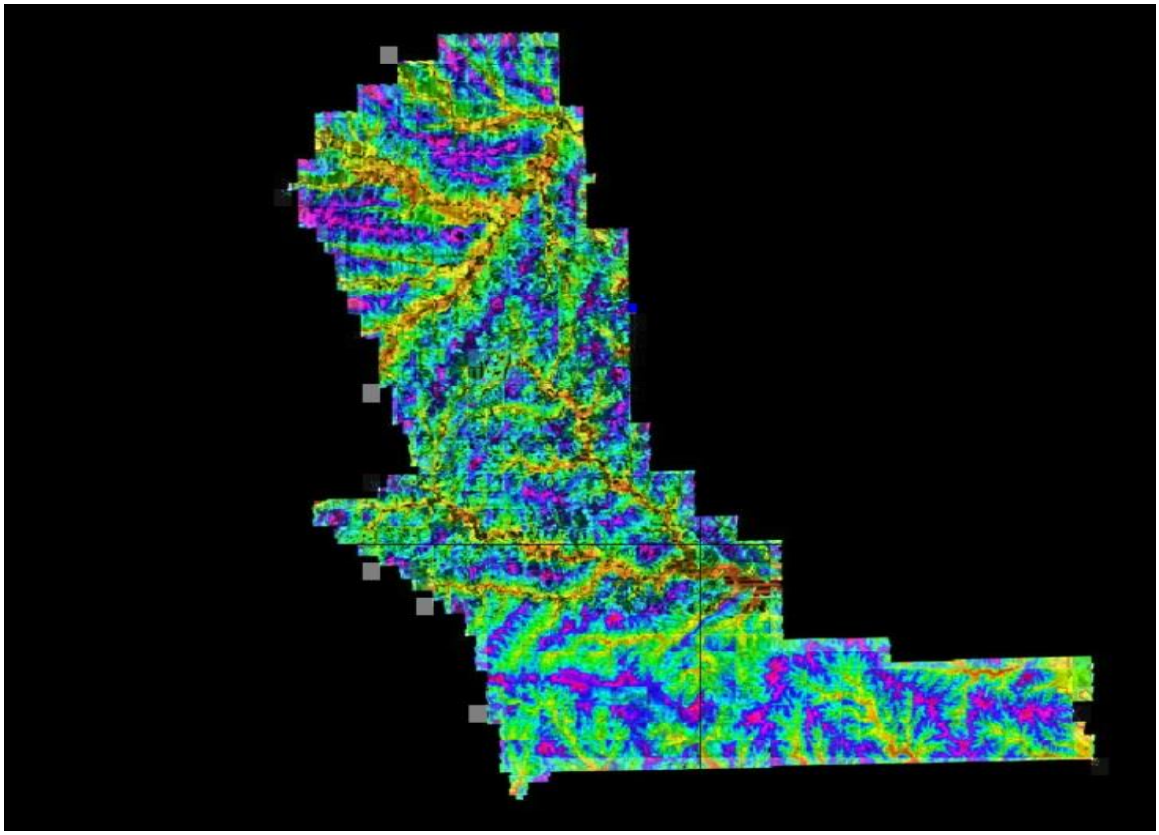


Image 3: EASTERN TX QL2 LiDAR QL1 Intensity Image

Relative vertical accuracy assessments are normally made using the tie-lines generated in the Terramatch software, as these lines provide positional observations throughout the extent of individual swaths, and between neighboring swaths.

This data set was produced to meet ASPRS "Positional Accuracy Standards for Digital Geospatial Data" (2014) for a 22.6 (cm) RMSEx / RMSEy Horizontal Accuracy Class which equates to Positional Horizontal Accuracy =+/- 78.3 cm at a 95% confidence level.

Estimated LiDAR Horizontal:	(cm)
Error Per Point ($RMSE_R$)	32.0
Error Per Point ($RMSE_X$/$RMSE_Y$)	22.6
Per Point at 95% confidence level	78.3

Table 6: Estimated LiDAR Horizontal Accuracy

Absolute vertical accuracy assessments for the point cloud data are made against ground check point data. For the 140G0218F0069, EASTERN TX QL2 LiDAR, ground check point data consisted of the ground GPS base station and real-time kinematic (RTK) GPS techniques.

Check point locations were collected at 1 – second intervals during the RTK survey. Points collected during the static pre-initialization and post-initialization was removed from the assessment so as not to bias the assessment.

Local TIN models of the elevation points are built around each ground check points. The tin model elevation is sampled at the horizontal position of the ground check point. The TIN model elevation and ground check point survey elevation values were used to calculate the Non-vegetated Vertical Accuracy (NVA) of the swath point clouds. The NVA of the TIN tested RMSEz 0.059meters and 0.116 meters at the 95% confidence level in open terrain. NVA of the DEM tested at an RMSEz of 0.059 meters and 0.116 meters at the 95% confidence level in open terrain. The full calculations for all check points can be found in Appendix B.

NVA of TIN		
$RMSE_Z$ =	0.059	meters
NSSDA =	0.116	meters

Table 7: Tested NVA of tin from Classified Point Cloud.

NVA of DEM		
$RMSE_Z$ =	0.059	meters
NSSDA =	0.116	meters

Table 7: Tested NVA of Digital Elevation Model.

The tiled point cloud products were reviewed for full coverage of the AOI and proper classification. As part of the QC process, TINs are built in the Terramodeler software for each tile using the ground class and the hydro-flattening breaklines. The TINs are reviewed for non-ground features, and edited where necessary to remove any remaining non-ground features. Points were also reviewed for absolute elevation, and points falling below the selected orthometric elevation for water were removed from the ground class.

5.2 Breaklines

The final breaklines in ESRI 3D shapefile format were reviewed for topological consistency and correct elevation. Breaklines features are continuous and do not have overlaps or dangles.

5.3 Digital Elevation Models

Digital elevation models (DEMs) were reviewed for conformance with the SOW and the Base Mapping Specification version 1.3 guidelines. DEM files were loaded in the Global Mapper software and inspected visually for edge matching between tiles, void areas within the project AOI, and proper coding of the NODATA values. DEM file naming was verified for consistency with the USNG index.

Appendix A. Flight Logs

Leica ALS80 Flight Log

Project:	2018 Tx FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	3/6/2018	ALS80 SN# 8137		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	3582.2					2018 TX FEMA					Keith	
Hobbs ST	3578.2		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	4		A			155		TEMP		1.500	C421-N13RF	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		44											IMU Error Air Start
		44	180307_005631	:56	1:08	6819	357°	154	121	19	1.1	0.6	Refly
		45	180307_011257	1:12	1:24	6879	177°	154	116	20	1.1	0.6	
		46	180307_012937	1:29	1:41	6820	357°	150	112	21	1.2	0.7	
		47	180307_014558	1:45	1:57	6796	177°	151	107	23	1	0.6	
		48	180307_020230	2:02	2:14	6758	357°	152	102	19	1.1	0.7	
		49	180307_021818	2:18	2:30	6784	177°	155	98	19	1.1	0.7	
		50	180307_023501	2:35	2:47	6780	357°	155	93	16	1.3	0.8	
		51	180307_025131	2:51	3:03	6776	177°	152	88	19	1.2	0.7	

Leica ALS80 Flight Log

Project:	2018 TX FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	03/0618	ALS80 SN# 8137		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End						2018 TX FEMA					Keith Morrel	
Hobbs ST	3578.2		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time			A			155		TEMP		1.500	C421-N13RF	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		350	180306_234212	23:42	23:50	6852	267°	153	134	18	1.2	0.7	
		42	180306_235553	23:55	:7	6872	357°	151	130	16	1.3	0.7	
		43	180307_001139	:11	:23	6857	177°	151	126	16	1.4	0.8	IMU Error on line 44. Air Start.

Leica ALS80 Flight Log

Project:	2018 TX FEMA							Sensor Operator/s	
								Hunter Stavnes	
Date/Julian:	3/7/2018	ALS80 SN# 8137		Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	3586.6				2018 TX Fema			Keith Morrel	
Hobbs ST	3582.2		LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.4		A		155	TEMP	1.500	C421-N13RF	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		52	180307_132632	13:26	13:39	6,808	357°	135	693	20	1.1	0.6	
		53	180307_134407	13:44	13:55	6856	177°	158	687	20	1.1	0.6	
		345	180307_140406	14:04	14:11	6818	267°	151	683	18	1.1	0.6	
		346	180307_141645	14:16	14:23	6852	87°	158	680	18	1.2	0.6	
		347	180307_142911	14:29	14:36	6830	267°	151	677	17	1.3	0.7	
		348	180307_144134	14:41	14:48	6870	87°	156	674	19	1.2	0.6	
		349	180307_145400	14:54	15:01	6839	267°	154	671	19	1.2	0.6	
		354	180307_150456	15:04	15:14	6847	87°	155	668	21	1.1	0.6	
		355	180307_151857	15:18	15:28	6808	267°	151	664	20	1.2	0.6	
		356	180307_153315	15:33	15:42	6835	87°	154	660	20	1.3	0.7	
		357	180307_154727	15:47	15:58	6830	267°	153	657	18	1.3	0.7	
		358	180307_160313	16:03	16:14	6809	86°	154	652	19	1.2	0.7	
		359	180307_161915	16:19	16:30	6802	267°	150	647	19	1.2	0.6	
		360	180307_163446	16:34	16:45	6766	86°	156	643	18	1.1	0.6	
		361	180307_165012	16:50	17:02	6738	267°	150	638	16	1.4	0.7	
		362	180307_170700	17:07	17:18	6766	86°	156	633	15	1.4	0.7	

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	3/7/2018	ALS80 SN# 8137		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	3590.8					2018 TX FEMA			Keith Morrel	
Hobbs ST	3586.6		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.2		B			155	TEMP	1.500	C421-N13RF	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						PDOP	HDOP	
B		363	180307_183807	18:38	18:50	6,797	267°	153	628	20	1.1	0.6	
		364	180307_185415	18:54	19:05	6780	87°	150	623	20	1.1	0.6	
		365	180307_191131	19:11	19:24	6803	267°	152	619	18	1.2	0.6	
		366	180307_192837	19:28	19:40	6782	87°	155	614	19	1.2	0.6	
		367	180307_194517	19:45	19:57	6767	267°	149	608	19	1.1	0.6	
		368	180307_200213	20:02	20:13	6771	87°	154	604	20	1.1	0.6	
		369	180307_201806	20:18	20:29	6769	267°	154	599	20	1.1	0.6	
		370	180307_203351	20:33	20:44	6783	87°	156	594	20	1.1	0.6	
		371	180307_204922	20:49	21:00	6736	267°	153	590	19	1.2	0.6	
		372	180307_210519	21:05	21:15	6783	87°	156	585	18	1.2	0.6	
		373	180307_212035	21:20	21:31	6736	267°	149	581	17	1.3	0.6	
		374	180307_213539	21:35	21:45	6752	87°	154	577	18	1.3	0.6	
		375	180307_215023	21:50	22:00	6722	267°	149	573	19	1.3	0.6	
		376	180307_220526	22:05	22:14	6749	87°	150	569	19	1.3	0.6	

Leica ALS80 Flight Log

Project:	2018 TX FEMA						Sensor Operator/s	
							Hunter Stavnes	
Date/Julian:	3/7/2018	ALS80 SN# 8137		Disk Drive MM70	Flight Plan(s):		Pilot/s	
Hobbs End	3594.4				2018 TX FEMA		Keith Morrel	
Hobbs ST	3590.8		LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.2		C		155	TEMP	1.500	C421-N13RF	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
C		54	180307_233001	23:30	23:42	6,816	357°	152	565	19	1.2	0.7	
		55	180307_234543	23:45	23:57	6839	177°	155	560	17	1.3	0.8	
		56	180308_000135	:1	:13	6832	357°	152	555	16	1.4	0.8	
		57	180308_001915	:19	:28	6821	177°	154	551	17	1.2	0.7	
		58	180308_003305	:33	:42	6828	357°	150	547	17	1.2	0.7	
		59	180308_004702	:47	:56	6816	177°	155	543	17	1.2	0.7	
		60	180308_010136	1:01	1:11	6800	357°	152	539	19	1.1	0.6	
		61	180308_011757	1:17	1:23	6809	177°	151	534	18	1.2	0.7	
		62	180308_012758	1:27	1:34	6810	357°	154	532	20	1	0.6	
		63	180308_013754	1:37	1:43	6782	177°	153	529	20	1	0.6	
		64	180308_014748	1:47	1:53	6827	357°	152	527	19	1.1	0.6	
		65	180308_015826	1:58	2:04	6832	177°	152	524	19	1	0.6	
		66	180308_020910	2:09	2:15	6818	357°	153	522	18	1.1	0.7	
		67	180308_021935	2:19	2:25	6788	177°	154	519	14	1.3	0.7	

Leica ALS80 Flight Log

Project:	2018 TX FEMA						Sensor Operator/s	
							Hunter Stavnes	
Date/Julian:	3/8/2018	ALS80 SN# 8137	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	3598.7			2018 TX FEMA			Keith Morrel	
Hobbs ST	3594.4	LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.3	A		155	TEMP	1.500	C421-N13RF	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		288	180308_153811	15:38	15:46	6,740	177°	152	517	18	1.3	0.7	
		289	180308_155059	15:50	15:56	6730	357°	155	513	18	1.3	0.7	
		290	180308_160122	16:01	16:06	6711	177°	157	511	20	1.1	0.6	
		291	180308_161137	16:11	16:13	6721	357°	157	509	19	1.2	0.6	
		287	180308_163559	16:35	16:44	6721	357°	156	508	18	1.2	0.7	
		286	180308_165106	16:51	17:01	6705	177°	155	504	17	1.2	0.7	
		285	180308_170704	17:07	17:18	6709	357°	156	500	17	1.1	0.7	
		284	180308_172321	17:23	17:34	6700	177°	154	495	16	1.3	0.8	
		283	180308_173918	17:39	17:50	6689	357°	150	491	17	1.2	0.7	
		282	180308_175446	17:54	18:05	6714	177°	151	486	18	1.1	0.7	
		281	180308_180949	18:09	18:20	6723	357°	150	482	16	1.3	0.7	
		280	180308_182442	18:24	18:35	6720	177°	156	478	17	1.2	0.7	
		279	180308_183933	18:39	18:50	6714	357°	152	474	21	1.1	0.6	
		278	180308_185510	18:55	19:05	6711	177°	153	469	21	1.1	0.6	
		277	180308_191100	19:11	19:23	6720	357°	153	465	21	1.2	0.6	

Leica ALS80 Flight Log

Project:	2018 Texas_Fema						Sensor Operator/s	
							Cynthia Williams	
Date/Julian:	3/12/2018	ALS80 SN# 8137	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	3607.9			2018 Texas_Fema			Keith Morrel	
Hobbs ST	3603.4	LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.5	A		155	TEMP	1.500	C421-N13RF	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		4	180312_003905	:39	:55	6668	88°	150	1117	20	1	0.6	
		210	180312_010223	1:02	1:02	6694	177°	161	1110	20	1.3	0.8	
		195	180312_011051	1:15	1:15	6665	357°	147	1110	21	1.5	0.8	
		194	180312_012055	1:20	1:24	6674	178°	159	1108	23	1	0.6	ALS Warning Range Gauge
		193	180312_013119	1:31	1:42	6618	359°	147	1107	21	1.1	0.7	
		192	180312_014652	1:46	14:57	6628	178°	154	1102	18	1.1	0.7	
		191	180312_020246	2:04	2:13	6625	356°	145	1098	17	1.2	0.7	
		190	180312_021759	1:21	2:21	6661	177°	156	1094	15	1.3	0.7	ALS Warning
		189	180312_023313	2:33	2:44	6622	358°	151	1089	16	1.1	0.7	ALS Warning
		188	180312_025021	2:50	3:03	6677	176°	157	1085	16	1.1	0.7	
		187	180312_030858	3:08	3:22	6625	358°	149	1083	17	1.1	0.6	
		186	180312_033250	3:32	3:49	6645	178°	332	1074	16	1.3	0.7	ALS Warning
		185	180312_035353	3:53	4:10	6645	356°	147	1067	16	1.5	0.7	ALS Warning
		5	180312_042001	4:20	4:35	6662	268°	163	1060	17	1.4	0.6	ALS Warning

Leica ALS80 Flight Log

Project:	2018 Texas_Fema								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	3/12/2018	ALS80 SN# 8137		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End						2018 Texas_Fema			Keith Morrel	
Hobbs ST	3607.9		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time			B			155	TEMP	1.500	C421-N13RF	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		184	180312_055100	5:51	6:08	6600	356°	148	1053	20	1	0.6	ALS Warning
		183	180312_061253	6:12	6:27	6647	179°	153	1046	18	1.2	0.6	ALS Warning
		182	180312_063406	6:34	6:51	6634	358°	146	1039	20	1.1	0.6	
		181	180312_065609	6:56	7:10	6644	177°	167	1032	18	1.2	0.6	SOW Warning Error Air Restart

Leica ALS80 Flight Log

Project:	2018 Texas_Fema								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	3/12/2018	ALS80 SN# 8137		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	3611.4					2018 Texas_Fema			Keith Morrel	
Hobbs ST	3607.9		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time			B			155	TEMP	1.500	C421-N13RF	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		181	180312_072554	7:25	7:43	6633	357°	144	1030	16	1.5	0.7	Refly
		180	180312_074722	7:47	8:04	6660	177°	156	1023	18	1.2	0.7	
		179	180312_080842	8:08	8:26	6617	358°	1409	1016	16	1.3	0.7	
		178	180312_083125	8:31	8:48	6651	177°	154	1008	16	1.2	0.7	

Leica ALS80 Flight Log

Project:	2018 Texas_Fema								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	3/12/2018	ALS80 SN# 8137		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End						2018 Texas_Fema			Keith Morrel	
Hobbs ST	3612.6		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time			C			155	TEMP	1.500	C421-N13RF	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
C		177	180312_184803	18:48	19:05	6612	358°	150	914	21	1.1	0.6	ALS Warning
		176	180312_191045	19:10	19:28	6680	177°	155	906	20	1.2	0.6	
		175	180312_193206	19:32	19:40	6675	357°	152	899	19	1.2	0.6	
		174	180312_195436	19:54	20:12	6655	178°	156	891	19	1.2	0.6	NO PPS Dectected

Leica ALS80 Flight Log

Project:	2018 Texas_Fema						Sensor Operator/s	
							Cynthia Williams	
Date/Julian:	3/6/2018	ALS80 SN# 8235	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	1628.1			2018 Texas_Fema			Mike Wasielewski	
Hobbs ST	1624.7	LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.4	A		155	TEMP	1.500	C421-N112MJ	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		255	180306_234714	23:47	1:31	6693	180°	157	813	17	1.2	0.7	
		256	180307_000609	:6	:21	6670	0°	144	808	17	1.2	0.7	ALS Warning
		257	180307_002527	:25	:39	6673	180°	163	802	17	1.2	0.7	
		258	180307_004334	:43	:58	6659	0°	148	797	17	1.2	0.7	
		259	180307_010318	1:03	1:17	6662	180°	143	792	20	1	0.6	ALS Warning
		260	180307_012249	1:22	1:37	6656	1°	146	786	18	1.2	0.7	
		261	180307_014149	1:41	1:56	6645	180°	150	781	22	1	0.6	ALS Warning
		262	180307_020025	2:00	2:15	6666	359°	134	776	19	1.1	0.7	
		263	180307_021925	2:19	2:32	6684	180°	149	770	19	1.1	0.7	

Leica ALS80 Flight Log

Project:	2018 Texas_Fema						Sensor Operator/s	
							Cynthia Williams	
Date/Julian:	3/7/2018	ALS80 SN# 8235	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	1631.8			2018 Texas_Fema			Mike Wasielewski	
Hobbs ST	1628.1	LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.7	A		155	TEMP	1.500	C421-N112MJ	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		381	180307_140149	14:01	14:10	6827	271°	153	765	18	1.1	0.6	
		382	180307_141508	14:15	14:27	6818	90°	156	767	18	1.2	0.6	
		383	180307_143220	14:32	14:44	6807	270°	157	757	19	1.2	0.6	
		384	180307_144829	14:48	15:01	6839	90°	152	753	19	1.2	0.6	
		385	180307_150540	15:05	15:17	6821	270°	151	748	21	1.1	0.6	
		386	180307_152218	15:22	15:40	6750	88°	151	744	20	1.1	0.7	
		387	180307_154424	15:44	16:02	6659	26.9.	153	737	18	1.3	0.7	
		388	180307_160658	16:06	16:24	6696	90°	149	730	19	1.2	0.7	
		389	180307_162859	16:28	16:47	6676	270°	150	724	17	1.2	0.7	
		390	180307_165017	16:50	17:08	6702	91°	160	717	16	1.4	0.7	System Freeze

Leica ALS80 Flight Log

Project:	2018 Texas_Fema						Sensor Operator/s	
							Cynthia Williams	
Date/Julian:	3/7/2018	ALS80 SN# 8235	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	1635.6			2018 Texas_Fema			Mike Wasielewski	
Hobbs ST	1631.8	LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.8	B		155	TEMP	1.500	C421-N112MJ	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		391	180307_184147	18:41	18:59	6636	270°	150	710	19	1.1	0.6	
		392	180307_190331	19:03	19:21	6646	89°	154	704	21	1	0.6	
		393	180307_192544	19:25	19:43	6690	271°	144	697	19	1.2	0.6	ALS Warning
		394	180307_194619	19:46	20:04	6696	91°	157	690	19	1.1	0.6	
		395	180307_200811	20:08	20:28	6686	271°	150	684	19	1.2	0.6	
		396	180307_202845	20:28	20:45	6718	89°	158	678	20	1.1	0.6	
		397	180307_204938	20:49	21:07	6707	270°	151	671	19	1.2	0.6	
		398	180307_211039	21:10	21:27	6749	88°	157	665	18	1.2	0.6	
		399	180307_213154	21:31	21:49	6583	272°	151	659	21	1.1	0.5	

Leica ALS80 Flight Log

Project:	2018 Texas_Fema								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	3/8/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1635.6					2018 Texas_Fema			Mike Wasielewski	
Hobbs ST	1631.8		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.8		C			155	TEMP	1.500	C421-N112MJ	CFD(Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						PDOP	HDOP	
C		12	180307_233221	23:32	23:43	6842	179°	152	652	19	1.1	0.7	ALS Warning
		406	180307_234901	23:49	23:49	6848	90°	153	647	17	1.3	0.8	
		405	180307_235420	23:54	23:54	6849	269°	141	647	16	1.5	0.8	
		404	180307_235817	23:58	23:59	6848	89°	155	647	16	1.5	0.8	
		403	180308_000346	:3	6:44	6836	271°	135	647	16	1.4	0.8	
		402	180308_000926	:9	:27	6681	89°	152	646	16	1.4	0.8	
		401	180308_003152	:31	:50	6637	271°	143	640	17	1.2	0.7	
		400	180308_005429	:54	1:12	6687	90°	151	633	18	1.3	0.7	
		380	180308_012543	1:25	1:35	6743	270°	150	626	18	1.2	0.7	
		379	180308_013917	1:39	1:48	6769	90°	153	622	20	1	0.6	
		378	180308_015328	1:53	20:36	6735	271°	150	619	19	1.1	0.6	
		377	180308_020703	2:07	2:16	6768	89°	155	615	18	1.1	0.7	

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	3/8/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1642.6					2018 TX FEMA			Mike Wasielewski	
Hobbs ST	1639.1		LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	3.2		A		155	TEMP	1.500		C421-N112MJ	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						PDOP	HDOP	
A		264	180308_164840	16:48	17:02	6,738	180°	155	673	16	1.4	0.8	
	1	265	180308_170622	17:06	17:20	6698	1°	151	668	17	1.1	0.7	
	2	266	180308_172412	17:24	17:38	6691	180°	156	663	16	1.3	0.8	
	3	267	180308_174220	17:42	17:56	6697	0°	153	658	17	1.2	0.7	
	4	268	180308_180008	18:00	18:14	6691	180°	159	653	17	1.1	0.7	
	5	269	180308_181818	18:18	18:39	6698	359°	155	648	16	1.3	0.7	
	6	270	180308_183604	18:36	18:49	6671	182°	155	647	21	1.1	0.6	
	7	271	180308_185510	18:55	19:06	6736	0°	153	637	21	1.1	0.6	
	8	272	180308_191110	19:11	19:23	6738	180°	151	633	21	1.2	0.6	
	9	273	180308_192654	19:26	19:38	6725	271°	153	6229	21	1.2	0.6	
	10	3	180308_194647	19:46	19:52	6725	271°	157	624	20	1.2	0.6	
	11												
	12												
	13												
	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	3/8/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1646.4					2018 TX FEMA			Mike Wasielewski	
Hobbs ST	1642.6		LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:	
Flight Time	3.8		B		155	TEMP	1.500	C421-N112MJ	CFD (Bryan, TX)	

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		118	180308_212331	21:23	21:31	6,796	1°	156	1069	21	1.3	0.6	ALS Warning
		117	180308_213528	21:35	21:43	6817	180°	155	1066	20	1.3	0.6	ALS Warning
		116	180308_214908	21:49	21:55	6815	360°	152	1063	21	1.3	0.6	ALS Warning
		115	180308_215900	21:59	22:05	6802	181°	154	1061	21	1.3	0.6	ALS Warning
		114	180308_220842	22:08	22:14	6803	359°	158	1059	22	1.2	0.6	ALS Warning
		113	180308_221820	22:18	22:24	6813	179°	153	1057	21	1.2	0.6	ALS Warning
		112	180308_223045	22:30	22:34	6916	360°	155	1055	22	1.1	0.6	ALS Warning
		111	180308_223814	22:38	22:42	6895	181°	154	1054	20	1.3	0.7	ALS Warning
		110	180308_224521	22:45	22:49	6891	1°	157	1052	20	1.3	0.7	ALS Warning
		109	180308_225236	22:52	22:56	6887	180°	153	1051	20	1.2	0.7	ALS Warning
		108	180308_230033	23:00	23:03	6913	358°	156	1050	21	1.1	0.6	ALS Warning
		107	180308_230711	23:07	23:09	6888	181°	154	1049	22	1.1	0.6	ALS Warning
		106	180308_231259	23:12	23:15	6894	360°	157	1048	20	1.3	0.7	
		105	180308_231846	23:18	23:20	6894	180°	155	1047	19	1.2	0.7	
		104	180308_232404	23:24	23:26	6901	1°	156	1046	19	1.2	0.7	
		103	180308_232908	23:29	23:31	6895	181°	151	1045	19	1.2	0.7	
		119	180308_233843	23:38	23:46	6813	181°	156	1044	18	1.2	0.7	ALS Warning
		120	180308_235241	23:52	:3	6828	359°	152	1041	17	1.3	0.7	ALS Warning
		121	180309_000706	:7	:18	6818	180°	151	1037	17	1.4	0.8	ALS Warning
		122	180309_002148	:21	:32	6833	359°	157	1033	17	1.2	0.7	
		123	180309_003623	:36	:47	6775	180°	153	1029	17	1.2	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	3/11/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1651.2					2018 TX FEMA			Mike Wasielewski	
Hobbs ST	1647.6		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.6		A			155	TEMP	1.500	C421-N112MJ	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		124	180311_233920	23:39	23:53	6842	360°	137	1025	17	1.3	0.8	ALS Warning
		125	180312_000132	:1	:13	6842	181°	156	1020	19	1.4	0.8	ALS Warning
		126	180312_001857	:18	:33	6743	359°	133	1015	18	1.3	0.8	ALS Warning
		127	180312_003829	:38	:53	6762	178°	147	1010	21	1	0.6	
		128	180312_005716	:57	1:13	6765	360°	131	1005	18	1.3	0.8	ALS Warning
		129	180312_011735	1:17	1:32	6786	180°	149	999	23	1	0.6	ALS Warning
		130	180312_013654	1:36	1:53	6790	1°	139	993	19	1.1	0.7	ALS Warning
		131	180312_015711	1:57	2:12	6770	180°	152	987	18	1.1	0.7	ALS Warning
		132	180312_021656	2:16	2:33	6778	1°	141	982	15	1.3	0.7	
		133	180312_023749	2:37	2:53	6792	179°	155	975	16	1.1	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	3/11/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End						2018 TX FEMA					Mike Wasielewski	
Hobbs ST	1651.2		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time			B			155		TEMP		1.500	C421-N112MJ	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		134	180312_035722	3:57	4:16	6743	1°	140	970	16	1.5	0.7	
		135	180312_042025	4:20	4:38	6779	181°	150	962	17	1.4	0.6	ALS Warning
		136	180312_044251	4:42	5:02	6737	359°	140	956	17	1.3	0.6	ALS Warning
		137	180312_050641	5:06	5:24	6783	180°	154	949	20	1	0.6	ALS Warning
		138	180312_052901	5:29	5:49	6770	0°	138	942	19	1	0.6	
		139	180312_055401	5:54	6:12	6791	180°	152	935	19	1.1	0.6	ALS Warning
		140	180312_061740	6:17	6:37	6775	360°	143	928	20	1.1	0.6	ALS Warning No PPS Detected by TDC. Air Start.

Leica ALS80 Flight Log

Project:	2018 TX FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	3/11/2018	ALS80 SN# 8253		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	1654.8					2018 TX FEMA					Mike Wasielewski	
Hobbs ST	1651.2		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	3.6		B			155		TEMP		1.500	C421-N112MJ	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		141	180312_065451	6:54	7:13	6796	179°	152	920	18	1.2	0.6	ALS Warning No PPS Detected by TDC
													Air Start after line 140

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	3/12/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1658.8					2018 TX FEMA			Mike Wasielewski	
Hobbs ST	1654.8		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4		A			155	TEMP	1.500	C421-N112MJ	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		142	180312_174806	17:48	18:06	6783	2°	152	621	17	1.3	0.8	ALS Warning
		143	180312_181038	18:10	18:29	6842	179°	154	615	18	1.2	0.7	ALS Warning
		144	180312_183314	18:33	18:52	6783	0°	151	608	21	1.1	0.6	ALS Warning
		145	180312_185659	18:56	19:15	6865	180°	157	601	19	1.2	0.6	
		146	180312_191856	19:18	19:37	6782	358°	153	594	20	1.2	0.6	ALS Warning
		147	180312_194145	19:41	20:00	6808	180°	154	587	19	1.2	0.6	ALS Warning
		148	180312_200528	20:05	20:24	6797	359°	152	580	21	1.2	0.6	
		149	180312_202837	20:28	20:47	6790	180°	153	574	21	1.2	0.6	ALS Warning
		196	180312_205735	20:57	21:00	661	1°	147	567	19	1.4	0.6	ALS Warning
		197	180312_210350	21:03	21:06	6719	180°	153	566	19	1.4	0.6	ALS Warning
		198	180312_211023	21:10	21:12	6709	360°	149	565	21	1.1	0.6	

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	3/12/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1662.4					2018 TX FEMA			Mike Wasielewski	
Hobbs ST	1658.8		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.6		B			155	TEMP	1.500	C421-N112MJ	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		199	180312_232525	23:25	23:27	6682	1°	153	563	21	1.2	0.7	
		200	180312_233114	23:31	23:33	6692	179°	154	563	20	1.4	0.8	
		201	180312_233715	23:37	23:38	6681	359°	151	562	20	1.5	0.8	
		202	180312_234214	23:42	23:43	6695	181°	150	561	19	1.5	0.8	
		203	180312_234813	23:48	23:49	6683	360°	151	561	19	1.5	0.8	
		204	180312_235306	23:53	23:54	6713	180°	152	560	19	1.5	0.8	
		205	180312_235753	23:57	23:59	6692	360°	150	560	19	1.2	0.7	
		206	180313_000242	:2	:3	6707	179°	147	559	19	1.4	0.8	Possible Smoke
		154	180313_001549	:15	:33	6708	360°	154	559	19	1.3	0.7	
		153	180313_003722	:37	:55	6762	180°	150	552	22	1	0.6	ALS Warning
		152	180313_010108	1:01	1:19	6754	1°	154	545	20	1.3	0.7	ALS Warning
		151	180313_012336	1:23	1:42	6761	183°	151	539	22	1.1	0.6	ALS Warning
		150	180313_014641	1:46	2:05	6676	360°	151	532	20	1	0.6	ALS Warning
		161	180313_020946	2:09	2:28	6747	181°	152	525	17	1.2	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	3/13/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	1666.9					2018 TX FEMA					Keith Morrel	
Hobbs ST	1663.1		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	3.8		A			155		TEMP		1.500	C421-N112MJ	LFK (Lufkin, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		211	180314_000242	:2	:5	6551	180°	153	730	17	1.4	0.8	ALS Warning
		212	180314_000805	:8	:10	6540	0°	144	729	17	1.4	0.8	ALS Warning
		213	180314_001359	:13	:16	6595	180°	154	728	18	1.2	0.7	ALS Warning
		214	180314_001927	:19	:41	6537	2°	151	728	20	1.1	0.6	ALS Warning
		215	180314_004501	:45	1:07	6544	181°	154	720	19	1.3	0.7	ALS Warning
		216	180314_011120	1:11	1:33	6572	0°	150	712	21	1.1	0.6	ALS Warning
		217	180314_013650	1:36	1:58	6554	181°	155	704	19	1	0.6	ALS Warning
		218	180314_020152	2:01	2:24	6548	360°	153	697	17	1.2	0.7	ALS Warning
		219	180314_022737	2:27	2:49	6594	178°	156	689	19	1.2	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	3/13/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1670.8					2018 TX FEMA			Keith Morrel	
Hobbs ST	1666.9		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.9		B			155	TEMP	1.500	C421-N112MJ	LFK (Lufkin, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						PDOP	HDOP	
B		6	180314_041128	4:11	4:18	6648	270°	153	681	22	1.4	0.6	ALS Warning
		68	180314_042331	4:23	4:26	6626	2°	146	679	22	1.4	0.6	ALS Warning
		69	180314_042918	4:29	4:32	6652	180°	151	678	22	1.4	0.6	ALS Warning
		70	180314_043535	4:35	4:38	6621	1°	146	677	24	1.3	0.6	ALS Warning
		71	180314_044207	4:42	4:45	6652	180°	156	676	23	1.3	0.6	ALS Warning
		72	180314_044905	4:49	4:53	6633	359°	144	675	23	1.2	0.6	ALS Warning
		73	180314_045648	4:56	5:00	6649	179°	153	673	24	1.1	0.6	ALS Warning
		74	180314_050344	5:03	5:07	6634	2°	143	672	25	1	0.6	ALS Warning
		75	180314_051134	5:11	5:15	6647	180°	154	670	21	1.1	0.6	ALS Warning
		76	180314_051908	5:19	5:22	6598	3°	149	669	23	1	0.6	ALS Warning
		77	180314_052540	5:25	5:28	6630	179°	154	668	24	1	0.6	ALS Warning
		78	180314_053504	5:35	5:41	6604	2°	150	667	24	1	0.6	ALS Warning
		79	180314_054506	5:45	5:51	6620	180°	157	665	23	1	0.6	ALS Warning
		80	180314_055432	5:54	6:14	6625	0°	149	662	21	1.1	0.6	ALS Warning
		81	180314_060457	6:04	6:11	6627	180°	156	660	20	1.2	0.6	ALS Warning
		82	180314_061434	6:14	6:22	6620	1°	150	658	20	1.1	0.6	ALS Warning
		83	180314_062442	6:24	6:31	6656	181°	155	656	20	1.1	0.6	ALS Warning
		84	180314_063451	6:34	6:41	6607	1°	150	653	20	1.1	0.6	ALS Warning
		85	180314_064512	6:45	6:51	6643	181°	158	651	18	1.2	0.7	ALS Warning
		86	180314_065519	6:55	7:02	6625	1°	151	649	19	1.2	0.6	ALS Warning
		87	180314_070551	7:05	7:12	6631	180°	158	646	18	1.3	0.7	ALS Warning
		88	180314_071547	7:15	7:22	6632	0°	151	644	17	1.4	0.7	ALS Warning
		89	180314_072605	7:26	7:32	6636	181°	154	642	17	1.4	0.7	ALS Warning
		90	180314_073634	7:36	7:43	6619	358°	150	639	18	1.2	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA						Sensor Operator/s	
							Hunter Stavnes	
Date/Julian:	3/13/2018	ALS80 SN# 8235		Disk Drive MM70	Flight Plan(s):		Pilot/s	
Hobbs End	1673.1				2018 TX FEMA		Keith Morrel	
Hobbs ST	1670.8		LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	2.3		C		155	TEMP	1.500	C421-N112MJ	LFK (Lufkin, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
C		91	180314_084837	8:48	8:55	6670	181°	151	637	17	1.1	0.7	ALS Warning
		92	180314_085837	8:58	9:05	6667	359°	152	635	16	1.2	0.7	ALS Warning
		93	180314_090858	9:08	9:16	6673	179°	154	632	16	1.2	0.7	ALS Warning
		94	180314_091855	9:18	9:25	6608	357°	143	630	15	1.3	0.8	ALS Warning
		95	180314_092907	9:29	9:36	6613	181°	150	628	13	1.5	0.8	ALS Warning
		96	180314_093932	9:39	9:46	6599	359°	152	625	14	1.4	0.8	ALS Warning
		97	180314_094910	9:49	9:55	6609	179°	156	623	15	1.3	0.7	ALS Warning
		98	180314_100023	10:00	10:05	6607	0°	144	621	16	1.1	0.6	ALS Warning
		99	180314_100907	10:09	10:14	6648	178°	159	619	16	1.2	0.6	ALS Warning
		100	180314_101750	10:17	10:24	6693	0°	150	615	16	1.3	0.7	ALS Warning
		101	180314_102633	10:26	10:31	6614	179°	156	615	18	1.1	0.6	ALS Warning
		102	180314_103513	10:35	10:40	6586	4°	151	613	19	1.1	0.6	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	3/14/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	1684.6					2018 TX FEMA					Keith Morrel	
Hobbs ST	1680.7		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	3.9		A			155		TEMP		1.500	C421-N112MJ	LFK (Lufkin, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		9	180314_220216	22:02	22:10	6697	90°	149	611	19	1.1	0.6	ALS Warning
		344	180314_221635	22:16	22:17	6697	179°	154	609	18	1.3	0.7	ALS Warning
		343	180314_222105	22:21	22:23	6702	359°	156	609	18	1.3	0.7	ALS Warning
		342	180314_222643	22:26	22:29	6707	180°	155	608	19	1.3	0.7	ALS Warning
		341	180314_223223	22:32	22:37	6712	359°	145	607	20	1.2	0.6	ALS Warning
		340	180314_224006	22:40	22:44	6738	178°	156	606	21	1.2	0.7	ALS Warning
		339	180314_224806	22:48	22:52	6721	360°	153	605	21	1.1	0.6	ALS Warning
		338	180314_225616	22:56	23:00	6726	179°	156	603	19	1.3	0.7	ALS Warning
		337	180314_230431	23:04	23:09	6726	360°	151	602	18	1.3	0.7	ALS Warning
		336	180314_231259	23:12	23:18	6734	180°	150	601	18	1.2	0.7	ALS Warning
		335	180314_232128	23:21	23:27	6716	0°	145	599	17	1.3	0.7	ALS Warning
		334	180314_233056	23:30	23:37	6715	180°	151	597	17	1.3	0.7	ALS Warning
		333	180314_234037	23:40	23:47	6707	1°	152	596	18	1.2	0.7	ALS Warning
		332	180314_235115	23:51	23:58	6734	182°	158	594	17	1.4	0.7	ALS Warning
		331	180315_000217	:2	:9	6723	360°	156	591	16	1.3	0.7	ALS Warning
		330	180315_001313	:13	:21	6722	181°	153	589	18	1.2	0.7	ALS Warning
		329	180315_002425	:24	:32	6695	359°	153	586	19	1.1	0.6	ALS Warning
		328	180315_003513	:35	:43	6663	180°	156	584	19	1.1	0.6	ALS Warning
		327	180315_004708	:47	:55	6661	360°	154	581	18	1.2	0.7	ALS Warning
		326	180315_005836	:58	1:06	6661	181°	160	579	19	1.1	0.6	ALS Warning
		325	180315_011000	1:10	1:18	6654	1°	150	576	20	1	0.6	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	3/14/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1688.6					2018 TX FEMA			Keith Morrel	
Hobbs ST	1684.6		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4		B			155	TEMP	1.500	C421-N112MJ	LFK (Lufkin, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						PDOP	HDOP	
B		324	180315_024352	2:43	2:52	6658	359°	153	573	18	1.1	0.6	ALS Warning
		323	180315_025926	2:59	3:12	6637	181°	155	571	18	1.1	0.6	ALS Warning
		322	180315_031527	3:15	3:28	6674	358°	154	566	19	1.2	0.6	ALS Warning
		321	180315_033108	3:31	3:44	6649	181°	153	562	18	1.4	0.7	ALS Warning
		320	180315_034711	3:47	4:00	6676	360°	153	558	18	1.5	0.7	ALS Warning
		319	180315_040426	4:04	4:19	6665	180°	155	554	20	1.3	0.6	ALS Warning
		318	180315_042207	4:22	4:36	6664	359°	149	550	22	1.2	0.6	ALS Warning
		317	180315_044008	4:40	4:55	6647	180°	150	545	21	1.3	0.6	ALS Warning
		316	180315_045829	4:58	5:13	6648	359°	150	540	22	1.1	0.6	ALS Warning
		315	180315_051647	5:16	5:32	6660	180°	151	535	21	1.1	0.6	ALS Warning
		314	180315_053510	5:35	5:50	6639	360°	153	530	23	1	0.6	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA							Sensor Operator/s	
								Hunter Stavnes	
Date/Julian:	3/19/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):		Pilot/s	
Hobbs End	3625.9					2018 TX FEMA		Keith Morrel	
Hobbs ST	3621.7		LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.2		A		155	TEMP	1.500	C421-N13RF	CFD (Bryan, TX)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		2	180319_135732	13:57	13:58	6955	180°	155	383	21	1.1	0.6	
		7	180319_140430	14:04	14:10	6938	271°	138	383	21	1.1	0.6	
		3	180319_141557	14:15	14:17	6974	90°	155	383	21	1.1	0.6	ALS Warning
		4	180319_142208	14:22	14:23	6944	270°	144	382	20	1.3	0.7	ALS Warning
		5	180319_143200	14:32	14:35	6971	90°	153	382	19	1.3	0.7	ALS Warning
		1	180319_145142	14:51	14:55	6600	360°	155	381	19	1.3	0.7	
		6	180319_151008	15:10	15:10	6826	1°	153	379	20	1.1	0.6	
		165	180319_152102	15:21	15:40	6713	180°	143	379	20	1.2	0.6	ALS Warning
		164	180319_154544	15:45	16:04	6685	0°	153	372	18	1.2	0.6	ALS Warning
		163	180319_161112	16:11	16:30	6648	180°	148	365	17	1.2	0.7	
		162	180319_163423	16:34	16:53	6775	360°	155	358	16	1.3	0.7	
		210	180319_171135	17:11	17:12	6773	180°	154	351	18	1.1	0.7	
		209	180319_171559	17:15	17:16	6810	359°	148	351	17	1.1	0.7	
		208	180319_172050	17:20	17:21	6771	181°	148	351	17	1.1	0.7	
		207	180319_172447	17:24	17:25	6772	360°	156	351	16	1.3	0.7	

Leica ALS80 Flight Log

Project:	2018 TX FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	3/19/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	3631.4					2018 TX FEMA					Keith Morrel	
Hobbs ST	3626.9		LIFT			TARGET AIRSPD (KNTS)		BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	4.5		B			155		TEMP	1.500		C421-N13RF	5R8 (Dequincy, LA)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		224	180319_211941	21:19	21:42	6544	358°	147	350	20	1.3	0.6	ALS Warning
		225	180319_214659	21:46	22:09	6472	181°	150	342	20	1.1	0.6	ALS Warning
		226	180319_221403	22:14	22:36	6502	360°	150	335	18	1.3	0.7	ALS Warning
		227	180319_224130	22:41	23:03	6535	181°	146	327	17	1.3	0.7	ALS Warning
		228	180319_230847	23:08	23:31	6574	359°	153	319	16	1.3	0.8	ALS Warning
		229	180319_233537	23:35	23:58	6495	179°	153	312	16	1.4	0.8	ALS Warning. Possible Clouds
		230	180320_000212	:2	:24	6542	359°	150	304	19	1.1	0.7	ALS Warning
		234	180320_002827	:28	:42	6479	180°	160	297	18	1.3	0.7	ALS Warning
		235	180320_004836	:48	1:03	6608	0°	149	292	23	1	0.6	ALS Warning
		236	180320_010809	1:08	1:21	6560	179°	154	287	21	1.1	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA						Sensor Operator/s	
							Hunter Stavnes	
Date/Julian:	3/20/2018	ALS80 SN# 8235	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	3634			2018 TX FEMA			Keith Morrel	
Hobbs ST	3632.5	LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	1.5	A		155	TEMP	1.500	C421-N13RF	5R8 (Dequincy, LA)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		11	180320_162858	16:28	16:33	6468	270°	137	282	16	1.4	0.8	ALS Warning
		8	180320_164031	16:40	16:42	6570	179°	157	281	17	1.4	0.8	ALS Warning
		9	180320_164607	16:46	16:49	6554	359°	132	280	17	1.3	0.8	ALS Warning
		231	180320_165709	16:57	17:22	6533	359°	136	279	15	1.6	0.9	ALS Warning. Cloud 27.22 miles from end of line.

Leica ALS80 Flight Log

Project:	2018 TX FEMA									Sensor Operator/s	
										Hunter Stavnes	
Date/Julian:	3/21/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):				Pilot/s	
Hobbs End	3639.5					2018 TX FEMA				Keith Morrel	
Hobbs ST	3635.3		LIFT			TARGET AIRSPD (KNTS)		BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.2		A			155		TEMP	1.500	C421-N13RF	5R8 (Dequincy, LA)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
A		244	180321_124150	12:41	12:53	6582	359°	141	135	20	1.1	0.6	ALS Warning
		243	180321_125735	12:57	13:08	6580	181°	154	131	22	1	0.5	ALS Warning
		242	180321_131206	13:12	13:25	6611	359°	137	127	20	1.1	0.6	ALS Warning
		241	180321_132855	13:28	13:40	6617	180°	160	123	18	1.3	0.7	ALS Warning
		240	180321_134426	13:44	13:58	6617	0°	137	119	19	1.1	0.6	ALS Warning
		239	180321_140133	14:01	14:13	6639	180°	160	114	19	1.1	0.6	ALS Warning
		238	180321_141804	14:18	14:31	6557	359°	138	110	21	1.1	0.6	ALS Warning
		237	180321_143614	14:36	14:48	6577	180°	158	105	18	1.4	0.7	ALS Warning
		232	180321_150000	15:00	15:24	6583	1°	141	101	19	1.3	0.7	ALS Warning
		231	180321_152819	15:28	15:38	6574	180°	158	92	19	1.2	0.7	Refly. Possible smoke.
		233	180321_155852	15:58	16:20	6577	180°	156	88	17	1.3	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	2018 TX FEMA										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	3/21/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	3641.3					2018 TX FEMA					Keith Morrel	
Hobbs ST	3639.5		LIFT			TARGET AIRSPD (KNTS)		BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	1.8		B			155		TEMP	1.500		C421-N13RF	5R8 (Dequincy, LA)

Lift	#	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Available	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B		249	180321_172102	17:21	17:31	6549	0°	142	81	16	1.3	0.7	ALS Warning
		245	180321_173453	17:34	17:45	6619	180°	160	77	17	1.3	0.7	ALS Warning
		246	180321_175007	17:50	18:01	6541	359°	147	74	22	1.1	0.6	ALS Warning
		247	180321_180520	18:05	18:14	6559	180°	156	70	22	1.1	0.6	ALS Warning
		248	180321_181922	18:19	18:29	6551	1°	145	67	21	1.1	0.6	ALS Warning

Appendix B. Vertical Accuracy Calculations

Project Information

Prepared By: Kenneth L. Coffey
Project Name: Eastern Texas QL2 LiDAR
Sensor Info: Lecia ALS80 SN# 8137
Required Nominal Pulse Spacing: 0.7
Vendor Name: Digital Aerial Solutions .LLC
Units: Meters
Percent of Extent Tolerance: Extents Not Checked
Date of Aquisition: Start: 3/6/2018 Finish: 3/21/2018

Metadata Information

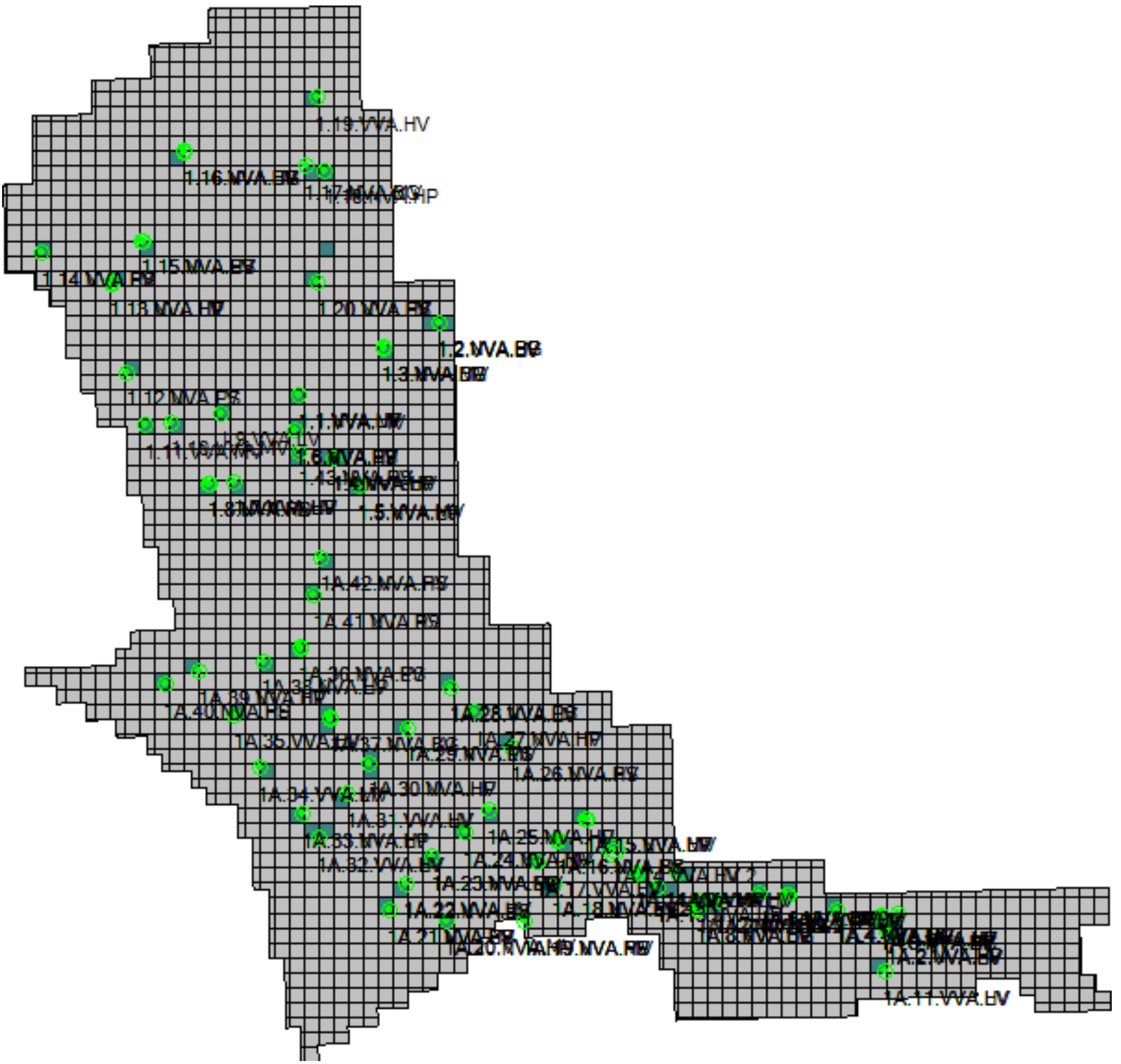
Tile Index:
- Filename: TX_BLK1_Clip_Tiles.shp
- Number of Polys: 0

Intensity:
- Tile Index Attribute: Not Specified
- Data Filename: Not Specified

DEM:
- Tile Index Attribute: NAME
- Data Filename: DEM

LAS:
- Tile Index Attribute: NAME
- Data Filename: LAS

Tiled-Data Area



LiDAR Accuracy Assessment Summary

LC Type	# of Points	NVA	VVA	
LAS				
Bare Ground	13	0.124		
Hard Pavement	34	0.111		
High Vegetation	40		0.160	
Low Vegetation	41		0.172	
Medium Vegetation	20		0.195	
Packed Sand	20	0.119		
Total	168			
DEM				
Bare Ground	13	0.124		
Hard Pavement	34	0.106		
High Vegetation	41		0.156	
Low Vegetation	41		0.176	
Medium Vegetation	20		0.220	
Packed Sand	20	0.126		
Total	169			

Units: Meters

Coordinates and Offsets of Analyzed Locations

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
1)	☑	**1.16.NVA.BG**					
			679499.872	3416881.57	157.879	157.88	157.892
					Bare Ground	0.001	0.013
2)	☑	**1.17.NVA.BG**					
			691631.752	3415455.628	127.697	127.743	127.747
					Bare Ground	0.046	0.05
3)	☑	**1.2.NVA.BG**					
			705018.664	3399748.371	152.903	152.915	152.91
					Bare Ground	0.012	0.007
4)	☑	**1.3.NVA.BG**					
			699447.496	3397270.182	132.216	132.045	132.026
					Bare Ground	-0.171	-0.19
5)	☑	**1A.12.NVA.BG**					
			731121.685	3341723.919	132.761	132.718	132.711
					Bare Ground	-0.043	-0.05
6)	☑	**1A.12.NVA.BG.2**					
			731136.356	3341741.94	134.177	134.085	134.113
					Bare Ground	-0.092	-0.064
7)	☑	**1A.16.NVA.BG**					
			717081.861	3347768.788	96.323	96.297	96.321
					Bare Ground	-0.026	-0.002

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
8)	☑	**1A.23.NVA.BG**					
			704381.941	3346151.162	102.867	102.909	102.92
					Bare Ground	0.042	0.053
9)	☑	**1A.3.NVA.BG**					
			749438.432	3340132.65	90.431	90.419	90.428
					Bare Ground	-0.012	-0.003
10)	☑	**1A.37.NVA.BG**					
			694176.371	3359994.646	106.475	106.489	106.501
					Bare Ground	0.014	0.026
11)	☑	**1A.4.NVA.BG**					
			745095.337	3340858.221	117.888	117.882	117.899
					Bare Ground	-0.006	0.011
12)	☑	**1A.6.NVA.BG**					
			737315.795	3342543.978	116.642	116.611	116.605
					Bare Ground	-0.031	-0.037
13)	☑	**1A.8.NVA.BG**					
			731049.769	3340829.93	134.795	134.713	134.749
					Bare Ground	-0.082	-0.046
14)	☑	**1.1.NVA.HP**					
			690969.914	3392496.121	139.637	139.687	139.689
					Hard Pavement	0.05	0.052

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
15)	☑	**1.13.NVA.HP**					
			672133.903	3403745.548	159.902	159.946	159.946
					Hard Pavement	0.044	0.044
16)	☑	**1.16.NVA.HP**					
			679486.15	3416911.812	158.548	158.563	158.551
					Hard Pavement	0.015	0.003
17)	☑	**1.18.NVA.HP**					
			693589.736	3415015.462	120.664	120.679	120.682
					Hard Pavement	0.015	0.018
18)	☑	**1.2.NVA.HP**					
			705002.362	3399777.629	153.402	153.41	153.411
					Hard Pavement	0.008	0.009
19)	☑	**1.3.NVA.HP**					
			699481.258	3397187.683	130.209	130.107	130.08
					Hard Pavement	-0.102	-0.129
20)	☑	**1.4.NVA.HP**					
			694443.774	3386221.838	136.634	136.622	136.631
					Hard Pavement	-0.012	-0.003
21)	☑	**1.5.NVA.HP**					
			697022.537	3383365.232	129.129	129.109	129.102
					Hard Pavement	-0.02	-0.027

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
22)	**1.6.NVA.HP**					
		690658.373	3388931.348	143.232	143.41	143.41
				Hard Pavement	0.178	0.178
23)	**1.7.NVA.HP**					
		684477.034	3383778.765	147.847	147.892	147.9
				Hard Pavement	0.045	0.053
24)	**1.8.NVA.HP**					
		681954.522	3383645.872	161.468	161.546	161.556
				Hard Pavement	0.078	0.088
25)	**1A.13.NVA.HP**					
		726941.879	3342987.717	152.273	152.264	152.249
				Hard Pavement	-0.009	-0.024
26)	**1A.14.NVA.HP**					
		725004.26	3344420.303	113.384	113.406	113.38
				Hard Pavement	0.022	-0.004
27)	**1A.15.NVA.HP**					
		719888.852	3349965.493	94.059	94.036	94.021
				Hard Pavement	-0.023	-0.038
28)	**1A.18.NVA.HP**					
		716541.17	3343428.205	102.705	102.733	102.738
				Hard Pavement	0.028	0.032

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
29)	**1A.19.NVA.HP**					
		713605.258	3339589.938	112.499	112.535	112.505
				Hard Pavement	0.036	0.006
30)	**1A.2.NVA.HP**					
		750208.534	3338746.363	104.737	104.645	104.651
				Hard Pavement	-0.092	-0.086
31)	**1A.20.NVA.HP**					
		705765.919	3339635.929	141.623	141.631	141.609
				Hard Pavement	0.008	-0.014
32)	**1A.21.NVA.HP**					
		699984.767	3340771.368	150.731	150.738	150.731
				Hard Pavement	0.007	0
33)	**1A.23.NVA.HP**					
		704364.136	3346172.767	102.605	102.662	102.662
				Hard Pavement	0.057	0.057
34)	**1A.24.NVA.HP**					
		707652.824	3348554.047	116.183	116.245	116.236
				Hard Pavement	0.062	0.053
35)	**1A.25.NVA.HP**					
		710023.984	3350786.494	119.016	118.995	118.986
				Hard Pavement	-0.021	-0.03

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
36)	**1A.27.NVA.HP**					
		708678.778	3360629.782	114.417	114.446	114.434
				Hard Pavement	0.029	0.017
37)	**1A.3.NVA.HP**					
		749518.456	3340210.164	89.851	89.813	89.82
				Hard Pavement	-0.038	-0.031
38)	**1A.30.NVA.HP**					
		698048.675	3355504.681	136.248	136.297	136.29
				Hard Pavement	0.049	0.042
39)	**1A.33.NVA.HP**					
		691369.454	3350394.567	146.786	146.789	146.802
				Hard Pavement	0.003	0.016
40)	**1A.38.NVA.HP**					
		687370.63	3365730.62	124.319	124.328	124.313
				Hard Pavement	0.009	-0.006
41)	**1A.39.NVA.HP**					
		680977.409	3364708.932	135.144	135.2	135.201
				Hard Pavement	0.056	0.057
42)	**1A.4.NVA.HP**					
		745079.472	3340837.217	118.555	118.555	118.545
				Hard Pavement	0	-0.01

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
43)	**1A.40.NVA.HP**					
		677540.433	3363437.237	145.764	145.821	145.851
				Hard Pavement	0.057	0.087
44)	**1A.5.NVA.HP**					
		740176.151	3342365.107	111.011	111.017	110.993
				Hard Pavement	0.006	-0.018
45)	**1A.6.NVA.HP**					
		737299.076	3342551.894	117.207	117.128	117.148
				Hard Pavement	-0.079	-0.059
46)	**1A.8.NVA.HP**					
		731064.256	3340832.318	134.669	134.593	134.587
				Hard Pavement	-0.076	-0.082
47)	**1A.NVA.HP**					
		751223.9	3340463.375	93.996	93.949	93.958
				Hard Pavement	-0.047	-0.038
48)	**1.12.NVA.PS**					
		673682.774	3394719.351	141.904	141.908	141.904
				Packed Sand	0.004	0
49)	**1.14.NVA.PS**					
		665172.954	3406764.161	167.223	167.25	167.259
				Packed Sand	0.027	0.036

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
50)	☑	**1.15.NVA.PS**					
			675214.375	3407924.506	140.018	140.057	140.059
					Packed Sand	0.039	0.041
51)	☑	**1.20.NVA.PS**					
			692869.146	3403782.899	128.415	128.45	128.443
					Packed Sand	0.035	0.028
52)	☑	**1.43.NVA.PS**					
			691021.846	3386744.026	132.144	132.185	132.186
					Packed Sand	0.041	0.042
53)	☑	**1.6.NVA.PS**					
			690642.779	3388906.676	142.985	143.144	143.141
					Packed Sand	0.159	0.156
54)	☑	**1.8.NVA.PS**					
			681937.178	3383625.776	162.199	162.307	162.296
					Packed Sand	0.108	0.097
55)	☑	**1A.16.NVA.PS**					
			717077.143	3347758.717	96.542	96.535	96.552
					Packed Sand	-0.007	0.01
56)	☑	**1A.18.NVA.PS2**					
			716552.486	3343437.545	102.67	102.709	102.71
					Packed Sand	0.039	0.04

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
57)	**1A.19.NVA.PS**					
		713621.634	3339595.177	111.506	111.514	111.51
				Packed Sand	0.008	0.004
58)	**1A.21.NVA.PS**					
		700022.624	3340763.243	150.608	150.586	150.597
				Packed Sand	-0.022	-0.011
59)	**1A.22.NVA.PS**					
		701705.44	3343376.608	126.554	126.617	126.604
				Packed Sand	0.063	0.05
60)	**1A.26.NVA.PS**					
		712355.681	3357082.605	88.827	88.892	88.894
				Packed Sand	0.065	0.067
61)	**1A.28.NVA.PS**					
		706232.772	3363100.812	126.921	126.939	126.935
				Packed Sand	0.018	0.014
62)	**1A.29.NVA.PS**					
		701858.985	3359080.072	99.01	99.104	99.078
				Packed Sand	0.094	0.068
63)	**1A.36.NVA.PS**					
		691082.397	3367100.019	137.475	137.49	137.484
				Packed Sand	0.015	0.009

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
64)	☑	**1A.40.NVA.PS**					
			677539.832	3363446.782	145.327	145.419	145.403
					Packed Sand	0.092	0.076
65)	☑	**1A.41.NVA.PS**					
			692461.817	3372366.426	119.656	119.729	119.736
					Packed Sand	0.073	0.08
66)	☑	**1A.42.NVA.PS**					
			693203.386	3376122.832	139.696	139.761	139.768
					Packed Sand	0.065	0.071
67)	☑	**1A.7.NVA.PS**					
			732977.797	3341770.155	138.724	138.67	138.67
					Packed Sand	-0.054	-0.054
68)	☑	**1.1.VVA.HV**					
			690978.643	3392497.512	139.771	139.846	139.858
					High Vegetation	0.075	0.087
69)	☑	**1.13.VVA.HV**					
			672136.144	3403681.017	158.976	159.065	159.054
					High Vegetation	0.089	0.078
70)	☑	**1.14.VVA.HV**					
			665197.819	3406726.235	166.758	166.937	166.931
					High Vegetation	0.179	0.173

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
71)	1.15.VVA.HV					
		675256.561	3407972.637	135.559	135.622	135.6
				High Vegetation	0.063	0.041
72)	1.16.VVA.HV					
		679482.074	3416888.784	158.571	158.56	158.579
				High Vegetation	-0.011	0.008
73)	1.19.VVA.HV					
		692739.136	3422375.611	110.536	110.594	110.599
				High Vegetation	0.058	0.063
74)	1.2.VVA.HV					
		704999.423	3399703.127	151.053	151.146	151.142
				High Vegetation	0.093	0.089
75)	1.20.VVA.HV					
		692889.329	3403771.232	128.544	128.601	128.593
				High Vegetation	0.057	0.049
76)	1.3.VVA.HV					
		699469.678	3397213.986	130.764	130.656	130.659
				High Vegetation	-0.108	-0.105
77)	1.4.VVA.HV					
		694509.239	3386214.345	137.466	137.445	137.438
				High Vegetation	-0.021	-0.028

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
78)	**1.43.VVA.HV**					
		691012.935	3386732.403	131.165	131.211	131.216
				High Vegetation	0.046	0.051
79)	**1.6.VVA.HV**					
		690611.388	3388934.583	144.786	144.946	144.976
				High Vegetation	0.16	0.19
80)	**1.7.VVA.HV**					
		684460.641	3383764.591	146.101	146.21	146.211
				High Vegetation	0.109	0.11
81)	**1A.11.VVA.HV**					
		749831.191	3334615.457	110.255	110.316	110.283
				High Vegetation	0.061	0.028
82)	**1A.13.VVA.HV**					
		726955.925	3342970.082	152.534	152.58	152.589
				High Vegetation	0.046	0.055
83)	**1A.14.VVA.HV.2**					
		722634.849	3346759.649	103.538	103.494	NaN
				High Vegetation	-0.044	NaN
84)	**1A.14.VVA.HV**					
		724986.014	3344400.085	112.086	112.237	112.21
				High Vegetation	0.151	0.124

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
85)	1A.15.VVA.HV					
		719896.964	3349937.246	93.352	93.447	93.415
				High Vegetation	0.095	0.063
86)	1A.17.VVA.HV					
		714885.216	3345606.451	102.517	102.487	102.496
				High Vegetation	-0.03	-0.021
87)	1A.19.VVA.HV					
		713615.912	3339580.271	112.209	112.227	112.241
				High Vegetation	0.018	0.032
88)	1A.2.VVA.HV					
		750171.014	3338632.793	105.184	105.197	105.149
				High Vegetation	0.013	-0.035
89)	1A.21.VVA.HV					
		700055.073	3340738.869	150.136	150.149	150.163
				High Vegetation	0.013	0.027
90)	1A.22.VVA.HV					
		701690.649	3343404.585	126.943	127.037	126.993
				High Vegetation	0.094	0.05
91)	1A.24.VVA.HV					
		707644.144	3348552.208	115.783	115.857	115.866
				High Vegetation	0.074	0.083

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
92)	1A.25.VVA.HV					
		710037.225	3350789.361	118.56	118.591	118.603
				High Vegetation	0.031	0.043
93)	1A.26.VVA.HV					
		712364.416	3357084.284	88.8	88.938	88.933
				High Vegetation	0.138	0.133
94)	1A.27.VVA.HV					
		708661.816	3360645.907	114.181	114.205	114.193
				High Vegetation	0.024	0.012
95)	1A.28.VVA.HV					
		706246.238	3363094.276	127.057	127.151	127.13
				High Vegetation	0.094	0.073
96)	1A.3.VVA.HV					
		749478.793	3340205.557	90.086	90.102	90.104
				High Vegetation	0.016	0.018
97)	1A.30.VVA.HV					
		698056.839	3355498.316	136.106	136.258	136.266
				High Vegetation	0.152	0.16
98)	1A.31.VVA.HV					
		695874.534	3352448.607	110.521	110.517	110.523
				High Vegetation	-0.004	0.002

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
99)	☑	**1A.32.VVA.HV**					
			692990.337	3348015.941	130.275	130.32	130.32
					High Vegetation	0.045	0.045
100)	☑	**1A.35.VVA.HV**					
			684462.25	3360386.253	126.172	126.175	126.22
					High Vegetation	0.003	0.048
101)	☑	**1A.39.VVA.HV**					
			680999.884	3364706.703	134.933	134.992	134.992
					High Vegetation	0.059	0.059
102)	☑	**1A.41.VVA.HV**					
			692471.411	3372359.935	119.377	119.498	119.499
					High Vegetation	0.121	0.122
103)	☑	**1A.42.VVA.HV**					
			693197.576	3376128.522	139.635	139.723	139.725
					High Vegetation	0.088	0.09
104)	☑	**1A.5.VVA.HV**					
			740180.709	3342359.434	110.424	110.519	110.566
					High Vegetation	0.095	0.142
105)	☑	**1A.6.VVA.HV**					
			737297.291	3342544.464	117.405	117.385	117.383
					High Vegetation	-0.02	-0.022

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
106) ☑	**1A.8.VVA.HV**					
		731023.299	3340832.948	135.569	135.485	135.511
				High Vegetation	-0.084	-0.058
107) ☑	**1A.9.VVA.HV**					
		729079.46	3344465.305	135.502	135.501	135.515
				High Vegetation	-0.001	0.013
108) ☑	**1A.VVA.HV**					
		751207.803	3340481.225	93.716	93.707	93.713
				High Vegetation	-0.009	-0.003
109) ☑	**1.1.VVA.LV**					
		690990.786	3392507.22	139.756	139.824	139.826
				Low Vegetation	0.068	0.07
110) ☑	**1.12.VVA.LV**					
		673696.597	3394756.621	141.785	141.798	141.811
				Low Vegetation	0.013	0.026
111) ☑	**1.13.VVA.LV**					
		672155.913	3403701.74	159.712	159.778	159.784
				Low Vegetation	0.066	0.072
112) ☑	**1.14.VVA.LV**					
		665120.237	3406744.214	167.107	167.161	167.161
				Low Vegetation	0.054	0.054

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
113)	☑	**1.15.VVA.LV**					
			675232.86	3407939.325	137.84	137.972	137.946
					Low Vegetation	0.132	0.106
114)	☑	**1.16.VVA.LV**					
			679485.486	3416939.071	157.866	157.875	157.904
					Low Vegetation	0.009	0.038
115)	☑	**1.2.VVA.LV**					
			705037.565	3399679.075	151.359	151.511	151.49
					Low Vegetation	0.152	0.131
116)	☑	**1.20.VVA.LV**					
			692904.863	3403738.034	129.35	129.356	129.411
					Low Vegetation	0.006	0.061
117)	☑	**1.4.VVA.LV**					
			694461.218	3386249.118	136.916	136.964	136.953
					Low Vegetation	0.048	0.037
118)	☑	**1.5.VVA.LV**					
			697003.778	3383331.769	129.176	129.23	129.216
					Low Vegetation	0.054	0.04
119)	☑	**1.6.VVA.LV**					
			690630.698	3388951.141	144.64	144.84	144.826
					Low Vegetation	0.2	0.186

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
120)	1.7.VVA.LV					
		684484.963	3383782.822	147.015	147.165	147.173
				Low Vegetation	0.15	0.158
121)	1.9.VVA.LV					
		683114.179	3390688.466	136.724	136.846	136.851
				Low Vegetation	0.122	0.127
122)	1A.11.VVA.LV					
		749848.625	3334632.538	111.61	111.612	111.615
				Low Vegetation	0.002	0.005
123)	1A.14.VVA.LV					
		722634.182	3346746.175	102.973	103.012	103.03
				Low Vegetation	0.039	0.057
124)	1A.15.VVA.LV					
		719931.151	3349962.457	92.742	92.83	92.823
				Low Vegetation	0.088	0.081
125)	1A.16.VVA.LV					
		717051.724	3347777.202	96.731	96.783	96.771
				Low Vegetation	0.052	0.04
126)	1A.17.VVA.LV					
		714857.378	3345598.156	102.824	102.823	102.844
				Low Vegetation	-0.001	0.02

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
127)	**1A.18.VVA.LV**					
		716572.464	3343450.545	101.863	102.594	102.591
				Low Vegetation	0.731	0.728
128)	**1A.18.VVA.LV2**					
		716573.328	3343448.461	102.477	102.58	102.588
				Low Vegetation	0.103	0.111
129)	**1A.2.VVA.LV**					
		750220.589	3338704.046	106.339	106.3	106.312
				Low Vegetation	-0.039	-0.027
130)	**1A.21.VVA.LV**					
		700018.614	3340744.976	150.52	150.537	150.554
				Low Vegetation	0.017	0.034
131)	**1A.22.VVA.LV**					
		701688.324	3343369.252	126.779	126.835	126.854
				Low Vegetation	0.056	0.075
132)	**1A.23.VVA.LV**					
		704367.869	3346156.553	102.445	102.498	102.504
				Low Vegetation	0.053	0.059
133)	**1A.28.VVA.LV**					
		706230.591	3363088.193	126.729	126.769	126.774
				Low Vegetation	0.04	0.045

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
134)	1A.29.VVA.LV					
		701843.199	3359062.048	98.71	98.734	98.733
				Low Vegetation	0.024	0.023
135)	1A.3.VVA.LV					
		749451.044	3340160.958	90.379	90.387	90.381
				Low Vegetation	0.008	0.002
136)	1A.31.VVA.LV					
		695852.793	3352455.688	110.769	110.892	110.876
				Low Vegetation	0.123	0.107
137)	1A.32.VVA.LV					
		692998.725	3348008.408	129.984	129.991	129.992
				Low Vegetation	0.007	0.008
138)	1A.33.VVA.LV					
		691351.719	3350373.009	146.288	146.281	146.293
				Low Vegetation	-0.007	0.005
139)	1A.34.VVA.LV					
		687023.202	3355101.321	124.947	125.044	125.053
				Low Vegetation	0.097	0.106
140)	1A.35.VVA.LV					
		684469.83	3360364.569	126.751	126.833	126.83
				Low Vegetation	0.082	0.079

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
141)	1A.36.VVA.LV					
		691075.702	3367093.852	137.396	137.388	137.406
				Low Vegetation	-0.008	0.01
142)	1A.37.VVA.LV					
		694172.175	3360035.279	106.686	106.704	106.712
				Low Vegetation	0.018	0.026
143)	1A.38.VVA.LV					
		687378.683	3365723.999	124.478	124.612	124.582
				Low Vegetation	0.134	0.104
144)	1A.4.VVA.LV					
		745065.591	3340849.072	117.443	117.464	117.493
				Low Vegetation	0.021	0.05
145)	1A.5.VVA.LV					
		740137.538	3342346.841	109.07	109.038	109.061
				Low Vegetation	-0.032	-0.009
146)	1A.7.VVA.LV					
		732924.277	3341779.177	138.355	138.33	138.326
				Low Vegetation	-0.025	-0.029
147)	1A.8.VVA.LV					
		731035.746	3340825.016	135.079	135.053	135.052
				Low Vegetation	-0.026	-0.027

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
148)	☑	**1A.9.VVA.LV**					
			729058.782	3344471.701	135.433	135.436	135.443
					Low Vegetation	0.003	0.01
149)	☑	**1A.VVA.LV**					
			751237.632	3340494.886	92.732	92.756	92.746
					Low Vegetation	0.024	0.014
150)	☑	**1.1.VVA.MV**					
			691004.479	3392448.193	139.118	139.18	139.168
					Medium Vegetation	0.062	0.05
151)	☑	**1.10.VVA.MV**					
			678162.758	3389691.293	134.906	134.891	134.928
					Medium Vegetation	-0.015	0.022
152)	☑	**1.11.VVA.MV**					
			675541.471	3389484.733	126.508	126.553	126.565
					Medium Vegetation	0.045	0.057
153)	☑	**1.17.VVA.MV**					
			691628.382	3415480.024	127.805	127.937	127.926
					Medium Vegetation	0.132	0.121
154)	☑	**1.3.VVA.MV**					
			699463.128	3397255.926	131.869	131.735	131.763
					Medium Vegetation	-0.134	-0.106

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
155)	☑	**1.5.VVA.MV**					
			697067.804	3383388.869	131.627	131.571	131.602
					Medium Vegetation	-0.056	-0.025
156)	☑	**1.8.VVA.MV**					
			681974.966	3383632.837	161.921	162.036	162.043
					Medium Vegetation	0.115	0.122
157)	☑	**1A.14.VVA.MV**					
			724983.316	3344412.31	112.231	112.308	112.3
					Medium Vegetation	0.077	0.069
158)	☑	**1A.15.VVA.MV**					
			719860.539	3349980.575	94.247	94.285	94.288
					Medium Vegetation	0.038	0.04
159)	☑	**1A.19.VVA.MV**					
			713627.666	3339579.259	111.95	111.986	112.004
					Medium Vegetation	0.036	0.054
160)	☑	**1A.20.VVA.MV**					
			705796.808	3339679.288	141.194	141.336	141.325
					Medium Vegetation	0.142	0.131
161)	☑	**1A.23.VVA.MV**					
			704375.023	3346137.979	103.13	103.288	103.294
					Medium Vegetation	0.158	0.164

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
162)	**1A.24.VVA.MV**					
		707650.533	3348565.234	115.838	116.058	116.033
				Medium Vegetation	0.22	0.195
163)	**1A.29.VVA.MV**					
		701865.217	3359063.066	98.449	98.609	98.608
				Medium Vegetation	0.16	0.159
164)	**1A.34.VVA.MV**					
		687032.019	3355088.249	125.031	125.257	125.25
				Medium Vegetation	0.226	0.219
165)	**1A.4.VVA.MV**					
		745041.674	3340868.04	115.802	115.836	115.866
				Medium Vegetation	0.034	0.064
166)	**1A.5.VVA.MV**					
		740096.585	3342342.639	107.578	107.689	107.634
				Medium Vegetation	0.111	0.056
167)	**1A.6.VVA.MV**					
		737277.021	3342536.348	117.72	117.736	117.703
				Medium Vegetation	0.016	-0.017
168)	**1A.6.VVA.MV2**					
		737277.015	3342536.337	117.722	117.736	117.703
				Medium Vegetation	0.014	-0.019

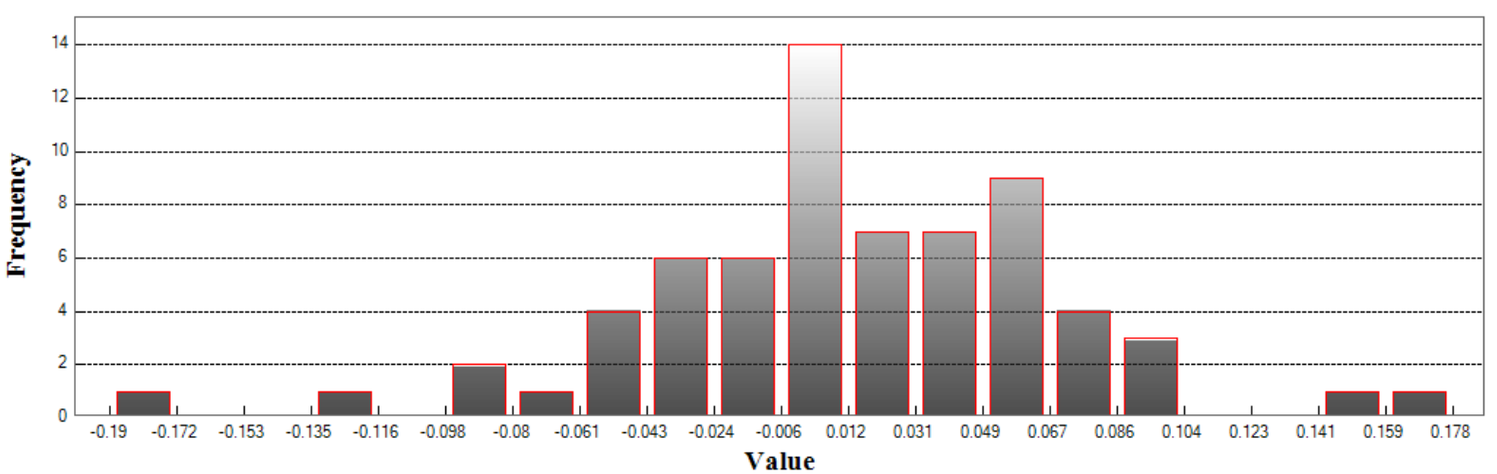
Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
169)	☑ **1A.7.VVA.MV**					
		732929.991	3341749.272	137.686	137.684	137.72
				Medium Vegetation	-0.002	0.034

LAS

Nonvegetated Vertical Accuracy
LandCover Type: Bare Ground, Hard Pavement, Packed Sand
Minimum DZ: -0.19
Maximum DZ: 0.178
Mean DZ: 0.012
Mean Magnitude DZ: 0.209
Number Observations: 67
Standard Deviation DZ: 0.058
RMSE Z: 0.059
95% Confidence Level Z: 0.116
Units: Meters

Histogram



Min: -0.19
Max: 0.178
Number Of Bins: 20
Bin Interval: 0.018

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: -0.105

Maximum DZ: 0.19

Mean DZ: 0.052

Mean Magnitude DZ: 0.256

Number Observations: 40

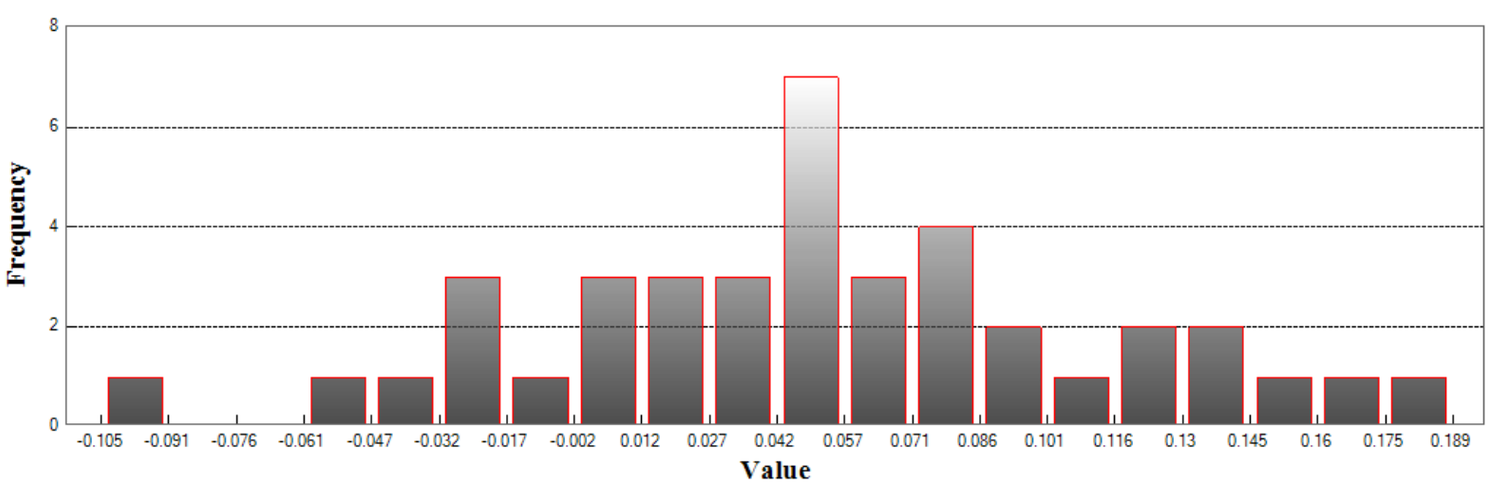
Standard Deviation DZ: 0.063

RMSE Z: 0.081

95th Percentile: 0.16

Units: Meters

Histogram



Min: -0.105

Max: 0.19

Number Of Bins: 20

Bin Interval: 0.015

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: -0.029

Maximum DZ: 0.728

Mean DZ: 0.069

Mean Magnitude DZ: 0.27

Number Observations: 41

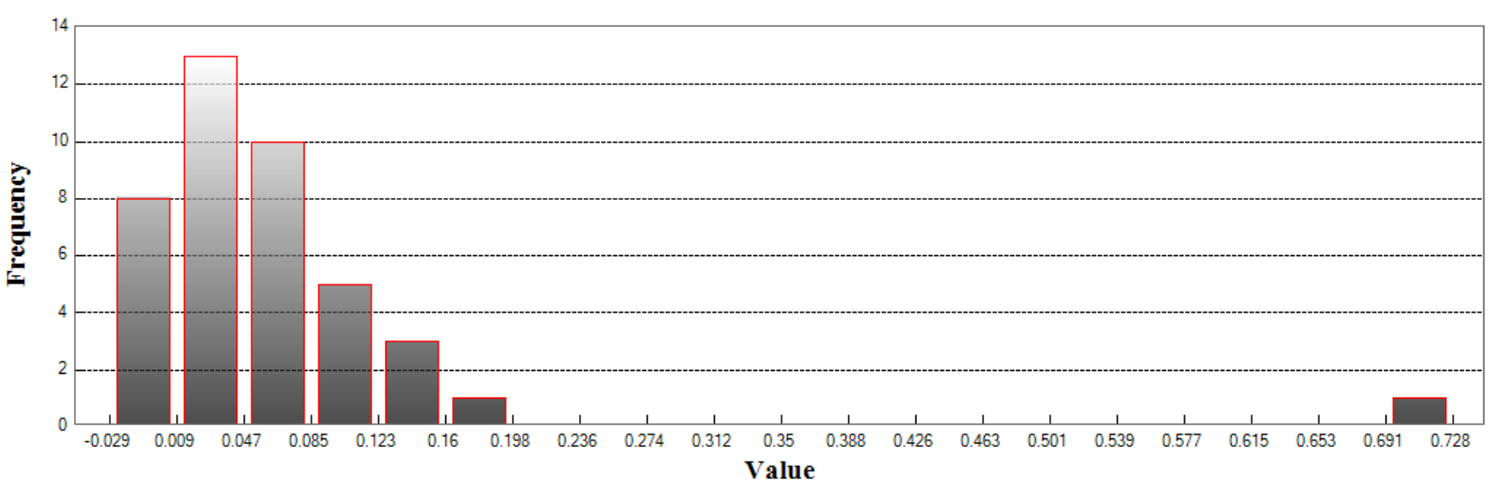
Standard Deviation DZ: 0.117

RMSE Z: 0.134

95th Percentile: 0.172

Units: Meters

Histogram



Min: -0.029

Max: 0.728

Number Of Bins: 20

Bin Interval: 0.038

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Medium Vegetation

Minimum DZ: -0.106

Maximum DZ: 0.219

Mean DZ: 0.07

Mean Magnitude DZ: 0.294

Number Observations: 20

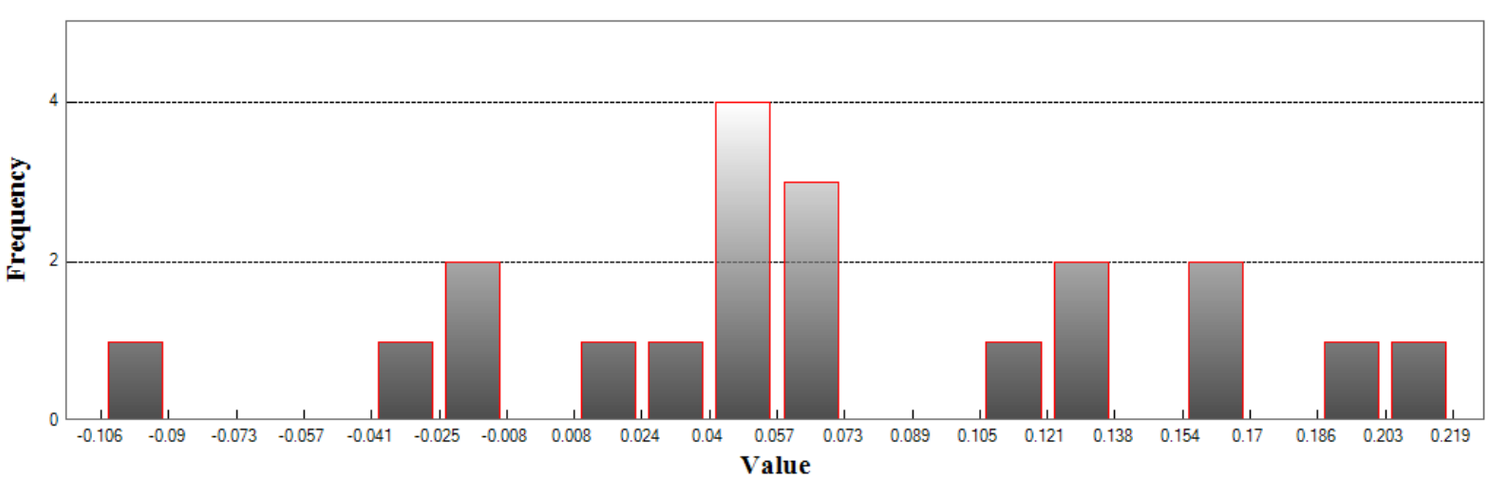
Standard Deviation DZ: 0.081

RMSE Z: 0.105

95th Percentile: 0.195

Units: Meters

Histogram



Min: -0.106

Max: 0.219

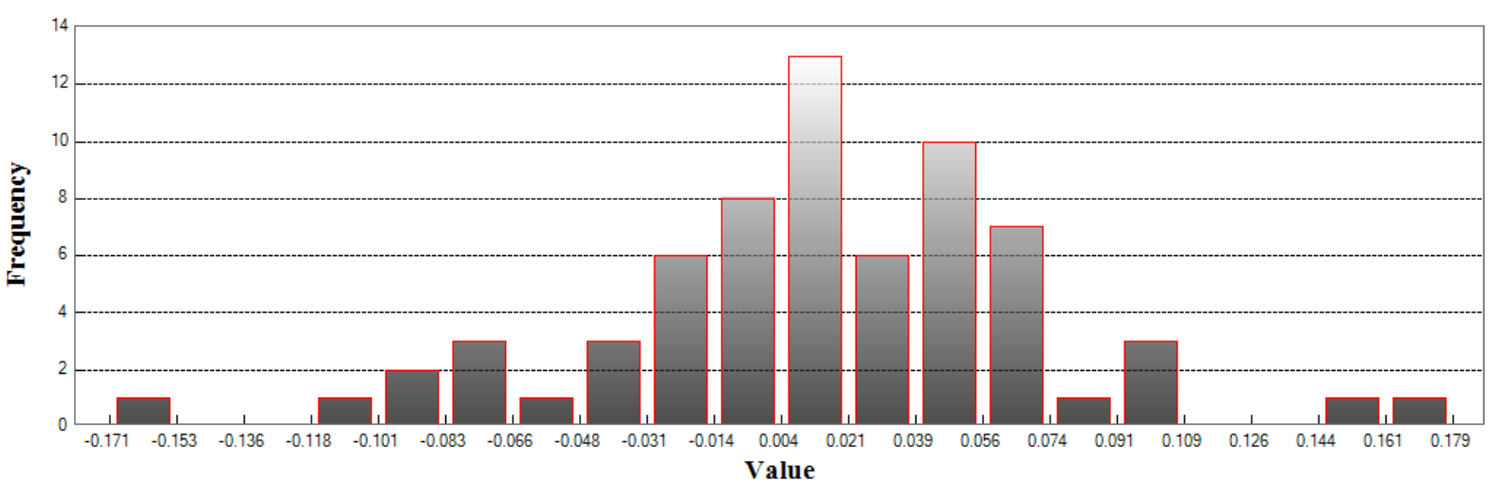
Number Of Bins: 20

Bin Interval: 0.016

DEM

Nonvegetated Vertical Accuracy
LandCover Type: Bare Ground, Hard Pavement, Packed Sand
Minimum DZ: -0.171
Maximum DZ: 0.178
Mean DZ: 0.013
Mean Magnitude DZ: 0.211
Number Observations: 67
Standard Deviation DZ: 0.058
RMSE Z: 0.059
95% Confidence Level Z: 0.116
Units: Meters

Histogram



Min: -0.171
Max: 0.178
Number Of Bins: 20
Bin Interval: 0.017

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: -0.108

Maximum DZ: 0.179

Mean DZ: 0.049

Mean Magnitude DZ: 0.256

Number Observations: 41

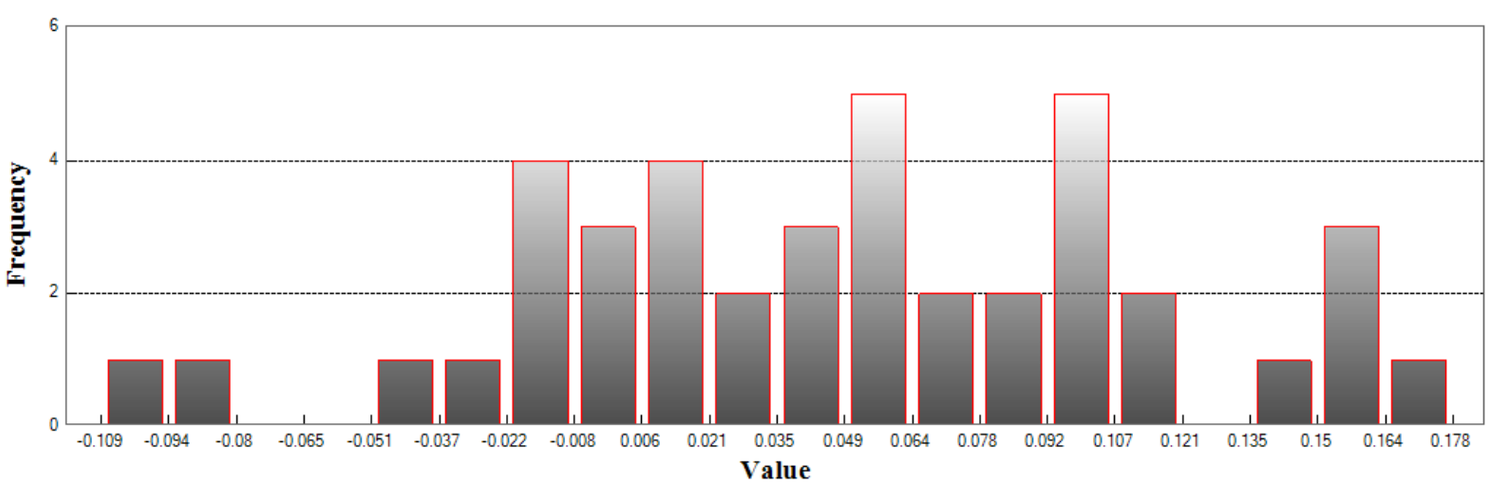
Standard Deviation DZ: 0.065

RMSE Z: 0.081

95th Percentile: 0.156

Units: Meters

Histogram



Min: -0.108

Max: 0.179

Number Of Bins: 20

Bin Interval: 0.014

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: -0.039

Maximum DZ: 0.731

Mean DZ: 0.065

Mean Magnitude DZ: 0.268

Number Observations: 41

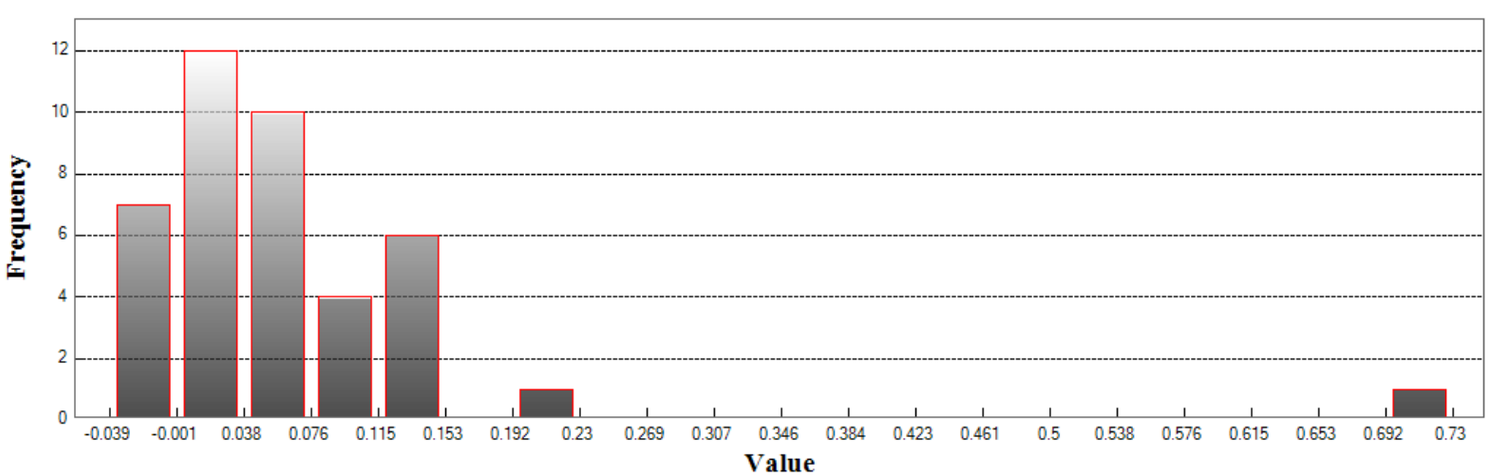
Standard Deviation DZ: 0.121

RMSE Z: 0.136

95th Percentile: 0.176

Units: Meters

Histogram



Min: -0.039

Max: 0.731

Number Of Bins: 20

Bin Interval: 0.038

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Medium Vegetation

Minimum DZ: -0.134

Maximum DZ: 0.226

Mean DZ: 0.069

Mean Magnitude DZ: 0.299

Number Observations: 20

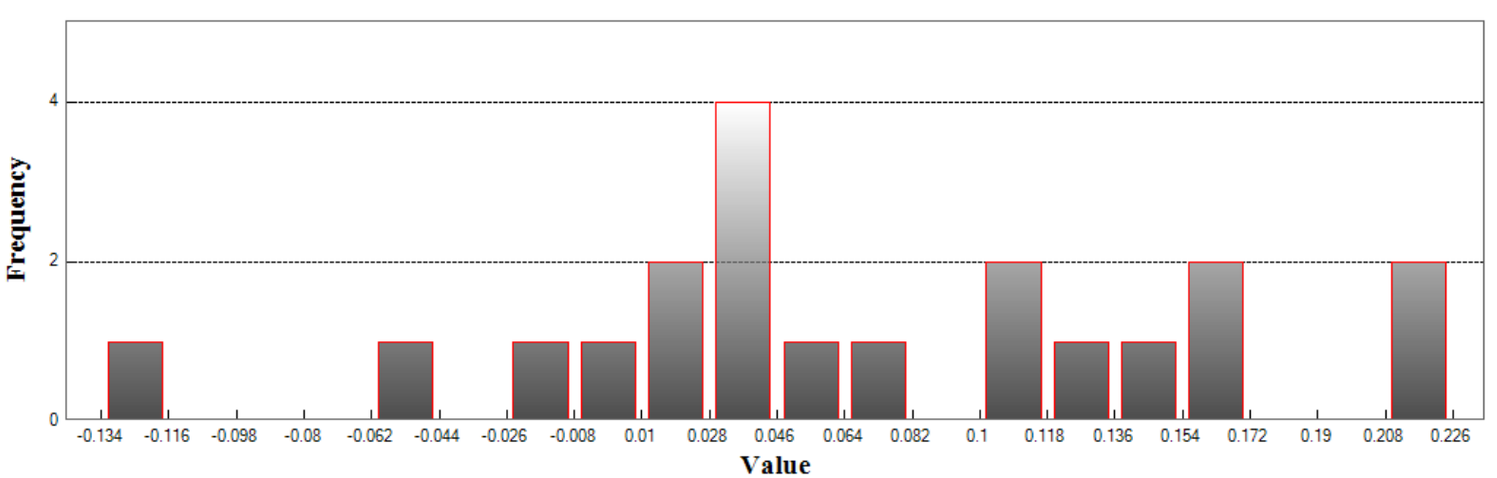
Standard Deviation DZ: 0.091

RMSE Z: 0.112

95th Percentile: 0.22

Units: Meters

Histogram



Min: -0.134

Max: 0.226

Number Of Bins: 20

Bin Interval: 0.018