LiDAR Project Report

140G0218F0179,
FL SOUTHWEST 2018 D18

Prepared For:

United States Geological Survey

USGS
science for a changing world

Prepared By:

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DAS
Digital Aerial Solutions

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Project Report
LiDAR Collection, Processing, and QA/QC

FL_Southwest_2018_D18

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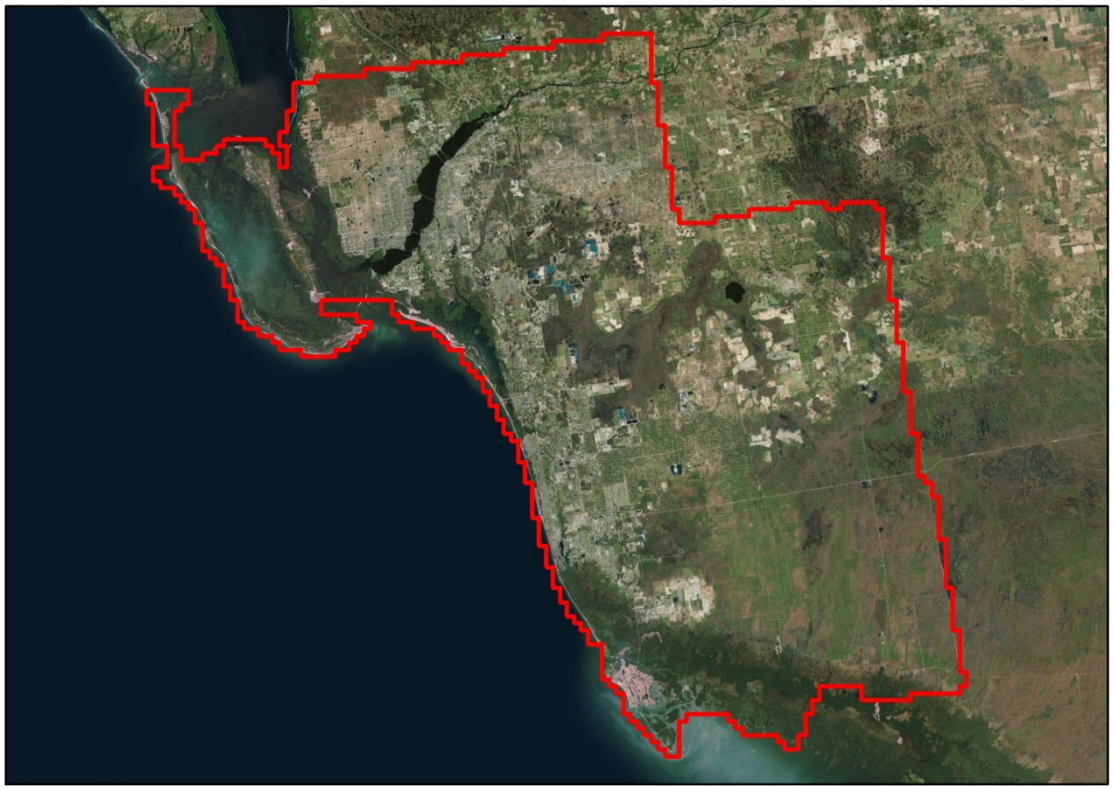
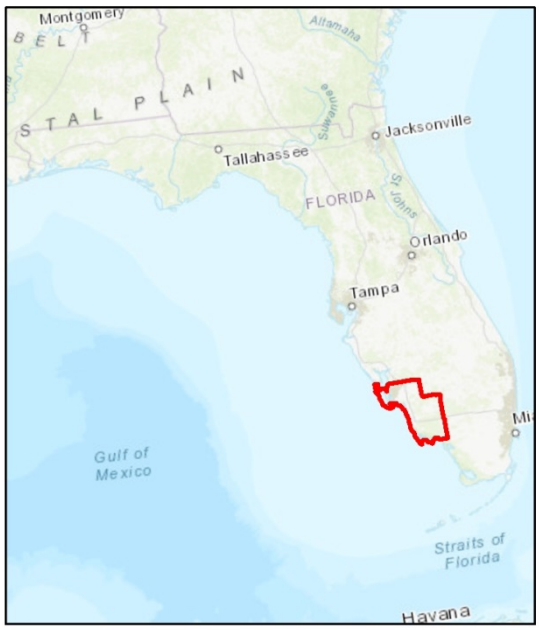
FL Southwest 2018 D18





0 5 10 20 30 40
Miles

Projected Coordinate System:
NAD_1983_2011_Contiguous_USA_Albers
Projection: Albers
False_Easting: 0.00000000
False_Northing: 0.00000000
Central_Meridian: -96.00000000
Standard_Parallel_1: 29.50000000
Standard_Parallel_2: 45.50000000
Latitude_Of_Origin: 23.00000000
Linear Unit: Meter

Geographic Coordinate System:
GCS_NAD_1983_2011
Datum: D_NAD_1983_2011
Prime Meridian: Greenwich
Angular Unit: Degree

Image 1: FL SOUTHWEST 2018 D18

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Abbreviations

ANPD – Aggregate Nominal Pulse Density
ASPRS – American Society for Photogrammetry and Remote Sensing
DEM – Digital Elevation Model
DSM – Digital Surface Model
DTM – Digital Terrain Model
GSD – Ground Sample Distance
GNSS - Global Navigation Satellite System
GPS – Global Positioning System
IMU – Inertial Measurement Unit
INS – Inertial Navigation System
NPD − Nominal Pulse Density
NMAS − National Map Accuracy Standard
NPS − Nominal Pulse Spacing
NSSDA − National Standard for Spatial Data Accuracy
NVA − Non-vegetated Vertical Accuracy
PDOP – Airborne GPS positional dilution of precision
PPSM – Points Per Square Meter
QL2 – USGS Quality Level 2
RMSE − root-mean-square-error
RMSEr − the horizontal linear RMSE in the radial direction; includes both x- and y-coordinate errors.
RMSEx − the horizontal linear RMSE in the X direction (Easting)
RMSEy − the horizontal linear RMSE in the Y direction (Northing)
RMSEz − the vertical linear RMSE in the Z direction (Elevation)
RMSDz − root-mean-square-difference in elevation (z)
SBET – Smooth Best Estimate of Trajectory
TIN – Triangulated Irregular Network
USGS – United States Geological Survey
VVA − Vegetated Vertical Accuracy

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 FL SOUTHWEST 2018 D18. The area encompasses approximately 2,347 square miles. Aerial LiDAR data were collected utilizing a Leica ALS80 aerial LiDAR sensor. The ALS80 is a discrete return topographic LiDAR mapping system manufactured by Leica Geosystems. LiDAR data collected for the FL SOUTHWEST 2018 D18 LiDAR survey has an Aggregate Nominal Pulse (ANPS) spacing of USGS Quality Level 1 (QL1) at 0.35 meters, and includes up to 4 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)s, 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 1,000 Meters x 1,000 Meters grid. Tile name is based on the Albers National Indexing Scheme.

2 Spatial Reference System

The spatial reference of the data is as follows:

Horizontal Spatial Reference

- Coordinates: Albers Conical Equal Area
    - Meters (to 3 decimal places)
- Datum: North American Datum 1983 (2011)
    - Meters (to 3 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)
    - Meters (to 3 decimal places)

3 LiDAR Acquisition

3.1 Survey Area

The FL SOUTHWEST 2018 D18 LiDAR survey covers approximately 2,347 square miles for the Quality Level-1 (QL1) area covering part of Lee and Collier County in FL. The flight plan consisted of 355 survey lines and 2 control lines.

Image 2: FL SOUTHWEST 2018 D18 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 for QL1 Area of Interest is no less than 8ppsm. The project parameters are summarized below.

Parameter	QL1
Flying Height Above Ground Level:	3,669 feet
Nominal Sidelap:	30%
Nominal Speed Over Ground:	155 Knots
Field of View:	27°
Laser Rate:	498.0 kHz
Scan Rate:	60.3 Hz
Maximum Cross Track Spacing:	0.38 meters
Maximum Along Track Spacing:	0.66 meters
Average point Spacing:	0.29 meters

Table 1: Flight Parameters

3.3 Acquisition Mission

The acquisition mission for FL SOUTHWEST 2018 D18 LiDAR survey was coordinated for optimal collection conditions (weather, leaf off, ground water level, tides, etc.). Collection began on May 07, 2018 and was completed on March 01, 2019.

3.4 Airborne GPS/IMU

Airborne global positioning system (GPS) and inertial measurement unit (IMU) data were 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 were collected at a frequency of 200Hz.

Aircraft	Sensor	GPS Lever Arm (m)	IMU Lever Arm (m)
C421-N112MJ	ALS80 SN#8137	X: -0.169, Y: -0.007, Z: -1.369	X: -0.450, Y: 0.164, Z: -0.169
C421-N13RF	ALS80 SN#8235 HP	X: -0.156, Y: -0.048, Z: -1.376	X: -0.450, Y: 0.164, Z: -0.169
C421-N112MJ	ALS80 SN#8253UP	X: -0.197, Y: -0.054, Z: -1.366	X: -0.450, Y: 0.164, Z: -0.169

Table 2: Aircraft and Lever Arms

GPS data were 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 Page Field Airport Ft. Myers FL. Ground GPS observations were collected at a frequency of 2Hz. The use of sux base stations was employed to support data acquisition for the project area. The following table's (Table 3) list the positions used in to post-process the airborne GPS.

Airport – Station Name	Latitude	Longitude	Ellipsoid (m)
Immokalee Reginal (KIMM) – IMM	26° 25' 12.45612"	-81° 24' 13.28198"	-15.065
Immokalee Reginal (KIMM) – IMM2	26° 25' 12.33453"	-81° 24' 13.26692"	-15.047
Immokalee Reginal (KIMM) – KIMM3	26° 25' 14.41521"	-81° 24' 11.43829"	-14.564
Immokalee Reginal (KIMM) – KIMM4	26° 25' 14.41134"	-81° 24' 11.58717"	-14.576
Immokalee Reginal (KIMM) – KIMM05	26° 25' 12.54445"	-81° 24' 13.16423"	-15.16
Immokalee Reginal (KIMM) – KIMM11	26° 25' 12.69145"	-81° 24' 13.16984"	-15.142
Immokalee Reginal (KIMM) – IMM	26° 25' 12.45612"	-81° 24' 13.28198"	-15.065

Table 3: Base Stations locations

4 LiDAR Processing

4.1 Acquisition Post-Processing

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

Airborne GPS and IMU data were post processed to develop a Smooth Best Estimate of Trajectory (SBET) for each mission, using Leica's Inertial Explorer software. Inertial Explorer applies the reference lever arms for the GPS and IMU measurement system during the processing to determine the trajectory (position and orientation) of the LiDAR sensor during the acquisition mission. The lever arm values were resolved in Inertial Explorer to validate the measurement made during sensor installation in the aircraft.

Raw LiDAR sensor ranging data and the final sensor trajectory from Inertial Explorer were processed in Leica's Cloud Pro 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 FL SOUTHWEST 2018 D18 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 sight calibration), and mirror deformation constants (scaling). The Bore sight calibration was connected at Lakeland Linder Regional Airport (KLAL) in Lakeland Florida. The most recent bore sight calibration was conducted on 07/12/2017 for SN#8235 and on 07/25/2017 for SN#8137.

The manufacturer specific calibration parameters are applied in Leica's Cloud Pro software for the Leica ALS80 sensor system. Terrasolid's Terramatch software was used to calculate the IMU bore-sight and mirror scale parameters for the FL SOUTHWEST 2018 D18 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-sight 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-sight and mirror scale parameters with the automated algorithms. Manual estimation of the bore-sight calibration 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-sight and mirror scale calculation step; and an absolute step, where groups of lines are leveled to project ground control.

For FL SOUTHWEST 2018 D18 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 +0.065 meters.

Point Id	Easting	Northing	Orth. Height
18.GCP.BG	1393901.732	508926.581	2.163
21.GCP.BG	1419697.757	501676.114	6.487
26.GCP.BG	1429616.091	463843.293	3.944
9.GCP.BG	1436389.504	515198.910	3.599
1.GCP.HQ	1461949.124	486400.088	9.868
11.GCP.HP	1421160.030	515775.396	4.527
12.GCP.HP	1414477.425	511945.738	3.549
13.GCP.HP	1407732.592	507207.206	2.678
15.GCP.HP	1392278.940	499277.734	0.550
16.GCP.HP	1383131.521	504929.676	1.462
19.GCP.HP	1396203.759	495752.786	1.373
200.GCP.HP	1435679.153	432080.628	1.777
201.GCP.HP	1439043.017	428545.648	2.924
22.GCP.HP	1421542.834	494731.981	7.138
24.GCP.HP	1424540.036	483259.417	5.433
27.GCP.HP	1431312.360	453097.729	2.706
30.GCP.HP	1429249.444	489581.244	8.368
33.GCP.HP	1462692.951	472640.757	6.231
34.GCP.HP	1473557.680	475234.316	6.088
36.GCP.HP	1472235.821	457683.876	4.790
37.GCP.HP	1473763.653	448206.227	3.808
39.GCP.HP	1482843.086	431358.634	1.477
53.GCP.HP	1436420.222	463276.151	4.793
55.GCP.HP	1439397.896	461609.580	3.882
6.GCP.HP	1439262.415	504991.841	7.560
64.GCP.HP	1451728.135	444155.475	1.979
73.GCP.HP	1445536.039	469605.269	4.875
8.GCP.HP	1437914.195	512775.145	5.598
2.GCP.PS	1472081.289	488220.258	8.343
4.GCP.PS	1448767.200	494094.675	8.491

Point Id	Easting	Northing	Orth. Height
5.GCP.PS	1439986.327	495159.569	9.572
62.GCP.PS	1450718.702	450241.343	2.462

Table 5: Ground Control Points Units: Meters

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 1,000 Meters x 1,000 Meters tile index in LAS 1.4 format tiles for point cloud classification and derived in LAS 1.4 format for product creation.

Tiled point cloud data were processed in Terrasolid's Terrascan software to assign initial classification values. The Terrascan software provides a number of routines to automate and assign points to their appropriate classes. Points left unclassified by the classification algorithm remain as Class 1.

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

```
Class 1 – Processed, but unclassified
Class 2 – Bare-earth ground
Class 7 – Low Noise (low, manually identified, if necessary)
Class 6 – Buildings
Class 9 – Water
Class 17 – Bridge Decks
Class 18 – High Noise (high, manually identified, if necessary)
Class 20 – Ignored Ground (breakline proximity)
Class 21 – Snow
Class 22 – Temporal exclusion
```

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 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 where collected directly from triangulated irregular network (TIN) surface models built from the classified point clouds and intensity raster's. They were then conflated using the LiDAR point cloud. Breaklines were delivered ESRI GDB format.

The data collected for the FL SOUTHWEST 2018 D18 LiDAR survey maintained significant point density in the water, marsh, and swamp, limiting the usefulness of point density as guiding factor in breakline placement.

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 FL SOUTHWEST 2018 D18 LiDAR project, two base stations were run to meet this requirement. 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 Leica's Cloud Pro 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.

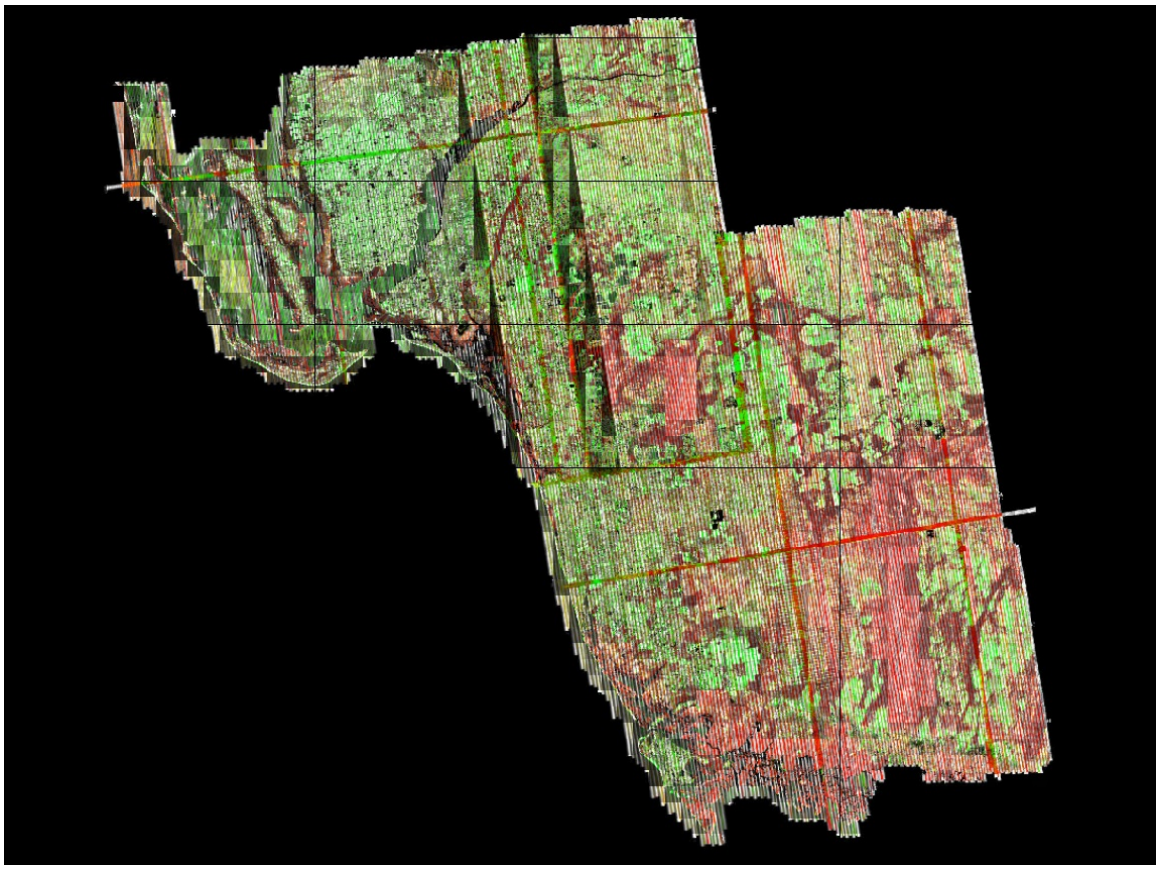


Image 3: FL SOUTHWEST 2018 D18 LiDAR QL1 Intensity Image

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

The root mean square error or (RMSE) of the data set was produced to meet ASPRS "Positional Accuracy Standards for Digital Geospatial Data" (2014) for a 0.226 (Meters) RMSEx / RMSEy Horizontal Accuracy Class which equates to Positional Horizontal Accuracy =+/- 0.783 (Meters) at a 95% confidence level.

Estimated LiDAR Horizontal:	Meters
Error Per Point ($RMSE_R$)	0.320
Error Per Point ($RMSE_X$/$RMSE_Y$)	0.226
Per Point at 95% confidence level	0.783

Table 6: Estimated LiDAR Horizontal Accuracy

Absolute vertical accuracy assessments for the point cloud data are made against ground check point data. For the FL SOUTHWEST 2018 D18 LiDAR, ground check point data was collected using Florida Department of Transportation's real-time kinematic (RTK) network.

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

Local TIN models of the elevation points are built around each ground check point. The TIN model elevation is sampled at the horizontal position of the ground check point. Comparison of the TIN model elevation and ground check point survey elevation values were used to calculate the Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA) of the swath point clouds. The accuracy was calculated in the NRCS State plane coordinate system. The NVA of the TIN tested RMSEz 0.089 Meters and 0.175 Meters at the 95% confidence level in open terrain. NVA of the DEM tested at an RMSEz of 0.091 US Feet and 0.179 Meters at the 95% confidence level in open terrain. The VVA of the TIN tested at 0.190 Meters at the 95% percentile level in vegetated terrain. VVA of the DEM tested at 0.229 Meters at the 95% percentile level in vegetated terrain. The full calculations for all check points can be found in Appendix B.

Tested Accuracy (Meters)	$RMSE_Z$	NVA	VVA
Classified LiDAR	0.089	0.175	0.190
Digital Elevation Model	0.091	0.179	0.229

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

Total #	# NVA	# VVA
139	79	60

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 GDB format were reviewed for topological consistency and correct elevation. Breaklines features are tested for monotonicity and vertical variance with LiDAR point cloud as well as not having overlaps or dangles.

5.3 Digital Elevation Models

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

Appendix A. Flight Logs

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest							Sensor Operator/s	
								Jackson Beebe	
Date/Julian:	6/26/2018	ALS80 SN# 8235_HP		Disk Drive MM70		Flight Plan(s):		Pilot/s	
Hobbs End	6443.6			3		USGS_FL_Southwest		MWAZ	
Hobbs ST	6439.1		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft / Airport Idnt:
Flight Time	4.5		B	3,500		155	TEMP	1.500	207SS / KIMM

Lift	#	Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A	1	1041	180626_080921	8:09	8:22	3,577	186	155	646	21	1.4	0.7	
	2	1042	180626_082715	8:26	8:40	3,524	0	154	637	21	1.4	0.7	
	3	1122	180626_085106	8:50	9:03	3,423	186	150	627	20	1.2	0.6	
	4	1123	180626_090729	9:07	9:19	3,419	0	156	619	20	1.1	0.6	
	5	1124	180626_092421	9:23	9:36	3,554	186		610	21	1.0	0.6	
	6	1125	180626_094019	9:39	9:52	3,554	0		602	16	1.5	0.6	
	7	1126	180626_095643	9:56	10:08	3,580	186		593	18	1.1	0.9	
	8	1127	180626_101210	10:12	10:23		0		585	18	1.2	0.7	
	9	1128	180626_102808	10:27	10:40		186		577	18	1.2	0.7	
	10	1129	180626_104405	10:43	10:55	3,580	0		568	18	1.4	0.7	
	11	1130	180626_105935	10:58	11:11	3,580	186		560	18	1.1	0.7	
	12	1131	180626_111517	11:14	11:27	3,501	0		552	21	1.3	0.7	
	13	1132	180626_113116	11:30	11:43	3,560	186		543	20	1.3	0.6	
	14	1121	180626_114928	11:48	12:01	3,577	95		535	21	1.4	0.6	
	15	1182	180626_120900	12:08	12:09	3,593	005		526	20	1.2	0.6	
	16	1185	180626_121427	12:14	12:15	3,593	184		525	21	1.1	0.5	
	17	1184	180626_121939	12:18	12:19	3,609	94		525	20	1.1	0.6	
	18	1183	180626_122446	12:24	12:25	3,609	224		524	22	1.1	0.6	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/29/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	85.1			3		USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	81.4		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.7		A	35,000		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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		536	181029_104322	10:43	10:55	3550	185°	159	523	19	1.2	0.6	ALS
		537	181029_105906	10:59	11:12	3570	8°	137	514	19	1.3	0.6	Range GATE
		538	181029_111522	11:15	11:27	3575	185°	164	505	21	1.3	0.6	
		539	181029_113229	11:34		3558	5°	123	496	21	1.1	0.6	Refly SOW Error
		540	181029_122307	12:22	12:37	3544	8°	136	483	23	1.3	0.6	ALS
		541	181029_123929	12:39	12:51	3550	186°	172	474	25	1.2	0.6	
		542	181029_125611	12:56	13:08	3520	4°	133	465	22	1.4	0.6	ALS
		543	181029_131244	13:12	13:24	3536	185°	159	456	21	1.4	0.7	ALS
		544	181029_132905	13:29	13:42	3487	001..8	145	447	20	1.4	0.7	
		545	181029_134531	13:45	13:57	3512	184°	154	438	22	1.7	0.6	
		539	181029_120559	12:06	12:19	3568	184°	166	492	22	1.2	0.6	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/29/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	86.7			3		USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	85.1		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	1.6		B	35,000		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	546	181029_150252	15:02	15:15	3499	187°	151	429	19	1.3	0.7	ALS
	2	547	181029_151859	15:18	15:31	3476	6°	135	420	20	1.2	0.7	
	3	548	181029_153447	15:34	15:46	3515	186°	160	411	16	1.5	0.8	
	4	549	181029_155128	15:51	16:03	3511	8°	125	402	15	1.5	0.8	
	5	550	181029_160734	16:07	16:19	3519	184°	160	393	15	1.4	0.8	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest							Sensor Operator/s	
								Cynthia Williams	
Date/Julian:	10/29/2018	ALS80 SN # 8137- HP		Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	90.3			3	USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	86.7		LIFT	Target Altitude (MSL)	TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.6		C	3,500	155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	551	181029_190414	19:04	19:21	3469	185°	164	384	19	1.1	0.6	
	2	552	181029_192439	19:24	19:41	3510	4°	135	373	19	1.2	0.6	ALS
	3	553	181029_194448	19:44	20:01	3524	187°	157	361	17	1.3	0.8	ALS
	4	554	181029_200432	20:04	20:21	3464	186°	132	350	19	1.2	0.6	
	5	555	181029_202458	20:24	20:41	3456	182°	154	338	22	1.1	0.5	8 Miles fire smoke
	6	556	181029_204528	20:45	21:01	3410	3°	136	326	22	1.1	0.5	ALS
	7	557	181029_210515	21:05	21:21	3420	187°	171	314	20	1.3	0.6	
	8	558	181029_212515	21:25	21:42	3438	7°	137	302	19	1.3	0.6	ALS
	9	559	181029_214520	21:45	22:01	3483	186°	150	296	20	1.1	0.6	
	10	560	181029_220445	22:04	22:21	3429	8°	134	278	18	1.2	0.6	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/30/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	95.3			4		USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	91.7		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.6		A	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	561	181030_201028	20:10	20:27	3415	187°	160	611	21	1.1	0.6	
	2	562	181030_203023	20:30	20:46	3448	4°	147	599	23	1.1	0.6	
	3	563	181030_205018	20:50	21:06	3484	193°	154	587	22	1.2	0.6	
	4	564	181030_210952	21:09	21:25	3490	5°	138	576	21	1.2	0.6	
	5	565	181030_212942	21:29	21:45	3496	187°	159	565	21	1.2	0.6	
	6	566	181030_214913	21:49	22:04	3511	4°	140	553	18	1.3	0.7	
	7	567	181030_221706	22:17	22:32	3504	187°	156	542	20	1.2	0.7	
	8	568	181030_223613	22:36	22:51	3467	6°	139	530	19	1.2	0.7	
	9	569	181030_225515	22:55	23:10	3483	187°	162	519	20	1.2	0.7	
	10	570	181030_231405	23:13	23:28	3502	9°	130	508	21	1.3	0.7	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/30/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	98.5					USGS_FL_Southwest			Dave Carlson	
Hobbs ST	95.3		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.2		B	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	571	181031_002510	:25	:40	3387	187°	146	497	21	1	0.6	
	2	572	181031_004406	:44	:59	3491	10°	129	486	19	1.1	0.7	
	3	573	181031_010239	1:02	1:17	3491	185°	156	475	17	1.5	0.9	
	4	574	181031_012100	1:21	1:35	3509	5°	136	464	18	1.2	0.7	
	5	575	181031_013926	1:39	1:54	3506	187°	154	453	19	1.2	0.6	
	6	576	181031_015801	1:58	2:12	3532	8°	133	447	20	1.3	0.6	
	7	577	181031_021617	2:16	2:31	3498	186°	161	430	22	1.1	0.6	
	8	578	181031_023415	2:34	2:48	3519	7°	135	419	20	1.4	0.6	
	9	579	181031_025241	2:52	3:07	3506	186°	154	408	21	1.4	0.6	
	10	580	181031_031049	3:10	3:25	3502	7°	132	397	22	1.2	0.5	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/31/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1803.6			4		USGS_FL_Southwest			Mike Wasielewski	
Hobbs ST	1800		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.6		A	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	581	181101_022742	2:27	2:44	3518	187°	146	386	21	1.3	0.6	ALS
	2	582	181101_024715	2:47	3:02	3433	6°	150	375	22	1.4	0.6	
	3	583	181101_030651	3:06	3:22	3406	187°	132	364	23	1.2	0.6	
	4	584	181101_032640	3:26	3:41	3408	7°	159	352	22	1.1	0.6	
	5	585	181101_034602	3:45	4:01	3428	184°	143	341	21	1.1	0.6	ALS
	6	586	181101_040558	4:05	4:20	3412	6°	167	329	21	1.1	0.6	
	7	587	181101_042535	4:25	4:41	3472	185°	145	318	20	1.2	0.6	ALS
	8	588	181101_044507	4:45	5:00	3472	1°	163	306	22	1.1	0.6	ALS
	9	589	181101_052348	5:04	5:20	3467	187°	148	294	21	1.2	0.6	ALS
	10	590	181101_052756	5:27	5:43	3485	7°	186	282	22	1.1	0.6	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	11/1/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1807			704		USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	1805		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	2		A	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	591	181101_212359	21:23	21:40	3518	187°	129	745	20	1.1	0.6	
	2	592	181101_214344	21:44	21:59	3323	7°	168	732	18	1.4	0.7	
	3	593	181101_220316	22:03	22:20	3354	186°	131	720	20	1.3	0.7	
	4	594	181101_222306	22:23	22:38	3357	6°	155	708	19	1.2	0.7	10 miles in clouds
	5	595	181101_224228	22:42	23:00	3421	187°	132	696	19	1.2	0.7	clouds drop 3k ALT

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest							Sensor Operator/s	
								Cynthia Williams	
Date/Julian:	11/5/2018	ALS80 SN # 8137- HP		Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	1811.6			704	USGS_FL_Southwest			Mike Wasielewski	
Hobbs ST	1808.6		LIFT	Target Altitude (MSL)	TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3		A	3,500	155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	596	181105_235202	23:51	:8	3500	186°	147	684	20	1.1	.6.	
	2	597	181106_001038	:10	:25	3531	5°	156	672	21	1	0.6	ALS
	3	598	181106_002911	:29	:44	3545	187°	151	661	16	1.7	1	
	4	599	181106_004742	:47	1:02	3571	7°	147	650	17	1.1	0.7	ALS
	5	600	181106_010636	1:06	1:21	3514	181°	158	639	18	1.2	0.7	
	6	601	181106_012532	1:25	1:40	3533	10°	148	627	18	1.3	0.7	
	7	602	181106_014500	1:44	2:00	3522	187°	151	616	22	1.1	0.6	
	8	603	181106_020358	2:03	2:19	3507	7°	160	605	21	1.2	0.6	Range Gate

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest							Sensor Operator/s	
								Cynthia Williams	
Date/Julian:	11/6/2018	ALS80 SN # 8137- HP		Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	1814.2			704	USGS_FL_Southwest			Mike Wasielewski	
Hobbs ST	1811.6		LIFT	Target Altitude (MSL)	TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	2.6		A	3,500	155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	604	181106_130826	13:08	13:23	3487	186°	144	592	18	1.2	0.6	ALS
	2	605	181106_132706	13:27	13:42	3502	5°	164	581	19	1	0.6	
	3	606	181106_134553	13:45	14:01	3538	186°	165	570	19	1.1	0.6	
	4	607	181106_140454	14:05	14:19	3518	6°	163	558	18	1.2	0.6	ALS
	5	608	181106_142343	14:23	14:39	3570	186°	134	547	17	1.4	0.7	Last 3 Miles clouds
	6	609	181106_144223	14:42	14:57	3547	7°	152	536	17	1.2	0.7	Clouds at last 8 miles refly ?

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	11/7/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1819.1			704		USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	1816		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.1		A	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	610	181108_001622	:16	:31	3496	187°	151	525	17	1.1	0.7	Range Gate Auto pitch malfunction
	2	611	181108_003519	:35	:51	3524	6°	147	514	17	1.2	0.7	
	3	612	181108_005451	:55	1:10	3515	184°	151	501	18	1.1	0.6	
	4	613	181108_011348	1:13	1:28	3522	7°	150	491	18	1.2	0.6	
	5	614	181108_013316	1:33	1:40	3538	187°	151	480	20	1.1	0.6	
	6	615	181108_015242	1:52	2:08	3514	8°	152	468	22	1.2	0.6	
	7	616	181108_021202	2:11	2:27	3515	185°	151	457	21	1.4	0.6	
	8	617	181108_023101	2:31	2:46	3514	6°	153	446	21	1.4	0.6	
	9	618	181108_025011	2:50	3:05	3520	186°	149	435	22	1.1	0.6	
	10	619	181108_030935	3:09	3:24	3525	9°	154	423	19	1.2	0.6	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/24/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	76.2			3		USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	72.4		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.8		A	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	512	181025_005701	:56	1:09	3510	185°	153	736	20	1.1	0.6	ALS
	2	513	181025_011243	1:12	1:26	3520	5°	135	727	19	1.1	0.7	
	3	514	181025_012949	1:29	1:42	3517	184°	151	717	16	1.3	0.8	ALS
	4	515	181025_014525	1:45	1:58	3550	6°	138	709	17	1.2	0.7	
	5	516	181025_020218	2:02	2:14	3538	187°	150	700	18	1.2	0.7	
	6	517	181025_021914	2:19	2:31	3578	5°	153	691	18	1.4	0.6	ALS
	7	518	181025_023600	2:36	2:47	3559	186°	153	682	22	1.1	0.6	Clouds 5 miles at end of line
	8	519	181025_025200	2:51	3:04	3425	6°	141	673	22	1.2	0.6	
	9	520	181025_030824	3:08	3:20	3462	186°	154	664	22	1.4	0.6	6 miles at north end
	10	521	181025_032357	3:23	3:37	3370	6°	146	656	22	1.4	0.6	ALS
	11	522	181025_034041	3:40	3:52	3437	187°	158	647	23	1.2	0.6	
	12	523	181025_035606	3:56	4:08	3503	5°	149	639	22	1.1	0.6	ALS

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/24/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	79.9			3		USGS_FL_Southwest			Mike Wasielewski	
Hobbs ST	76.2		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.7		B	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	524	181025_052030	5:20	5:32	3518	186°	153	630	22	1.1	0.6	
	2	525	181025_053641	5:36	5:49	3527	5°	141	622	21	1.2	0.6	
	3	526	181025_055330	5:53	6:04	3520	185°	156	613	22	1.1	0.6	
	4	527	181025_060943	6:09	6:22	3517	5°	146	604	21	1.2	0.6	
	5	528	181025_062624	6:25	6:38	3504	188°	141	595	20	1.2	0.6	
	6	529	181025_064228	6:42	6:48	3504	188°	150	585	20	1.2	0.6	
	7	530	181025_065923	6:59	7:11	3520	187°	156	577	18	1.1	0.6	
	8	531	181025_071526	7:14	7:27	3531	7°	147	569	17	1.2	0.7	
	9	532	181025_073136	7:31	7:42	3524	186°	158	559	18	1.1	0.7	
	10	533	181025_074705	7:47	7:59	3257	6°	145	551	19	1	0.6	
	11	534	181025_080310	8:02	8:24	3552	192°	158	541	20	1.1	0.6	
	12	535	181025_081842	8:18	8:31	3538	6°	146	532	19	1.1	0.6	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	11/9/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1823.2					USGS_FL_Southwest			Dave Carlson	
Hobbs ST	1820.7		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	2.5		A	35,000		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	633	181109_182919	18:29	18:45	3478	188°	157	412	18	1.2	0.6	ALS
	2	632	181109_184757	18:48	18:54	3475	8°	157	401	19	1.1	0.6	
	3	620	181109_191017	19:10	19:25	3478	186°	152	397	21	1.1	0.6	
	4	621	181109_192923	19:30	19:44	3506	6°	159	385	21	1.1	0.6	Clouds right at beginning
	5	622	181109_194841	19:48	20:04	3505	187°	151	375	23	1.1	0.6	Clouds last 5 miles
	6	631	181109_201517	20:15	20:16	3507	6°	152	364	22	1.2	0.6	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Geoffrey McCall	
Date/Julian:	11/12/2018	ALS80 SN # 8137- HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1826.4					USGS_FL_Southwest			Dave Carlson	
Hobbs ST	1824.6		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	1.8		A	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	623	181112_211058	21:11	21:26	3528	185°	149	363	18	1.2	0.7	
	2	624	181112_213122	21:30	21:46	3483	8°	153	352	19	1.1	0.6	
	3	625	181112_215631	21:56	22:02	3497	187°	151	341	19	1.3	0.7	
	4	626	181112_220645	22:07	22:13	3542	5°	164	336	19	1.2	0.7	
	5	627	181112_221837	22:18	22:24	3520	187°	152	331	18	1.3	0.7	
	6	628	181112_222845	22:28	22:34	3510	6°	156	326	19	1.4	0.7	

Leica ALS80 Flight Log

Project:	18012_FL_SW_2018_D18										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	5/7/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	3698.6					18012_FL_SW_2018_D18					Keith Morrel	
Hobbs ST	3694.1		LIFT			TARGET AIRSPD (KNTS)		BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	4.5		A	3,500		155		TEMP	1.500		C421-N13RF	IMM (Immokalee, FL)

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	2	180508_022900	2:29	2:45	3521	271°	151	674	16	1.2	0.7	ALS Warning
	2	3	180508_024944	2:49	2:50	3505	0°	146	664	15	1.4	0.7	ALS Warning
	3	4	180508_025627	2:56	2:59	3515	180°	154	664	15	1.3	0.7	ALS Warning
	4	5	180508_030331	3:03	3:06	3540	0°	151	662	15	1.3	0.7	ALS Warning
	5	6	180508_031122	3:11	3:14	3575	180°	152	661	16	1.3	0.7	ALS Warning
	6	7	180508_031844	3:18	3:21	3551	359°	152	659	14	1.6	0.8	ALS Warning
	7	8	180508_032612	3:26	3:29	3493	180°	149	657	14	1.6	0.8	ALS Warning
	8	9	180508_033334	3:33	3:36	3492	360°	153	656	14	1.6	0.8	ALS Warning
	9	10	180508_034105	3:41	3:44	3505	180°	151	654	14	2.3	1	ALS Warning
	10	11	180508_034905	3:49	3:52	3480	0°	149	652	14	1.7	0.9	ALS Warning
	11	12	180508_035652	3:56	4:00	3513	181°	152	650	14	1.5	0.8	ALS Warning
	12	13	180508_040458	4:04	4:08	3483	360°	152	648	14	1.4	0.8	ALS Warning
	13	14	180508_041234	4:12	4:16	3505	180°	149	646	15	1.3	0.8	ALS Warning
	14	15	180508_042041	4:20	4:24	3490	360°	148	644	13	1.6	0.9	ALS Warning
	15	16	180508_042846	4:28	4:33	3501	180°	150	641	14	1.3	0.8	ALS Warning
	16	17	180508_043715	4:37	4:42	3489	360°	151	639	14	1.2	0.8	ALS Warning
	17	18	180508_044634	4:46	4:52	3495	178°	152	636	14	1.2	0.7	ALS Warning. Clouds 3 miles from north end.
	18	19	180508_045601	4:56	5:01	3482	360°	147	633	13	1.4	0.8	ALS Warning. Possible Clouds.
	19	41	180508_050739	5:07	5:14	3540	180°	148	631	14	1.2	0.7	ALS Warning
	20	42	180508_051848	5:18	5:25	3507	359°	152	627	13	1.4	0.8	ALS Warning
	21	43	180508_052943	5:29	5:36	3471	179°	151	623	14	1.4	0.8	ALS Warning
	22	44	180508_054044	5:40	5:47	3470	360°	150	619	15	1.2	0.7	ALS Warning
	23	45	180508_055130	5:51	5:58	3487	180°	151	616	15	1.2	0.7	ALS Warning
	24	46	180508_060226	6:02	6:09	3463	359°	150	612	14	1.3	0.8	ALS Warning
	25	47	180508_061311	6:13	6:19	3479	179°	153	608	16	1.1	0.6	ALS Warning

Leica ALS80 Flight Log

Project:	18012_FL_SW_2018_D18										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	5/8/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	3702.9					18012_FL_SW_2018_D18					Keith Morrel	
Hobbs ST	3698.6		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	4.3		B	3,500		155		TEMP		1.500	C421-N13RF	IMM (Immokalee, FL)

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	20	180508_161308	16:13	16:18	3497	359°	151	603	21	1.1	0.6	ALS Warning
	2	21	180508_162224	16:22	16:27	3565	181°	149	601	21	1.1	0.6	ALS Warning
	3	22	180508_163243	16:32	16:38	3556	0°	152	597	19	1.3	0.7	ALS Warning
	4	23	180508_164339	16:43	16:48	3565	181°	151	595	21	1.2	0.6	ALS Warning
	5	24	180508_165212	16:52	16:56	3545	360°	148	592	22	1.1	0.6	ALS Warning
	6	25	180508_170023	17:00	17:05	3553	180°	148	590	22	1.1	0.6	ALS Warning
	7	26	180508_170902	17:09	17:14	3536	1°	150	588	21	1.2	0.6	ALS Warning
	8	27	180508_171820	17:18	17:23	3565	180°	154	585	22	1.1	0.6	ALS Warning
	9	28	180508_172748	17:27	17:33	3540	360°	150	582	22	1.1	0.6	ALS Warning
	10	29	180508_173719	17:37	17:43	3569	180°	153	579	21	1.2	0.6	ALS Warning
	11	30	180508_174718	17:47	17:53	3516	358°	152	576	21	1.2	0.6	ALS Warning
	12	31	180508_175718	17:57	18:03	3491	179°	155	573	21	1.3	0.7	ALS Warning
	13	32	180508_180743	18:07	18:13	3500	359°	149	570	20	1.3	0.7	ALS Warning
	14	33	180508_181802	18:18	18:24	3505	180°	153	566	20	1.2	0.7	ALS Warning
	15	34	180508_182827	18:28	18:34	3503	359°	151	563	18	1.2	0.7	ALS Warning
	16	35	180508_183846	18:38	18:45	3496	180°	148	559	18	1.1	0.7	ALS Warning
	17	36	180508_184924	18:49	18:55	3487	359°	152	556	17	1.4	0.8	ALS Warning
	18	37	180508_185954	18:59	19:06	3492	180°	149	553	18	1.2	0.7	ALS Warning
	19	38	180508_191025	19:10	19:16	3508	1°	141	550	19	1.1	0.7	ALS Warning
	20	39	180508_192107	19:21	19:27	3559	179°	149	546	20	1	0.6	ALS Warning
	21	40	180508_193155	19:32	19:38	3528	1°	150	542	19	1.1	0.7	ALS Warning
	22	48	180508_194144	19:41	19:48	3535	180°	153	539	20	1.1	0.6	ALS Warning

Leica ALS80 Flight Log

Project:	18012_FL_SW_2018_D18								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	5/8/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	3707.3					18012_FL_SW_2018_D18			Keith Morrel	
Hobbs ST	3702.9		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.4		B			155	TEMP	1.500	C421-N13RF	IMM (Immokalee, FL)

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	49	180509_042515	4:25	4:32	3517	360°	146	625	15	1.3	0.8	ALS Warning
	2	50	180509_043608	4:36	4:42	3493	181°	154	621	15	1.3	0.8	ALS Warning
	3	51	180509_044646	4:46	4:53	3514	0°	149	616	14	1.4	0.8	ALS Warning
	4	52	180509_045742	4:57	5:04	3503	179°	155	613	15	1.3	0.8	ALS Warning
	5	53	180509_050822	5:08	5:15	3508	360°	146	608	15	1.4	0.8	ALS Warning
	6	54	180509_051939	5:19	5:26	3515	181°	154	604	16	1.3	0.8	ALS Warning
	7	55	180509_053044	5:30	5:38	3490	1°	146	599	17	1.2	0.7	ALS Warning
	8	56	180509_054226	5:42	5:49	3523	181°	155	595	17	1.2	0.7	ALS Warning
	9	57	180509_055418	5:54	6:02	3523	359°	145	591	16	1.3	0.7	ALS Warning
	10	58	180509_060621	6:06	6:14	3521	181°	157	586	15	1.3	0.7	ALS Warning
	11	59	180509_061833	6:18	6:26	3494	0°	144	581	16	1.2	0.7	ALS Warning
	12	60	180509_063047	6:30	6:39	3476	180°	154	576	17	1.2	0.6	ALS Warning
	13	61	180509_064329	6:43	6:52	3492	1°	147	572	18	1.1	0.6	ALS Warning
	14	62	180509_065615	6:56	7:04	3492	179°	154	567	18	1.1	0.6	ALS Warning
	15	63	180509_070915	7:09	7:18	3482	360°	150	561	17	1.2	0.6	ALS Warning
	16	64	180509_072159	7:22	7:30	3499	181°	154	556	18	1.2	0.6	ALS Warning
	17	65	180509_073500	7:35	7:43	3480	360°	150	552	17	1.3	0.7	ALS Warning
	18	66	180509_074744	7:47	7:56	3494	180°	154	546	17	1.2	0.6	ALS Warning
	19	67	180509_080026	8:00	8:09	3512	358°	147	541	19	1.1	0.6	ALS Warning

Leica ALS80 Flight Log

Project:	18012_FL_SW_2018_D18									Sensor Operator/s	
										Hunter Stavnes	
Date/Julian:	5/9/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):				Pilot/s	
Hobbs End	3708.6					18012_FL_SW_2018_D18				Keith Morrel	
Hobbs ST	3707.3		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	1.3		B	3,500		155	TEMP	1.500		C421-N13RF	IMM (Immokalee, FL)

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	68	180509_172306	17:23	N/A	3526	360°	151	536	19	1.1	0.6	Air Start. The NIDAQ device ran out of buffers.

Leica ALS80 Flight Log

Project:	18012_FL_SW_2018_D18									Sensor Operator/s	
										Hunter Stavnes	
Date/Julian:	5/9/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):				Pilot/s	
Hobbs End	3708.6					18012_FL_SW_2018_D18				Keith Morrel	
Hobbs ST	3707.3		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	1.3		B	3,500		155	TEMP	1.500		C421-N13RF	IMM (Immokalee, FL)

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	68	180509_174345	17:43	17:52	3547	1°	152	535	19	1.2	0.6	ALS Warning
	2	69	180509_175644	17:56	18:05	3473	181°	155	529	17	1.4	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	18012_FL_SW_2018_D18										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	5/10/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	3713.2			1-808654A		18012_FL_SW_2018_D18					Keith Morrel	
Hobbs ST	3708.6		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	4.6		A	3,500		155		TEMP		1.500	C421-N13RF	IMM (Immokalee, FL)

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	70	180510_052557	5:26	5:34	3499	179°	154	534	17	1.2	0.7	ALS Warning.
	2	71	180510_053842	5:38	5:47	3497	360°	150	529	17	1.2	0.7	ALS Warning.
	3	72	180510_055128	5:51	5:59	3472	180°	153	523	17	1.2	0.7	ALS Warning.
	4	73	180510_060420	6:04	6:12	3481	360°	149	518	18	1.1	0.6	ALS Warning.
	5	74	180510_061652	6:16	6:25	3536	180°	153	513	17	1.2	0.6	ALS Warning.
	6	75	180510_062927	6:29	6:38	3529	360°	146	508	18	1.2	0.6	ALS Warning.
	7	76	180510_064205	6:42	6:49	3540	180°	153	502	19	1.1	0.6	ALS Warning.
	8	77	180510_065418	6:54	7:02	3519	359°	145	497	19	1.1	0.6	ALS Warning.
	9	78	180510_070651	7:06	7:14	3536	180°	154	492	18	1.2	0.6	ALS Warning.
	10	79	180510_071914	7:19	7:27	3556	360°	149	487	20	1.1	0.6	ALS Warning.
	11	80	180510_073119	7:31	7:38	3525	181°	153	482	18	1.2	0.7	ALS Warning.
	12	81	180510_074243	7:42	7:49	3547	359°	150	477	20	1.2	0.7	ALS Warning.
	13	82	180510_075402	7:54	8:01	3515	181°	157	472	21	1.1	0.6	ALS Warning.
	14	83	180510_080520	8:05	8:12	3523	360°	149	468	22	1.1	0.6	ALS Warning.
	15	84	180510_081643	8:16	8:23	3527	181°	152	463	22	1.1	0.6	ALS Warning.
	16	85	180510_082753	8:27	8:34	3470	0°	152	458	21	1.2	0.6	ALS Warning.
	17	86	180510_083909	8:39	8:46	3475	179°	152	454	21	1.3	0.6	ALS Warning.
	18	87	180510_085039	8:50	8:58	3503	359°	150	449	20	1.4	0.6	ALS Warning.
	19	88	180510_090228	9:02	9:10	3541	181°	154	444	19	1.3	0.6	ALS Warning.
	20	89	180510_091422	9:14	9:22	3505	359°	151	438	19	1.3	0.6	ALS Warning.

Leica ALS80 Flight Log

Project:	18012_FL_SW_2018_D18										Sensor Operator/s	
											Hunter Stavnes	
Date/Julian:	5/11/2018	ALS80 SN# 8235		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	3717.5					18012_FL_SW_2018_D18					Keith Morrel	
Hobbs ST	3713.2		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	4.3		A	3,500		155		TEMP		1.500	C421-N13RF	IMM (Immokalee, FL)

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	90	180511_060817	6:08	6:16	3521	360°	148	434	17	1.1	0.6	ALS Warning.
	2	91	180511_062017	6:20	6:28	3535	179°	151	428	17	1.2	0.6	ALS Warning.
	3	92	180511_063213	6:32	6:40	3527	1°	149	423	18	1.2	0.6	ALS Warning.
	4	93	180511_064411	6:44	6:52	3529	179°	152	418	18	1.2	0.6	ALS Warning.
	5	94	180511_065616	6:56	7:04	3545	1°	150	413	17	1.2	0.6	ALS Warning.
	6	95	180511_070835	7:08	7:16	3540	180°	151	407	17	1.2	0.6	ALS Warning.
	7	96	180511_072105	7:21	7:29	3540	0°	146	402	17	1.2	0.7	ALS Warning.
	8	97	180511_073346	7:33	7:42	3527	180°	147	396	16	1.3	0.7	ALS Warning.
	9	98	180511_074627	7:46	7:54	3455	359°	152	391	20	1.2	0.6	ALS Warning.
	10	99	180511_075847	7:59	8:07	3461	181°	150	385	21	1.2	0.6	ALS Warning.
	11	100	180511_081120	8:11	8:20	3473	0°	141	380	21	1.2	0.6	ALS Warning.
	12	101	180511_082437	8:24	8:33	3512	180°	148	375	21	1.2	0.6	ALS Warning.
	13	102	180511_083716	8:37	8:45	3524	359°	151	370	20	1.4	0.6	ALS Warning.
	14	103	180511_084944	8:49	8:58	3520	180°	153	364	18	1.7	0.6	ALS Warning.
	15	104	180511_090302	9:03	9:11	3510	2°	149	359	19	1.3	0.6	ALS Warning.
	16	105	180511_091542	9:15	9:24	3520	180°	157	353	20	1.2	0.6	ALS Warning.
	17	106	180511_092844	9:28	9:37	3519	0°	143	348	19	1.2	0.6	ALS Warning.
	18	107	180511_094143	9:41	9:50	3502	180°	157	341	20	1	0.6	ALS Warning.

Leica ALS80 Flight Log

Project:	FL SW 2018								Sensor Operator/s	
									Hunter Stavnes	
Date/Julian:	6/10/2018	ALS80 SN# 8235_HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	3723.1								Keith Morrel	
Hobbs ST	3718.9		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.2		A	3,500		155	TEMP	1.500	C421-N13RF	IMM

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	108	180610_060016	6:00	6:09	3555	360°	154	583	21	1.1	0.5	ALS Warning
	2	109	180610_061312	6:13	6:22	3545	180°	154	577	21	1.1	0.5	ALS Warning
	3	110	180610_062545	6:25	6:35	3547	1°	150	572	21	1.1	0.5	ALS Warning
	4	111	180610_063856	6:39	6:48	3523	179°	154	566	19	1.3	0.6	ALS Warning
	5	112	180610_065210	6:52	7:01	3519	1°	154	560	18	1.4	0.6	ALS Warning
	6	113	180610_070601	7:06	7:15	3515	180°	152	554	20	1.2	0.6	ALS Warning
	7	114	180610_071942	7:19	7:29	3517	360°	149	547	19	1.2	0.6	ALS Warning
	8	115	180610_073352	7:33	7:43	3528	181°	152	542	19	1.1	0.6	ALS Warning
	9	116	180610_074828	7:48	7:58	3505	360°	154	535	18	1.2	0.7	ALS Warning
	10	117	180610_080308	8:03	8:15	3521	180°	141	528	19	1.1	0.7	ALS Warning
	11	118	180610_081811	8:18	8:28	3515	0°	151	522	19	1.2	0.8	ALS Warning
	12	119	180610_083343	8:33	8:44	3518	178°	151	516	18	1.2	0.7	ALS Warning
	13	120	180610_084826	8:48	9:00	3524	359°	149	509	18	1.2	0.7	ALS Warning
	14	121	180610_090412	9:04	9:15	3523	181°	150	502	18	1.5	0.8	ALS Warning
	15	122	180610_092017	9:20	9:31	3510	0°	155	495	19	1.3	0.7	ALS Warning

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	10/22/2018	ALS80 SN# 8235_HP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	69			3		USGS_FL_Southwest			Wes Ashmore	
Hobbs ST	66.5		LIFT	Target Altitude (MSL)		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	2.5		A	3,500		155	TEMP	1.500	C421-N112MJ	IMM (Immokalee,FL)

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	501	181023_021839	2:18	2:30	3521	179°	146	488	18	1.2	0.6	BG return
	2	502	181023_023415	2:34	2:46	3535	359°	145	480	21	1.3	0.7	AG warning
	3	503	181023_025057	2:50	3:03	3548	179°	151	471	21	1.1	0.6	
	4	504	181023_030636	3:06	3:19	3580	0°	146	463	20	1.4	0.6	
	5	505	181023_032241	3:23	3:35	3225	181°	157	455	20	1.5	0.6	
	6	506	181023_033814	3:38	3:50	3556	360°	145	447	21	1.4	0.6	ALS
	7	507	181023_035409	3:54	4:06	3569	182°	150	439	22	1.1	0.6	ALS
	8	508	181023_041053	4:11	4:23	3570	0°	147	431	21	1.1	0.6	ALS
	9	509	181023_042721	4:27	4:37	3583	181°	154	423	20	1.1	0.6	
	10	510	181023_044253	4:42	4:56	3577	359°	144	415	21	1.1	0.6	ALS
	11	511	181023_045902	4:59	5:11	3592	180°	157	407	21	1.1	0.6	

Leica ALS80 Flight Log

Project:	USGS _ FL_Southwest						Sensor Operator/s	
							Cynthia Williams	
Date/Julian:	5/7/2018	ALS80 SN# 8253_UP	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	1733.8			USGS _ FL_Southwest			Mike Wasielewski	
Hobbs ST	1730.3		LIFT	TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.5	Block 2	A	3,500	155	TEMP	1.500	C421-N112MJ	IMM(Immokalee ,FL)

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	241	180508_022743	2:27	2:43	2844	181°	156	797	16	1.2	0.7	Range Gate Over Max
	2	240	180508_024754	2:47	3:05	2789	0°	135	783	14	1.4	0.7	Spike in AGL
	3	239	180508_030834	3:08	3:24	2819	181°	149	768	15	1.3	0.7	ALS
	4	238	180508_032842	3:28	3:45	2846	359°	136	755	14	1.6	0.8	ALS
	5	242	180508_035149	3:51	4:07	2858	179°	154	740	14	1.6	0.9	Range Gate Over Max ,ALS
	6	237	180508_041043	4:10	4:23	2843	359°	142	726	14	1.4	0.8	NO PPS Error Air Start
	7	236	180508_043605	4:36	4:46	2834	180°	154	715	14	1.2	0.8	ALS
	8	235	180508_045005	4:50	5:00	2826	5°	142	706	14	1.2	0.7	ALS
	9	234	180508_050410	5:04	5:14	2845	179°	153	697	13	1.5	0.9	ALS
	10	243	180508_051908	5:19	5:35	2831	358°	150	688	13	1.4	0.8	ALS

Leica ALS80 Flight Log

Project:	USGS _ FL_Southwest										Sensor Operator/s	
											Cynthia Williams	
Date/Julian:	5/8/2018	ALS80 SN# 8253_UP		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	1737.4					USGS _ FL_Southwest					Mike Wasielewski	
Hobbs ST	1733.8		LIFT			TARGET AIRSPD (KNTS)		BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	3.6	Block 2	A	3,500		155		TEMP	1.500		C421-N112MJ	IMM(Immokalee ,FL)

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	174	180508_160850	16:08	16:09	2882	180°	151	674	20	1.1	0.6	ALS
	2	175	180508_161350	16:13	16:16	2794	360°	138	674	21	1.1	0.6	ALS
	3	176	180508_161945	16:19	16:23	2903	179°	130	672	21	1.1	0.6	ALS
	4	177	180508_162627	16:26	16:30	2819	1°	124	669	21	1.1	0.6	
	5	178	180508_163423	16:34	16:39	2835	177°	151	666	19	1.3	0.7	Range Gate , ALS
	6	179	180508_164145	16:41	16:47	2838	1°	127	663	21	1.2	0.6	
	7	180	180508_165107	16:51	16:56	2836	186°	154	659	22	1.1	0.6	
	8	181	180508_170014	17:00	17:06	2807	1°	132	655	22	1.1	0.6	
	9	182	180508_170950	17:09	17:16	2798	179°	148	650	21	1.2	0.6	ALS
	10	183	180508_171942	17:19	17:26	2830	1°	132	645	22	1.1	0.6	
	11	184	180508_172954	17:29	17:35	2797	180°	145	640	22	1.1	0.6	
	12	185	180508_173949	17:40	17:46	2850	357°	143	635	21	1.2	0.6	
	13	186	180508_174953	17:50	17:56	2782	178°	141	629	21	1.2	0.6	
	14	187	180508_175901	17:59	18:05	2758	358°	138	624	21	1.3	0.7	
	15	188	180508_180944	18:09	18:17	2730	181°	138	618	21	1.3	0.7	ALS
	16	189	180508_182043	18:20	18:28	2799	1°	134	612	20	1.2	0.7	
	17	190	180508_183159	18:31	18:40	2737	177°	150	606	18	1.2	0.7	
	18	191	180508_184337	18:43	18:51	2776	1°	126	599	16	1.5	0.8	
	19	192	180508_185601	18:56	19:05	2792	179°	144	591	17	1.2	0.8	
	20	193	180508_190737	19:07	19:17	2790	1°	127	585	18	1.2	0.7	

Leica ALS80 Flight Log

Project:	USGS _ FL_Southwest						Sensor Operator/s	
							Cynthia Williams	
Date/Julian:	5/8/2018	ALS80 SN# 8253_UP	Disk Drive MM70	Flight Plan(s):			Pilot/s	
Hobbs End	1741.1			USGS _ FL_Southwest			Mike Wasielewski	
Hobbs ST	1737.4	LIFT		TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.7	Block 2	B	155	TEMP	1.500	C421-N112MJ	IMM(Immokalee ,FL)

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	194	180509_042038	4:20	4:29	2770	180°	150	627	14	1.5	0.9	ALS
	2	195	180509_043144	4:31	4:43	2787	360°	129	620	15	1.3	0.8	ALS
	3	196	180509_044448	4:44	4:53	2782	180°	155	612	15	1.3	0.8	ALS
	4	197	180509_045643	4:56	5:07	2761	359°	137	605	15	1.5	0.9	ALS
	5	198	180509_051006	5:10	5:19	2784	181°	153	592	15	1.4	0.8	ALS
	6	199	180509_052158	5:22	5:33	2778	0°	133	590	16	1.4	0.8	ALS
	7	200	180509_053519	5:35	5:45	2796	183°	158	581	17	1.2	0.7	ALS
	8	201	180509_054738	5:47	5:55	2800	359°	139	574	17	1.2	0.7	
	9	202	180509_060100	6:01	6:11	2800	181°	157	565	16	1.3	0.7	
	10	203	180509_061359	6:13	6:20	2809	1°	145	557	17	1.1	0.6	
	11	204	180509_062750	6:27	6:35	2813	180°	155	549	16	1.2	0.7	
	12	205	180509_064036	6:40	6:51	2778	357°	145	541	18	1.1	0.6	
	13	206	180509_065413	6:54	7:01	2814	180°	153	532	18	1.1	0.6	
	14	207	180509_070744	7:07	7:13	2818	359°	145	523	17	1.3	0.6	
	15	208	180509_072148	7:21	7:32	2816	180°	154	515	18	1.2	0.8	

Leica ALS80 Flight Log

Project:	USGS _ FL_Southwest								Sensor Operator/s	
									Cynthia Williams	
Date/Julian:	5/9/2018	ALS80 SN# 8253_UP		Disk Drive MM70		Flight Plan(s):			Pilot/s	
Hobbs End	1742.4					USGS _ FL_Southwest			Mike Wasielewski	
Hobbs ST	1741.1		LIFT			TARGET AIRSPD (KNTS)	BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	1.3	Block 2	A	3,500		155	TEMP	1.500	C421-N112MJ	IMM(Immokalee ,FL)

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	209	209	17:13	17:24	2751	179°	139	506	20	1.1	0.6	ALS
	2	210	210	17:28	17:40	2720	1°	127	497	20	1.1	0.6	
	3	211	211	17:43	17:53	2701	180°	148	486	19	1.2	0.6	ALS
	4	212	212	17:57	18:13	2748	359°	126	477	17	1.4	0.7	ALS

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest										Sensor Operator/s	
											Cynthia Williams	
Date/Julian:	5/10/2018	ALS80 SN# 8253_UP		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	1745.9					USGS_FL_Southwest					Mike Wasielewski	
Hobbs ST	1742.4		LIFT			TARGET AIRSPD (KNTS)		BASE PID:		Base Height:	Aircraft	Airport Idnt:
Flight Time	3.5		A	3,500		155		TEMP		1.500	C421-N112MJ	IMM(Immokalee ,FL)

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	213	180510_051903	5:19	5:29	2853	180°	154	577	16	1.3	0.7	Range Gate ALS
	2	214	180510_053259	5:32	5:43	2866	8°	133	568	17	1.2	0.7	ALS
	3	215	180510_054703	5:47	5:56	2856	180°	153	559	17	1.2	0.7	
	4	216	180510_055930	5:59	6:09	2864	2°	140	551	18	1.1	0.6	
	5	217	180510_061246	6:13	6:22	2869	181°	153	542	19	1.1	0.6	
	6	218	180510_062514	6:25	6:35	2829	360°	142	534	17	1.3	0.6	ALS
	7	219	180510_063810	6:38	6:47	2821	179°	148	525	19	1.1	0.6	
	8	220	180510_065040	6:50	7:00	2826	2°	144	518	19	1.1	0.6	
	9	171	180510_070527	7:05	7:18	2834	3°	144	509	18	1.2	0.6	Block 1
	10	170	180510_072115	7:22	7:33	2837	181°	153	498	19	1.1	0.6	Block 1
	11	169	180510_073632	7:36	7:48	2818	353°	151	489	16	1.4	0.7	Block 1
	12	168	180510_075142	7:51	8:03	2834	182°	155	479	19	1.2	0.7	Block 1
	13	167	180510_080659	8:06	8:19	2834	359°	152	469	21	1.1	0.6	Block 1
	14	166	180510_082233	8:22	8:32	2856	179°	157	458	21	1.2	0.6	Block 1

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest										Sensor Operator/s	
											Cynthia Williams	
Date/Julian:	5/11/2018	ALS80 SN# 8253_UP		Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	1749.6					USGS_FL_Southwest					Mike Wasielewski	
Hobbs ST	1745.9		LIFT			TARGET AIRSPD (KNTS)		BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	3.7		A	3,500		155		TEMP	1.500		C421-N112MJ	IMM(Immokalee ,FL)

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	221	180511_060159	6:02	6:11	2826	180°	147	448	18	1.1	0.6	
	2	222	180511_061449	6:15	6:24	2829	3°	149	440	16	1.1	0.6	
	3	223	180511_062742	6:27	6:37	2844	181°	155	432	18	1.2	0.6	
	4	224	180511_064024	6:40	6:49	2860	3°	150	424	18	1.2	0.6	
	5	225	180511_065251	6:52	7:02	2851	181°	153	416	18	1.1	0.6	Range Gate
	6	226	180511_070523	7:05	7:15	2820	1°	150	408	17	1.2	0.6	ALS
	7	227	180511_071852	7:18	7:28	2834	180°	152	400	18	1.1	0.6	
	8	228	180511_073121	7:31	7:41	2847	2°	153	391	16	1.3	0.7	ALS
	9	229	180511_074520	7:45	7:55	2780	179°	150	384	18	1.2	0.7	ALS
	10	230	180511_075759	7:57	8:07	2777	360°	150	375	20	1.2	0.6	
	11	231	180511_081051	8:11	8:20	2790	179°	154	367	21	1.2	0.6	
	12	232	180511_082401	8:24	8:34	2802	359°	145	358	21	1.2	0.6	
	13	233	180511_083730	8:37	8:47	2797	180°	153	349	20	1.4	0.6	
	14	244	180511_084958	8:49	9:06	2781	3°	145	341	19	1.5	0.6	
	15	173	180511_091136	9:11	9:18	2815	359°	150	327	20	1.2	0.6	Block 1

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest								Sensor Operator/s	
									Jackson Beebe	
Date/Julian:			Disk Drive MM70		Flight Plan(s):				Pilot/s	
Hobbs End	1755.6				USGS_FL_Southwest				Mike Wasielewski	
Hobbs ST	1751.9		LIFT	Target Altitude (MSL)	TARGET AIRSPD (KNTS)		BASE PID:	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.7		A	3,500	155		TEMP	1.500	C421-N112MJ	IMM(Immokalee, FL)

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	172	180617_055528	5:55	6:06	2826	0	155	652	20	1.2	..6	
	2	105	180617_061551	6:15	6:28		180	145	643	19	1.3	0.6	
	3	106	180617_063119	6:31	6:43		0	158	633	19	1.2	0.6	
	4	107	180617_064655	6:46	6:59		180	142	624	20	1.1	0.6	
	5	108	180617_070230	7:03	7:15		0	154	613	19	1.2	0.6	
	6	109	180617_071844	7:18	7:31		180	147	603	19	1.3	0.6	
	7	110	180617_073418	7:34	7:46		0	156	593	21	1.1	0.7	
	8	111	180617_074946	7:49	8:02		180	145	583	22	1.2	0.7	
	9	112	180617_080515	8:04	8:17		0	155	572	20	1.2	0.7	
	10	113	180617_082023	8:20	8:32		180	150	562	21	1.2	0.7	
	11	114	180617_083603	8:35	8:47		0	153	553	20	1.2	0.7	
	12	115	180617_085106	8:50	9:03		180	156	542	20	1.3	0.7	

Leica ALS80 Flight Log

Project:	USGS_FL_Southwest									Sensor Operator/s	
										Jackson Beebe	
Date/Julian:			Disk Drive MM70		Flight Plan(s):					Pilot/s	
Hobbs End	1758				USGS_FL_Southwest					Mike Wasielewski	
Hobbs ST	1756.8		LIFT	Target Altitude (MSL)	TARGET AIRSPD (KNTS)		BASE PID:	Base Height:		Aircraft	Airport Idnt:
Flight Time	1.2		A	3,500	155		TEMP	1.500		C421-N112MJ	IMM(Immokalee,FL)

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	116	180619_071041	7:10	7:23	2640	180	151	531	17	1.4	0.7	
	2	117	180619_072629	7:26			0°	152	521	19	1.1	0.6	NIDAQ Erro/ NO Pulse Start

Appendix B. Vertical Accuracy Calculations

Project Information

Prepared By: Kenneth L. Coffey II
Project Name: SW FL 2018 D18
Sensor Info: Lecia ASL80
Required Nominal Pulse Spacing: 0.35
Vendor Name: Digital Aerial Solutions .LLC
Units: Meters
Percent of Extent Tolerance: Extents Not Checked
Date of Aquisition: Start: 5/8/2018 Finish: 3/1/2019

Metadata Information

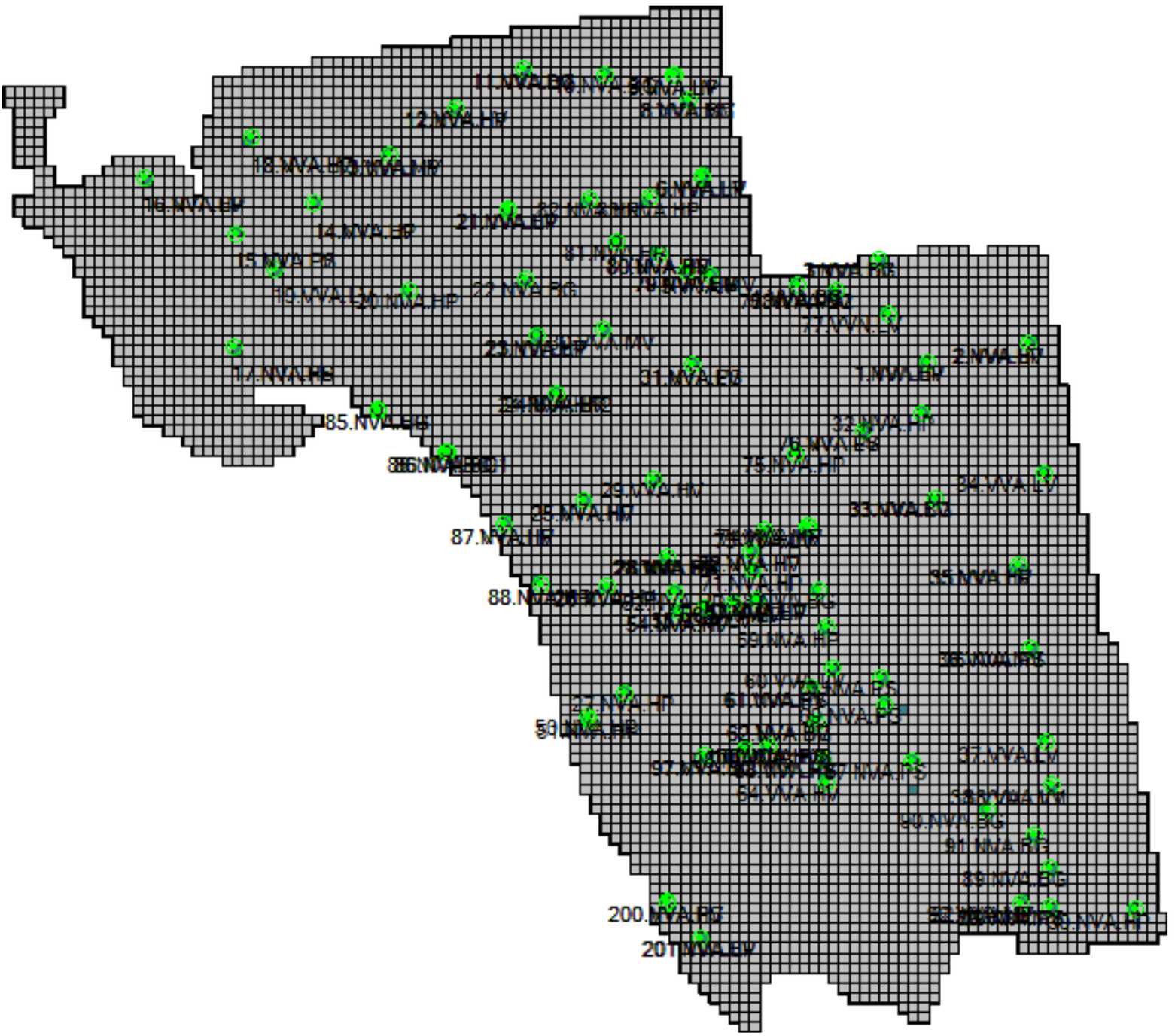
Tile Index:
- Filename: Clip_SW_FL_Tiles_1k_Albers.shp
- Number of Polys: 0

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

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

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

Tiled-Data Area



LiDAR Accuracy Assessment Summary

LC Type	# Points	NVA	VVA	RMSE Z
LAS		95% Confidence	95 Percentile	
Bare Ground	17	0.147		0.075
Hard Pavement	45	0.175		0.089
High Vegetation	20		0.190	0.124
Low Vegetation	32		0.186	0.111
Medium Vegetation	8		0.164	0.108
Packed Sand	17	0.199		0.101
NVA Total:	79	0.175		0.089
VVA Total:	60		0.190	0.115
Total:	139			0.101
DEM		95% Confidence	95 Percentile	
Bare Ground	17	0.151		0.077
Hard Pavement	45	0.179		0.091
High Vegetation	20		0.197	0.124
Low Vegetation	32		0.243	0.125
Medium Vegetation	8		0.189	0.127
Packed Sand	17	0.205		0.104
NVA Total:	79	0.179		0.091
VVA Total:	60		0.229	0.125
Total:	139			0.101

LiDAR Accuracy Assessment Summary (continued)

LC Type	# Points	NVA	VVA	RMSE Z
			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)	☑	**10.NVA.BG**					
			1429425.779	515325.153	3.41	3.431	3.427
					Bare Ground	0.021	0.017
2)	☑	**11.NVA.BG**					
			1421170.411	515769.438	4.264	4.204	4.191
					Bare Ground	-0.06	-0.073
3)	☑	**22.NVA.BG**					
			1421522.846	494758.625	6.78	6.801	6.806
					Bare Ground	0.021	0.026
4)	☑	**3.NVA.BG**					
			1457019.356	496742.657	11.471	11.483	11.469
					Bare Ground	0.012	-0.002
5)	☑	**33.NVA.BG**					
			1462707.999	472667.846	6.448	6.535	6.519
					Bare Ground	0.087	0.071
6)	☑	**4.NVA.BG**					
			1448771.46	494077.082	8.397	8.501	8.502
					Bare Ground	0.104	0.105
7)	☑	**58.NVA.BG**					
			1450976.139	463549.289	3.796	3.918	3.913
					Bare Ground	0.122	0.117

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
8)	☑	**62.NVA.BG**					
			1450698.024	450245.648	2.349	2.397	2.398
					Bare Ground	0.048	0.049
9)	☑	**79.NVA.BG**					
			1437705.717	495431.952	8.363	8.454	8.465
					Bare Ground	0.091	0.102
10)	☑	**8.NVA.BG**					
			1437921.897	512787.835	5.451	5.355	5.351
					Bare Ground	-0.096	-0.1
11)	☑	**85.NVA.BG**					
			1406676.964	481522.65	1.945	1.958	1.963
					Bare Ground	0.013	0.018
12)	☑	**86.NVA.BG**					
			1413522.988	477328.225	1.666	1.72	1.701
					Bare Ground	0.054	0.035
13)	☑	**86.NVA.BG.1**					
			1413536.334	477334.477	1.135	1.203	1.191
					Bare Ground	0.068	0.056
14)	☑	**89.NVA.BG**					
			1474275.908	435560.803	1.433	1.509	1.499
					Bare Ground	0.076	0.066

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
15)	☑	**90.NVA.BG**					
			1467998.911	441456.45	2.29	2.33	2.317
					Bare Ground	0.04	0.027
16)	☑	**91.NVA.BG**					
			1472591.553	438842.866	1.897	1.902	1.903
					Bare Ground	0.005	0.006
17)	☑	**97.NVA.BG**					
			1439401.633	446781.507	3.132	3.301	3.296
					Bare Ground	0.169	0.164
18)	☑	**1.NVA.HP**					
			1461914.346	486401.595	10.039	10.041	10.037
					Hard Pavement	0.002	-0.002
19)	☑	**12.NVA.HP**					
			1414479.668	511928.621	3.961	3.943	3.942
					Hard Pavement	-0.018	-0.019
20)	☑	**13.NVA.HP**					
			1407750.267	507194.368	2.667	2.697	2.695
					Hard Pavement	0.03	0.028
21)	☑	**14.NVA.HP**					
			1400180.216	502303.963	3.774	3.793	3.794
					Hard Pavement	0.019	0.02

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
22)	**16.NVA.HP**					
		1383115.003	504925.553	1.514	1.525	1.513
				Hard Pavement	0.011	-0.001
23)	**17.NVA.HP**					
		1392099.543	487959.909	1.655	1.87	1.867
				Hard Pavement	0.215	0.212
24)	**18.NVA.HP**					
		1393894.828	508925.962	2.376	2.351	2.352
				Hard Pavement	-0.025	-0.024
25)	**2.NVA.HP**					
		1472090.785	488227.775	8.497	8.552	8.554
				Hard Pavement	0.055	0.057
26)	**20.NVA.HP**					
		1409659.785	493586.712	2.168	2.173	2.184
				Hard Pavement	0.005	0.016
27)	**201.NVA.HP**					
		1439041.275	428569.592	2.725	2.48	2.488
				Hard Pavement	-0.245	-0.237
28)	**21.NVA.HP**					
		1419697.208	501688.836	6.476	6.45	6.459
				Hard Pavement	-0.026	-0.017

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
29)	**23.NVA.HP**					
		1422686.911	488989.611	6.911	6.953	6.965
				Hard Pavement	0.042	0.054
30)	**24.NVA.HP**					
		1424540.029	483259.417	5.432	5.476	5.468
				Hard Pavement	0.044	0.036
31)	**24.NVA.HP2**					
		1424563.301	483257.352	5.54	5.58	5.583
				Hard Pavement	0.04	0.043
32)	**25.NVA.HP**					
		1427372.615	472437.543	3.676	3.713	3.708
				Hard Pavement	0.037	0.032
33)	**26.NVA.HP**					
		1429628.913	463851.488	4.853	4.945	4.937
				Hard Pavement	0.092	0.084
34)	**27.NVA.HP**					
		1431323.855	453103.767	2.63	2.75	2.748
				Hard Pavement	0.12	0.118
35)	**28.NVA.HP**					
		1435710.706	466849.024	4.34	4.405	4.415
				Hard Pavement	0.065	0.075

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
36)	**32.NVA.HP**					
		1461276.289	481276.636	7.375	7.35	7.347
				Hard Pavement	-0.025	-0.028
37)	**35.NVA.HP**					
		1471011.549	465957.9	5.449	5.57	5.523
				Hard Pavement	0.121	0.073
38)	**39.NVA.HP**					
		1482847.484	431316.837	0.918	0.99	0.98
				Hard Pavement	0.072	0.062
39)	**50.NVA.HP**					
		1427785.464	450759.76	1.357	1.344	1.351
				Hard Pavement	-0.013	-0.006
40)	**51.NVA.HP**					
		1427832.634	450462.779	2.1	2.135	2.141
				Hard Pavement	0.035	0.041
41)	**52.NVA.HP**					
		1436471.77	463278.196	4.472	4.536	4.547
				Hard Pavement	0.064	0.075
42)	**54.NVA.HP**					
		1436862.879	461260.549	3.657	3.8	3.802
				Hard Pavement	0.143	0.145

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
43)	**56.NVA.HP**					
		1442273.497	462131.005	4	3.989	3.994
				Hard Pavement	-0.011	-0.006
44)	**57.NVA.HP**					
		1444779.219	462437.238	4.315	4.18	4.164
				Hard Pavement	-0.135	-0.151
45)	**59.NVA.HP**					
		1451646.464	459681.849	3.904	3.983	3.978
				Hard Pavement	0.079	0.074
46)	**6.NVA.HP**					
		1439280.026	504996.644	7.594	7.5	7.504
				Hard Pavement	-0.094	-0.09
47)	**71.NVA.HP**					
		1444301.939	465364.203	3.818	3.694	3.696
				Hard Pavement	-0.124	-0.122
48)	**72.NVA.HP**					
		1444034.708	467343.119	4.325	4.213	4.218
				Hard Pavement	-0.112	-0.107
49)	**74.NVA.HP**					
		1449885.721	469943.326	4.947	5.049	5.047
				Hard Pavement	0.102	0.1

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
50)	**75.NVA.HP**					
		1448688.204	477237.448	6.455	6.6	6.594
				Hard Pavement	0.145	0.139
51)	**79.NVA.HP**					
		1437722.735	495431.005	9.457	9.404	9.404
				Hard Pavement	-0.053	-0.053
52)	**80.NVA.HP**					
		1434895.466	497260.448	9.203	9.269	9.245
				Hard Pavement	0.066	0.042
53)	**81.NVA.HP**					
		1430602.204	498545.731	9.386	9.346	9.339
				Hard Pavement	-0.04	-0.047
54)	**82.NVA.HP**					
		1427822.115	502834.617	6.946	6.991	6.998
				Hard Pavement	0.045	0.052
55)	**83.NVA.HP**					
		1433945.756	502935.736	7.763	7.769	7.791
				Hard Pavement	0.006	0.028
56)	**85.NVA.HP**					
		1406647.777	481560.608	1.607	1.61	1.605
				Hard Pavement	0.003	-0.002

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
57)	☑	**86.NVA.HP**					
			1413537.694	477318.349	1.455	1.458	1.449
					Hard Pavement	0.003	-0.006
58)	☑	**87.NVA.HP**					
			1419314.632	470028.825	1.876	1.897	1.89
					Hard Pavement	0.021	0.014
59)	☑	**88.NVA.HP**					
			1422920.381	464020.153	2.061	2.05	2.062
					Hard Pavement	-0.011	0.001
60)	☑	**88.NVA.HQ**					
			1422927.46	464010.568	2.083	2.082	2.086
					Hard Pavement	-0.001	0.003
61)	☑	**9.NVA.HP**					
			1436396.156	515222.557	3.774	3.509	3.517
					Hard Pavement	-0.265	-0.257
62)	☑	**92.NVA.HP**					
			1471205.172	432085.109	0.951	0.864	0.841
					Hard Pavement	-0.087	-0.11
63)	☑	**100.NVA.PS**					
			1445893.523	447849.196	2.586	2.682	2.69
					Packed Sand	0.096	0.104

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
64)	☑	**15.NVA.PS**					
			1392265.809	499274.646	0.703	0.722	0.727
					Packed Sand	0.019	0.024
65)	☑	**17.NVA.PS**					
			1392075.514	487955.645	1.529	1.745	1.737
					Packed Sand	0.216	0.208
66)	☑	**200.NVA.PS**					
			1435645.211	432100.237	1.521	1.297	1.298
					Packed Sand	-0.224	-0.223
67)	☑	**28.NVA.PS**					
			1435709.868	466868.178	4.154	4.245	4.254
					Packed Sand	0.091	0.1
68)	☑	**31.NVA.PS**					
			1438216.234	486117.745	8.538	8.533	8.536
					Packed Sand	-0.005	-0.002
69)	☑	**36.NVA.PS**					
			1472223.292	457687.548	3.829	3.875	3.86
					Packed Sand	0.046	0.031
70)	☑	**39.NVA.PS**					
			1474180.317	431697.243	0.996	1.038	1.013
					Packed Sand	0.042	0.017

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
71)	**61.NVA.PS**					
		1450205.648	453607.469	2.946	3	2.993
				Packed Sand	0.054	0.047
72)	**63.NVA.PS**					
		1451338.696	446519.84	2.216	2.294	2.281
				Packed Sand	0.078	0.065
73)	**67.NVA.PS**					
		1460323.241	446319.093	2.078	2.262	2.263
				Packed Sand	0.184	0.185
74)	**69.NVA.PS**					
		1457687.854	452005.266	4.684	4.69	4.7
				Packed Sand	0.006	0.016
75)	**70.NVA.PS**					
		1457232.073	454742.889	3.045	3.128	3.133
				Packed Sand	0.083	0.088
76)	**76.NVA.PS**					
		1455533.032	479421.402	6.203	6.222	6.219
				Packed Sand	0.019	0.016
77)	**78.NVA.PS2**					
		1452718.433	493615.703	10.778	10.797	10.798
				Packed Sand	0.019	0.02

Coordinates and Offsets of Analyzed Locations (Continued)

	ID					
		Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
78)	**80.NVA.PS**					
		1434882.494	497268.666	8.55	8.653	8.621
				Packed Sand	0.103	0.071
79)	**98.NVA.PS**					
		1443432.881	447506.09	2.521	2.595	2.591
				Packed Sand	0.074	0.07
80)	**100.VVA.HV**					
		1445894.078	447838.801	2.191	2.323	2.321
				High Vegetation	0.132	0.13
81)	**100.VVA.HV2**					
		1445894.096	447838.797	2.198	2.323	2.319
				High Vegetation	0.125	0.121
82)	**100.VVA.HV3**					
		1445894.101	447838.798	2.183	2.323	2.319
				High Vegetation	0.14	0.136
83)	**12.VVA.HV**					
		1414440.172	511936.88	3.465	3.464	3.462
				High Vegetation	-0.001	-0.003
84)	**200.VVA.HV**					
		1435657.224	432085.914	1.327	1.098	1.108
				High Vegetation	-0.229	-0.219

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
85)	**25.VVA.HV**					
		1427377.968	472452.107	3.305	3.38	3.398
				High Vegetation	0.075	0.093
86)	**28.VVA.HV**					
		1435697.227	466877.73	4.052	4.236	4.214
				High Vegetation	0.184	0.162
87)	**28.VVA.HW**					
		1435697.22	466877.725	4.039	4.236	4.214
				High Vegetation	0.197	0.175
88)	**29.VVA.HV**					
		1434403.579	474648.157	4.488	4.594	4.599
				High Vegetation	0.106	0.111
89)	**4.VVA.HV**					
		1448790.851	494078.144	8.251	8.369	8.378
				High Vegetation	0.118	0.127
90)	**54.VVA.HV**					
		1436863.941	461246.973	3.542	3.725	3.732
				High Vegetation	0.183	0.19
91)	**57.VVA.HV**					
		1444776.364	462407.648	4.314	4.191	4.15
				High Vegetation	-0.123	-0.164

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
92)	☑	**61.VVA.HV**					
			1450207.298	453594.172	2.699	2.837	2.836
					High Vegetation	0.138	0.137
93)	☑	**62.VVA.HV**					
			1450699.123	450230.272	2.375	2.456	2.456
					High Vegetation	0.081	0.081
94)	☑	**63.VVA.HV**					
			1451329.718	446515.992	2.291	2.374	2.383
					High Vegetation	0.083	0.092
95)	☑	**64.VVA.HV**					
			1451722.111	444158.606	1.762	1.872	1.878
					High Vegetation	0.11	0.116
96)	☑	**72.VVA.HV**					
			1444021.646	467353.458	4.285	4.241	4.225
					High Vegetation	-0.044	-0.06
97)	☑	**79.VVA.HV**					
			1437720.137	495449.829	9.072	9.041	9.025
					High Vegetation	-0.031	-0.047
98)	☑	**80.VVA.HV**					
			1434900.599	497274.178	9.135	9.148	9.122
					High Vegetation	0.013	-0.013

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
99)	☑	**87.VVA.HV**					
			1419325.136	470029.394	1.738	1.76	1.749
					High Vegetation	0.022	0.011
100)	☑	**1.VVA.LV**					
			1461989.621	486358.649	9.84	10.128	10.022
					Low Vegetation	0.288	0.182
101)	☑	**11.VVA.LV**					
			1421156.138	515784.967	4.255	4.315	4.27
					Low Vegetation	0.06	0.015
102)	☑	**14.VVA.LV**					
			1400177.11	502323.799	4.498	4.57	4.559
					Low Vegetation	0.072	0.061
103)	☑	**15.VVA.LV**					
			1392250.45	499259.212	0.799	0.837	0.836
					Low Vegetation	0.038	0.037
104)	☑	**16.VVA.LV**					
			1383116.325	504916.34	1.367	1.384	1.378
					Low Vegetation	0.017	0.011
105)	☑	**18.VVA.LV**					
			1393892.386	508961.323	2.118	2.124	2.131
					Low Vegetation	0.006	0.013

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
106)	☑	19.VVA.LV					
			1396216.293	495753.72	1.326	1.346	1.335
					Low Vegetation	0.02	0.009
107)	☑	2.VVA.LV					
			1472096.098	488220.866	7.768	7.899	7.906
					Low Vegetation	0.131	0.138
108)	☑	201.VVA.LV					
			1439066.399	428551.407	2.571	2.328	2.334
					Low Vegetation	-0.243	-0.237
109)	☑	21.VVA.LV					
			1419718.479	501651.689	6.445	6.521	6.539
					Low Vegetation	0.076	0.094
110)	☑	23.VVA.LV					
			1422695.44	489005.699	7.005	7.129	7.114
					Low Vegetation	0.124	0.109
111)	☑	24.VVA.LV					
			1424550.289	483265.477	5.455	5.54	5.549
					Low Vegetation	0.085	0.094
112)	☑	26.VVA.LV					
			1429619.957	463856.916	3.956	4.117	4.102
					Low Vegetation	0.161	0.146

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
113)	☑	3.VVA.LV					
			1457039.188	496752.176	10.88	10.967	10.943
					Low Vegetation	0.087	0.063
114)	☑	31.VVA.LV					
			1438204.685	486125.186	8.407	8.466	8.443
					Low Vegetation	0.059	0.036
115)	☑	33.VVA.LV					
			1462683.324	472666.833	5.546	5.65	5.65
					Low Vegetation	0.104	0.104
116)	☑	34.VVA.LV					
			1473560.957	475222.418	5.286	5.538	5.451
					Low Vegetation	0.252	0.165
117)	☑	35.VVA.LV					
			1471029.384	465948.318	5.118	5.195	5.197
					Low Vegetation	0.077	0.079
118)	☑	37.VVA.LV					
			1473776.061	448199.516	3.249	3.362	3.337
					Low Vegetation	0.113	0.088
119)	☑	38.VVA.LV.1					
			1474320.884	443835.18	1.979	2.077	2.097
					Low Vegetation	0.098	0.118

Coordinates and Offsets of Analyzed Locations (Continued)

	ID	Survey X	Survey Y	Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
120) ☑	**38.VVA.LV**					
		1474324.488	443860.457	2.803	2.866	2.858
				Low Vegetation	0.063	0.055
121) ☑	**55.VVA.LV**					
		1439390.29	461615.481	3.421	3.632	3.634
				Low Vegetation	0.211	0.213
122) ☑	**56.VVA.LV**					
		1442280.117	462101.246	3.408	3.428	3.428
				Low Vegetation	0.02	0.02
123) ☑	**57.VVA.LV**					
		1444769.35	462429.854	4.459	4.401	4.402
				Low Vegetation	-0.058	-0.057
124) ☑	**6.VVA.LV**					
		1439277.44	505010.895	7.505	7.464	7.471
				Low Vegetation	-0.041	-0.034
125) ☑	**60.VVA.LV**					
		1452295.036	455571.318	3.217	3.298	3.286
				Low Vegetation	0.081	0.069
126) ☑	**73.VVA.LV**					
		1445540.414	469613.522	4.862	4.925	4.927
				Low Vegetation	0.063	0.065

Coordinates and Offsets of Analyzed Locations (Continued)

	ID			Z1	Z DEM	Z LAS
				LC Type	ΔZ DEM	ΔZ LAS
127)	**76.VVA.LV**					
		1455521.086	479432.046	6.219	6.332	6.358
				Low Vegetation	0.113	0.139
128)	**77.VVN.LV**					
		1457953.793	491281.832	12.406	12.419	12.433
				Low Vegetation	0.013	0.027
129)	**78.VVA.LV**					
		1452740.227	493613.185	10.57	10.65	10.657
				Low Vegetation	0.08	0.087
130)	**9.VVA.LV**					
		1436390.025	515184.81	3.481	3.289	3.295
				Low Vegetation	-0.192	-0.186
131)	**97.VVA.LV**					
		1439405.597	446799.954	2.958	3.153	3.143
				Low Vegetation	0.195	0.185
132)	**13.VVA.MV**					
		1407739.751	507193.867	2.691	2.77	2.782
				Medium Vegetation	0.079	0.091
133)	**30.VVA.MV**					
		1429240.817	489590.499	8.314	8.309	8.284
				Medium Vegetation	-0.005	-0.031

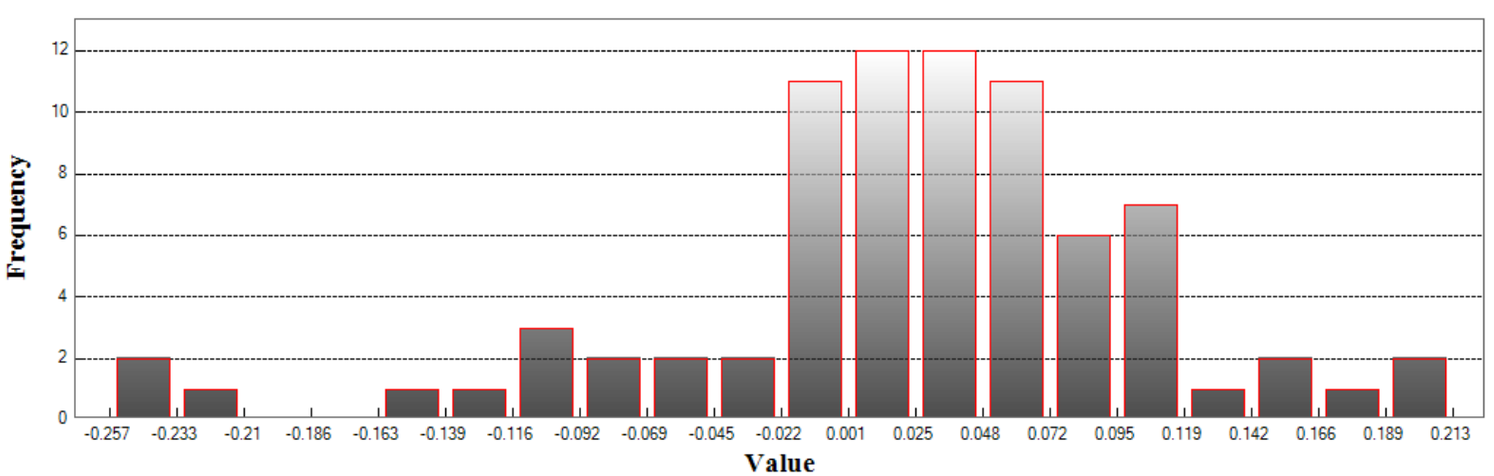
Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					LC Type	ΔZ DEM	ΔZ LAS
134)	☑	**36.VVA.MV**					
			1472227.213	457668.205	3.824	4.006	3.988
					Medium Vegetation	0.182	0.164
135)	☑	**39.VVA.MV**					
			1474154.166	431672.659	0.801	0.855	0.865
					Medium Vegetation	0.054	0.064
136)	☑	**5.VVA.MV**					
			1440024.48	495148.498	8.635	8.584	8.586
					Medium Vegetation	-0.051	-0.049
137)	☑	**74.VVA.MV**					
			1449865.125	469931.411	4.583	4.772	4.666
					Medium Vegetation	0.189	0.083
138)	☑	**8.VVA.MV**					
			1437930.162	512757.345	5.558	5.413	5.413
					Medium Vegetation	-0.145	-0.145
139)	☑	**92.VVA.MV**					
			1471205.363	432076.697	0.025	0.192	0.177
					Medium Vegetation	0.167	0.152

LAS

Nonvegetated Vertical Accuracy
LandCover Type: Bare Ground, Hard Pavement, Packed Sand
Minimum DZ: -0.257
Maximum DZ: 0.212
Mean DZ: 0.024
Mean Magnitude DZ: 0.257
Number Observations: 79
Standard Deviation DZ: 0.087
RMSE Z: 0.089
95% Confidence Level Z: 0.175
Units: Meters

Histogram



Min: -0.257
Max: 0.212
Number Of Bins: 20
Bin Interval: 0.023

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: -0.219

Maximum DZ: 0.19

Mean DZ: 0.059

Mean Magnitude DZ: 0.331

Number Observations: 20

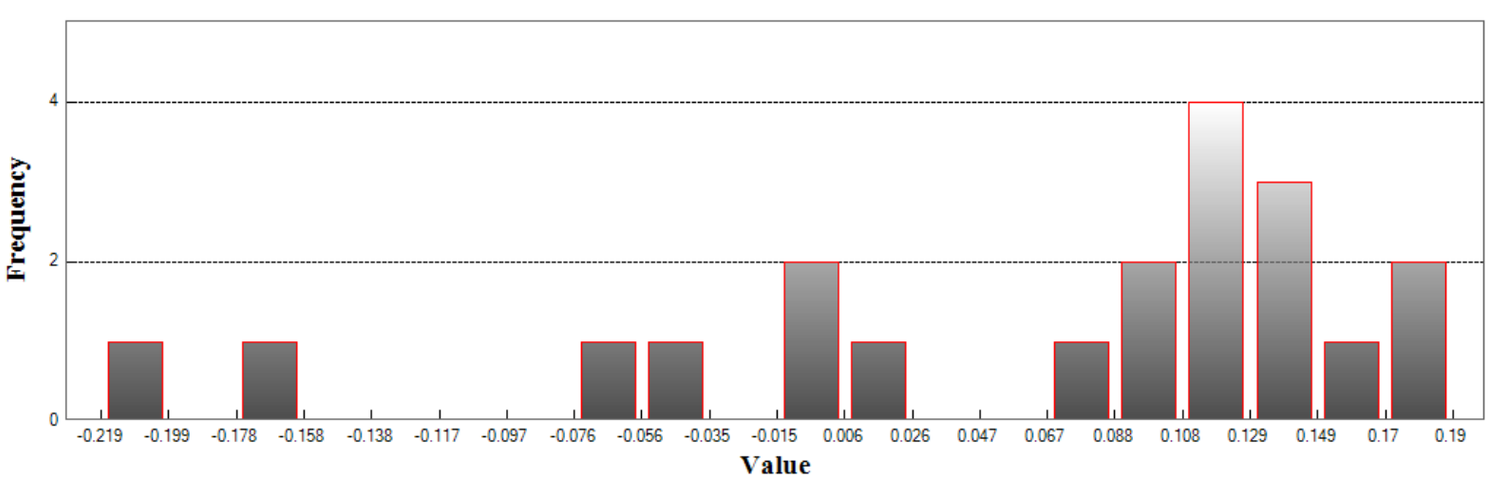
Standard Deviation DZ: 0.112

RMSE Z: 0.124

95th Percentile: 0.19

Units: Meters

Histogram



Min: -0.219

Max: 0.19

Number Of Bins: 20

Bin Interval: 0.02

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: -0.237

Maximum DZ: 0.213

Mean DZ: 0.06

Mean Magnitude DZ: 0.303

Number Observations: 32

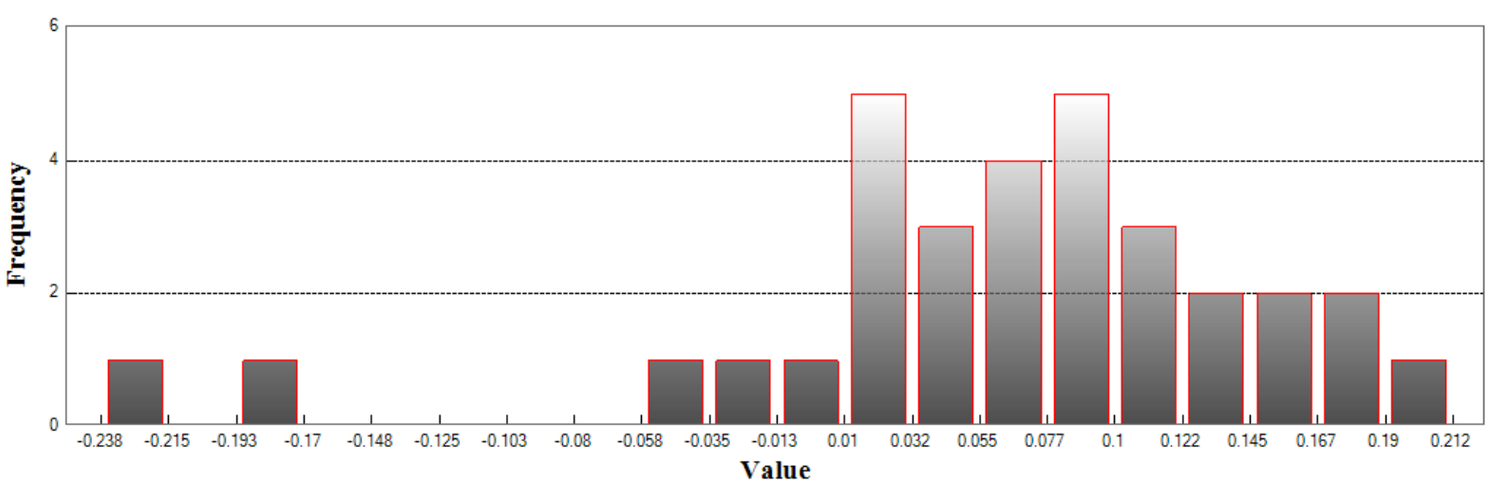
Standard Deviation DZ: 0.095

RMSE Z: 0.111

95th Percentile: 0.186

Units: Meters

Histogram



Min: -0.237

Max: 0.213

Number Of Bins: 20

Bin Interval: 0.023

LAS (Continued)

Vegetated Vertical Accuracy

LandCover Type: Medium Vegetation

Minimum DZ: -0.145

Maximum DZ: 0.164

Mean DZ: 0.041

Mean Magnitude DZ: 0.312

Number Observations: 8

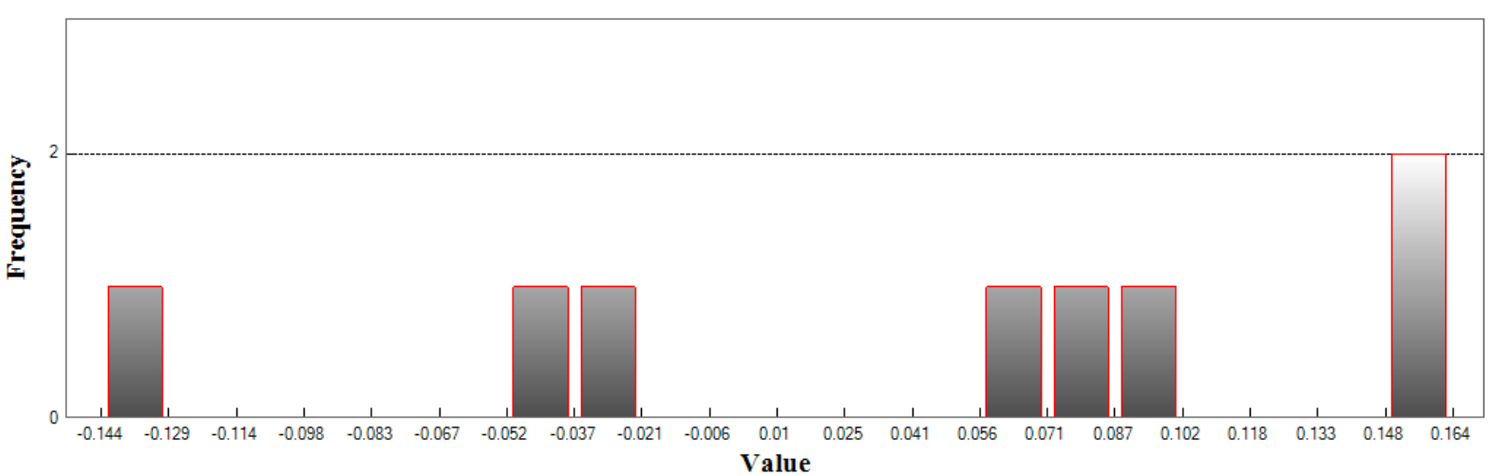
Standard Deviation DZ: 0.107

RMSE Z: 0.108

95th Percentile: 0.164

Units: Meters

Histogram



Min: -0.145

Max: 0.164

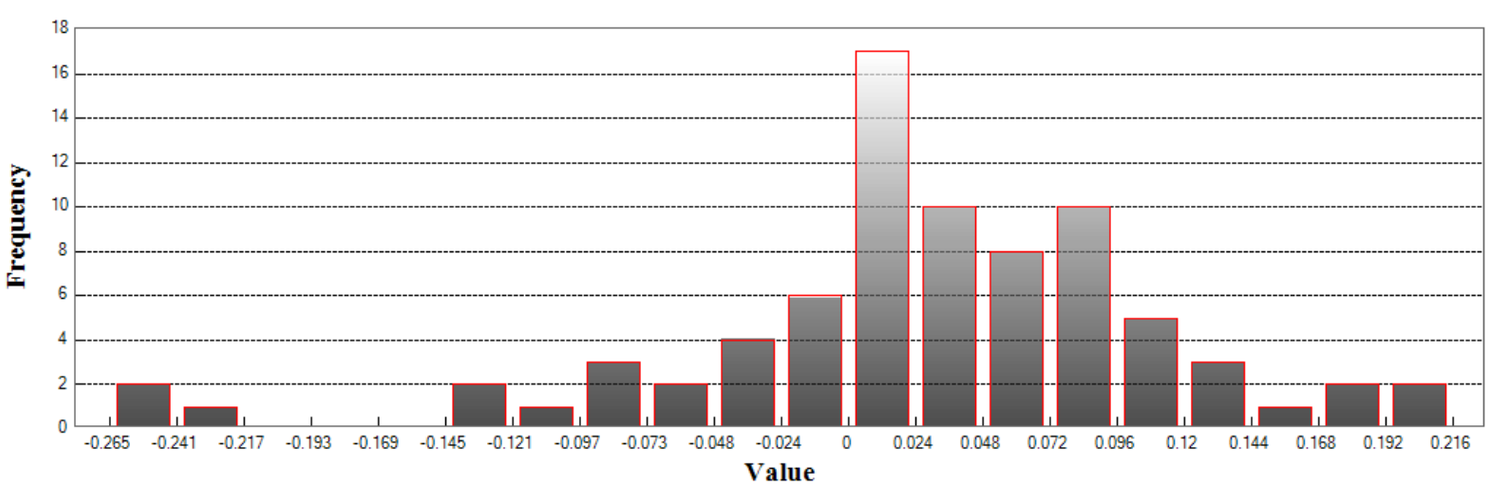
Number Of Bins: 20

Bin Interval: 0.015

DEM

Nonvegetated Vertical Accuracy
LandCover Type: Bare Ground, Hard Pavement, Packed Sand
Minimum DZ: -0.265
Maximum DZ: 0.216
Mean DZ: 0.026
Mean Magnitude DZ: 0.262
Number Observations: 79
Standard Deviation DZ: 0.088
RMSE Z: 0.091
95% Confidence Level Z: 0.179
Units: Meters

Histogram



Min: -0.265
Max: 0.216
Number Of Bins: 20
Bin Interval: 0.024

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: High Vegetation

Minimum DZ: -0.229

Maximum DZ: 0.197

Mean DZ: 0.064

Mean Magnitude DZ: 0.327

Number Observations: 20

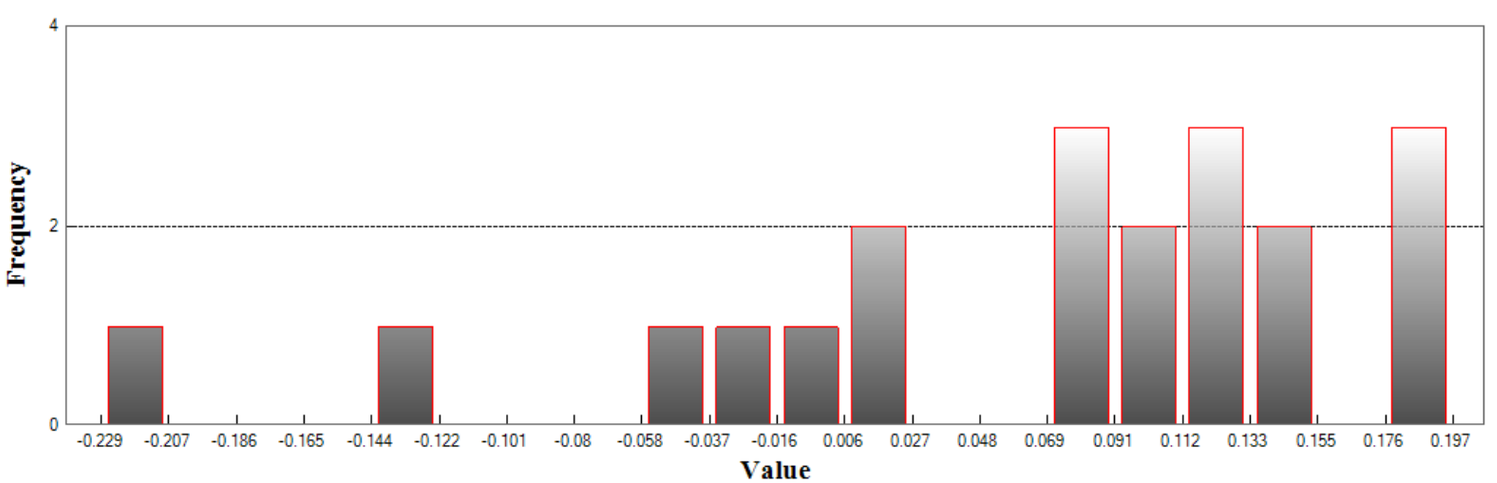
Standard Deviation DZ: 0.109

RMSE Z: 0.124

95th Percentile: 0.197

Units: Meters

Histogram



Min: -0.229

Max: 0.197

Number Of Bins: 20

Bin Interval: 0.021

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Low Vegetation

Minimum DZ: -0.243

Maximum DZ: 0.288

Mean DZ: 0.068

Mean Magnitude DZ: 0.318

Number Observations: 32

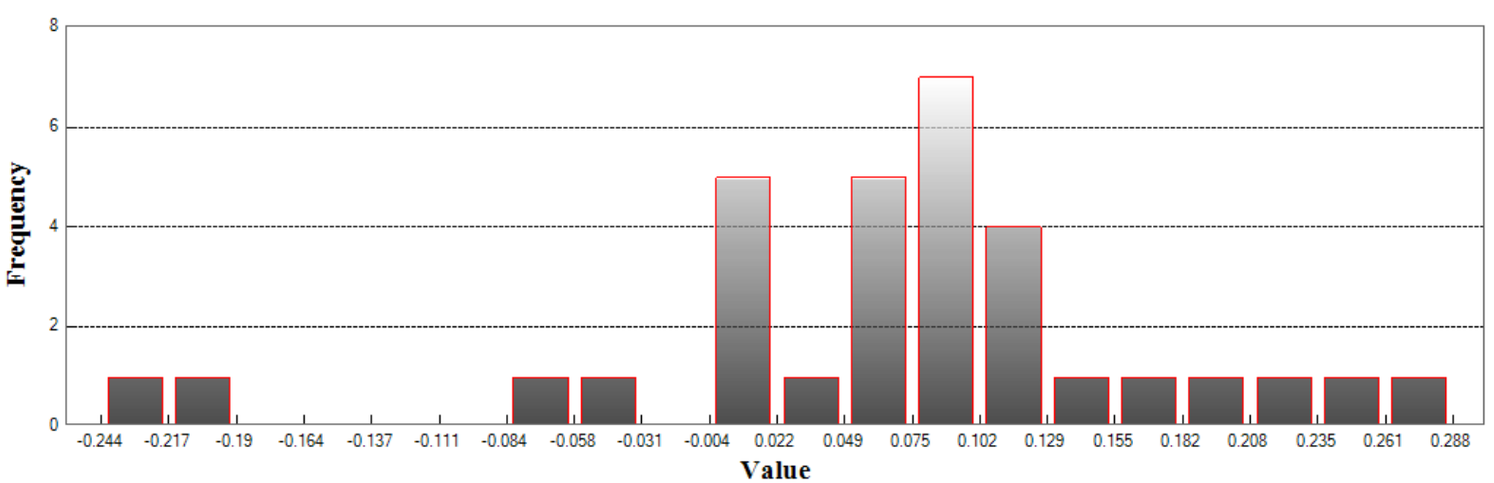
Standard Deviation DZ: 0.106

RMSE Z: 0.125

95th Percentile: 0.243

Units: Meters

Histogram



Min: -0.243

Max: 0.288

Number Of Bins: 20

Bin Interval: 0.027

DEM (Continued)

Vegetated Vertical Accuracy

LandCover Type: Medium Vegetation

Minimum DZ: -0.145

Maximum DZ: 0.189

Mean DZ: 0.059

Mean Magnitude DZ: 0.33

Number Observations: 8

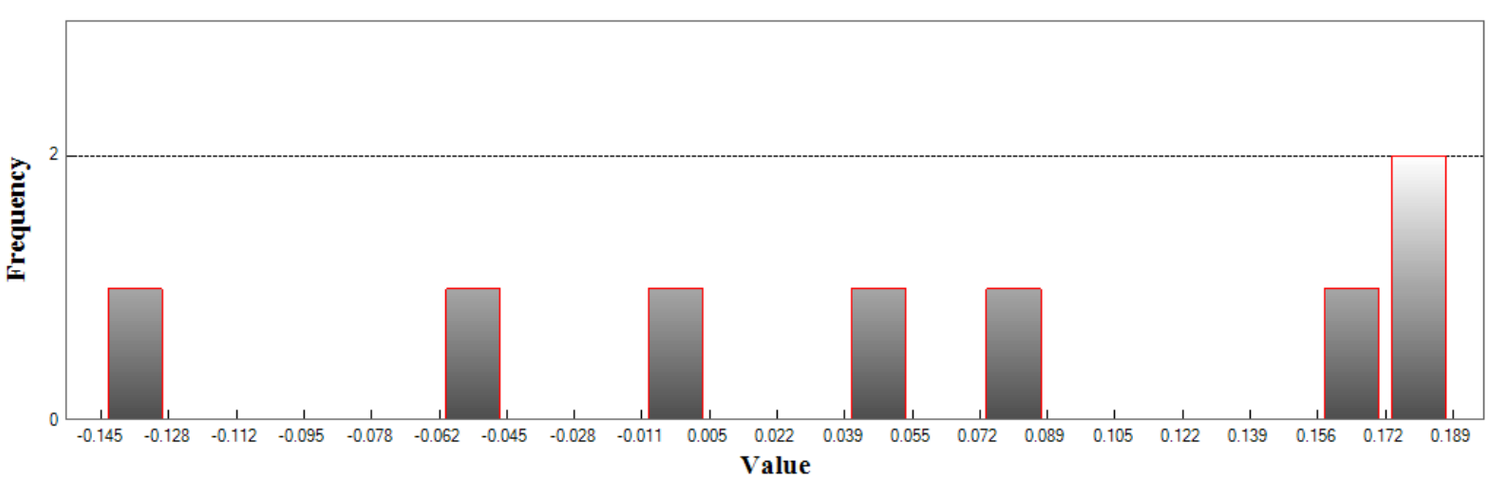
Standard Deviation DZ: 0.121

RMSE Z: 0.127

95th Percentile: 0.189

Units: Meters

Histogram



Min: -0.145

Max: 0.189

Number Of Bins: 20

Bin Interval: 0.017