LiDAR Project Report

G15PD00884, Roosevelt-Curry NM

QL2 LiDAR

Prepared For:

United States Geological Survey

Prepared By:

Digital Aerial Solutions, LLC

CONTRACT: #G10PC00093
CONTRACTOR: DIGITAL AERIAL SOLUTIONS
TASK ORDER: # G15PD00884

Project Report

LiDAR Collection, Processing, and QA/QC

G15PD00884, Roosevelt-Curry NM
QL2 LiDAR

Prepared For:
US Geological Survey
1400 Independence Road
Rolla, MO 65401
Phone: (573) 308-3587

Prepared By:
Digital Aerial Solutions, LLC
8409 Laurel Fair Circle, Suite 100
Tampa, FL 33610
Phone: (813) 628-0788

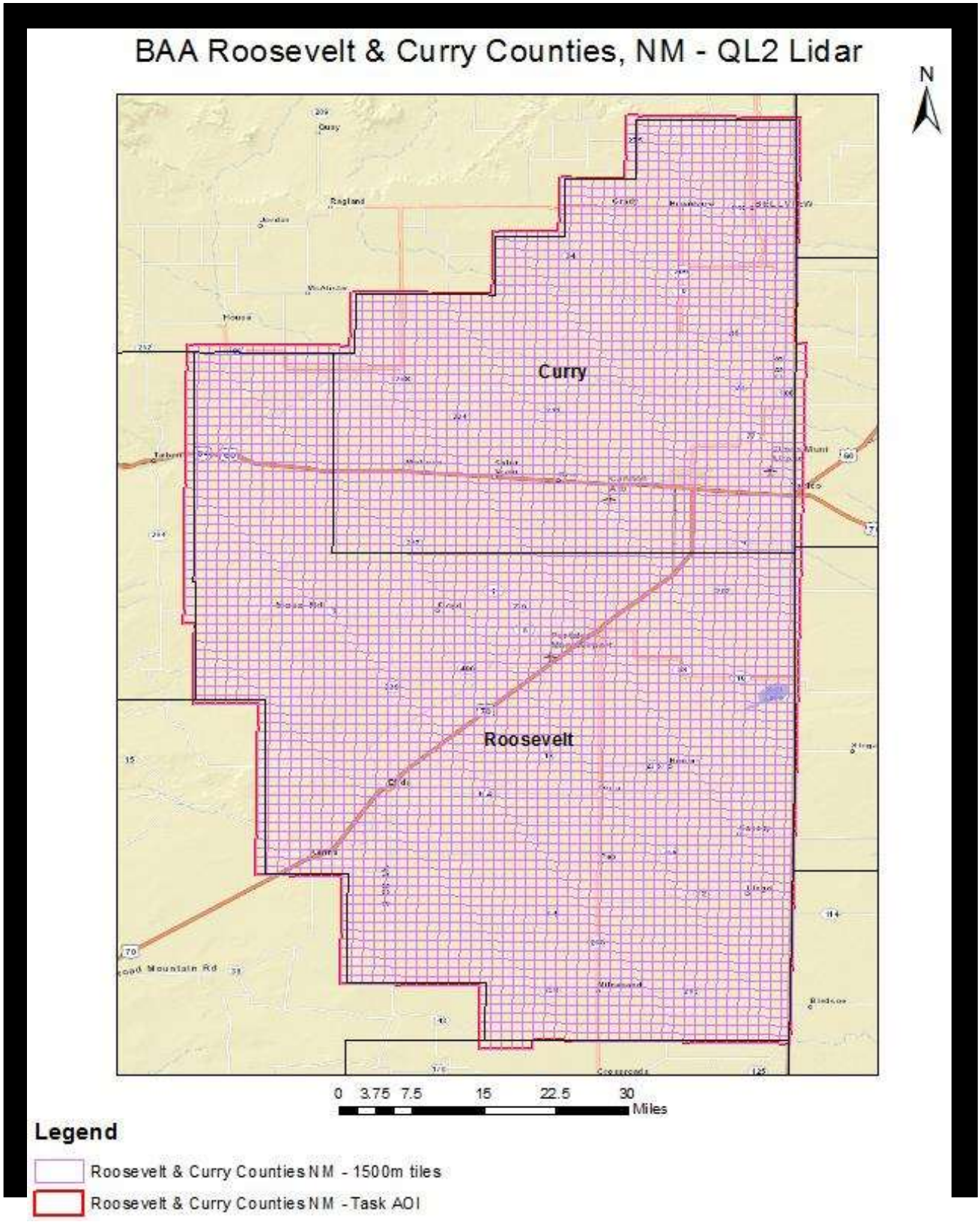

BAA Roosevelt & Curry Counties, NM - QL2 Lidar
N
Curry
Roosevelt
0 3.75 7.5 15 22.5 30
Miles
Legend
Roosevelt & Curry Counties NM - 1500m tiles
Roosevelt & Curry Counties NM - Task AOI

Table of Contents

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 G15PD00884, Roosevelt Curry NM QL2 LiDAR. The area encompasses approximately 3993 square miles Aerial LiDAR data was collected utilizing an ALS70 and ALS80. The ALS70 is a discrete return topographic LiDAR mapping system manufactured by Leica Geosystems.
LiDAR data collected for the G15PD00884, Rooselvelt Curry NM QL2 LiDARLidar survey has a nominal pulse spacing of 0.7 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. Point cloud deliverables are stored in the LAS version 1.4 format, point data record format 6. The tiling scheme for tiled deliverables is a 1500 meters x 1500 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 1.2.*

2 Spatial Reference System

The spatial reference of the data is as follows.

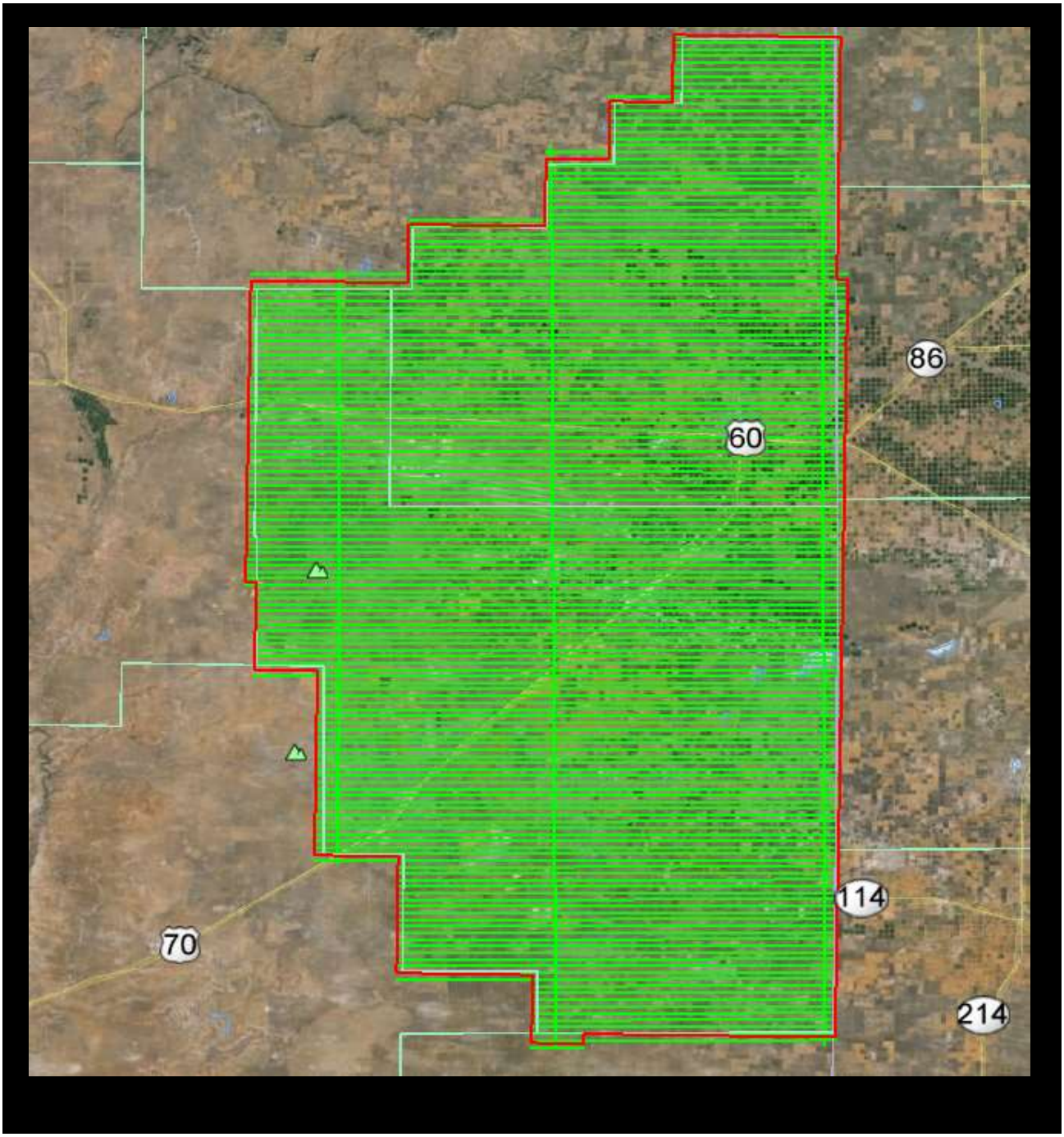
Horizontal Spatial Reference
- Datum: NAVD88, Meters (to 3 decimal places)
- Coordinates: UTM Zone 15, NAD83, Meters (to 2 decimal places);

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 1983 (GEOID12B)

3 LiDAR Acquisition

3.1 Survey Area

The G15PD00884, Roosevelt Curry NM QL2 Lidar survey covers approximately 3993 square miles covering all of Roosevelt and Curry Counties. The flight plan consisted of 180 survey lines and 3 control lines.



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. Acquisition parameters selected for the Roosevelt and Curry County NM, 2ppsm Lidar project are summarized below.

Parameter	Value
Flying Height Above Ground Level	6230 feet
Nominal Sidelap	30%
Nominal Speed Over Ground	155 knots
Field of View	36°
Laser Rate	132 kHz
Scan Rate	66.2 hz
Maximum Cross Track Spacing	0.78 meters
Maximum Along Track Spacing	0.82 meters
Average Spacing	0.7 meters

3.3 Acquisition Mission

The acquisition mission for G15PD00884, Roosevelt Curry NM QL2 LiDAR survey was coordinated to be acquired in 2 weeks, due to weather conditions and the completion of acquisition was not until 3 weeks. Collection began on September 30th 2015 and was completed on October 15th, 2015.

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	ALS70 – SN1132	x: -0.210, y: -0.060, z: -1.370	x: -0.450, y: -0.159, z: -0.169

In addition, GPS data was collected with ground base stations during the acquisition mission, providing corrections to support differential post-processing of the airborne GPS. One ground base station was setup at an NGS Benchmark (Keyport) as the base of operation. The additional ground base station were selected and place threw the project to ensure complete coverage. Ground GPS observations were collected at a frequency of 2Hz.

4 LiDAR Processing

4.1 Acquisition Post-Processing

Once the acquisition was completed, initial post-processing was performed to generate geo-referenced LiDAR elevation point clouds.

The airborne GPS dataset was differentially corrected using the ground base station GPS datasets collected by DAS in Lecia's IPAS software. IPAS computes the GPS dataset corrections in both forward and reverse chronological sequence, obtaining two solutions for the GPS trajectory. The differences between these two solutions were reviewed to ensure a consistent result, and agree within +/- 3cm. The forward and reverse solutions also show good fit between the two different base stations used in the post-processing.

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 flightline, 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 G15PD00884, Roosevelt Curry NM 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 Cloud Pro software for the ALS80 sensor system. Terrasolid's Terramatch software was used to calculate the IMU bore-site and mirror scale parameters for the G15PD00884, Roosevelt Curry NM 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.

survey and control lines. 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. 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. 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 the G15PD00884, Roosevelt Curry NM QL2 LiDAR project, the control lines were used to determine relative z offset corrections in areas of discernible ground. The base station operated by DAS in the survey area provided for minimal baseline lengths, resulting in generally good z agreement between the survey lines and control lines.

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 could LAS files. Geometrically calibrated swath point clouds were cut into USNG index, 1500 meter x 1500 meter LAS 1.4 format tiles for point cloud classification and derived 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:

Class 1 – Processed, but unclassified
Class 2 – Bare-earth ground
Class 7 – Low Noise (low, manually identified, if necessary)
Code 8 – Model Key Point
Class 9 — Water
Class 10 — Ignored Ground (Breakline Proximity)
Class 17 — Bride Decks
Class 18 – High Noise (high, manually identified, if necessary)

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 Terrasolids'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 G15PD00884, Roosevelt Curry NM QL2 LiDAR survey maintained significant point density in the water, 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 10 – 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 32 bit raster 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 G15PD00884, Roosevelt Curry NM 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 CloudPro 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.

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.

There is not a systematic method of testing when testing horizontal accuracy in LiDAR. The estimated Horizontal accuracy at one sigma based on the flying height for the project, is between 10cm and 20cm according to manufacturer specifications.

Absolute vertical accuracy assessments for the point cloud data are made against ground check point data. For the G15PD00884, Roosevelt Curry NM 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 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 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 fundamental vertical accuracy (FVA) of the swath point clouds. The NVA of the TIN tested RMSEz 0.062 meters and 0.121 meters at the 95% confidence level in open terrain. NVA of the DEM tested at an RMSEz of 0.061 meters and 0.119 meters at the 95% confidence level in open terrain. The full calculations for all check points can be found in Appendix B.

FVA of TIN

$RMSE_Z$ =	0.062	meters
NSSDA=	0.121	meters

FVA of DEM

$RMSE_Z$ =	0.061	meters
NSSDA=	0.119	meters

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 1.2 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

Digital Aerial Solutions

745

ALS80 LiDAR Flight Log

Project	BAA New Mexico Lidar			ALS80	SN 8235							Sensor Operator/s	
Date/Julian:	9130			Memory Drive			TAR AIRSPD (KNTS)			Base PID:		Pilot/s	
Hobbs End	1120			8654			145			CUN		Mike	
Hobb Start	1078	1606 UTC					TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:	
Flight Time	0.042						10600			1.5	112MJ	CUN	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
1		93	+N	1622	1632	10575	000	144	745	15	1.4		Clear
		92	-S	1638	1646	10606	181.3	145	741	15	1.4		Clear
		91	+N	1651	1709	10634	001.2	145	737	16	1.2		Clear
		90	-S	1703	1732	10639	181.4	141	731	16	1.3		Clear
		89	+N 1737	1737	1757	10656	001.2	145	724	15	1.3		Clear *
		88	-S	1759	1817	10657	181.6	142	717	18	1.1		Clear *
		87	+N	1821	1840	10657	000.3	147	710	18	1.1		Clear *
		86	-S	1844	1902	10645	180.9	145	703	15	1.4		Clear *
		85	+N	1906	1924	10652	001.2	147	696	15	1.4		Clear
		X06	+E	1931	1937	10591	269.1	143	689	17	1.1		Clear 6.91km of X06
		X04	-W-S	1938	1958	10636	181.7	144	688	18	1.0		Clear
		X02	+W E	2005	2008	10645	272.3	140	691	16	1.3		Clear

for cross strip overlap 1

ALS80 LiDAR Flight Log

Project	BAA New Mexico			ALS80	SN 8235							Sensor Operator/s	
Date/Julian:	9/30			Memory Drive			TAR AIRSPD (KNTS)				Base PID:	Pilot/s	
Hobbs End				8654			145				CUN	Leo	
Hobb Start	~~#07.6~~	1112.0 UTC 1:20					TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:	
Flight Time	0.0						10600			1.5	12MJ	CUN	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
2		84	+N	0139	0158	10612	~~300~~2.5	137	679	15	1.1		ENE 8-7? Check Clear
		83	-S	0202	0221	10628	179.9	145	672	20	1.2		Clear
		X02	-W 7.4 ~~FIX~~	0229	0232	10625	269.9	143	665	24	1.0		Clear
		X01	+E 7.4	0244	0248	10643	0905	145	664	23	1.1		Clear
		171	-S	~~0250~~ 0300	0317	10592	181.2	143	663	20	1.2		Clear
		170	+N	0322	0339	10535	000.0	144	657	20	1.1		Clear
		169	-S	0343	0400	10543	181.	149	650	21	0.9		Clear
		168	+N	04	0422	1053	001.4	141	644	19	1.1		~~ENE~~ 8-4
		~~169~~	~~X02 -W~~	0433	0436	10564	268	145	638	19	1.1		Clear
		~~170~~	X03 +E	0458	0441	10563	089.5	148	637	18	1.2		Clear

ALS Warning The range measurments (2236)

ALS80 LiDAR Flight Log

Project	BAA Nm Lidar		ALS80	SN 8235								Sensor Operator/s	
												MASON	
Date/Julian:	101115		Memory Drive			TAR AIRSPD (KNTS)					Base PID:	Pilot/s	
Hobbs End	1119.7	UTC	[illegible] 654			145					CUN	Mike	
Hobb Start	1115.5	UTC 1445				TAR ALT AGL (ft):		Flight Plan(s):			Base Height:	Aircraft	Airport Idnt:
Flight Time	0.0					10666					1.5	112 MT	CUN

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	SVs:	Position Acc: PDOP	Position Acc: HDOP	Comments and Conditions:
3		82	+N						745				ALS fov error, cable
		Air restart							—				—
		82	+N	1533	1552	10646	001.2	146	744	15	1.2		clear
		81	-S	1556	1615	10696	181.1	148	737	16	1.2		clear
		80	+N	1618	1637	10670	001.0	142	730	14	1.5		clear
		79	-S	1641	1700	10673	181.1	146	723	15	1.5		clear
		78	+N	1703	1722	10680	001.0	143	716	15	1.4		clear
		X06	-W	1727	1729	1058	270.3	142	709	15	1.3		45 4.6 68-5 000 NMI from right
		77	-S	1733	1753	10580	180.1	150	708	15	1.3		clear
		76	+N	1756	1816	10674	001.1	143	701	18	1.1		clear
		75	-S	1818	1838	10610	181.2	145	694	17	1.3		clear
		X02	+E	1844	1847	10632	091.5	142	687	16	1.4		

ALS warning

ALS80 LiDAR Flight Log

Project	BAA NewMexico Lidar		ALS80	SN 8235								Sensor Operator/s	
Date/Julian:	10/1/15		Memory Drive			TAR AIRSPD (KNTS)			Base PID:			Mason	
Hobbs End	1123.7			654		145			CVN			Pilot/s	
Hobb Start	1119.7					TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:	Leo	
Flight Time	0.0					10666			1.5	112MJ	CVN		

Lift		Flight Line	Mission Line	UTC time: B	UTC time: E	GPS Altitude: MSL	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
4		74	+N	2157	2217	10655	001.3	145	745	17	1.1		
		73	-S	2222	2241	10640	181.3	149	737	16	1.3		
		72	+N	2247	2307	10687	001.2	151	730	18	1.1		
		71	-S	2311	2331	10607	180.9	147	723	18	1.0		
		70	+N	2335	2355	10627	000.9	147	716	18	1.1		
		69	-S	0000	0020	10623	181.5	149	708	19	1.1		
		68	+N	0024	0044	10645	359.5	145	701	17	1.3		
		X06	+E	0050	0052	10624	270.4	150	694	17	1.3		
		67	-S	0058	0118	10596	180.6	145	693	17	1.2		
		X02	+E	0124	0127	10617	091.3	145	685	19	1.1		

Digital [illegible]utions

E

ALS80 LiDAR Flight Log															
Project	BAA NM LiDAR			ALS80	SN 8235									Sensor Operator/s	
														MASON	
Date/Julian:	6/12/14			Memory Drive			TAR AIRSPD (KNTS)				Base PID:			Pilot/s	
Hobbs End	127.5				654		145				CUN			MIKE	
Hobb Start	123.7						TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:	
Flight Time	0.0						10666				1.5		112 MI	CUN	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
5		66	+N	01	0155	10625	008.1	146	636	19	1.2		
		65	-S	0200	0220	10624	179.1	130	629	20	1.3		
		64	+N	0225	0242	10671	358.4	145	621	21	1		
		63	-S	0247	0305	10585	181.1	141	615	20	1.2		
		62	+N	0309	0326	10661	000.1	145	608	20	1.1		
		61	-S	0331	0350	10623	181.2	139	602	21	.9		
		60	+N	0353	0410	10667	002.7	147	595	17	1.2		
		x01	-W	0420	0422	10645	270.5	146	589	17	1.2		
		59	-S	0430	0448	10659	182.5	143	588	19	1.1		
		x02	-W	0455	0458	10664	270.6	144	[illegible]	17	1.2		
									581				
									580				

ALS80 LiDAR Flight Log

Project	BAA NM LiDAR		ALS80	SN 8235							Sensor Operator/s	
Date/Julian:	10/3/15		Memory Drive		TAR AIRSPD (KNTS)			Base PID:			Mason	
Hobbs End	1131.0			654	145			CNN			Pilot/s	Leo
Hobb Start	1127.5				TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:		
Flight Time	0.0				10666			1.5	172RG	CUN		

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
6		58	+N	1551	–	10640	002.4	138	[illegible]	16	1.2		Stop for cloud
		167	-S	1601	1619	10525	187	150	579	15	1.3		Clear
		166	+N	1622	1639	10526	359.7	141	573	15	1.4		Clear
		165	-S	1643	1700	10501	184.1	147	567	16	1.3		Clear
		164	+N	1705	1721	10535	006	144	561	16	1.3		Clear
		163	-S	1726	1743	10443	180.9	146	554	17	1.2		Clear
		162	+N	1748	18	10460	359.2	[illegible]	548	18	1.1		Clear
		161	-S	1845	1827	10442	186.3	147	542	17	1.3		FSE 32-30 Rally
		X05	-W	1835	1838	10468	089.1	152	536	15	1.5		Clear
		160	+N	1847	1959	10470	001.1	140	535	15	1.5		FNE 13 Like rain ~~GD~~ bad
		X03	+E	1906	1909	10438	272.1	147	530	17	1.2		

26-16
10 5.44

ALS80 LiDAR Flight Log

Project	BAA NM LIDAR		ALS80	SN 8235							Sensor Operator/s	MASON	
Date/Julian:	10/6/15		Memory Drive	654	TAR AIRSPD (KNTS)	145			Base PID:	CUN	Pilot/s	Leo	
Hobbs End	~~1137~~	1138.2			TAR ALT AGL (ft):	10600	Flight Plan(s):		Base Height:	1.5	Aircraft	112MJ	Airport Idnt: CUN
Hobb Start	1134.1												
Flight Time	0.0												

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL	Direction	Speed: kts:	remaining: Memory	SVs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
7		58	+N	1511	1518	10655	000.4	147	528	15	1.2		FNE 27 Cal Cor
		57	-S	1523	1531	10640	166.4	145	526	15	1.2		FSE 20/FSE 16→10 Refly for cloud
		159	-S	1540	1556	10640	181.2	144	523	16	1.2		clear
		158	+N	1600	1615	10540	001.8	149	516	15	1.5		Clear
★		161	-S	1620	1627	10528	181.5	146	511	15	1.5		Cal 28 FSE for Refly
★		160	+N	1631	1636	10537	002.1	145	508	16	1.1		Refly Fix 13→End Runs NE
		157	-S	1642	1658	10505	163.8	137	506	16	1.2		Clear
		X05	-W	1706	1709	10564	270.2	144	500	17	1.2		Clear
		156	+N	1716	1732	10526	000.8	155	498	16	1.3		Clear
		X02	-W	1735	1737	10557	271.7	147	492	18	1.1		X02 FWE clear
		X02	+E	1742	1744	10594	090.3	146	492	16	1.1		Clear
		1~~4~~6	-S	1746	1802	10602	163.3	145	491	16	1.2		Clear
		X05	+E	1805	1809	10573	090.7	146	485	17	1.3		Clear
		145	+N	1815	1830	10585	000.4	149	485	16	1.4		FNE 17→9 Refly ~~cut to cloud~~
		X03	+E	1838	1644	10580	089.7	149	479	15	1.5		

+12, -30

ALS80 LiDAR Flight Log

Project	NM Lidar		ALS80	SN 8235	START 17:08		END 2026			Sensor Operator/s	
Date/Julian:	10/10/15		Memory Drive		TAR AIRSPD (KNTS)		TEMP	Base PID:		Pilot/s	
Hobbs End	1141.3		0098		145		CVN.101015			Mike	
Hobb Start	1138.2	~~1141.3~~			TAR ALT AGL (ft):		Flight Plan(s):	Base Height:		Aircraft	Airport Idnt:
Flight Time	0.0				10762		NM_Lidar_QL2	1.5		112MJ	CVN

Lift		Flight Line	Mission Line	UTC time: B	UTC time: E	GPS Altitude: MSL	Direction	Speed: kts:	remaining: Memory	SVs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
8		~~1~~	031	1738	1754	10750	N	145±5	476	17	1.3	0.7	Clear
		2	030	1758	1813	10748	S	142	~~471~~	16	1.4	0.6	Clear
		3	029	1817	1832	10762	N	142	465	15	1.5	0.7	Clear Check plature QA
		4	028	1836	1852	10754	S	145	459	16	1.2	0.6	Clear fly in same plature QA
		5	027	1855	1911	10789	N	147	453	19	1.0	0.6	clear fly in same plature QA
		6	026	1914	1930	10762	S	146	447	17	1.2	0.6	Clear plature QA
		~~7~~	~~025XO2~~	—	—	—	~~S~~	~~143~~	~~441~~	~~18~~	~~1.1~~	~~0.6~~	-Had to shutdown b/c
		~~8~~ 7	XO2	1956	1959	10663	W	143	441	18	1.1	0.6	froze. No 360/fly over CORS
		8	XO2	2003	2006	10671	E	149	440	17	1.2	0.6	Clear

135.6 Gal ~~for fuel~~
Gal for Fuel

ALS80 LiDAR Flight Log														
					ALS80	SN 8235							Sensor Operator/s	
Project	NM BAA LIDAR												MASON	
Date/Julian:	10/10/15				Memory Drive		TAR AIRSPD (KNTS)				Base PID:		Pilot/s	
Hobbs End	1145.5					809654	145				CVN		Mike	
Hobb Start	1141.3						TAR ALT AGL (ft):	Flight Plan(s):			Base Height:	Aircraft	Airport Idnt:	
Flight Time	0.0						10795				1.5	112MJ	CVN	

Liftoff		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining Memory	SVs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
9	1	26	-S	2146	2202	10753	179.8	142	686	15	1.5	0.9	clear
	2	25	+N	2205	2221	10771	359.6	144	680	17	1.1	0.7	clear
	3	X01	~~+E~~ +E	2225	2228	10935	091.2	143	674	17	1.1	0.6	clear
	4	24	-S	2232	2249	10790	181.1	151	673	18	1.0	0.6	clear
	5	23	+N	2253	2306	10784	000.6	144	667	18	1.1	0.6	clear
	6	22	-S	2309	2323	10776	179.8	146	662	16	1.1	0.6	clear
	7	21	+N	2326	2340	10780	002.0	144	657	19	1.0	0.6	clear
	8	20	-S	2344	2357	10800	180.4	146	652	17	1.3	0.7	clear
	9	19	+N	0001	0014	10816	000.5	144	647	17	1.3	0.7	clear
	10	18	-S	0017	0031	10794	181.9	144	642	17	1.3	0.7	clear
	11	17	+N	0034	0048	10817	001.9	143	637	18	1.1	0.6	clear
	12	16	-S	0051	0105	10820	180.6	142	632	18	1.1	0.6	Clear
	13	X02	~~+E~~ +E	0114	0119	10631	091.5	145	627	21	1.1	0.6	Clear
									625				

+1; -38 10m WE

ALS80 LiDAR Flight Log

Project	NM_LIDAR		ALS80	SN 8235							Sensor Operator/s	
Date/Julian:	10/11/15			START: 1447	END: 1856						Will	
Hobbs End			Memory Drive		TAR AIRSPD (KNTS)					Base PID:	Pilot/s	
Hobb Start	1145.5	1149.6	099		145		Temp		CVN1011S		Mike	
Flight Time	0.0	4.1			TAR ALT AGL (ft):		Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:	
					10884		NM_Lidar_02		1.5	112MJ	CVN	

Lift		Flight Line	Mission Line	UTC time: G	UTC time: E	GPS Altitude MSL	Direction	Speed: kts	remaining: Memory	SVs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
10		1	15	1513	1527	10852	S	142	625	16	1.2	0.7	Clear
		2	14	1531	1544	10847	N	144	620	15	1.4	0.7	Clear
		3	13	1548	1602	10844	S	146	615	15	1.4	0.7	Clear
		4	12	1606	1619	10859	N	143	609	16	1.2	0.6	Clear
		5	11	1623	1637	10852	S	145	604	16	1.3	0.7	Clear 10 mi FOE space-10
		6	10	1641	1654	10832	N	142	594	16	1.4	0.7	Clear
		7	9	1658	1712	10835	S	148	594	15	1.3	0.6	Clear
		8	8	1716	1730	10813	N	145	589	18	1.1	0.6	Clear
		9	7	1733	1747	10829	S	148	584	17	1.3	0.7	clear
		10	6	1751	1804	10822	N	143	579	16	1.4	0.6	Clear
		11	5	1808	—	10863	S	144	574	15	1.5	0.7	Clear ; Abort b/c fly traffic
		12	X02	1823	1827	10657	W	149	572	15	1.5	0.7	Clear
		13	X02	1831	1835	10644	E	148	570	16	1.2	0.6	Clear

D
Digital A ations

ALS80 LiDAR Flight Log

Project	BAA NM LIDAR		ALS80	SN 8235							Sensor Operator/s	
Date/Julian:	10/11/15		Memory Drive		TAR AIRSPD (KNTS)				Base PID:		Pilot/s	
Hobbs End	1152.9			099	145				CVN		Mike	
Hobb Start	1149.6				TAR ALT AGL (ft):	Flight Plan(s):			Base Height:	Aircraft	Airport Idnt:	
Flight Time	0.0				10700				~~1.5~~	112MT	~~TTD~~ CVN	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	SVs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
11	1	5	-S	2125	2139	10~~2~~801	160.3	148	569	16	1.3	0.8	Clear
	2	4	+N	2143	2156	10810	001.0	150	564	16	1.2	0.7	Clear
	3	3	-S	2200	2213	10795	179.4	145	559	17	1.1	0.7	Clear
	4	2	+N	2217	2231	10~~8~~746	002.7	140	553	18	1.1	0.6	Clear
	5	1	-S	2234	2245	10753	182.2	147	548	19	1.0	0.6	Clear
	6	x02	-W	2251	2257	10658	272.7	142	544	19	1.0	0.6	Clear
	7	x02	+E	2257	2259	10650	091.6	147	544	19	1.0	0.6	Clear
	8	32	+N	2308	2325	10756	359.0	143	543	18	1.1	0.6	Clear
	9	x01	-W	2329	2330	10933	270.1	141	537	17	1.2	0.7	Clear
	10	33	-S	2335	2351	10736	180.5	139	536	17	1.3	0.7	check FSE 30-20
	11	x02	+E	2359	[illegible]02	10655	091.5	145	531	17	1.3	0.7	Clear
									530				

4mi 29
15 23

ALS80 LiDAR Flight Log																
					ALS80	SN 8235									Sensor Operator/s	
Project	NM. LiDAR					START: 1556	END: 2011								Will	
Date/Julian:	10/12/15					Memory Drive			TAR AIRSPD (KNTS)					Base PID:	Pilot/s	
Hobbs End		1157.1				00099			145					CVN.101215	Mike	
Hobb Start	~~1150.1~~	1153.1							TAR ALT AGL (ft):			Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:
Flight Time	0.0								10751			NM_LiDAR_Q12		1.5	112MJ	~~EVW~~ PRZ→CVN

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
12		1	34	1641	1656	10731	S	144	530	15	1.4	0.7	clear
		2	35	1700	1716	10742	N	146	523	17	1.1	0.6	Clear
		3	36	1714	1735	10678	S	144	518	17	1.2	0.6	Clear
		4	37	1738	1758	10691	N	145	512	17	1.3	0.6	clear
		5	38	1758	18:13	10693	S	147	506	15	1.5	0.7	clear
		6	39	18:16	18:32	10631	N	144	500	15	1.5	0.7	clear
		7	40	18:36	1852	10677	S	143	495	18	1.0	0.6	clear
		8	41	18:54	1910	10610	N	147	489	19	1.0	0.6	Clear
		9	X01	1915	1918	10841	W	149	483	18	1.1	0.7	clear
		10	42	1424	1939	10620	S	143	482	19	1.1	0.6	Clear
		11	X02	1947	1951	10624	E	142	476	18	1.1	0.6	Clear

Digital Ac ...tions

ALS80 LiDAR Flight Log															
Project	BAA NM LIDAR			ALS80	SN 8235								Sensor Operator/s		
Date/Julian:	10/12/15			Memory Drive			TAR AIRSPD (KNTS)					Base PID:	Pilot/s		
Hobbs End	1161.1				099		145					CUN 2015/2	Mike		
Hobb Start	1157.1	2243					TAR ALT AGL (ft):		Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:		
Flight Time	0.0						107				1.5	112MJ	CUN		

Lift		Flight Line	Mission Line	UTC time: B	UTC time: E	GPS Altitude: MSL	Direction	Speed: kts	remaining Memory	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
13	1	43	-S	2302	2317	10642	179.9	146	474	16	1.1	0.6	Clear
	2	44	+N	2321	2336	10655	002.1	146	469	18	1.1	0.6	Clear
	3	45	-S	2342	2359	10600	180.1	147	463	17	1.3	0.7	Clear
	4	46	+N	0003	0020	10634	001.9	144	457	16	1.3	0.7	Clear
	5	47	-S	0023	0040	10633	180.1	147	450	16	1.4	0.7	Clear
	6	48	+N	0044	0101	10652	001.9	146	444	17	1.2	0.6	Clear
	7	49	-S	0104	0121	10646	180.1	144	438	21	1.1	0.6	Clear
	8	50	+N	0125	0142	10651	002.7	146	432	21	1.1	0.6	Clear
	9	X01	+E	0149	0152	10907	091.3	151	485	23	1.0	0.5	Clear
	10	51	-S	0200	0217	10676	180.1	147	424	20	1.1	0.6	Clear
	11	~~X02~~	+E	0225	0228	10688	092.6	173	418	19	1.2	0.6	Clear
									416				

X01 +13 -161
0 5.390'
0 ——— 34.390

X05 +121 -121
2.321

ALS80 LiDAR Flight Log

Project	BAA NM LIDAR	ALS80	SN 8235		Sensor Operator/s: MASON
Date/Julian:	6/13/18	Memory Drive	099	TAR AIRSPD (KNTS): 145	Base PID: CUN / Pilot/s: MIKE
Hobbs End	1165.2 / 1916			TAR ALT AGL (ft): 10700	Flight Plan(s): / Base Height: 1.5 / Aircraft: 112 MJ / Airport Idnt: CUN
Hobb Start	1161.1 / 1500				
Flight Time	0.0				

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	SVs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
14	1	52	-S	1524	1541	10680	002.1	147	416	15	1.3	.7	Clear
	2	53	+N	1544	1601	10636	001.5	142	410	15	1.4	.7	clear
	3	54	-S	1604	1621	10613	180.1	145	404	16	1.3	.6	Clear
	4	55	+N	1625	1643	10651	001.8	145	398	16	1.4	.6	Clear
	5	56	-S	1646	1705	10645	180	147	391	16	1.2	.6	clear
	6	57	+N	1708	1726	10641	001.9	145	384	16	1.1	.6	Clear
	7	X01	+E	1734	1737	10941	090.1	142	377	17	1.3	.6	Clear
	8	58	-S	1745	1804	10654	181.2	143	377	16	1.4	.6	Clear
	9	X02	+E	1809	1811	10604	091.4	143	370	15	1.5	.7	Clear
	10	147	-S	1815	1830	10623	181.1	144	369	15	1.5	.7	Clear
	11	X05	+E	1835	1836	10603	090.	144	363	19	1.1	.6	Clear
	12	148	+N	1842	1858	10596	000.1	143	363	20	1.0	.6	Clear
	13	X03	+E	1904	1905	10570	089.1	148	357	16	1.1	.6	Clear

Digital A ations

+18, -8

ALS80 LiDAR Flight Log

Project	NM_LiDAR		ALS80	SN 8235	START: 2203	END: 0214				Sensor Operator/s			
Date/Julian:	10/13/15		Memory Drive		TAR AIRSPD (KNTS)				Base PID:	Will			
Hobbs End	~~1165.7~~	1169.2	000099		145				CVN101315	Pilot/s			
Hobb Start		1165.2			TAR ALT AGL (ft):	Flight Plan(s):			Base Height:	Aircraft	Airport Idnt:		
Flight Time	0.0				10596	NM_LiDAR_02			1.5	112MJ	CVN		

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	SVs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
15		1	155	2218	2233	10525	S	142	356	17	1.1	0.6	Clear
		2	154	2238	2254	10618	N	146	350	18	1.1	0.6	Clear
		3	153	2258	2313	10582	S	144	345	18	1.1	0.6	Clear
		4	152	2317	2332	10576	N	147	339	18	1.1	0.6	Clear
		5	151	2336	2351	10589	S	146	333	17	1.2	0.7	Clear
		6	150	2355	0011	10608	N	143	328	17	1.2	0.7	Clear
		7	149	0014	0030	10626	S	150	321	15	1.4	0.7	Clear
		8	145 Retry	0034	0049	10604	N	148	316	17	1.2	0.6	Clear
		9	144	0053	0108	10561	S	145	310	18	1.2	0.6	Clear
		10	X05	0115	0119	10571	W	147	304	21	1.2	0.6	Clear
		11	143	0125	0141	10582	N	145	303	23	1.0	0.5	Clear
		12	X03	0147	0151	10531	E	141	297	22	1.0	0.5	Clear

Digital A... utions

ALS80 LiDAR Flight Log

Project	NM_LiDAR		ALS80	SN 8235	START: 1550		END: 1952				Sensor Operator/s	
Date/Julian:	10/14/15		Memory Drive		TAR AIRSPD (KNTS)				Base PID:		Will	Pilot/s
Hobbs End	1173.1		00101		145		PR2101415 / CVN.104K				Mike	
Hobb Start	1169.2				TAR ALT AGL (ft):		Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:	
Flight Time	0.0				10945		NM-LiDAR-02		1.5	11ZMJ	CVN	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	SVs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
16		[redacted]1	112	1624	1635	10900	S	141	683	17	1.2	0.6	Clear
		2	113	1634	1649	10839	N	143	680	16	1.3	0.6	Clear
		3	114	1653	1702	10835	S	145	676	17	1.2	0.6	Clear
		4	115	1707	1718	10838	N	143	672	17	1.2	0.6	Clear
		5	116	1721	1732	10834	S	149	668	17	1.3	0.7	Clear
		6	117	1735	1746	10835	N	145	664	17	1.3	0.6	Clear
		7	118	1750	1800	10819	S	148	660	16	1.4	0.6	Clear
		8	119	1804	1815	10833	N	148	656	15	1.5	0.7	Clear
		9	120	1818	1829	10829	S	149	652	16	1.2	0.7	Clear
		10	121	1833	1843	10856	N	143	648	18	1.0	0.6	Clear
		11	122	1848	1859	10847	S	143	644	19	1.0	0.6	Clear
		12	X05	1904	1908	10588	W	147	640	18	1.1	0.6	Clear
		13	111	1913	1923	10798	N	146	638	19	1.1	0.6	Clear
		14	X03	1928	1932	10527	E	147	635	18	1.1	0.6	Clear

X03 −14 −23
0 14.469

ALS80 LiDAR Flight Log

Project	BAANMLIDAR		ALS80	SN 8235							Sensor Operator/s	
Date/Julian:	10/14/15		Memory Drive		TAR AIRSPD (KNTS)			Base PID:			MASON	
Hobbs End	1177.2			161	145			CON/POR			Pilot/s	Mike
Hobb Start	1173.1				TAR ALT AGL (ft):	Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:	
Flight Time	0.0	4.1			1700			1.5		112MT	CON	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
17	1	110	−S	2130	2140	10818	179.6	140	633	16	1.4	.8	Clear
	2	109	+N	2144	2155	10816	0008	142	629	17	1.2	.7	Clear
★	3	108	−S	2158	2208	10634	161.9	147	625	18	1.0	.6	Clear / Check
★	4	107	+N	2212	22	10648	001.1	149	621	17	1.1	.6	Need refly
	~~X~~	~~106~~	−S										Air restart
	5	106	−S	2251	2303	10901	178.1	147	617	17	1.2	.7	Clear
	6	[illegible]											
	6	123	+N	2307	238	10817	359.1	142	613	16	1.2	.7	Clear
	7	124	−S	2322	2333	10787	180.3	147	608	17	1.2	.7	Clear
	8	125	+N	2337	2349	10784	0008	145	604	17	1.3	.7	Clear
	9	X03	+W	2354	3001	10500	270.1	147	600	17	1.3	.7	Clear
	10	105	−S	0005	0012	10930	180.1	141	598	17	1.2	.6	Clear
	11	104	+N	0015	0022	10919	359.1	145	595	16	1.4	.6	Clear
	12	103	−S	0026	0033	10953	180.1	151	593	17	1.2	.6	Clear
	13	X04	+E	0037	0049	10557	09.4	145	596	16	1.1	.6	Clear
				0043									

X04 -1 1— 33
0 0.552

ALS80 LiDAR Flight Log

Project	BAA NM LIDAR		ALS80	SN 8235								Sensor Operator/s	
												Mason	
Date/Julian:	10/15/14		Memory Drive			TAR AIRSPD (KNTS)			Base PID:			Pilot/s	
Hobbs End	~~181~~181.5	2000		101		145			PRE			Mike	
Hobb Start	1177.4	1615				TAR ALT AGL (ft):		Flight Plan(s):	Base Height:		Aircraft	Airport Idnt:	
Flight Time	0.0					10950			1.5		112MS	PRE	

Lift		Flight Line	Mission Line	UTC time: B.	UTC time: E.	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
18	1	94	-S	1633	1640	10892	160.1	144	588	16	1.2	.6	Clear
	2	95	+N	1643	1650	10909	009.9	144	585	17	1.2	.6	Clear
	3	96	-S	1654	1700	10915	182.5	141	583	17	1.1	.6	clear
	4	97	+N	1704	1711	10992	001.0	148	580	17	1.2	.6	Clear
	5	98	-S	1715	1721	10966	161.8	142	578	18	1.1	.6	Clear
	6	99	+N	1725	1731	10963	001.0	137	575	17	1.3	.6	Clear
	7	100	-S	1735	1742	10984	161.0	145	573	16	1.4	.6	clear
	8	101	+N	1746	1753	10981	001.2	146	571	16	1.4	.6	clear
	9	102	-S	1756	1803	10991	161.5	145	568	15	1.5	.7	Clear
	10	X04	+E	1809	1813	10501	091.0	141	565	16	1.2	.6	Clear
	11	107	+N	1821	1831	10834	001.5	150	564	17	1.1	.6	Rafly for 10114/15
	12	X03	+E	1838	1847	10460	088.9	149	560	18	1.1	.6	clear
	13	126	-S	1852	1906	10724	160.9	147	557	17	1.2	.6	Clear
	14	127	+N	1910	1924	10760	001.4	149	552	18	1.2	.6	Clear
	15	128	-S	1927	1941	10788	192.7	143	547	18	1.1	.6	Clear
	16	X05	+E	1948	1949	10493	088.9	146	541	17	1.2	.4	Clear
	17	129	+N	1956	2010	10794	001.0	149	541	17	1.1	.6	Clear
									535				

ALS80 LiDAR Flight Log

Project	NM_LiDAR		ALS80	SN 8235							Sensor Operator/s	
				START: 2055	END: 0058						Will	
Date/Julian:	10/15/15			Memory Drive		TAR AIRSPD (KNTS)				Base PID:	Pilot/s	
Hobbs End	1185.4			101		145				PRZ.101515	Mike	
Hobb Start	1181.5					TAR ALT AGL (ft):		Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:	
Flight Time	0.0					10643		NM_LiDAR	1.5			

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
19	✓	1	[redacted] 142	2114	2130	10631	S	146	535	16	1.3	0.8	Clear
		2	141	2134	2149	10622	N	147	529	16	1.2	0.7	Clear
	✓	3	140	2153	2208	10642	S	145	524	18	1.1	0.6	Clear
		4	139	2211	2226	10631	N	146	518	17	1.1	0.6	Clear
		5	138	2230	2245	10642	S	143	513	18	1.1	0.6	Clear
		6	137	2249	2304	10711	N	144	507	18	1.1	0.6	Clear
		7	136	2308	2322	10712	S	142	502	19	1.0	0.6	Clear
	✓	8	135	2326	2341	10685	N	143	497	17	1.3	0.7	Clear
		9	134	2344	2359	10682	S	146	491	17	1.3	0.7	Clear
		10	X05 ~~135~~	0005	0009	10705	E	141	486	16	1.4	0.7	Clear
		11	133	0015	0030	10703	N	146	484	18	1.1	0.6	Clear
		12	X03	0036	0039	10538	W	146	479	18	1.1	0.6	Clear

ALS80 LiDAR Flight Log

Project	BAA NM LIDAR		ALS80	SN 8235						Sensor Operator/s	
										MASON	
Date/Julian:	10/15/14		Memory Drive			TAR AIRSPD (KNTS)			Base PID:	Pilot/s	
Hobbs End	1187.6					145			PRZ	Mike	
Hobb Start	1185.4					TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:	
Flight Time	0.0					10900		1.5	12MT	PRZ	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: MSL:	Direction	Speed: kts:	remaining: Memory	S/Vs:	Position Acc.: PDOP	Position Acc.: HDOP	Comments and Conditions:
20	1	130	-S	0154	0209	10777	181.3	143	437	20	1.1	.6	Clear
	2	131	+N	0212	0226	10767	006.1	142	434	19	1.2	.6	Clear
	3	X03	+E	0232	0234	10472	269.9	141	428	21	1.0	.5	Clear
	4	132	-S	0241	2255	~~10779~~ 10731	180.1	145	420	21	.9	.5	clear
	5	X05	+E	0301	0307	10565	091.1	140	422	16	1.1	.6	Clear

Appendix B. Vertical Accuracy Calculations

Project Information

Prepared By: Kenneth L. Coffey
Project Name: BAA Roosevelt & Curry Counties, NM
Sensor Info: Leica ALS80 SN#8235
Required Nominal Pulse Spacing: 0.7
Vendor Name: Digtia Aerial Solutions .LLC
Units: Meters
Percent of Extent Tolerance: Extents Not Checked
Date of Aquisition: Start: 9/30/2015 Finish: 10/16/2015

Metadata Information

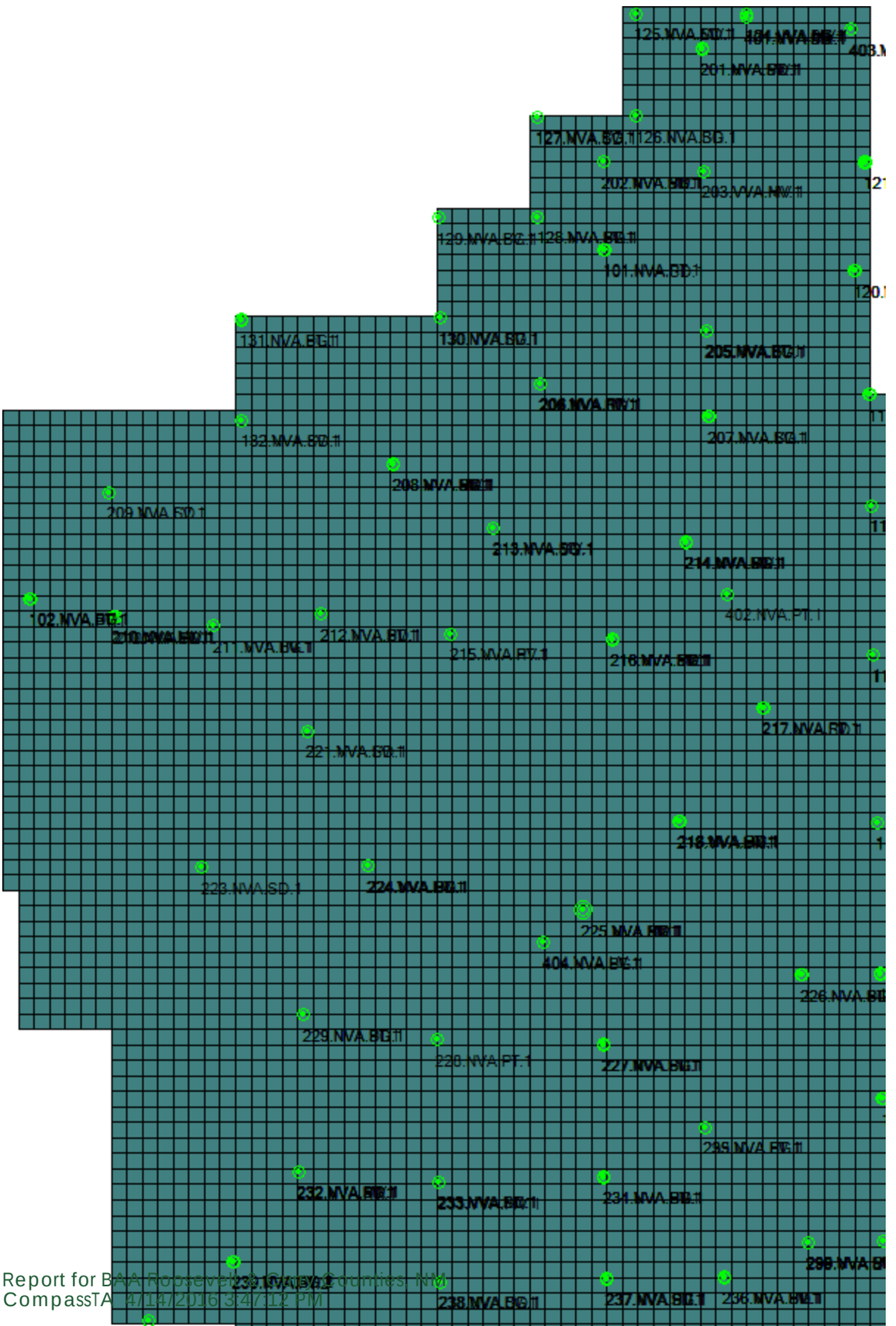
Tile Index:
- Path: Z:\Accuracy_Reports\LiDAR_New_Mexico\NM_Index\DAS_Roosevelt_Curry_tiles_utm13_nsrs2011.shp
- Number of Polys: 0

Intensity:
- Tile Index Attribute: Not Specified
- Path to Data: Not Specified
- Number of Data Files Matching Attribute: Not Specified

DEM:
- Tile Index Attribute: Name
- Path to Data: L:\LiDAR_Projects\BAA_Roosevelt_and_Curry_Counties_NM\Production\DEM\DEM_20160411
- Number of Data Files Matching Attribute: Not Specified

LAS:
- Tile Index Attribute: Name
- Path to Data: Z:\Accuracy_Reports\LiDAR_New_Mexico\NM_Accuracy_Final_LAS
- Number of Data Files Matching Attribute: Not Specified

Tiled-Data Area



LiDAR Accuracy Assessment Summary

LC Type	# of Points	NVA	VVA	
LAS				
ALL	248			
NVA	152	0.121		
VVA	96		0.270	
Total	248			
DEM				
ALL	248			
NVA	152	0.119		
VVA	96		0.248	
Total	248			

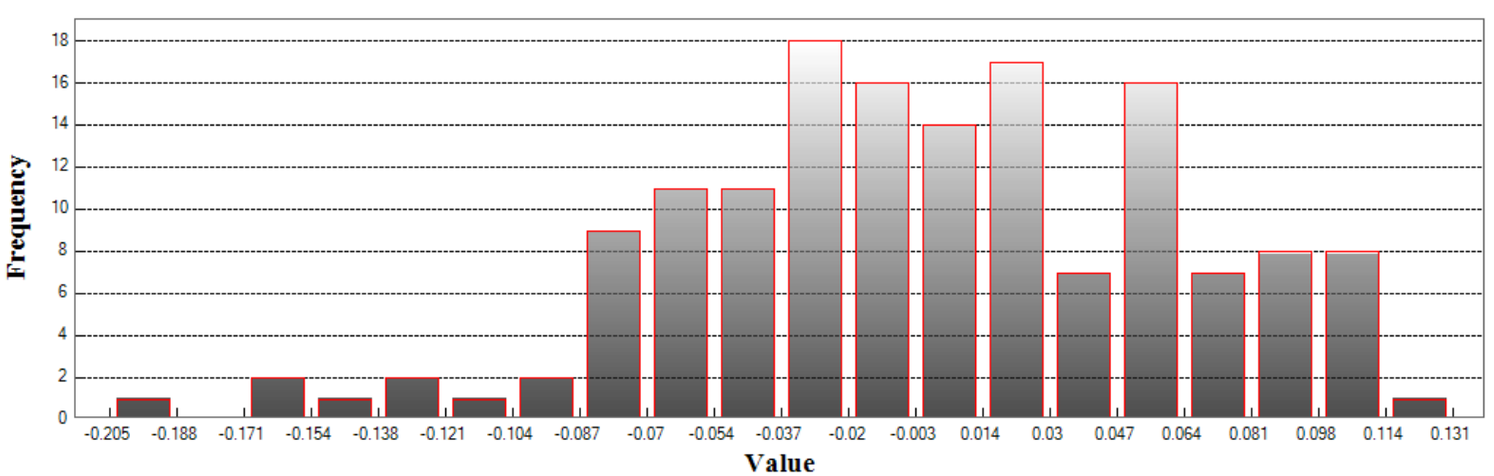
Units: Meters

LAS

Fundamental Vertical Accuracy

LandCover Type: NVA
Minimum DZ: -0.204
Maximum DZ: 0.132
Mean DZ: 0
Mean Magnitude DZ: 0.224
Number Observations: 152
Standard Deviation DZ: 0.062
RMSE Z: 0.062
95% Confidence Level Z: 0.121
Units: Meters

Histogram



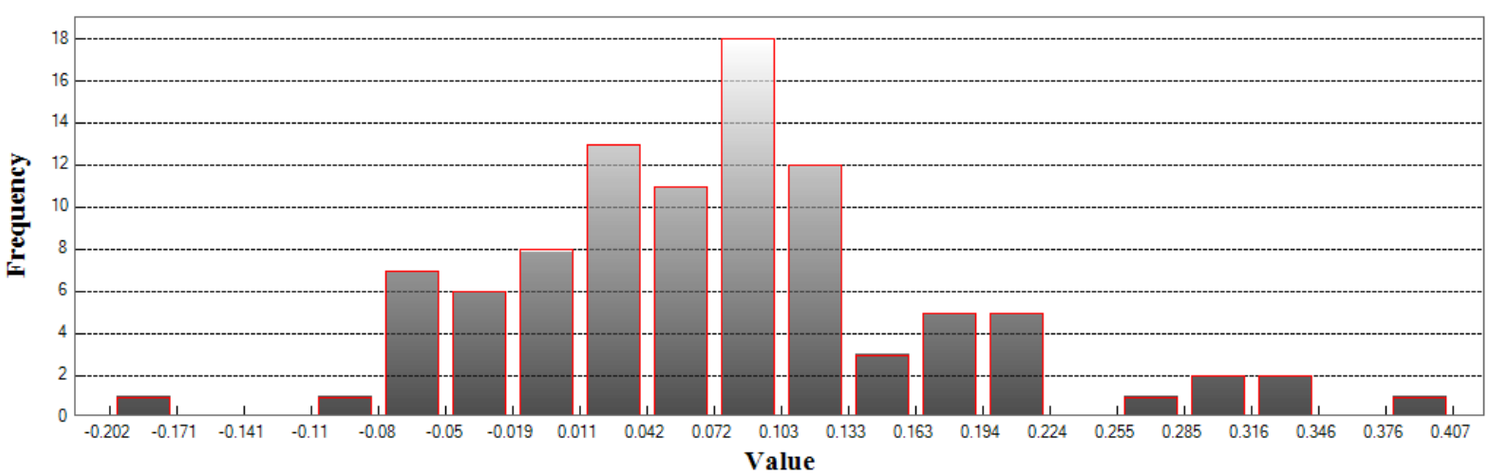
Min: -0.204
Max: 0.132
Number Of Bins: 20
Bin Interval: 0.017

LAS (Continued)

Supplemental Vertical Accuracy

LandCover Type: VVA
Minimum DZ: -0.201
Maximum DZ: 0.407
Mean DZ: 0.078
Mean Magnitude DZ: 0.314
Number Observations: 96
Standard Deviation DZ: 0.1
RMSE Z: 0.126
95th Percentile: 0.27
Units: Meters

Histogram



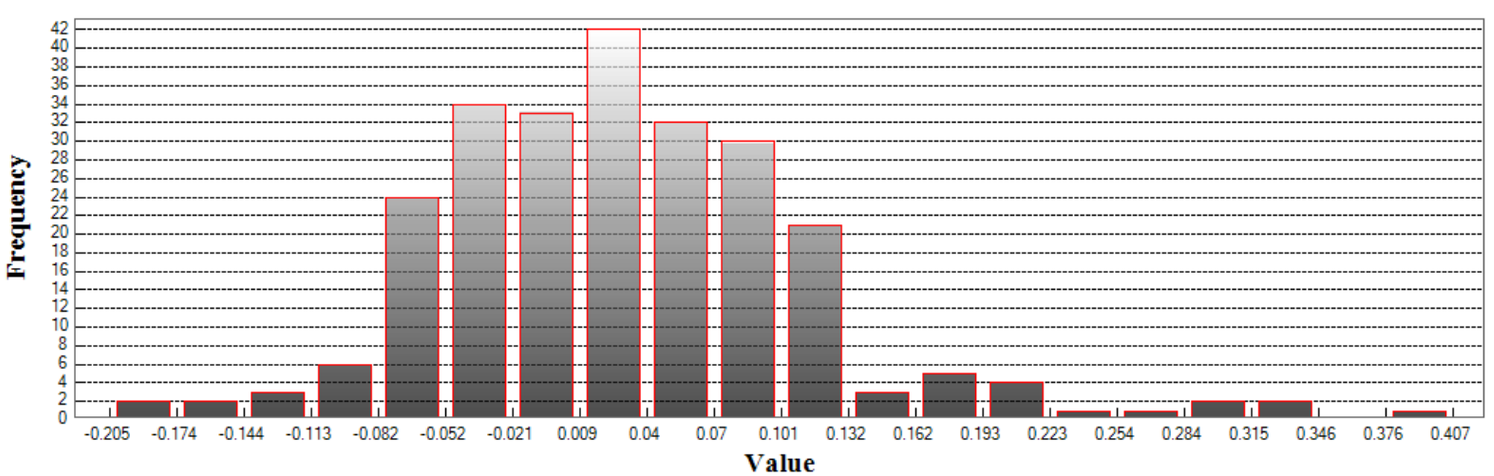
Min: -0.201
Max: 0.407
Number Of Bins: 20
Bin Interval: 0.03

LAS (Continued)

Consolidated Vertical Accuracy

LandCover Type: ALL
Minimum DZ: -0.204
Maximum DZ: 0.407
Mean DZ: 0.03
Mean Magnitude DZ: 0.262
Number Observations: 248
Standard Deviation DZ: 0.087
RMSE Z: 0.092
95th Percentile: 0.194
Units: Meters

Histogram



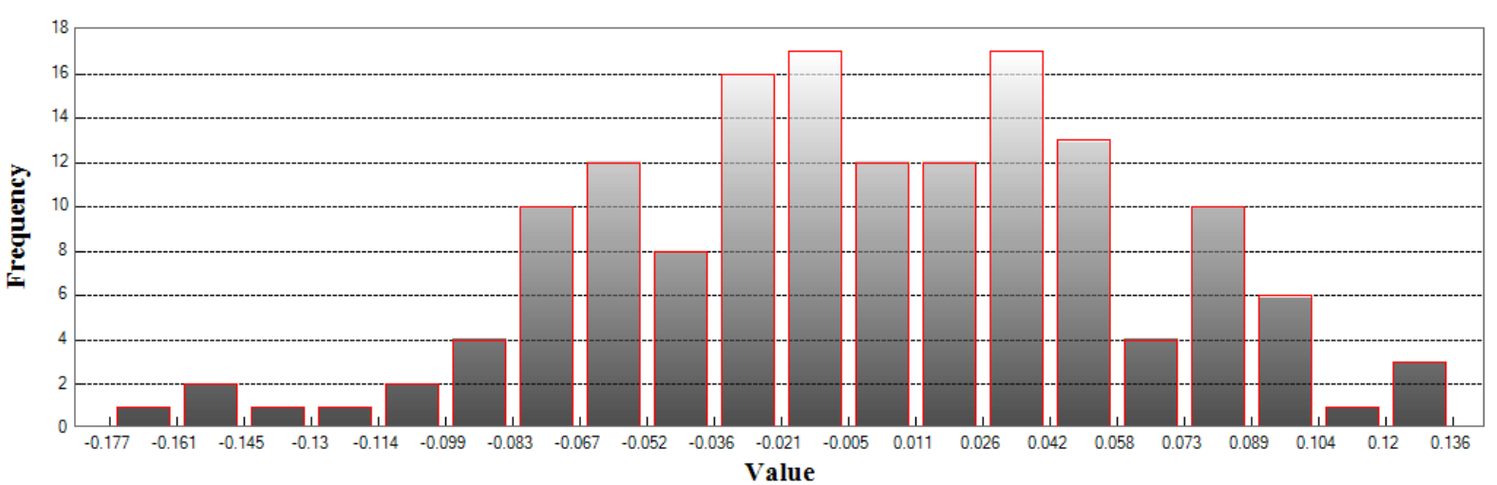
Min: -0.204
Max: 0.407
Number Of Bins: 20
Bin Interval: 0.031

DEM

Fundamental Vertical Accuracy

LandCover Type: NVA
Minimum DZ: -0.177
Maximum DZ: 0.135
Mean DZ: -0.001
Mean Magnitude DZ: 0.223
Number Observations: 152
Standard Deviation DZ: 0.061
RMSE Z: 0.061
95% Confidence Level Z: 0.119
Units: Meters

Histogram



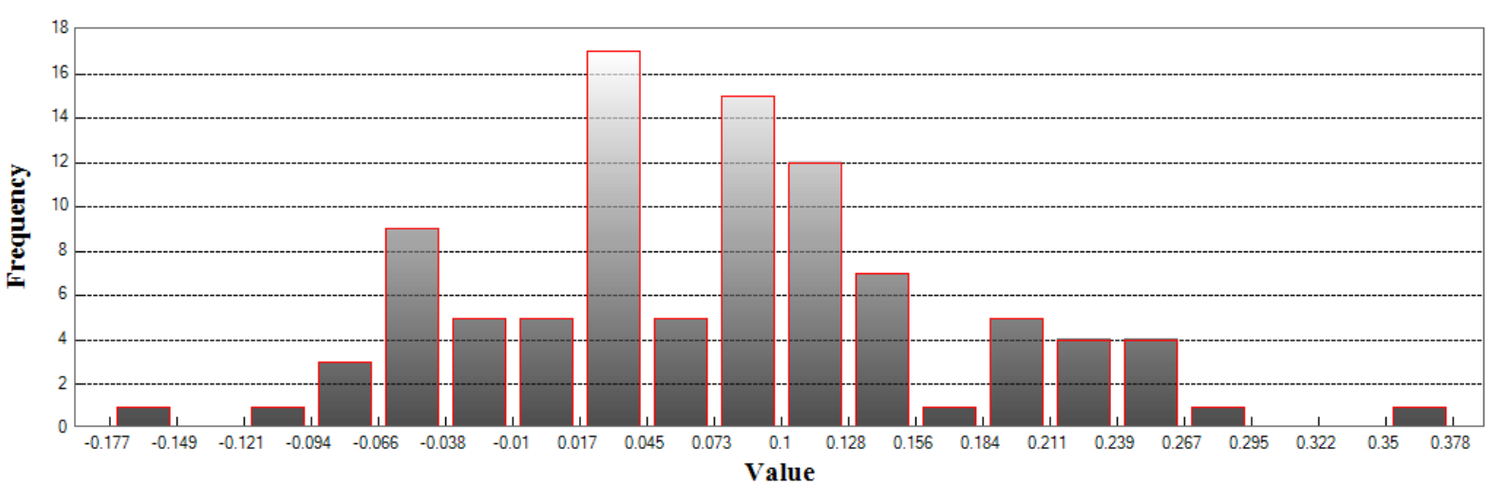
Min: -0.177
Max: 0.135
Number Of Bins: 20
Bin Interval: 0.016

DEM (Continued)

Supplemental Vertical Accuracy

LandCover Type: VVA
Minimum DZ: -0.177
Maximum DZ: 0.378
Mean DZ: 0.074
Mean Magnitude DZ: 0.311
Number Observations: 96
Standard Deviation DZ: 0.097
RMSE Z: 0.122
95th Percentile: 0.248
Units: Meters

Histogram



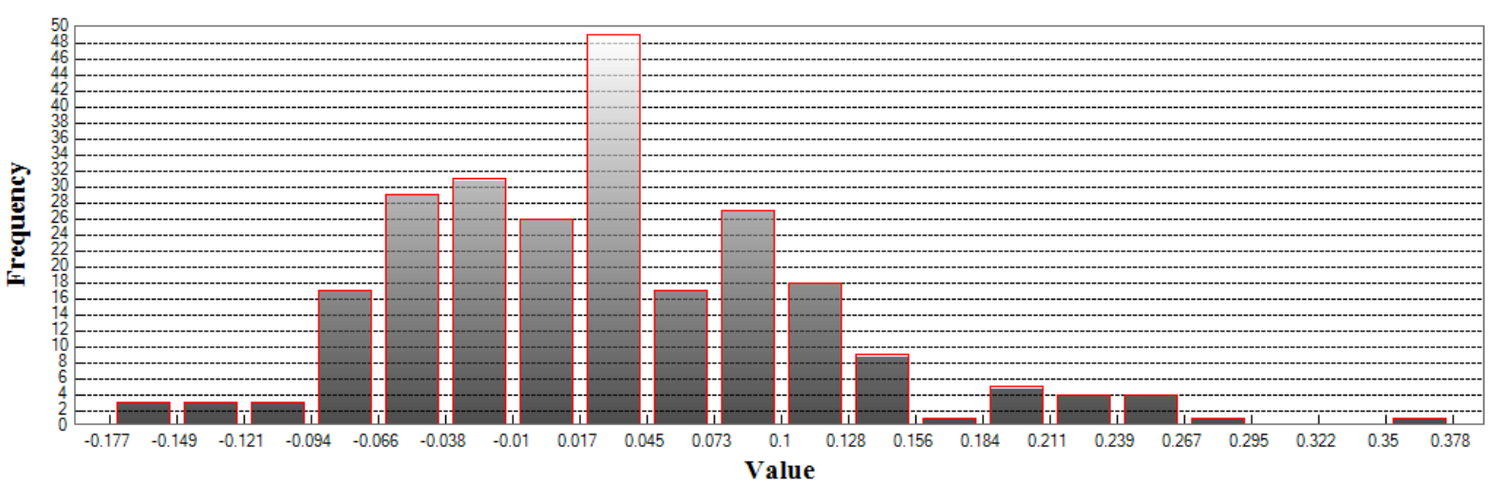
Min: -0.177
Max: 0.378
Number Of Bins: 20
Bin Interval: 0.028

DEM (Continued)

Consolidated Vertical Accuracy

LandCover Type: ALL
Minimum DZ: -0.177
Maximum DZ: 0.378
Mean DZ: 0.028
Mean Magnitude DZ: 0.261
Number Observations: 248
Standard Deviation DZ: 0.085
RMSE Z: 0.089
95th Percentile: 0.189
Units: Meters

Histogram



Min: -0.177
Max: 0.378
Number Of Bins: 20
Bin Interval: 0.028