LiDAR Project Report

140G0218F0069, EASTERN TX QL2 LiDAR

Prepared For:

United States Geological Survey

Prepared By:

Digital Aerial Solutions, LLC

CONTRACT: # G16PC00044
CONTRACTOR: DIGITAL AERIAL
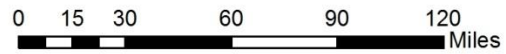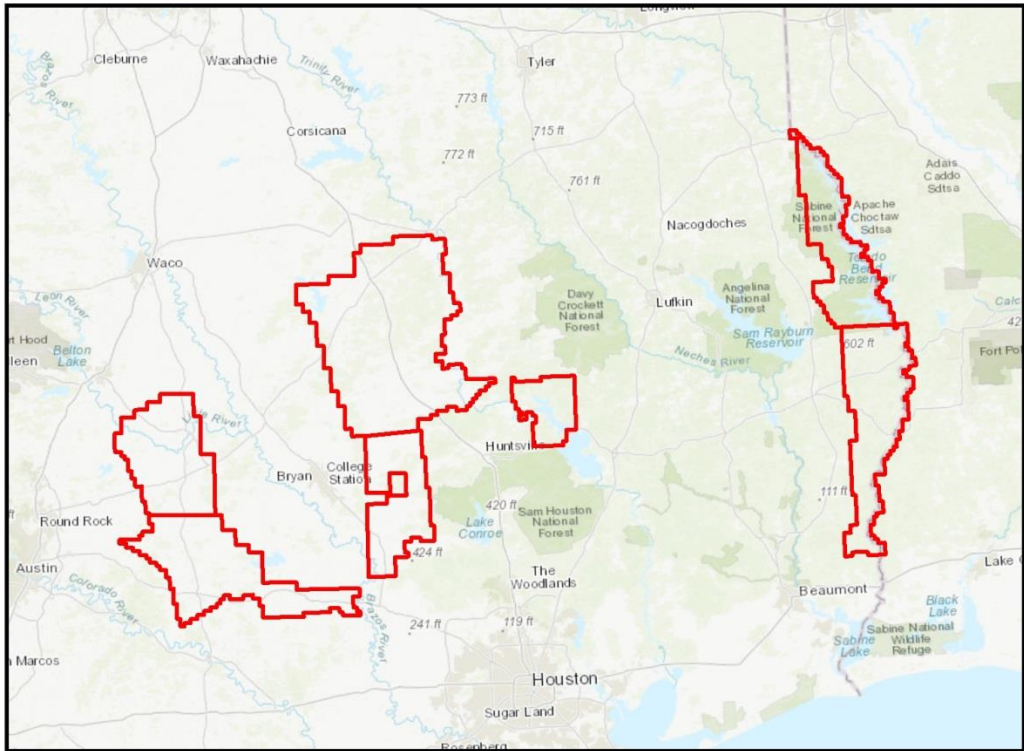SOLUTIONS
TASK ORDER: # 140G0218F0069

Project Report
LiDAR Collection, Processing, and QA/QC

140G0218F0069, EASTERN TX QL2
LiDAR

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EASTERN TX QL2 LiDAR AOI

Legend

☐ EASTERN TX LiDAR AOI

Projected Coordinate System:
NAD83 (2011) UTM Zone 14 N
Projection: Transverse_Mercator
False_Easting: 500000.00000000
False_Northing: 0.00000000
Central_Meridian: -99.00000000
Scale_Factor: 0.99960000
Latitude_Of_Origin: 0.00000000
Linear Unit: Meter

Image 1: EASTERN TX QL2 LiDAR AOI

G17PD01257, EASTERN TX QL2 LiDAR

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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 NV. The flight plan consisted of 405 survey lines and 11 control lines.
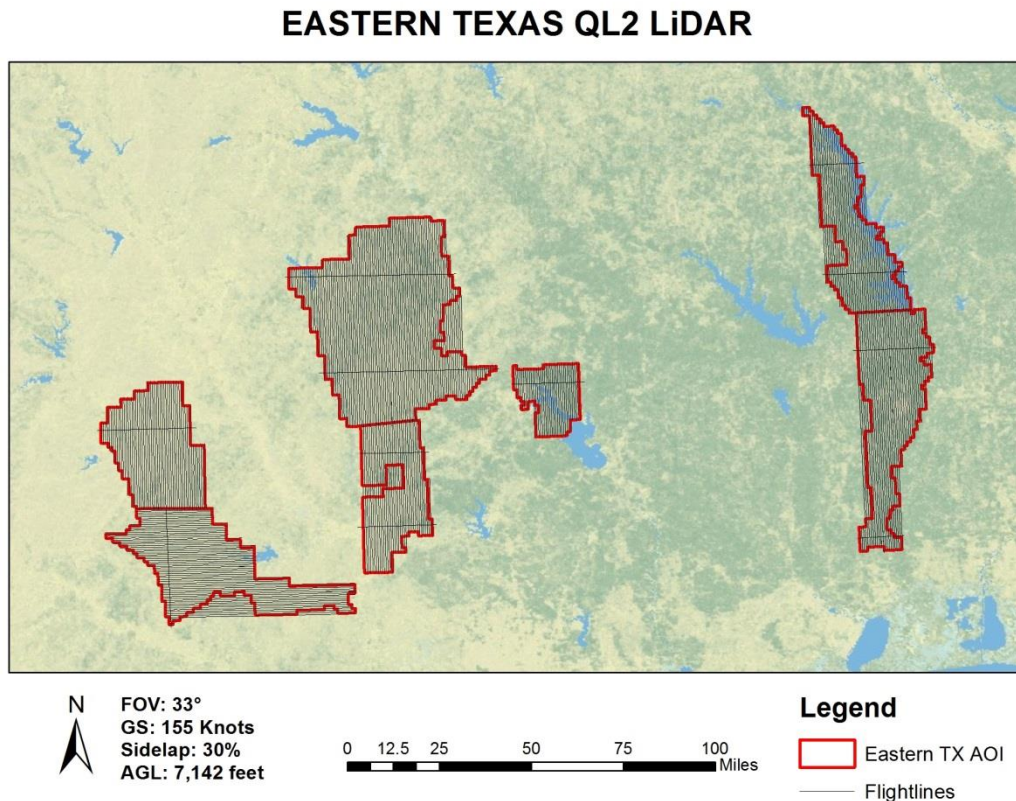
Image 2: EASTERN TX QL2 LiDAR Flightlines

3.2 Acquisition Parameters

Acquisition parameters include the sensor configuration and the flight plan characteristics, and are selected based on a number of project specific criteria. Criteria reviewed include 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)
C421-N112MJ	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 Minden-Tahoe Airport NV. 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 validate 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 data 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

– Processed, but unclassified. Automated classification routines assigned points to one of the following classes:

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```
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 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 was 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 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 accuracies 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.
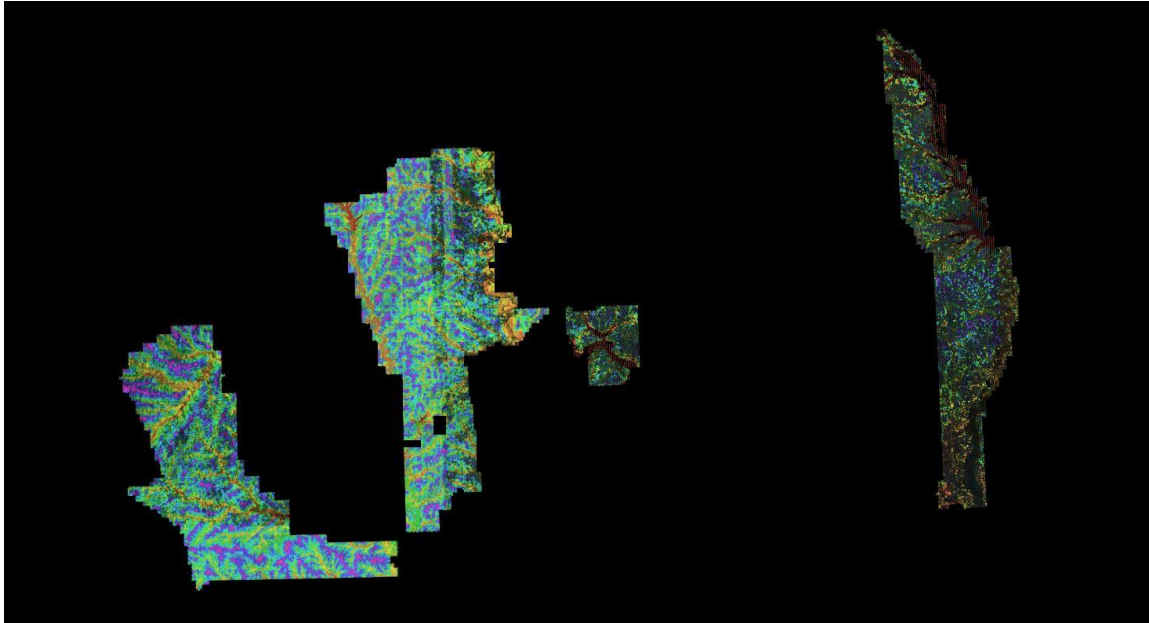
Image 3: EASTERN TX QL2 LiDAR Intensity Image

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.

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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. All accuracies specified are referring to the final accuracies which fully comprise of the entire project area. The full calculations for all check points can be found in Appendix B.

Tested Accuracy	RMSE$_Z$	NVA	VVA
Raw Unclassified LiDAR	0.050	0.098	-
Classified LiDAR	0.050	0.098	0.144
Digital Elevation Model	0.051	0.100	0.152

Table 7: Tested RMSE$_Z$ of NVA, NVA and VVA of LiDAR Point Cloud and Digital Elevation Model.

Total #	# NVA	# VVA
225	130	95

Table 8: Number of Survey Points used to calculate accuracy of data.

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

DAS Digital Aerial Solutions

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	

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Leica ALS80 Flight Log

DAS Digital Aerial Solutions

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 MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						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

DAS Digital Aerial Solutions

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	

20180307_125520_A_6325782

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	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		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	

20180307_181251_B_6328C28

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	

20180307_230158_C_632D70D

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 MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						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	

20180308_151118_A_63321E2

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

20180312_001515__A_6337C41

Leica ALS80 Flight Log

DAS Digital Aerial Solutions

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

20180312_052348__B_633BD84

Leica ALS80 Flight Log

DAS Digital Aerial Solutions

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	

20180312_070933__B_633F45C

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

20180312_180621_C_6342D18

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	1	255	180306_234714	23:47	1:31	6693	180°	157	813	17	1.2	0.7	
	2	256	180307_000609	:6	:21	6670	0°	144	808	17	1.2	0.7	ALS Warning
	3	257	180307_002527	:25	:39	6673	180°	163	802	17	1.2	0.7	
	4	258	180307_004334	:43	:58	6659	0°	148	797	17	1.2	0.7	
	5	259	180307_010318	1:03	1:17	6662	180°	143	792	20	1	0.6	ALS Warning
	6	260	180307_012249	1:22	1:37	6656	1°	146	786	18	1.2	0.7	
	7	261	180307_014149	1:41	1:56	6645	180°	150	781	22	1	0.6	ALS Warning
	8	262	180307_020025	2:00	2:15	6666	359°	134	776	19	1.1	0.7	
	9	263	180307_021925	2:19	2:32	6684	180°	149	770	19	1.1	0.7	
	10												
	11												
	12												
	13												
	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												

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	1	381	180307_140149	14:01	14:10	6827	271°	153	765		18	1.1	0.6	
	2	382	180307_141508	14:15	14:27	6818	90°	156	767		18	1.2	0.6	
	3	383	180307_143220	14:32	14:44	6807	270°	157	757		19	1.2	0.6	
	4	384	180307_144829	14:48	15:01	6839	90°	152	753		19	1.2	0.6	
	5	385	180307_150540	15:05	15:17	6821	270°	151	748		21	1.1	0.6	
	6	386	180307_152218	15:22	15:40	6750	88°	151	744		20	1.1	0.7	
	7	387	180307_154424	15:44	16:02	6659	26.9.	153	737		18	1.3	0.7	
	8	388	180307_160658	16:06	16:24	6696	90°	149	730		19	1.2	0.7	
	9	389	180307_162859	16:28	16:47	6676	270°	150	724		17	1.2	0.7	
	10	390	180307_165017	16:50	17:08	6702	91°	160	717		16	1.4	0.7	System Freeze
	11													
	12													
	13													
	14													
	15													
	16													
	17													
	18													
	19													
	20													
	21													
	22													
	23													
	24													
	25													

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 MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						PDOP	HDOP	
B	1	391	180307_184147	18:41	18:59	6636	270°	150	710	19	1.1	0.6	
	2	392	180307_190331	19:03	19:21	6646	89°	154	704	21	1	0.6	
	3	393	180307_192544	19:25	19:43	6690	271°	144	697	19	1.2	0.6	ALS Warning
	4	394	180307_194619	19:46	20:04	6696	91°	157	690	19	1.1	0.6	
	5	395	180307_200811	20:08	20:28	6686	271°	150	684	19	1.2	0.6	
	6	396	180307_202845	20:28	20:45	6718	89°	158	678	20	1.1	0.6	
	7	397	180307_204938	20:49	21:07	6707	270°	151	671	19	1.2	0.6	
	8	398	180307_211039	21:10	21:27	6749	88°	157	665	18	1.2	0.6	
	9	399	180307_213154	21:31	21:49	6583	272°	151	659	21	1.1	0.5	
	10												
	11												
	12												
	13												
	14												
	15												
	16												
	17												
	18												
	19												
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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		**C**				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	
C	1	12	180307_233221	23:32	23:43	6842	179°	152	652	19	1.1	0.7	ALS Warning
	2	406	180307_234901	23:49	23:49	6848	90°	153	647	17	1.3	0.8	
	3	405	180307_235420	23:54	23:54	6849	269°	141	647	16	1.5	0.8	
	4	404	180307_235817	23:58	23:59	6848	89°	155	647	16	1.5	0.8	
	5	403	180308_000346	:3	6:44	6836	271°	135	647	16	1.4	0.8	
	6	402	180308_000926	:9	:27	6681	89°	152	646	16	1.4	0.8	
	7	401	180308_003152	:31	:50	6637	271°	143	640	17	1.2	0.7	
	8	400	180308_005429	:54	1:12	6687	90°	151	633	18	1.3	0.7	
	9	380	180308_012543	1:25	1:35	6743	270°	150	626	18	1.2	0.7	
	10	379	180308_013917	1:39	1:48	6769	90°	153	622	20	1	0.6	
	11	378	180308_015328	1:53	20:36	6735	271°	150	619	19	1.1	0.6	
	12	377	180308_020703	2:07	2:16	6768	89°	155	615	18	1.1	0.7	
	13												
	14												
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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: Begin:	End:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	HDOP	Comments and Conditions:
A	1	264	180308_164840	16:48	17:02	6,738	180°	155	673	16	1.4	0.8	
	2	265	180308_170622	17:06	17:20	6698	1°	151	668	17	1.1	0.7	
	3	266	180308_172412	17:24	17:38	6691	180°	156	663	16	1.3	0.8	
	4	267	180308_174220	17:42	17:56	6697	0°	153	658	17	1.2	0.7	
	5	268	180308_180008	18:00	18:14	6691	180°	159	653	17	1.1	0.7	
	6	269	180308_181818	18:18	18:39	6698	359°	155	648	16	1.3	0.7	
	7	270	180308_183604	18:36	18:49	6671	182°	155	647	21	1.1	0.6	
	8	271	180308_185510	18:55	19:06	6736	0°	153	637	21	1.1	0.6	
	9	272	180308_191110	19:11	19:23	6738	180°	151	633	21	1.2	0.6	
	10	273	180308_192654	19:26	19:38	6725	271°	153	6229	21	1.2	0.6	
	11	3	180308_194647	19:46	19:52	6725	271°	157	624	20	1.2	0.6	
	12												
	13												
	14												
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20180308_162000_A_5871245

Leica ALS80 Flight Log

DAS Digital Aerial Solutions

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	1	118	180308_212331	21:23	21:31	6,796	1°	156	1069	21	1.3	0.6	ALS Warning
	2	117	180308_213528	21:35	21:43	6817	180°	155	1066	20	1.3	0.6	ALS Warning
	3	116	180308_214908	21:49	21:55	6815	360°	152	1063	21	1.3	0.6	ALS Warning
	4	115	180308_215900	21:59	22:05	6802	181°	154	1061	21	1.3	0.6	ALS Warning
	5	114	180308_220842	22:08	22:14	6803	359°	158	1059	22	1.2	0.6	ALS Warning
	6	113	180308_221820	22:18	22:24	6813	179°	153	1057	21	1.2	0.6	ALS Warning
	7	112	180308_223045	22:30	22:34	6916	360°	155	1055	22	1.1	0.6	ALS Warning
	8	111	180308_223814	22:38	22:42	6895	181°	154	1054	20	1.3	0.7	ALS Warning
	9	110	180308_224521	22:45	22:49	6891	1°	157	1052	20	1.3	0.7	ALS Warning
	10	109	180308_225236	22:52	22:56	6887	180°	153	1051	20	1.2	0.7	ALS Warning
	11	108	180308_230033	23:00	23:03	6913	358°	156	1050	21	1.1	0.6	ALS Warning
	12	107	180308_230711	23:07	23:09	6888	181°	154	1049	22	1.1	0.6	ALS Warning
	13	106	180308_231259	23:12	23:15	6894	360°	157	1048	20	1.3	0.7	
	14	105	180308_231846	23:18	23:20	6894	180°	155	1047	19	1.2	0.7	
	15	104	180308_232404	23:24	23:26	6901	1°	156	1046	19	1.2	0.7	
	16	103	180308_232908	23:29	23:31	6895	181°	151	1045	19	1.2	0.7	
	17	119	180308_233843	23:38	23:46	6813	181°	156	1044	18	1.2	0.7	ALS Warning
	18	120	180308_235241	23:52	:3	6828	359°	152	1041	17	1.3	0.7	ALS Warning
	19	121	180309_000706	:7	:18	6818	180°	151	1037	17	1.4	0.8	ALS Warning
	20	122	180309_002148	:21	:32	6833	359°	157	1033	17	1.2	0.7	
	21	123	180309_003623	:36	:47	6775	180°	153	1029	17	1.2	0.7	ALS Warning
	22												
	23												
	24												
	25												

20180308_210129_B_587417F

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	1	124	180311_233920	23:39	23:53	6842	360°	137	1025	17	1.3	0.8	ALS Warning
	2	125	180312_000132	:1	:13	6842	181°	156	1020	19	1.4	0.8	ALS Warning
	3	126	180312_001857	:18	:33	6743	359°	133	1015	18	1.3	0.8	ALS Warning
	4	127	180312_003829	:38	:53	6762	178°	147	1010	21	1	0.6	
	5	128	180312_005716	:57	1:13	6765	360°	131	1005	18	1.3	0.8	ALS Warning
	6	129	180312_011735	1:17	1:32	6786	180°	149	999	23	1	0.6	ALS Warning
	7	130	180312_013654	1:36	1:53	6790	1°	139	993	19	1.1	0.7	ALS Warning
	8	131	180312_015711	1:57	2:12	6770	180°	152	987	18	1.1	0.7	ALS Warning
	9	132	180312_021656	2:16	2:33	6778	1°	141	982	15	1.3	0.7	
	10	133	180312_023749	2:37	2:53	6792	179°	155	975	16	1.1	0.7	ALS Warning
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	12												
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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							2018 TX FEMA					Mike Wasielewski	
Hobbs ST	1651.2		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height	Aircraft	Airport Idnt:	
Flight Time			A			155		TEMP		1.500	C421-N112MJ	CFD (Bryan, TX)	

Lift	#	Flight Line	Mission Line	UTC time: Begin:	UTC time: End:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A		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.

20180312_033651_A_5879440

Leica ALS80 Flight Log

Project:	**2018 TX FEMA**											Sensor Operator/s	
												Hunter Stavnes	
Date/Julian:	3/12/2018	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

20180312_063907_B_587C5BB

Leica ALS80 Flight Log

DAS — Digital Aerial Solutions

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		C			155		TEMP		1.500	C421-N112MJ	CFD (Bryan, TX)	

Lift	#	Flight Line	Mission Line	UTC time: Begin:	UTC time: End:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
C	1	142	180312_174806	17:48	18:06	6783	2°	152	621	17	1.3	0.8	ALS Warning
	2	143	180312_181038	18:10	18:29	6842	179°	154	615	18	1.2	0.7	ALS Warning
	3	144	180312_183314	18:33	18:52	6783	0°	151	608	21	1.1	0.6	ALS Warning
	4	145	180312_185659	18:56	19:15	6865	180°	157	601	19	1.2	0.6	
	5	146	180312_191856	19:18	19:37	6782	358°	153	594	20	1.2	0.6	ALS Warning
	6	147	180312_194145	19:41	20:00	6808	180°	154	587	19	1.2	0.6	ALS Warning
	7	148	180312_200528	20:05	20:24	6797	359°	152	580	21	1.2	0.6	
	8	149	180312_202837	20:28	20:47	6790	180°	153	574	21	1.2	0.6	ALS Warning
	9	196	180312_205735	20:57	21:00	661	1°	147	567	19	1.4	0.6	ALS Warning
	10	197	180312_210350	21:03	21:06	6719	180°	153	566	19	1.4	0.6	ALS Warning
	11	198	180312_211023	21:10	21:12	6709	360°	149	565	21	1.1	0.6	
	12												
	13												
	14												
	15												
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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		D			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	
D	1	199	180312_232525	23:25	23:27	6682	1°	153	563		21	1.2	0.7	
	2	200	180312_233114	23:31	23:33	6692	179°	154	563		20	1.4	0.8	
	3	201	180312_233715	23:37	23:38	6681	359°	151	562		20	1.5	0.8	
	4	202	180312_234214	23:42	23:43	6695	181°	150	561		19	1.5	0.8	
	5	203	180312_234813	23:48	23:49	6683	360°	151	561		19	1.5	0.8	
	6	204	180312_235306	23:53	23:54	6713	180°	152	560		19	1.5	0.8	
	7	205	180312_235753	23:57	23:59	6692	360°	150	560		19	1.2	0.7	
	8	206	180313_000242	:2	:3	6707	179°	147	559		19	1.4	0.8	Possible Smoke
	9	154	180313_001549	:15	:33	6708	360°	154	559		19	1.3	0.7	
	10	153	180313_003722	:37	:55	6762	180°	150	552		22	1	0.6	ALS Warning
	11	152	180313_010108	1:01	1:19	6754	1°	154	545		20	1.3	0.7	ALS Warning
	12	151	180313_012336	1:23	1:42	6761	183°	151	539		22	1.1	0.6	ALS Warning
	13	150	180313_014641	1:46	2:05	6676	360°	151	532		20	1	0.6	ALS Warning
	14	161	180313_020946	2:09	2:28	6747	181°	152	525		17	1.2	0.7	ALS Warning
	15													
	16													
	17													
	18													
	19													
	20													
	21													
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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		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	1	211	180314_000242	:2	:5	6551	180°	153	730	17	1.4	0.8	ALS Warning
	2	212	180314_000805	:8	:10	6540	0°	144	729	17	1.4	0.8	ALS Warning
	3	213	180314_001359	:13	:16	6595	180°	154	728	18	1.2	0.7	ALS Warning
	4	214	180314_001927	:19	:41	6537	2°	151	728	20	1.1	0.6	ALS Warning
	5	215	180314_004501	:45	1:07	6544	181°	154	720	19	1.3	0.7	ALS Warning
	6	216	180314_011120	1:11	1:33	6572	0°	150	712	21	1.1	0.6	ALS Warning
	7	217	180314_013650	1:36	1:58	6554	181°	155	704	19	1	0.6	ALS Warning
	8	218	180314_020152	2:01	2:24	6548	360°	153	697	17	1.2	0.7	ALS Warning
	9	219	180314_022737	2:27	2:49	6594	178°	156	689	19	1.2	0.7	ALS Warning
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	11												
	12												
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	14												
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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	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		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	1	6	180314_041128	4:11	4:18	6648	270°	153	681	22	1.4	0.6	ALS Warning
	2	68	180314_042331	4:23	4:26	6626	2°	146	679	22	1.4	0.6	ALS Warning
	3	69	180314_042918	4:29	4:32	6652	180°	151	678	22	1.4	0.6	ALS Warning
	4	70	180314_043535	4:35	4:38	6621	1°	146	677	24	1.3	0.6	ALS Warning
	5	71	180314_044207	4:42	4:45	6652	180°	156	676	23	1.3	0.6	ALS Warning
	6	72	180314_044905	4:49	4:53	6633	359°	144	675	23	1.2	0.6	ALS Warning
	7	73	180314_045648	4:56	5:00	6649	179°	153	673	24	1.1	0.6	ALS Warning
	8	74	180314_050344	5:03	5:07	6634	2°	143	672	25	1	0.6	ALS Warning
	9	75	180314_051134	5:11	5:15	6647	180°	154	670	21	1.1	0.6	ALS Warning
	10	76	180314_051908	5:19	5:22	6598	3°	149	669	23	1	0.6	ALS Warning
	11	77	180314_052540	5:25	5:28	6630	179°	154	668	24	1	0.6	ALS Warning
	12	78	180314_053504	5:35	5:41	6604	2°	150	667	24	1	0.6	ALS Warning
	13	79	180314_054506	5:45	5:51	6620	180°	157	665	23	1	0.6	ALS Warning
	14	80	180314_055432	5:54	6:14	6625	0°	149	662	21	1.1	0.6	ALS Warning
	15	81	180314_060457	6:04	6:11	6627	180°	156	660	20	1.2	0.6	ALS Warning
	16	82	180314_061434	6:14	6:22	6620	1°	150	658	20	1.1	0.6	ALS Warning
	17	83	180314_062442	6:24	6:31	6656	181°	155	656	20	1.1	0.6	ALS Warning
	18	84	180314_063451	6:34	6:41	6607	1°	150	653	20	1.1	0.6	ALS Warning
	19	85	180314_064512	6:45	6:51	6643	181°	158	651	18	1.2	0.7	ALS Warning
	20	86	180314_065519	6:55	7:02	6625	1°	151	649	19	1.2	0.6	ALS Warning
	21	87	180314_070551	7:05	7:12	6631	180°	158	646	18	1.3	0.7	ALS Warning
	22	88	180314_071547	7:15	7:22	6632	0°	151	644	17	1.4	0.7	ALS Warning
	23	89	180314_072605	7:26	7:32	6636	181°	154	642	17	1.4	0.7	ALS Warning
	24	90	180314_073634	7:36	7:43	6619	358°	150	639	18	1.2	0.7	ALS Warning
	25												

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	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	1	91	180314_084837	8:48	8:55	6670	181°	151	637	17	1.1	0.7	ALS Warning
	2	92	180314_085837	8:58	9:05	6667	359°	152	635	16	1.2	0.7	ALS Warning
	3	93	180314_090858	9:08	9:16	6673	179°	154	632	16	1.2	0.7	ALS Warning
	4	94	180314_091855	9:18	9:25	6608	357°	143	630	15	1.3	0.8	ALS Warning
	5	95	180314_092907	9:29	9:36	6613	181°	150	628	13	1.5	0.8	ALS Warning
	6	96	180314_093932	9:39	9:46	6599	359°	152	625	14	1.4	0.8	ALS Warning
	7	97	180314_094910	9:49	9:55	6609	179°	156	623	15	1.3	0.7	ALS Warning
	8	98	180314_100023	10:00	10:05	6607	0°	144	621	16	1.1	0.6	ALS Warning
	9	99	180314_100907	10:09	10:14	6648	178°	159	619	16	1.2	0.6	ALS Warning
	10	100	180314_101750	10:17	10:24	6693	0°	150	615	16	1.3	0.7	ALS Warning
	11	101	180314_102633	10:26	10:31	6614	179°	156	615	18	1.1	0.6	ALS Warning
	12	102	180314_103513	10:35	10:40	6586	4°	151	613	19	1.1	0.6	ALS Warning
	13												
	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												

20180314_082351_B_5888D4D

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: Begin:	UTC time: End:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A	1	9	180314_220216	22:02	22:10	6697	90°	149	611	19	1.1	0.6	ALS Warning
	2	344	180314_221635	22:16	22:17	6697	179°	154	609	18	1.3	0.7	ALS Warning
	3	343	180314_222105	22:21	22:23	6702	359°	156	609	18	1.3	0.7	ALS Warning
	4	342	180314_222643	22:26	22:29	6707	180°	155	608	19	1.3	0.7	ALS Warning
	5	341	180314_223223	22:32	22:37	6712	359°	145	607	20	1.2	0.6	ALS Warning
	6	340	180314_224006	22:40	22:44	6738	178°	156	606	21	1.2	0.7	ALS Warning
	7	339	180314_224806	22:48	22:52	6721	360°	153	605	21	1.1	0.6	ALS Warning
	8	338	180314_225616	22:56	23:00	6726	179°	156	603	19	1.3	0.7	ALS Warning
	9	337	180314_230431	23:04	23:09	6726	360°	151	602	18	1.3	0.7	ALS Warning
	10	336	180314_231259	23:12	23:18	6734	180°	150	601	18	1.2	0.7	ALS Warning
	11	335	180314_232128	23:21	23:27	6716	0°	145	599	17	1.3	0.7	ALS Warning
	12	334	180314_233056	23:30	23:37	6715	180°	151	597	17	1.3	0.7	ALS Warning
	13	333	180314_234037	23:40	23:47	6707	1°	152	596	18	1.2	0.7	ALS Warning
	14	332	180314_235115	23:51	23:58	6734	182°	158	594	17	1.4	0.7	ALS Warning
	15	331	180315_000217	:2	:9	6723	360°	156	591	16	1.3	0.7	ALS Warning
	16	330	180315_001313	:13	:21	6722	181°	153	589	18	1.2	0.7	ALS Warning
	17	329	180315_002425	:24	:32	6695	359°	153	586	19	1.1	0.6	ALS Warning
	18	328	180315_003513	:35	:43	6663	180°	156	584	19	1.1	0.6	ALS Warning
	19	327	180315_004708	:47	:55	6661	360°	154	581	18	1.2	0.7	ALS Warning
	20	326	180315_005836	:58	1:06	6661	181°	160	579	19	1.1	0.6	ALS Warning
	21	325	180315_011000	1:10	1:18	6654	1°	150	576	20	1	0.6	ALS Warning
	22												
	23												
	24												
	25												

20180314_213228_C_588B97B

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	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:				MM Space		PDOP	HDOP	
B	1	324	180315_024352	2:43	2:52	6658	359°	153	573	18	1.1	0.6	ALS Warning
	2	323	180315_025926	2:59	3:12	6637	181°	155	571	18	1.1	0.6	ALS Warning
	3	322	180315_031527	3:15	3:28	6674	358°	154	566	19	1.2	0.6	ALS Warning
	4	321	180315_033108	3:31	3:44	6649	181°	153	562	18	1.4	0.7	ALS Warning
	5	320	180315_034711	3:47	4:00	6676	360°	153	558	18	1.5	0.7	ALS Warning
	6	319	180315_040426	4:04	4:19	6665	180°	155	554	20	1.3	0.6	ALS Warning
	7	318	180315_042207	4:22	4:36	6664	359°	149	550	22	1.2	0.6	ALS Warning
	8	317	180315_044008	4:40	4:55	6647	180°	150	545	21	1.3	0.6	ALS Warning
	9	316	180315_045829	4:58	5:13	6648	359°	150	540	22	1.1	0.6	ALS Warning
	10	315	180315_051647	5:16	5:32	6660	180°	151	535	21	1.1	0.6	ALS Warning
	11	314	180315_053510	5:35	5:50	6639	360°	153	530	23	1	0.6	ALS Warning
	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:	3/19/2018	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: Begin:	UTC time: End:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A	1	2	180319_135732	13:57	13:58	6955	180°	155	383	21	1.1	0.6	
	2	7	180319_140430	14:04	14:10	6938	271°	138	383	21	1.1	0.6	
	3	3	180319_141557	14:15	14:17	6974	90°	155	383	21	1.1	0.6	ALS Warning
	4	4	180319_142208	14:22	14:23	6944	270°	144	382	20	1.3	0.7	ALS Warning
	5	5	180319_143200	14:32	14:35	6971	90°	153	382	19	1.3	0.7	ALS Warning
	6	1	180319_145142	14:51	14:55	6600	360°	155	381	19	1.3	0.7	
	7	6	180319_151008	15:10	15:10	6826	1°	153	379	20	1.1	0.6	
	8	165	180319_152102	15:21	15:40	6713	180°	143	379	20	1.2	0.6	ALS Warning
	9	164	180319_154544	15:45	16:04	6685	0°	153	372	18	1.2	0.6	ALS Warning
	10	163	180319_161112	16:11	16:30	6648	180°	148	365	17	1.2	0.7	
	11	162	180319_163423	16:34	16:53	6775	360°	155	358	16	1.3	0.7	
	12	210	180319_171135	17:11	17:12	6773	180°	154	351	18	1.1	0.7	
	13	209	180319_171559	17:15	17:16	6810	359°	148	351	17	1.1	0.7	
	14	208	180319_172050	17:20	17:21	6771	181°	148	351	17	1.1	0.7	
	15	207	180319_172447	17:24	17:25	6772	360°	156	351	16	1.3	0.7	
	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:	3/19/2018	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	1	224	180319_211941	21:19	21:42	6544	358°	147	350	20	1.3	0.6	ALS Warning
	2	225	180319_214659	21:46	22:09	6472	181°	150	342	20	1.1	0.6	ALS Warning
	3	226	180319_221403	22:14	22:36	6502	360°	150	335	18	1.3	0.7	ALS Warning
	4	227	180319_224130	22:41	23:03	6535	181°	146	327	17	1.3	0.7	ALS Warning
	5	228	180319_230847	23:08	23:31	6574	359°	153	319	16	1.3	0.8	ALS Warning
	6	229	180319_233537	23:35	23:58	6495	179°	153	312	16	1.4	0.8	ALS Warning. Possible Clouds
	7	230	180320_000212	:2	:24	6542	359°	150	304	19	1.1	0.7	ALS Warning
	8	234	180320_002827	:28	:42	6479	180°	160	297	18	1.3	0.7	ALS Warning
	9	235	180320_004836	:48	1:03	6608	0°	149	292	23	1	0.6	ALS Warning
	10	236	180320_010809	1:08	1:21	6560	179°	154	287	21	1.1	0.7	ALS Warning
	11												
	12												
	13												
	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												
	22												
	23												
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	25												

20180319_205234_B_58948A0

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	1	11	180320_162858	16:28	16:33	6468	270°	137	282	16	1.4	0.8	ALS Warning
	2	8	180320_164031	16:40	16:42	6570	179°	157	281	17	1.4	0.8	ALS Warning
	3	9	180320_164607	16:46	16:49	6554	359°	132	280	17	1.3	0.8	ALS Warning
	4	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.
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
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	22												
	23												
	24												
	25												

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 MM Space	S/Vs:	Position Acc.		Comments and Conditions:
				Begin:	End:						PDOP	HDOP	
A	1	244	180321_124150	12:41	12:53	6582	359°	141	135	20	1.1	0.6	ALS Warning
	2	243	180321_125735	12:57	13:08	6580	181°	154	131	22	1	0.5	ALS Warning
	3	242	180321_131206	13:12	13:25	6611	359°	137	127	20	1.1	0.6	ALS Warning
	4	241	180321_132855	13:28	13:40	6617	180°	160	123	18	1.3	0.7	ALS Warning
	5	240	180321_134426	13:44	13:58	6617	0°	137	119	19	1.1	0.6	ALS Warning
	6	239	180321_140133	14:01	14:13	6639	180°	160	114	19	1.1	0.6	ALS Warning
	7	238	180321_141804	14:18	14:31	6557	359°	138	110	21	1.1	0.6	ALS Warning
	8	237	180321_143614	14:36	14:48	6577	180°	158	105	18	1.4	0.7	ALS Warning
	9	232	180321_150000	15:00	15:24	6583	1°	141	101	19	1.3	0.7	ALS Warning
	10	231	180321_152819	15:28	15:38	6574	180°	158	92	19	1.2	0.7	Refly. Possible smoke.
	11	233	180321_155852	15:58	16:20	6577	180°	156	88	17	1.3	0.7	ALS Warning
	12												
	13												
	14												
	15												
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20180321_121242_A_5899E0F

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	1	249	180321_172102	17:21	17:31	6549	0°	142	81	16	1.3	0.7	ALS Warning
	2	245	180321_173453	17:34	17:45	6619	180°	160	77	17	1.3	0.7	ALS Warning
	3	246	180321_175007	17:50	18:01	6541	359°	147	74	22	1.1	0.6	ALS Warning
	4	247	180321_180520	18:05	18:14	6559	180°	156	70	22	1.1	0.6	ALS Warning
	5	248	180321_181922	18:19	18:29	6551	1°	145	67	21	1.1	0.6	ALS Warning
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
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	23												
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	25												

Appendix B. Vertical Accuracy Calculations

G17PD01257, EASTERN TX QL2 LiDAR

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: LAS_Working Segment.shp
    Number of Polys: 0
Intensity:
    Tile Index Attribute: Not Specified
    Data Filename: Not Specified

DEM:
    Tile Index Attribute: Name
    Data Filename: IMG

LAS:
    Tile Index Attribute: Name
    Data Filename: LAS_2

Tiled-Data Area
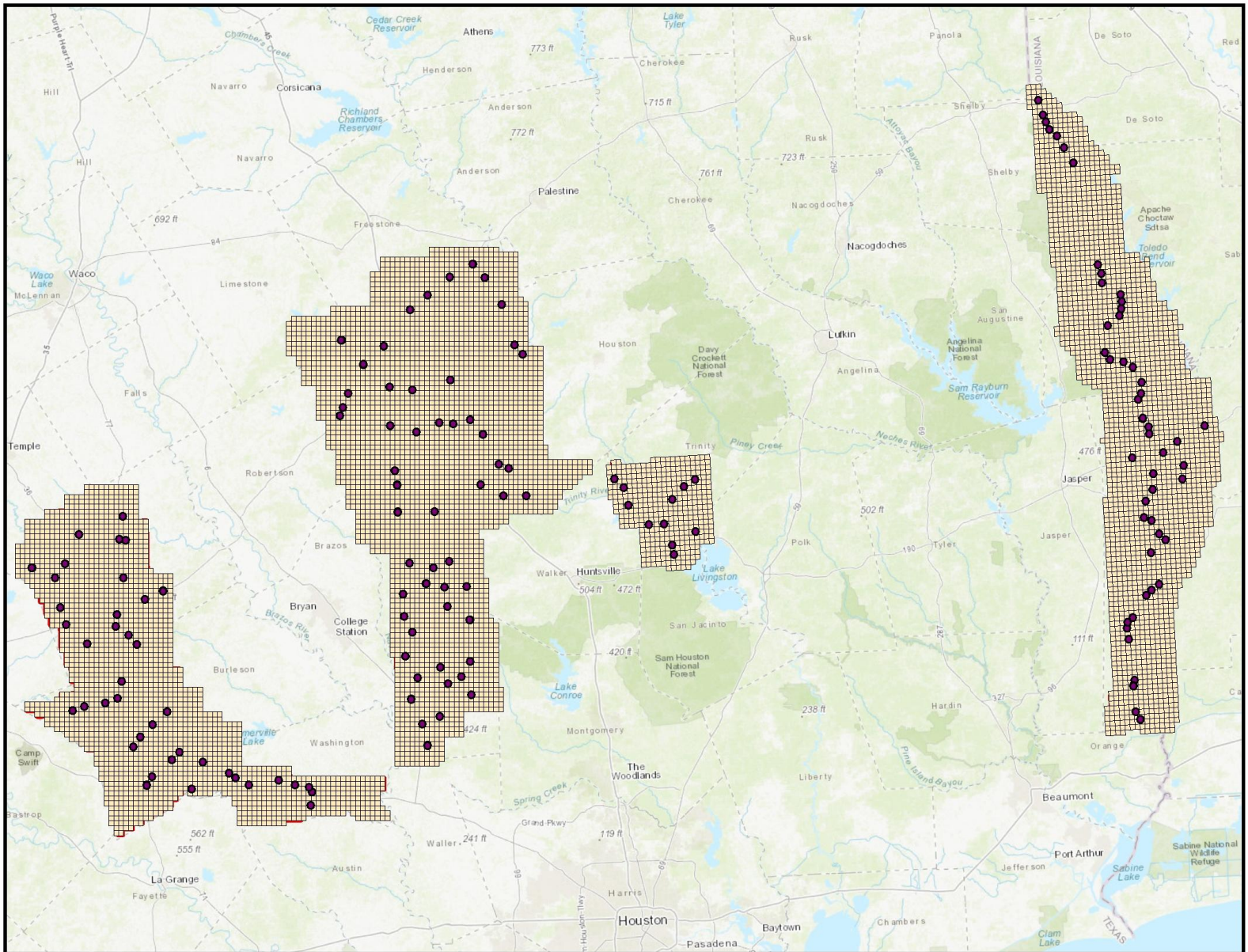
LiDAR Accuracy Assessment Summary

LC Type	# of Points	NVA	VVA	
LAS				
Bare Ground	51	0.094		
Hard Pavement	53	0.098		
High Vegetation	42		0.124	
Low Vegetation	35		0.137	
Medium Vegetation	18		0.144	
Packed Sand	26	0.106		
Total	225			
DEM				
Bare Ground	51	0.098		
Hard Pavement	53	0.094		
High Vegetation	42		0.151	
Low Vegetation	35		0.139	
Medium Vegetation	18		0.167	
Packed Sand	26	0.114		
Total	225			

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)	☑ **04.06.NVA.BG**					
		852630.029	3419895.311	53.626	53.569	53.577
				Bare Ground	-0.057	-0.049
2)	☑ **04.23.NVA.BG**					
		859832.593	3427528.039	59.716	59.711	59.69
				Bare Ground	-0.005	-0.026
3)	☑ **06.23.NVA.BG**					
		1002162.429	3360771.72	10.171	10.24	10.237
				Bare Ground	0.069	0.066
4)	☑ **06.29.NVA.BG**					
		1000777.479	3362970.707	8.843	8.785	8.785
				Bare Ground	-0.058	-0.058
5)	☑ **06.31.NVA.BG**					
		1000312.019	3372714.285	11.984	11.974	11.96
				Bare Ground	-0.01	-0.024
6)	☑ **06.34.NVA.BG**					
		998113.987	3388353.77	15.89	15.907	15.916
				Bare Ground	0.017	0.026
7)	☑ **06.35.NVA.BG**					
		998187.087	3390232.168	17.239	17.244	17.228
				Bare Ground	0.005	-0.011

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
8) ☑	**06.36.NVA.BG**					
		999945.072	3391654.234	18.695	18.649	18.642
				Bare Ground	-0.046	-0.053
9) ☑	**06.41.NVA.BG**					
		1007776.129	3401691.306	17.94	17.955	17.953
				Bare Ground	0.015	0.013
10) ☑	**1.16.NVA.BG**					
		679499.872	3416881.57	157.879	157.88	157.892
				Bare Ground	0.001	0.013
11) ☑	**1.17.NVA.BG**					
		691631.752	3415455.628	127.697	127.743	127.747
				Bare Ground	0.046	0.05
12) ☑	**1.2.NVA.BG**					
		705018.664	3399748.371	152.903	152.915	152.91
				Bare Ground	0.012	0.007
13) ☑	**1A.16.NVA.BG**					
		717081.861	3347768.788	96.323	96.297	96.321
				Bare Ground	-0.026	-0.002
14) ☑	**1A.3.NVA.BG**					
		749438.432	3340132.65	90.431	90.419	90.428
				Bare Ground	-0.012	-0.003

	ID			Z1	Z DEM	Z LAS
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
15) ☑	**1A.4.NVA.BG**					
		745095.337	3340858.221	117.888	117.882	117.899
				Bare Ground	-0.006	0.011
16) ☑	**1A.8.NVA.BG**					
		731049.769	3340829.93	134.795	134.713	134.749
				Bare Ground	-0.082	-0.046
17) ☑	**2.10.NVA.BG**					
		792105.526	3494947.015	104.54	104.508	104.507
				Bare Ground	-0.032	-0.033
18) ☑	**2.15.NVA.BG**					
		811919.486	3474344.318	83.055	83.016	83.015
				Bare Ground	-0.039	-0.04
19) ☑	**2.16.NVA.BH**					
		814265.136	3471551.111	59.338	59.217	59.245
				Bare Ground	-0.121	-0.093
20) ☑	**2.3.NVA.BG**					
		761203.261	3459592.523	123.018	122.983	122.969
				Bare Ground	-0.035	-0.049
21) ☑	**2.53.NVA.BG**					
		780832.887	3460655.048	150.167	150.092	150.092
				Bare Ground	-0.075	-0.075

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
22) ☑	**2.56.NVA.BG**					
		788945.606	3450713.905	103.84	103.849	103.83
				Bare Ground	0.009	-0.01
23) ☑	**2.6.NVA.BG**					
		772102.025	3473982.942	150.156	150.105	150.113
				Bare Ground	-0.051	-0.043
24) ☑	**2.61.NVA.BG**					
		807029.942	3438155.703	82.209	82.185	82.195
				Bare Ground	-0.024	-0.014
25) ☑	**2.62.NVA.BG**					
		810011.295	3436841.321	75.585	75.545	75.545
				Bare Ground	-0.04	-0.04
26) ☑	**2.70.NVA.BG**					
		775528.281	3436218.78	111.89	111.909	111.898
				Bare Ground	0.019	0.007
27) ☑	**2.8.NVA.BG**					
		780079.869	3484997.207	119.149	119.087	119.088
				Bare Ground	-0.062	-0.061
28) ☑	**3.12.NVA.BG**					
		795637.108	3373705.515	111.814	111.795	111.802
				Bare Ground	-0.019	-0.012

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
29)	☑ **3.14.NVA.BG**					
		791682.148	3371587.001	118.565	118.532	118.538
				Bare Ground	-0.033	-0.027
30)	☑ **3.17.NVA.BG**					
		798313.178	3390874.327	107.346	107.37	107.36
				Bare Ground	0.024	0.014
31)	☑ **3.19.NVA.BG**					
		792050.044	3408678.086	102.493	102.503	102.518
				Bare Ground	0.01	0.025
32)	☑ **3.21.NVA.BG**					
		791396.136	3395055.582	102.003	101.991	101.97
				Bare Ground	-0.012	-0.033
33)	☑ **3.7.NVA.BG**					
		780430.946	3366846.596	71.94	71.912	71.917
				Bare Ground	-0.028	-0.023
34)	☑ **5.10.NVA.BG**					
		989182.375	3498653.142	89.105	89.076	89.082
				Bare Ground	-0.029	-0.023
35)	☑ **5.11.NVA.BG**					
		992163.772	3480270.029	94.308	94.308	94.312
				Bare Ground	0	0.004

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
36)	☑ **5.17.NVA.BG**					
		999837.974	3467553.294	59.461	59.425	59.464
				Bare Ground	-0.036	0.003
37)	☑ **5.19.NVA.BG**					
		973487.84	3542049.885	67.735	67.619	67.62
				Bare Ground	-0.116	-0.115
38)	☑ **5.29.NVA.BG**					
		972496.006	3544036.044	76.994	76.9	76.896
				Bare Ground	-0.094	-0.098
39)	☑ **5.50.NVA.BG**					
		999725.277	3440095.495	80.219	80.083	80.085
				Bare Ground	-0.136	-0.134
40)	☑ **5.52.NVA.BG**					
		1013398.627	3445043.42	82.034	82.032	82.022
				Bare Ground	-0.002	-0.012
41)	☑ **5.54.NVA.BG**					
		1015305.865	3437863.099	36.029	36.069	36.046
				Bare Ground	0.04	0.017
42)	☑ **5.7.NVA.BG**					
		996428.058	3487526.432	54.716	54.791	54.763
				Bare Ground	0.075	0.046

	ID			Z1	Z DEM	Z LAS
		Survey X	Survey Y			
				LC Type	ΔZ DEM	ΔZ LAS
43)	☑ 5.80.NVA.BG					
		978897.289	3534162.765	54.405	54.367	54.369
				Bare Ground	-0.038	-0.036
44)	☑ 5.80.NVA.BH					
		978860.139	3534148.757	53.265	53.238	53.221
				Bare Ground	-0.027	-0.044
45)	☑ 6.02.NVA.BG					
		1001477.649	3457824.158	118.001	118.053	118.06
				Bare Ground	0.052	0.059
46)	☑ 6.1.NVA.BG					
		1002356.154	3459636.314	125.64	125.696	125.69
				Bare Ground	0.056	0.05
47)	☑ 6.13.NVA.BG					
		1005909.036	3430436.161	92.003	92.051	92.056
				Bare Ground	0.048	0.053
48)	☑ 6.14.NVA.BG					
		1003735.312	3426871.806	75.003	75.06	75.076
				Bare Ground	0.057	0.073
49)	☑ 6.20.NVA.BG					
		1009792.472	3415308.452	31	31.04	31.047
				Bare Ground	0.04	0.047

	ID			Z1	Z DEM	Z LAS
		Survey X	Survey Y			
				LC Type	ΔZ DEM	ΔZ LAS
50)	☑ 6.3.NVA.BG					
		1002943.793	3452076.61	135.823	135.842	135.836
				Bare Ground	0.019	0.013
51)	☑ 6.4.NVA.BG					
		1004627.334	3449585.896	117.652	117.598	117.606
				Bare Ground	-0.054	-0.046
52)	☑ 04.02.NVA.HP					
		845098.281	3431062.4	79.655	79.6	79.603
				Hard Pavement	-0.055	-0.052
53)	☑ 04.27.NVA.HP					
		866804.126	3433489.055	69.487	69.48	69.476
				Hard Pavement	-0.007	-0.011
54)	☑ 1.1.NVA.HP					
		690969.914	3392496.121	139.637	139.687	139.689
				Hard Pavement	0.05	0.052
55)	☑ 1.13.NVA.HP					
		672133.903	3403745.548	159.902	159.946	159.946
				Hard Pavement	0.044	0.044
56)	☑ 1.16.NVA.HP					
		679486.15	3416911.812	158.548	158.563	158.551
				Hard Pavement	0.015	0.003

	ID			Z1	Z DEM	Z LAS
		Survey X	Survey Y			
				LC Type	ΔZ DEM	ΔZ LAS
57)	☑ 1.18.NVA.HP					
		693589.736	3415015.462	120.664	120.679	120.682
				Hard Pavement	0.015	0.018
58)	☑ 1.2.NVA.HP					
		705002.362	3399777.629	153.402	153.41	153.411
				Hard Pavement	0.008	0.009
59)	☑ 1.3.NVA.HP					
		699481.258	3397187.683	130.209	130.107	130.08
				Hard Pavement	-0.102	-0.129
60)	☑ 1.4.NVA.HP					
		694443.774	3386221.838	136.634	136.622	136.631
				Hard Pavement	-0.012	-0.003
61)	☑ 1A.13.NVA.HP					
		726941.879	3342987.717	152.273	152.264	152.249
				Hard Pavement	-0.009	-0.024
62)	☑ 1A.19.NVA.HP					
		713605.258	3339589.938	112.499	112.535	112.505
				Hard Pavement	0.036	0.006
63)	☑ 1A.2.NVA.HP					
		750208.534	3338746.363	104.737	104.645	104.651
				Hard Pavement	-0.092	-0.086

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
64)	☑ **1A.21.NVA.HP**					
		699984.767	3340771.368	150.731	150.738	150.731
				Hard Pavement	0.007	0
65)	☑ **1A.24.NVA.HP**					
		707652.824	3348554.047	116.183	116.245	116.236
				Hard Pavement	0.062	0.053
66)	☑ **1A.25.NVA.HP**					
		710023.984	3350786.494	119.016	118.995	118.986
				Hard Pavement	-0.021	-0.03
67)	☑ **1A.30.NVA.HP**					
		698048.675	3355504.681	136.248	136.297	136.29
				Hard Pavement	0.049	0.042
68)	☑ **1A.38.NVA.HP**					
		687370.63	3365730.62	124.319	124.328	124.313
				Hard Pavement	0.009	-0.006
69)	☑ **1A.40.NVA.HP**					
		677540.433	3363437.237	145.764	145.821	145.851
				Hard Pavement	0.057	0.087
70)	☑ **1A.5.NVA.HP**					
		740176.151	3342365.107	111.011	111.017	110.993
				Hard Pavement	0.006	-0.018

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
71)	☑ **1A.8.NVA.HP**					
		731064.256	3340832.318	134.669	134.593	134.587
				Hard Pavement	-0.076	-0.082
72)	☑ **2.10.NVA.HP**					
		792100.37	3494955.242	104.399	104.333	104.339
				Hard Pavement	-0.066	-0.06
73)	☑ **2.12.NVA.HP**					
		802726.248	3494802.389	92.318	92.269	92.27
				Hard Pavement	-0.049	-0.048
74)	☑ **2.15.NVA.HP**					
		811920.22	3474356.974	83.115	83.086	83.072
				Hard Pavement	-0.029	-0.043
75)	☑ **2.2.NVA.HP**					
		759752.331	3455401.456	120.287	120.222	120.206
				Hard Pavement	-0.065	-0.081
76)	☑ **2.4.NVA.HP**					
		765884.81	3468450.851	137.032	136.963	136.965
				Hard Pavement	-0.069	-0.067
77)	☑ **2.54.NVA.HP**					
		773955.58	3461497.554	162.618	162.55	162.551
				Hard Pavement	-0.068	-0.067

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
78)	☑ **2.56.NVA.HP**					
		782065.779	3447833.519	126.366	126.3	126.298
				Hard Pavement	-0.066	-0.068
79)	☑ **2.58.NVA.HP**					
		793263.643	3450358.736	94.72	94.659	94.675
				Hard Pavement	-0.061	-0.045
80)	☑ **2.59.NVA.HP**					
		798303.766	3451553.994	62.744	62.693	62.697
				Hard Pavement	-0.051	-0.047
81)	☑ **2.6.NVA.HP**					
		772073.213	3473967.878	150.345	150.281	150.289
				Hard Pavement	-0.064	-0.056
82)	☑ **2.60.NVA.HP**					
		802204.357	3447133.718	88.871	88.816	88.805
				Hard Pavement	-0.055	-0.066
83)	☑ **2.64.NVA.HP**					
		808509.543	3428474.459	81.275	81.263	81.26
				Hard Pavement	-0.012	-0.015
84)	☑ **2.68.NVA.HP**					
		776368.244	3423700.647	101.575	101.534	101.524
				Hard Pavement	-0.041	-0.051

	ID			Z1	Z DEM	Z LAS
		Survey X	Survey Y			
				LC Type	ΔZ DEM	ΔZ LAS
85)	☑ 2.69.NVA.HP					
		776099.059	3431877.896	113.269	113.207	113.207
				Hard Pavement	-0.062	-0.062
86)	☑ 3.10.NVA.HP					
		789097.793	3361715.024	77.448	77.419	77.433
				Hard Pavement	-0.029	-0.015
87)	☑ 3.13.NVA.HP					
		789236.133	3376603.384	104.502	104.471	104.471
				Hard Pavement	-0.031	-0.031
88)	☑ 3.15.NVA.HP					
		798392.729	3378230.497	104.187	104.219	104.22
				Hard Pavement	0.032	0.033
89)	☑ 3.18.NVA.HP					
		797347.556	3401021.947	107.13	107.103	107.104
				Hard Pavement	-0.027	-0.026
90)	☑ 3.2.NVA.HP					
		777914.059	3398718.383	94.362	94.305	94.309
				Hard Pavement	-0.057	-0.053
91)	☑ 3.20.NVA.HP					
		790494.182	3400917.326	101.347	101.276	101.277
				Hard Pavement	-0.071	-0.07

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
92)	☑ **3.22.NVA.HP**					
		784964.514	3401870.73	103.273	103.214	103.193
				Hard Pavement	-0.059	-0.08
93)	☑ **3.3.NVA.HQ**					
		778337.2	3392007.627	91.028	91.012	91.007
				Hard Pavement	-0.016	-0.021
94)	☑ **3.4.NVA.HP**					
		780858.232	3387151.995	65.031	65.013	65.016
				Hard Pavement	-0.018	-0.015
95)	☑ **3.5.NVA.HP**					
		778733.558	3379997.669	65.592	65.529	65.526
				Hard Pavement	-0.063	-0.066
96)	☑ **3.9.NVA.HP**					
		785370.181	3352833.257	76.067	76.033	76.012
				Hard Pavement	-0.034	-0.055
97)	☑ **5.11.NVA.HP**					
		992153.17	3480226.213	95.149	95.139	95.154
				Hard Pavement	-0.01	0.005
98)	☑ **5.14.NVA.HP**					
		991341.957	3472115.662	96.979	96.921	96.933
				Hard Pavement	-0.058	-0.046

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
99)	☑ **5.15.NVA.HP**					
		992992.508	3469892.067	88.825	88.831	88.83
				Hard Pavement	0.006	0.005
100)	☑ **5.2.NVA.HP**					
		990430.893	3493143.416	140.017	139.986	140.01
				Hard Pavement	-0.031	-0.007
101)	☑ **6.14.NVA.HP**					
		1003757.076	3426911.286	75.837	75.908	75.898
				Hard Pavement	0.071	0.06
102)	☑ **6.19.NVA.HP**					
		1007839.462	3417050.309	42.149	42.145	42.131
				Hard Pavement	-0.004	-0.018
103)	☑ **6.22.NVA.HP**					
		1005403.36	3411372.225	35.178	35.208	35.213
				Hard Pavement	0.03	0.035
104)	☑ **6.3.NVA.HP**					
		1002908.91	3452097.319	135.816	135.782	135.776
				Hard Pavement	-0.034	-0.04
105)	☑ **04.14.NVA.PS**					
		866937.493	3417763.18	43.934	43.98	43.974
				Packed Sand	0.046	0.04

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
106) ☑	**1.12.NVA.PS**					
		673682.774	3394719.351	141.904	141.908	141.904
				Packed Sand	0.004	0
107) ☑	**1.20.NVA.PS**					
		692869.146	3403782.899	128.415	128.45	128.443
				Packed Sand	0.035	0.028
108) ☑	**1.8.NVA.PS**					
		681937.178	3383625.776	162.199	162.307	162.296
				Packed Sand	0.108	0.097
109) ☑	**1A.19.NVA.PS**					
		713621.634	3339595.177	111.506	111.514	111.51
				Packed Sand	0.008	0.004
110) ☑	**1A.22.NVA.PS**					
		701705.44	3343376.608	126.554	126.617	126.604
				Packed Sand	0.063	0.05
111) ☑	**1A.29.NVA.PS**					
		701858.985	3359080.072	99.01	99.104	99.078
				Packed Sand	0.094	0.068
112) ☑	**1A.40.NVA.PS**					
		677539.832	3363446.782	145.327	145.419	145.403
				Packed Sand	0.092	0.076

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
113) ☑	**1A.41.NVA.PS**					
		692461.817	3372366.426	119.656	119.729	119.736
				Packed Sand	0.073	0.08
114) ☑	**2.11.NVA.PS**					
		799208.088	3498795.71	83.152	83.112	83.108
				Packed Sand	-0.04	-0.044
115) ☑	**2.13.NVA.PS**					
		807961.78	3486648.087	70.281	70.262	70.255
				Packed Sand	-0.019	-0.026
116) ☑	**2.4.NVA.PS**					
		765935.171	3468430.614	136.175	136.098	136.095
				Packed Sand	-0.077	-0.08
117) ☑	**2.5.NVA.PS**					
		759236.515	3475747.159	128.624	128.552	128.556
				Packed Sand	-0.072	-0.068
118) ☑	**2.55.NVA.PS**					
		773968.67	3449917.433	141.396	141.34	141.344
				Packed Sand	-0.056	-0.052
119) ☑	**2.63.NVA.PS**					
		815428.03	3428619.296	64.655	64.533	64.543
				Packed Sand	-0.122	-0.112

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
120) ☑	**2.67.NVA.PS**					
		787606.446	3423711.053	91.796	91.751	91.735
				Packed Sand	-0.045	-0.061
121) ☑	**2.9.NVA.PS**					
		785328.199	3489446.587	86.066	85.992	85.988
				Packed Sand	-0.074	-0.078
122) ☑	**3.1.NVA.PS**					
		779944.69	3408189.146	101.645	101.621	101.615
				Packed Sand	-0.024	-0.03
123) ☑	**3.11.NVA.PS**					
		798660.393	3368114.525	97.667	97.687	97.686
				Packed Sand	0.02	0.019
124) ☑	**3.23.NVA.PS**					
		787258.099	3406644.257	108.184	108.15	108.174
				Packed Sand	-0.034	-0.01
125) ☑	**3.8.NVA.PS**					
		783821.604	3359320.935	65.122	65.139	65.141
				Packed Sand	0.017	0.019
126) ☑	**4.33.NVA.PS**					
		860397.643	3410724.147	79.476	79.476	79.488
				Packed Sand	0	0.012

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
127)	☑ **5.55.NVA.PS**					
		1014965.485	3433702.266	92.549	92.547	92.543
				Packed Sand	-0.002	-0.007
128)	☑ **5.6.NVA.PS**					
		996097.717	3489653.27	63.133	63.151	63.156
				Packed Sand	0.018	0.023
129)	☑ **5.85.NVA.PS**					
		974480.4	3539676.36	62.412	62.387	62.414
				Packed Sand	-0.025	0.002
130)	☑ **6.11.NVA.PS**					
		1005998.967	3435237.006	90.739	90.806	90.801
				Packed Sand	0.067	0.062
131)	☑ **04.01.VVA.HV**					
		842284.578	3433704.474	80.825	80.874	80.82
				High Vegetation	0.049	-0.005
132)	☑ **04.08.VVA.HV**					
		857333.484	3420028.565	54.081	54.006	53.983
				High Vegetation	-0.075	-0.098
133)	☑ **04.11.VVA.HV**					
		859774.711	3413617.917	52.097	52.176	52.181
				High Vegetation	0.079	0.084

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
134) ☑	**06.29.VVA.HV**					
		1000773.549	3362964.495	8.641	8.706	8.706
				High Vegetation	0.065	0.065
135) ☑	**06.30.VVA.HV**					
		1000120.696	3370957.141	11.759	11.858	11.838
				High Vegetation	0.099	0.078
136) ☑	**06.30.VVA.HV2**					
		1000120.976	3370934.637	11.436	11.54	11.513
				High Vegetation	0.104	0.077
137) ☑	**06.36.VVA.HV**					
		999945.857	3391637.076	18.047	18.015	18.042
				High Vegetation	-0.032	-0.005
138) ☑	**06.39.VVA.HV**					
		1003942.659	3398396.632	17.407	17.427	17.434
				High Vegetation	0.02	0.027
139) ☑	**06.40.VVA.HV**					
		1005537.611	3399906.609	17.803	17.902	17.893
				High Vegetation	0.099	0.09
140) ☑	**1.14.VVA.HV**					
		665197.819	3406726.235	166.758	166.937	166.931
				High Vegetation	0.179	0.173

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
141) ☑	**1.15.VVA.HV**					
		675256.561	3407972.637	135.559	135.622	135.6
				High Vegetation	0.063	0.041
142) ☑	**1.19.VVA.HV**					
		692739.136	3422375.611	110.536	110.594	110.599
				High Vegetation	0.058	0.063
143) ☑	**1.2.VVA.HV**					
		704999.423	3399703.127	151.053	151.146	151.142
				High Vegetation	0.093	0.089
144) ☑	**1A.11.VVA.HV**					
		749831.191	3334615.457	110.255	110.316	110.283
				High Vegetation	0.061	0.028
145) ☑	**1A.14.VVA.HV**					
		724986.014	3344400.085	112.086	112.237	112.21
				High Vegetation	0.151	0.124
146) ☑	**1A.21.VVA.HV**					
		700055.073	3340738.869	150.136	150.149	150.163
				High Vegetation	0.013	0.027
147) ☑	**1A.25.VVA.HV**					
		710037.225	3350789.361	118.56	118.591	118.603
				High Vegetation	0.031	0.043

		ID					
			Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
					LC Type	**ΔZ DEM**	**ΔZ LAS**
148)	✔	**1A.28.VVA.HV**					
			706246.238	3363094.276	127.057	127.151	127.13
					High Vegetation	0.094	0.073
149)	✔	**1A.31.VVA.HV**					
			695874.534	3352448.607	110.521	110.517	110.523
					High Vegetation	-0.004	0.002
150)	✔	**1A.39.VVA.HV**					
			680999.884	3364706.703	134.933	134.992	134.992
					High Vegetation	0.059	0.059
151)	✔	**2.1.VVA.HV**					
			758782.758	3452899.458	105.084	105.104	105.088
					High Vegetation	0.02	0.004
152)	✔	**2.11.VVA.HV**					
			799254.846	3498804.952	81.973	82.126	82.089
					High Vegetation	0.153	0.116
153)	✔	**2.5.VVA.HV**					
			759238.022	3475727.561	127.941	127.978	127.956
					High Vegetation	0.037	0.015
154)	✔	**2.51.VVA.HV**					
			792258.626	3463620.609	80.966	80.92	80.936
					High Vegetation	-0.046	-0.03

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
155) ☑	**2.65.VVA.HV**					
		801614.836	3431936.032	83.633	83.646	83.64
				High Vegetation	0.013	0.007
156) ☑	**3.12.VVA.HV**					
		795646.942	3373706.797	111.812	111.846	111.863
				High Vegetation	0.034	0.051
157) ☑	**3.13.VVA.HV**					
		789267.385	3376628.233	106.515	106.555	106.538
				High Vegetation	0.04	0.023
158) ☑	**3.17.VVA.HV**					
		798310.038	3390889.86	106.914	106.993	106.988
				High Vegetation	0.079	0.074
159) ☑	**3.17.VVA.HVHV**					
		798279.793	3390917.375	107.169	107.256	107.242
				High Vegetation	0.087	0.073
160) ☑	**3.19.VVA.HV**					
		792068.44	3408673.617	102.112	102.117	102.115
				High Vegetation	0.005	0.003
161) ☑	**3.21.VVA.HV**					
		791403.616	3395036.21	102.029	102.034	102.031
				High Vegetation	0.005	0.002

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
162) ☑	**3.3.VVA.HV**					
		778321.76	3392037	90.615	90.562	90.585
				High Vegetation	-0.053	-0.03
163) ☑	**3.7.VVA.HV**					
		780383.816	3366879.031	70.552	70.625	70.62
				High Vegetation	0.073	0.068
164) ☑	**3.9.VVA.HV**					
		785371.369	3352858.836	76.708	76.708	76.714
				High Vegetation	0	0.006
165) ☑	**5.15.VVA.HV**					
		993001.071	3469899.413	88.632	88.619	88.64
				High Vegetation	-0.013	0.008
166) ☑	**5.18.VVA.HV**					
		1002451.96	3462995.448	81.687	81.75	81.68
				High Vegetation	0.063	-0.007
167) ☑	**5.30.VVA.HV**					
		971076.567	3548495.785	60.365	60.217	60.21
				High Vegetation	-0.148	-0.155
168) ☑	**5.83.VVA.HV**					
		976809.693	3537675.555	75.845	75.895	75.888
				High Vegetation	0.05	0.043

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
169) ☑	6.16.VVA.HV					
		1003235.843	3421984.87	60.029	60.13	60.115
				High Vegetation	0.101	0.086
170) ☑	6.17.VVA.HV					
		1005509.766	3421022.164	50.827	50.883	50.883
				High Vegetation	0.056	0.056
171) ☑	6.5.VVA.HV					
		1004885.222	3447327.101	99.244	99.359	99.32
				High Vegetation	0.115	0.076
172) ☑	6.8.VVA.HV					
		1009153.083	3441648.963	57.624	57.702	57.712
				High Vegetation	0.078	0.088
173) ☑	04.05.VVA.LV					
		846416.674	3425706.635	57.992	58.101	58.093
				Low Vegetation	0.109	0.101
174) ☑	06.33.VVA.LV					
		998560.069	3385039.604	15.352	15.35	15.358
				Low Vegetation	-0.002	0.006
175) ☑	1.14.VVA.LV					
		665120.237	3406744.214	167.107	167.161	167.161
				Low Vegetation	0.054	0.054

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
176) ☑	**1.15.VVA.LV**					
		675232.86	3407939.325	137.84	137.972	137.946
				Low Vegetation	0.132	0.106
177) ☑	**1.2.VVA.LV**					
		705037.565	3399679.075	151.359	151.511	151.49
				Low Vegetation	0.152	0.131
178) ☑	**1.6.VVA.LV**					
		690630.698	3388951.141	144.64	144.84	144.826
				Low Vegetation	0.2	0.186
179) ☑	**1A.11.VVA.LV**					
		749848.625	3334632.538	111.61	111.612	111.615
				Low Vegetation	0.002	0.005
180) ☑	**1A.28.VVA.LV**					
		706230.591	3363088.193	126.729	126.769	126.774
				Low Vegetation	0.04	0.045
181) ☑	**1A.3.VVA.LV**					
		749451.044	3340160.958	90.379	90.387	90.381
				Low Vegetation	0.008	0.002
182) ☑	**1A.31.VVA.LV**					
		695852.793	3352455.688	110.769	110.892	110.876
				Low Vegetation	0.123	0.107

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
183)	☑ **1A.36.VVA.LV**					
		691075.702	3367093.852	137.396	137.388	137.406
				Low Vegetation	-0.008	0.01
184)	☑ **2.1.VVA.LV**					
		758784.546	3452923.097	105.295	105.357	105.354
				Low Vegetation	0.062	0.059
185)	☑ **2.11.VVA.LV**					
		799236.932	3498775.198	82.287	82.249	82.247
				Low Vegetation	-0.038	-0.04
186)	☑ **2.15.VVA.LV**					
		811871.835	3474367.459	82.578	82.611	82.603
				Low Vegetation	0.033	0.025
187)	☑ **2.4.VVA.LV**					
		765809.047	3468392.814	138.595	138.56	138.561
				Low Vegetation	-0.035	-0.034
188)	☑ **2.50.VVA.LV**					
		814278.438	3471491.66	59.011	58.914	58.915
				Low Vegetation	-0.097	-0.096
189)	☑ **2.61.VVA.LV**					
		807015.865	3438178.017	82.58	82.624	82.602
				Low Vegetation	0.044	0.022

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
190)	☑ **2.62.VVA.LV**					
		810024.277	3436845.81	75.627	75.611	75.62
				Low Vegetation	-0.016	-0.007
191)	☑ **2.68.VVA.LV**					
		776382.934	3423669.16	100.986	101.08	101.076
				Low Vegetation	0.094	0.09
192)	☑ **2.70.VVA.LV**					
		775495.608	3436203.464	111.624	111.596	111.586
				Low Vegetation	-0.028	-0.038
193)	☑ **3.15.VVA.LV**					
		798412.086	3378239.453	102.948	103.061	103.085
				Low Vegetation	0.113	0.137
194)	☑ **3.22.VVA.LV**					
		784979.909	3401859.039	102.712	102.692	102.686
				Low Vegetation	-0.02	-0.026
195)	☑ **3.5.VVA.LV**					
		778720.757	3379998.974	64.568	64.597	64.595
				Low Vegetation	0.029	0.027
196)	☑ **3.7.VVA.LV**					
		780413.412	3366856.731	71.206	71.277	71.28
				Low Vegetation	0.071	0.074

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
197) ☑	**3.8.VVA.LV**					
		783816.734	3359353.18	63.96	64.038	64.043
				Low Vegetation	0.078	0.082
198) ☑	**3.9.VVA.LV**					
		785390.451	3352834.074	76.052	76.103	76.116
				Low Vegetation	0.051	0.064
199) ☑	**5.16.VVA.LV**					
		997013.84	3469258.712	73.2	73.243	73.288
				Low Vegetation	0.043	0.088
200) ☑	**5.30.VVA.LV**					
		971051.472	3548478.093	60.024	59.885	59.867
				Low Vegetation	-0.139	-0.157
201) ☑	**5.8.VVA.LV**					
		996362.315	3485340.208	72.042	72.115	72.09
				Low Vegetation	0.073	0.048
202) ☑	**5.81.VVA.LV**					
		981670.158	3529557.086	84.975	84.907	84.914
				Low Vegetation	-0.068	-0.061
203) ☑	**5.9.VVA.LV**					
		995815.12	3483278.614	78.12	78.19	78.208
				Low Vegetation	0.07	0.088

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
204)	☑ **6.1.VVA.LV**					
		990301.567	3495992.185	70.504	70.597	70.576
				Low Vegetation	0.093	0.072
205)	☑ **6.16.VVA.LV**					
		1003210.488	3421977.392	60.596	60.634	60.648
				Low Vegetation	0.038	0.051
206)	☑ **6.5.VVA.LV**					
		1004901.548	3447303.167	99.035	99.098	99.068
				Low Vegetation	0.063	0.033
207)	☑ **6.8.VVA.LV**					
		1009146.298	3441637.017	57.553	57.608	57.6
				Low Vegetation	0.055	0.047
208)	☑ **04.25.VVA.MV**					
		863271.151	3431422.613	79.916	79.945	79.93
				Medium Vegetation	0.029	0.014
209)	☑ **06.39.VVA.MV**					
		1003932.997	3398357.013	17.291	17.295	17.333
				Medium Vegetation	0.004	0.042
210)	☑ **1.11.VVA.MV**					
		675541.471	3389484.733	126.508	126.553	126.565
				Medium Vegetation	0.045	0.057

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
211) ✔	**1.17.VVA.MV**					
		691628.382	3415480.024	127.805	127.937	127.926
				Medium Vegetation	0.132	0.121
212) ✔	**1.5.VVA.MV**					
		697067.804	3383388.869	131.627	131.571	131.602
				Medium Vegetation	-0.056	-0.025
213) ✔	**1A.14.VVA.MV**					
		724983.316	3344412.31	112.231	112.308	112.3
				Medium Vegetation	0.077	0.069
214) ✔	**2.11.VVA.MV**					
		799164.765	3498794.18	83.111	83.208	83.226
				Medium Vegetation	0.097	0.115
215) ✔	**2.4.VVA.MV**					
		765881.374	3468464.576	136.45	136.47	136.489
				Medium Vegetation	0.02	0.039
216) ✔	**2.5.VVA.MV**					
		759226.258	3475757.484	128.064	128.115	128.117
				Medium Vegetation	0.051	0.053
217) ✔	**2.6.VVA.MV**					
		772127.888	3473976.214	150.12	150.125	150.13
				Medium Vegetation	0.005	0.01

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
218)	☑ **2.69.VVA.MV**					
		776108.927	3431838.897	112.264	112.323	112.294
				Medium Vegetation	0.059	0.03
219)	☑ **2.9.VVA.MV**					
		785352.233	3489429.829	86	85.996	86.004
				Medium Vegetation	-0.004	0.004
220)	☑ **3.1.VVA.MV**					
		779964.857	3408187.808	101.304	101.329	101.313
				Medium Vegetation	0.025	0.008
221)	☑ **3.10.VVA.MV**					
		789144.58	3361709.853	75.519	75.754	75.746
				Medium Vegetation	0.235	0.227
222)	☑ **3.21.VVA.MV**					
		791363.218	3395031.315	102.117	102.139	102.134
				Medium Vegetation	0.022	0.017
223)	☑ **3.6.VVA.MV**					
		782432.368	3373391.843	90.483	90.448	90.472
				Medium Vegetation	-0.035	-0.011
224)	☑ **5.30.VVA.MV**					
		971077.112	3548484.773	60.384	60.217	60.24
				Medium Vegetation	-0.167	-0.144

	ID					
		Survey X	**Survey Y**	**Z1**	**Z DEM**	**Z LAS**
				LC Type	**ΔZ DEM**	**ΔZ LAS**
225)	☑ **5.53.VVA.MV**					
		1021704.097	3449783.998	31.471	31.466	31.485
				Medium Vegetation	-0.005	0.014

LAS

Nonvegetated Vertical Accuracy
LandCover Type: Bare Ground, Hard Pavement, Packed Sand

Minimum DZ: -0.134

Maximum DZ: 0.097

Mean DZ: -0.016

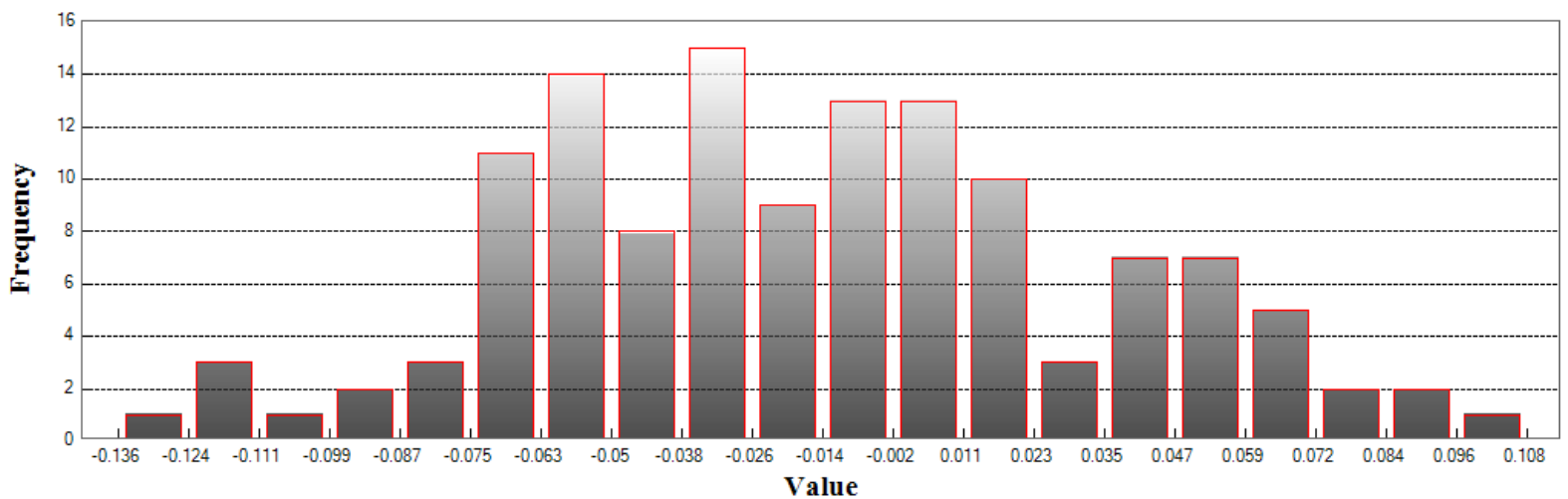Mean Magnitude DZ: 0.202

Number Observations: 130

Standard Deviation DZ: 0.048

RMSE Z: 0.05

95% Confidence Level Z: 0.098

Units: Meters

Histogram
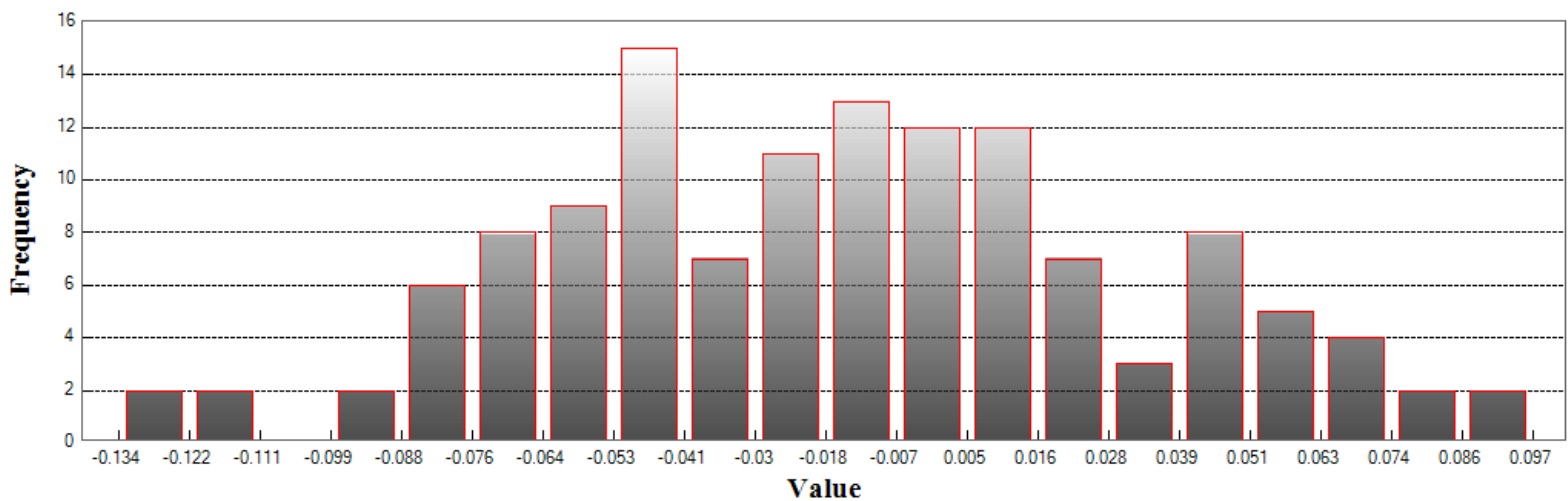
Min: -0.134

Max: 0.097

Number Of Bins: 20

Bin Interval: 0.012

LAS (Continued)

> ## Vegetated Vertical Accuracy
> LandCover Type: High Vegetation
>
> Minimum DZ: -0.155
>
> Maximum DZ: 0.173
>
> Mean DZ: 0.038
>
> Mean Magnitude DZ: 0.233
>
> Number Observations: 42
>
> Standard Deviation DZ: 0.057
>
> RMSE Z: 0.068
>
> 95th Percentile: 0.124
>
> Units: Meters

Histogram
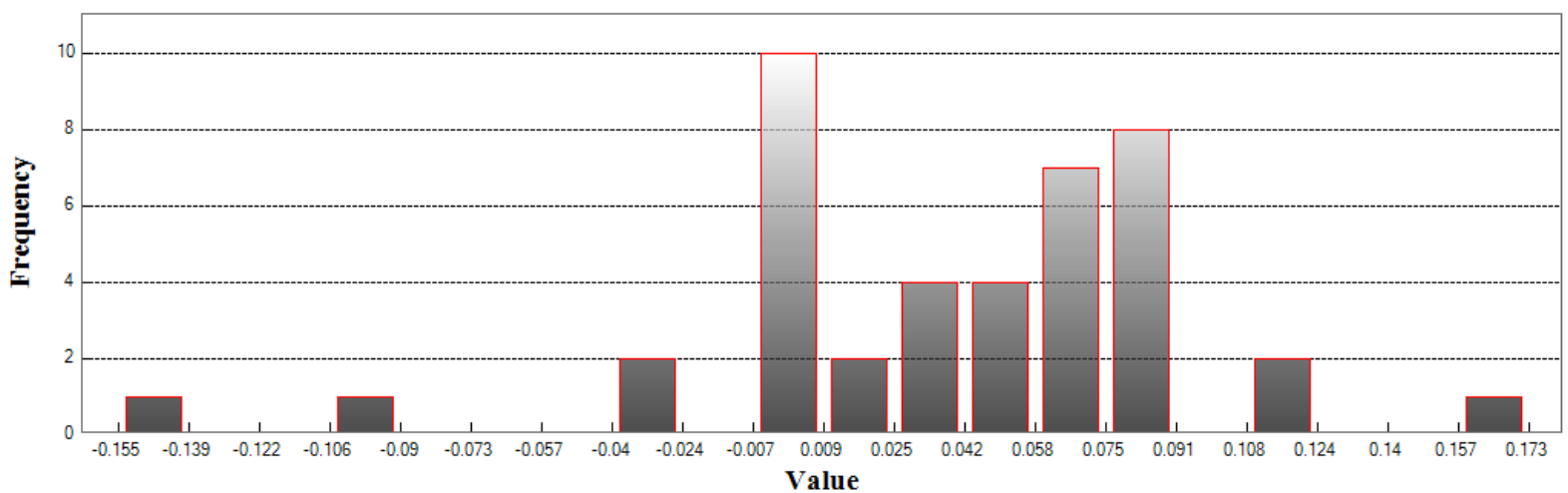
Min: -0.155

Max: 0.173

Number Of Bins: 20

Bin Interval: 0.016

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: -0.157

Maximum DZ: 0.186

Mean DZ: 0.037

Mean Magnitude DZ: 0.252

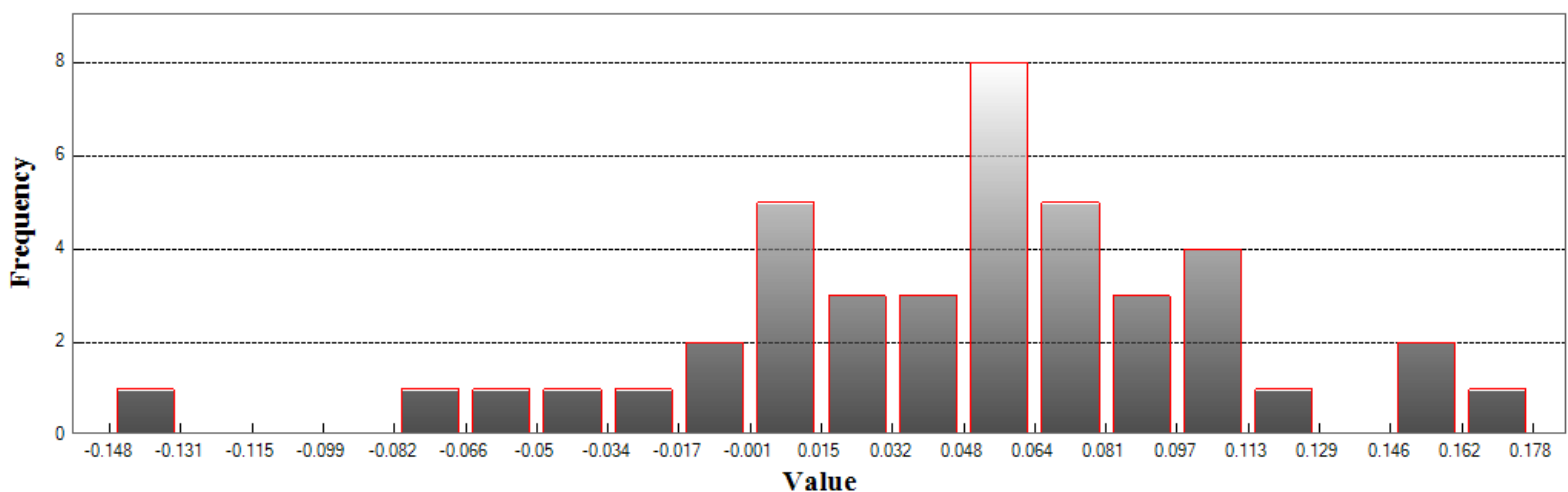Number Observations: 35

Standard Deviation DZ: 0.069

RMSE Z: 0.077

95th Percentile: 0.137

Units: Meters

Histogram
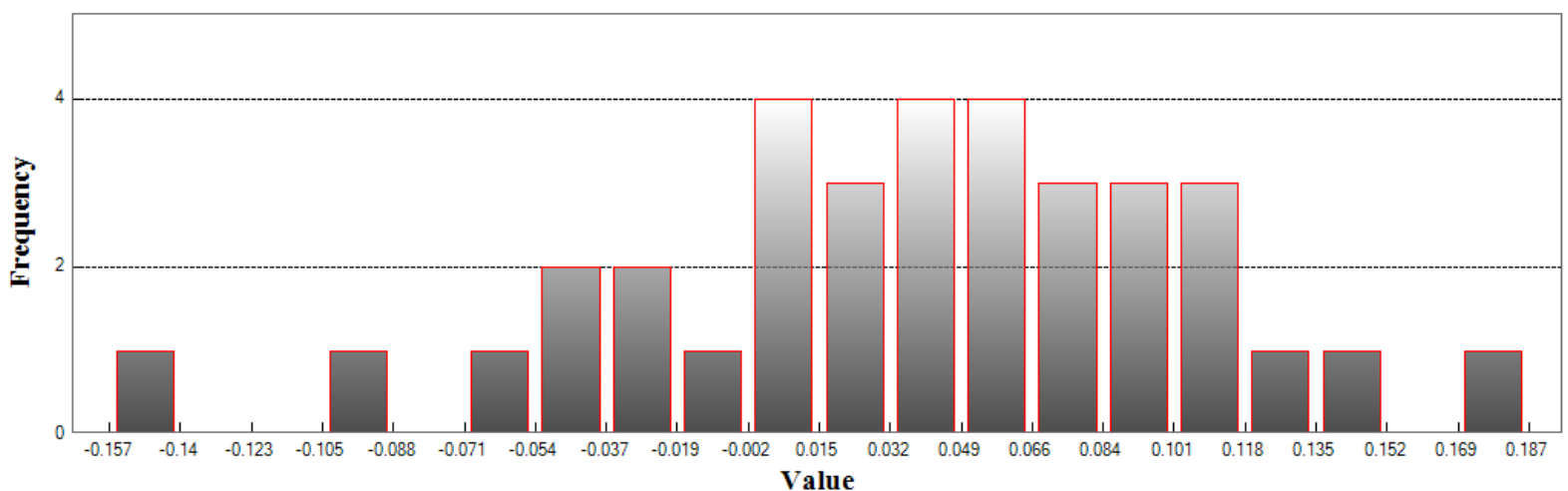
Min: -0.157

Max: 0.186

Number Of Bins: 20

Bin Interval: 0.017

LAS (Continued)

> ## Vegetated Vertical Accuracy
> LandCover Type: Medium Vegetation
>
> Minimum DZ: -0.144
>
> Maximum DZ: 0.227
>
> Mean DZ: 0.036
>
> Mean Magnitude DZ: 0.236
>
> Number Observations: 18
>
> Standard Deviation DZ: 0.074
>
> RMSE Z: 0.081
>
> 95th Percentile: 0.144
>
> Units: Meters

Histogram
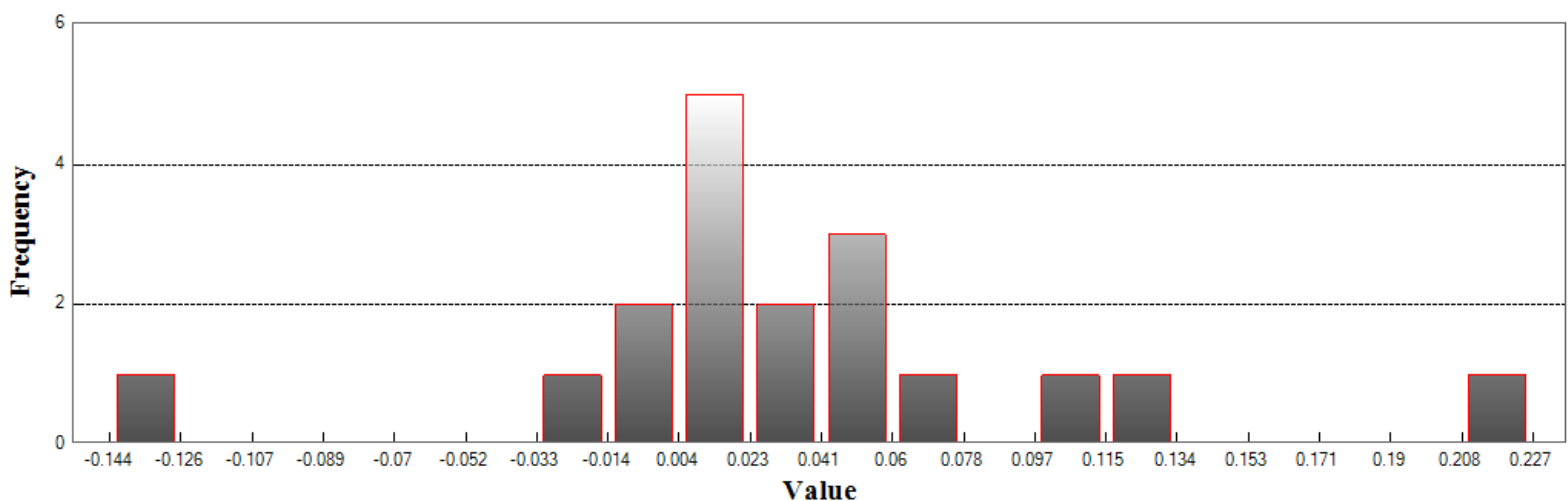
Min: -0.144

Max: 0.227

Number Of Bins: 20

Bin Interval: 0.019

DEM

> ## Nonvegetated Vertical Accuracy
> LandCover Type: Bare Ground, Hard Pavement, Packed Sand
>
> Minimum DZ: -0.136
>
> Maximum DZ: 0.108
>
> Mean DZ: -0.015
>
> Mean Magnitude DZ: 0.204
>
> Number Observations: 130
>
> Standard Deviation DZ: 0.049
>
> RMSE Z: 0.051
>
> 95% Confidence Level Z: 0.1
>
> Units: Meters

Histogram

Min: -0.136

Max: 0.108

Number Of Bins: 20

Bin Interval: 0.012

DEM (Continued)

> Vegetated Vertical Accuracy
> LandCover Type: High Vegetation
> Minimum DZ: -0.148
> Maximum DZ: 0.179
> Mean DZ: 0.047
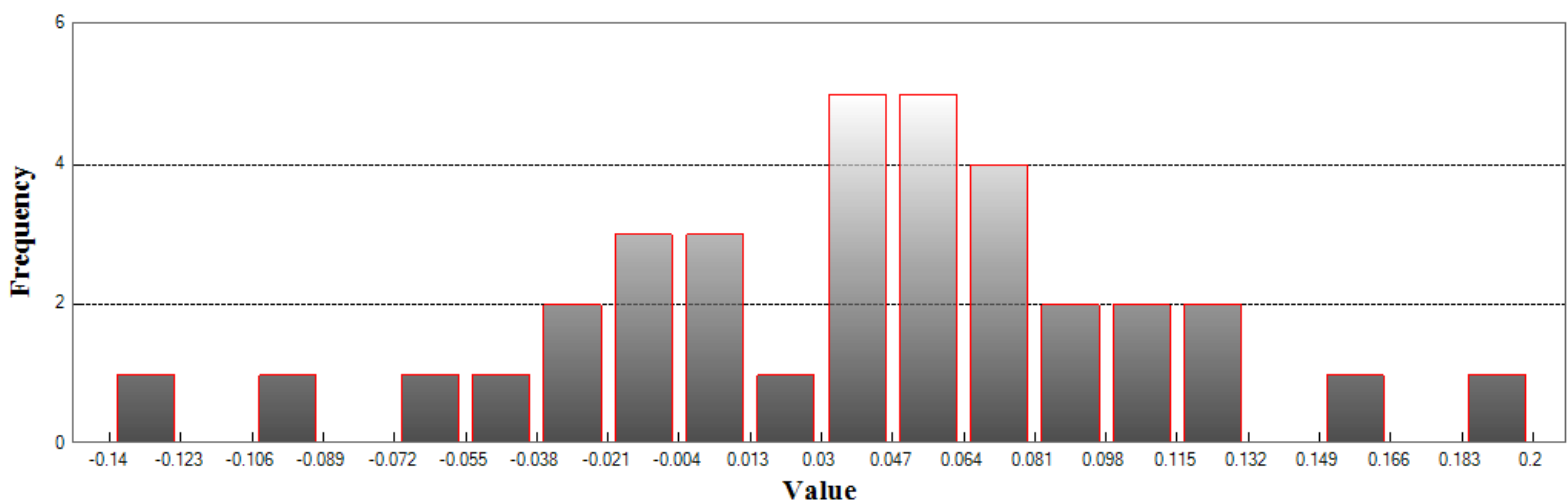> Mean Magnitude DZ: 0.253
> Number Observations: 42
> Standard Deviation DZ: 0.063
> RMSE Z: 0.077
> 95th Percentile: 0.151
> Units: Meters

Histogram

Min: -0.148

Max: 0.179

Number Of Bins: 20

Bin Interval: 0.016

DEM (Continued)

> ## Vegetated Vertical Accuracy
> LandCover Type: Low Vegetation
> Minimum DZ: -0.139
> Maximum DZ: 0.2
> Mean DZ: 0.039
> Mean Magnitude DZ: 0.255
> Number Observations: 35
> Standard Deviation DZ: 0.07
> RMSE Z: 0.08
> 95th Percentile: 0.139
> Units: Meters

Histogram

Min: -0.139

Max: 0.2

Number Of Bins: 20

Bin Interval: 0.017

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Medium Vegetation

Minimum DZ: -0.167

Maximum DZ: 0.235

Mean DZ: 0.03

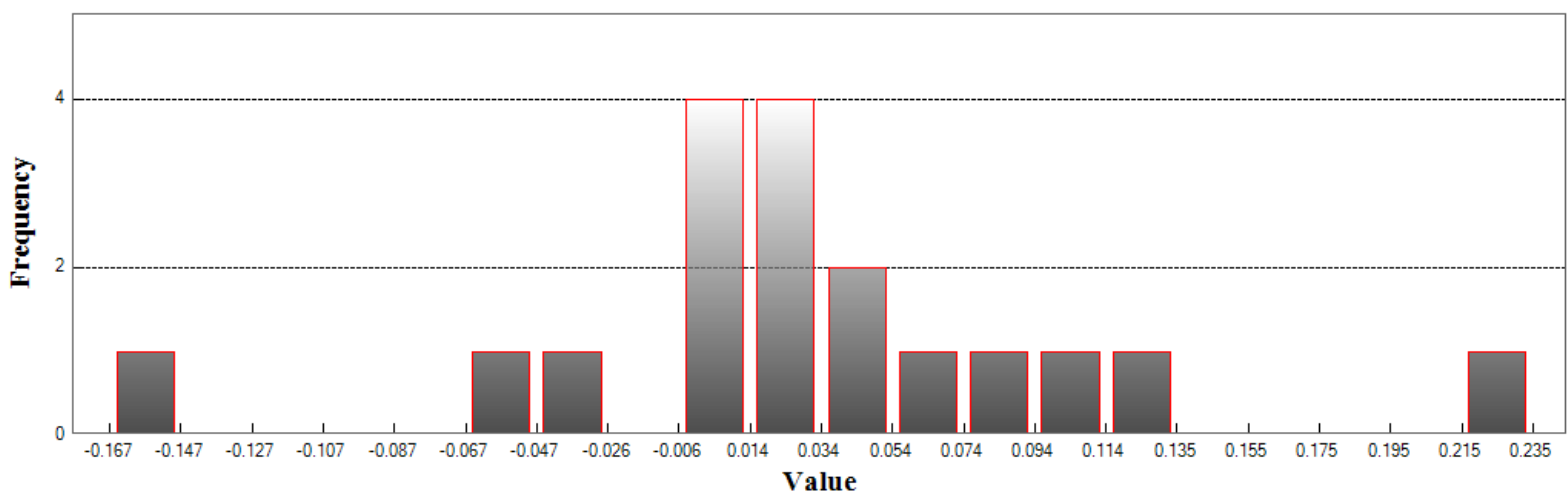Mean Magnitude DZ: 0.244

Number Observations: 18

Standard Deviation DZ: 0.082

RMSE Z: 0.085

95th Percentile: 0.167

Units: Meters

Histogram

Min: -0.167

Max: 0.235

Number Of Bins: 20

Bin Interval: 0.02