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# LiDAR Project Report

## Virginia - SANDY QL2 LiDAR

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Prepared For:

United States Geological Survey



Prepared By:

Digital Aerial Solutions, LLC



Contract: G10PC00093

Contractor: Digital Aerial Solutions

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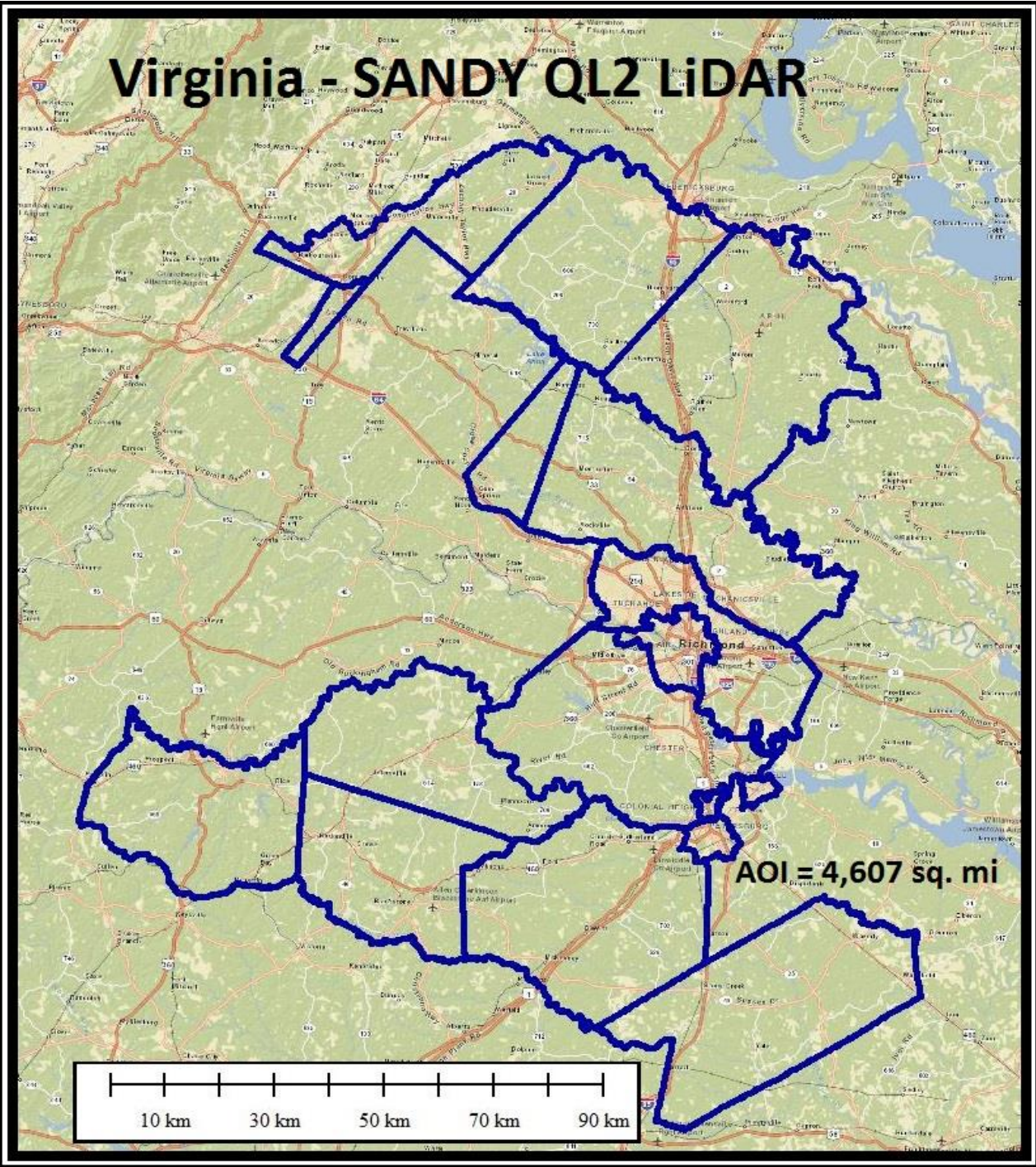
Project Report  
LiDAR Collection, Processing, and QA/QC

2014 Virginia-Sandy QL2  
Task Order G14PD00222

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# Virginia - SANDY QL2 LiDAR



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## 1 Introduction and Specifications

Digital Aerial Solutions, LLC (DAS) was tasked to collect and process a Light Detection And Ranging (LiDAR) derived elevation dataset for the counties and cities of Spotsylvania, Caroline, Hanover, Henrico, Chesterfield, Dinwiddie, Sussex, Richmond City, Hopewell City, Colonial Heights City, Petersburg City, portions of Orange and Louisa, Amelia, Nottoway and Prince Edward, Virginia with QL2 Specification. The Virginia-Sandy survey area encompasses approximately 4607 square miles. Aerial LiDAR data was collected utilizing three sensors, an ALS60, ALS70 and an Optech Pegasus HA500. The ALS60 and ALS70 is a discrete return topographic LiDAR mapping system manufactured by Leica Geosystems and Pegasus HA500 sensor manufactured by Optech. LiDAR data collected for the Virginia-Sandy 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, and bare-earth DEM tiles in ERDAS IMG format. Point cloud deliverables are stored in the LAS version 1.2 format, point data record format 1. The tiling scheme for tiled deliverables is named according to the US National Grid conventions, 1500 Meter x 1500 Meter grid. All deliverables were generated in conformance with the *U.S. Geological Survey National Geospatial Program Guidelines and Base Specifications, Version 1*.

## 2 Spatial Reference System

The spatial reference of the data is as follows.

### Horizontal Spatial Reference

- Datum: North American Datum of 1983
- Coordinates: UTM Zone 18, Meters

### Vertical Spatial Reference

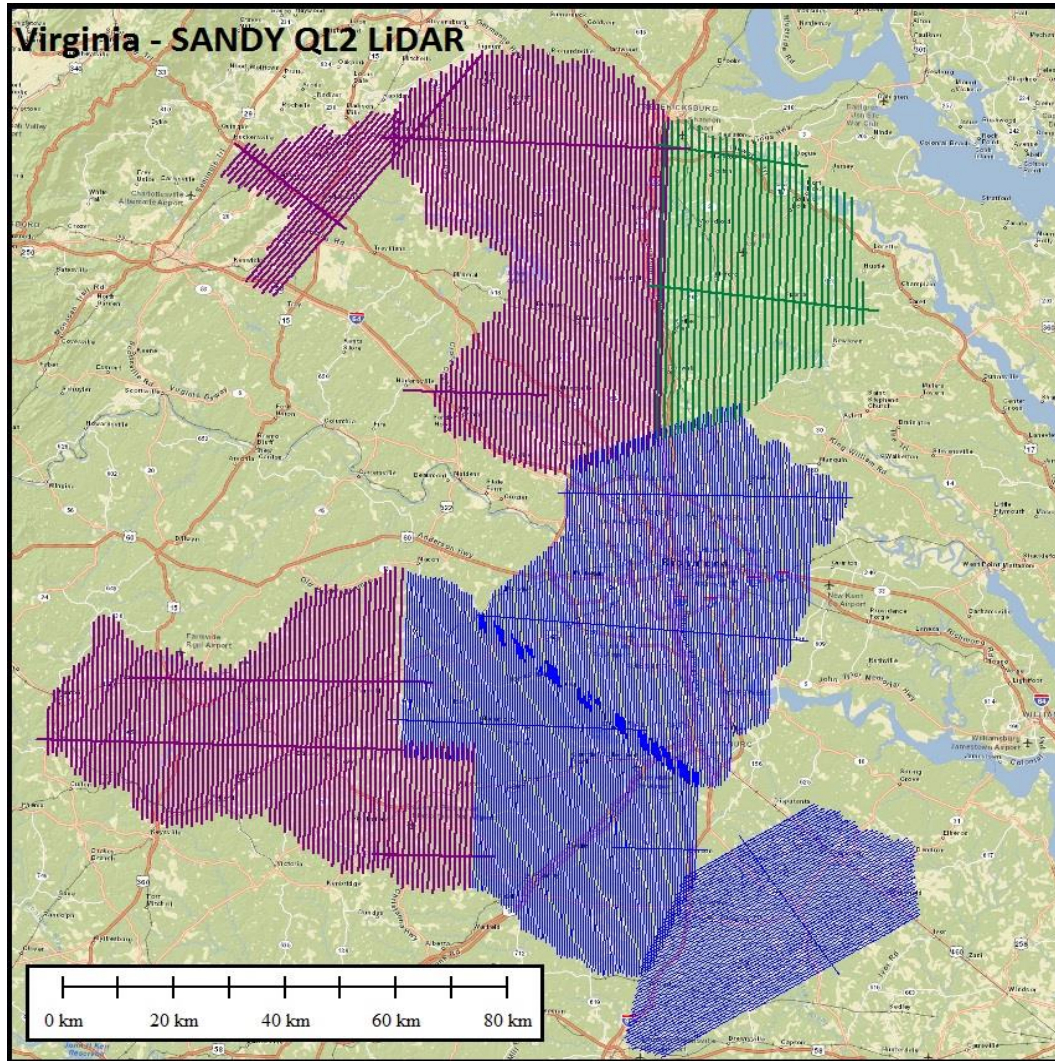
*All datasets are available with orthometric elevation; point cloud datasets are also available with ellipsoid heights*

- Datum: North American Vertical Datum of 1988 (GEOID12A)

# LIDAR Acquisition

## 3.1 Survey Area

The Virginia-Sandy LiDAR survey covers approximately 4607 square miles located Eastern Virginia affecting the counties and cities of Spotsylvania, Caroline, Hanover, Henrico, Chesterfield, Dinwiddie, Sussex, Richmond City, Hopewell City, Colonial Heights City, Petersburg City, portions of Orange and Louisa, Amelia, Nottoway and Prince Edward. The flight plan consisted of 512 survey lines and 21 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 Virginia LiDAR project are summarized below.

<b>Parameter</b>	<b>ALS60</b>	<b>ALS70</b>
<b>Flying Height Above Ground Level</b>	1,400 meters	1,850 meters
<b>Nominal Sidelap</b>	30%	20%
<b>Nominal Speed Over Ground</b>	140 knots	155 knots
<b>Field of View</b>	32°	36°
<b>Laser Pulse Rate</b>	154,300 Hz	301,600 Hz
<b>Scan Rate</b>	66.2 Hz	40.1 Hz
<b>Maximum Cross Track Spacing</b>	1.07 meters	0.70 meters
<b>Maximum Along Track Spacing</b>	1.09 meters	0.99 meters
<b>Average Spacing</b>	0.61 meters	0.56 meters

### 3.3 Acquisition Mission

The acquisition mission for the Virginia-Sandy LiDAR survey was coordinated to be acquired in 4 week period. The area has been divided in to 6 blocks (Block-1, Block-2, Block-2B, Block-3, Block-4 and Block-5) for timely collection and deploying multiple aircraft with LiDAR sensors. Collection began on March 24th 2014 and was completed on April 21st, 2014, a complete flight log for the acquisition mission may be found in Appendix A. Block 2B, north astern portion of Project was acquired by Merrick & Company, encompassing about 572 square miles using an Optech Pegasus HA500 sensor system.

### 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 georeferencing the LiDAR data. Airborne GPS observations were collected at a frequency of 2Hz, and IMU observations are collected at a frequency up to 200Hz for the ALS 60 and 500Hz for the ALS70.

Aircraft	Sensor	GPS Lever Arm (m)	IMU Lever Arm (m)
C421 - N112MJ	ALS60 - SN6130	x: -0.210, y: -0.060, z: -1.370	x: -0.450, y: -0.159, z: -0.169
C421 - C13RF	ALS70 - SN7231	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 as the base of operation. The additional ground base station were selected and place throughout the project to ensure complete coverage. Ground GPS observations were collected at a frequency of 1Hz.



## 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 Leica'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 with a +/- 3cm tolerance. 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 1.2 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. The LiDAR data collected for the Virginia - Sandy survey area passed these quality control checks.

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

### 4.2 Geometric Calibration

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

The manufacturer specific calibration parameters are applied in Leica's ALSPP software for the ALS60 and ALS70 sensor systems. Terrasolid's TerraMatch software was used to calculate the IMU bore-site and mirror scale parameters for the Virginia LiDAR data. 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

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 Virginia-Sandy 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

Georeferenced information was applied to the swath point cloud LAS files. Geometrically calibrated swath point clouds were cut into 1500 meter x 1500 meter US National Grid LAS format tiles for point cloud classification and derived product creation. It is important to note that US National Grid tiles are non-orthogonal when stored and displayed in a geographic coordinate system. As a result, tiled vector data does not have overlap, but tiled raster data does have overlap to permit seamless display of the data products

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 – Noise
- Class 9 – Water
- Class 10 – Ignored Ground
- Class 17 – Reserve
- Class 18 – Reserve

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



## 4.4 Breakline Collection

Manual breakline collection was performed to support the hydro-flattening requirements of the project's DEM deliverables. Breaklines were collected directly from the classified point clouds and from triangulated irregular network (TIN) surface models built from the classified point clouds, in Terrasolid, 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.

The data collected for the Virginia-Sandy LiDAR survey maintained significant point density in the water, marsh, and swamp, limiting the usefulness of point density as guiding factor in breakline placement.

Points classified as Class 2 – Bare-earth ground, falling within a half 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 and the NGP version 13 guidelines. 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 ERDAS .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 Virginia-Sandy 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 functionality. Airborne GPS positional dilution of precision (PDOP) estimates are monitored to ensure they remain less than 3. The optical system is monitored to ensure there are no ranging errors encountered during the flight lines.

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

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

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

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.

Horizontal accuracy assessments of LiDAR data require the presence of vertical targets such as buildings within in the survey area. Field check points are surveyed at the corners of the building roofs, and the surveyed locations compared to the estimated corner locations in the LiDAR point cloud. From the manufacturer’s specifications, the estimated horizontal accuracy at one sigma, based on flying height for the project, is between 10cm and 20cm.

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

Check point locations were collected at 1/2 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 as described in NDEP Elevation Guidelines Version 1. The FVA of the TIN tested RMSEz 0.075 meters and 0.148 meters at the 95% confidence level in open terrain. FVA of the DEM tested at an RMSEz of 0.074 and 0.146 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 <sub>z</sub> =	0.075	meters
NSSDA=	0.148	meters

FVA of DEM

RMSE <sub>z</sub> =	0.074	meters
NSSDA=	0.146	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 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 NGP version 1 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 US National Grid tile index.

## Appendix A. Flight Logs



**ALS60 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS60	N6130 090724				Sensor Operator/s		Bertin Evina-Ze		
Date/Julian:	3/26/2014	Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)			Base PID:		Pilot/s			
Hobbs End	561.6	2-600059224			140			TEMP		MWAZ			
Hobbs ST	557.0	LIFT A		TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:				
Flight Time	4.6			4,200	VA-Sandy		1,500	421C 13RF	KOFF				
Lift	Flight Line	Mission	Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
				B:	E:						PDOP	HDOP	
A							-	-	149				Static Alignment
1	927			21:46	21:47	4,190	180	139	146	18	1.1	1.0	CLEAR
2	926			21:52	21:53		0	137	144	18	1.1	0.9	CLEAR
3	925			21:58	22:00		180	133	142	18	1.1	0.7	CLEAR
4	924			22:04	22:05		0	140	140	20	1	0.7	CLEAR
5	923			22:11	22:13		180	137	137	18	1	0.7	CLEAR
6	922			22:18	22:21		0	133	135	19	1.5	0.7	CLEAR
7	921			22:25	22:28		180	142	133	17	1.5	0.7	CLEAR
8	920			22:32	22:35		0	138	131	16	1.5	0.7	CLEAR
9	919			22:39	22:42		180	135	128	17	1.2	0.7	CLEAR
10	918			22:46	22:49		0	141	126	16	1.2	0.7	CLEAR
11	917			22:53	22:56		180	136	124	16	1.3	0.7	CLEAR
12	916			23:00	23:03		0	141	121	15	1.4	0.8	CLEAR
13	915			23:07	23:12		180	136	120	15	1.3	0.8	CLEAR
14	914			23:16	23:22		0	138	119	16	1.3	0.8	CLEAR
15	913			23:26	23:33		150	134	135	16	1.3	0.8	CLEAR
16	912			23:37	23:44		0	137	133	17	1.2	7.0	CLEAR
17	911			23:48	23:55		180	134	131	17	1.2	0.7	CLEAR
18	910			23:59	:6	0	0	137	129	19	1.1	0.6	CLEAR
19	909			:10	:19		180	133	126	20	1.1	0.5	CLEAR
20	908			:23	:32		0	130	123	20	1.0	0.5	CLEAR
21	907			:36	:45		180	141	121	18	1.2	0.7	CLEAR
22	906			:49	:58		0	130	118	18	1.2	0.7	CLEAR
23	905			1:02	1:11		180	142	115	18	1.2	0.7	CLEAR
24	904			1:15	1:25		0	139	112	18	1.1	0.7	CLEAR
25	CR-27			1:32	2:36		270	132	110	18	1.1	0.7	X-Strip
26	CR-27			1:40	1:45		90	140		19	1.0	0.6	X-strip



**ALS60 LiDAR Flight Log**

<b>Project</b>	VA-Sandy_Lidar2014	<b>ALS60</b>	N6130_090724					<b>Sensor Operator/s</b>					
<b>Date/Julia</b>	3/26/2014	<b>Mem Drive MM60</b>		<b>Int. Time:</b>	AR AIRSPD (KNTS)		<b>Base PID:</b>	Bertin Evina-Ze					
<b>Hobbs En</b>	561.6		2-600059224		140		TEMP	Pilot/s					
<b>Hobbs ST</b>	557.0	LIFT B		<b>TAR ALT AGL (ft):</b>	4,200	<b>Flight Plan(s):</b>	VA-Sandy	<b>Base Height</b>	1500	<b>Aircraft</b>	421C 13RF	<b>Airport Idnt:</b>	KOFF
<b>Flight Tim</b>	4.6												

Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memor	SIYs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
B						-	-	149				Static Alignment
1	927	140326_214628	21:46	21:47	4,190	180	139	146	18	1.1	1.0	CLEAR
2	926	140326_215218	21:52	21:53		0	137	144	18	1.1	0.9	CLEAR
3	925	140326_215829	21:58	22:00		180	133	142	18	1.1	0.7	CLEAR
4	924	140326_220416	22:04	22:05		0	140	140	20	1	0.7	CLEAR
5	923	140326_221101	22:11	22:13		180	137	137	18	1	0.7	CLEAR
6	922	140326_221829	22:18	22:21		0	133	135	19	1.5	0.7	CLEAR
7	921	140326_222524	22:25	22:28		180	142	133	17	1.5	0.7	CLEAR
8	920	140326_223243	22:32	22:35		0	138	131	16	1.5	0.7	CLEAR
9	919	140326_223943	22:39	22:42		180	135	128	17	1.2	0.7	CLEAR
10	918	140326_224649	22:46	22:49		0	141	126	16	1.2	0.7	CLEAR
11	917	140326_225329	22:53	22:56		180	136	124	16	1.3	0.7	CLEAR
12	916	140326_230029	23:00	23:03		0	141	121	15	1.4	0.8	CLEAR
13	915	140326_230657	23:06	23:12		180	136	120	15	1.3	0.8	CLEAR
14	914	140326_231653	23:16	23:22		0	138	119	16	1.3	0.8	CLEAR
15	913	140326_232644	23:26	23:33		150	134	135	16	1.3	0.8	CLEAR
16	912	140326_233743	23:37	23:44		0	137	133	17	1.2	7.0	CLEAR
17	911	140326_234819	23:48	23:55		180	134	131	17	1.2	0.7	CLEAR
18	910	140326_235909	23:59	:06	0	0	137	129	19	1.1	0.6	CLEAR
19	909	140327_001030	20:10	:19		180	133	126	20	1.1	0.5	CLEAR
20	908	140327_002306	24:23	:32		0	130	123	20	1.0	0.5	CLEAR
21	907	140327_003603	24:36	:45		180	141	121	18	1.2	0.7	CLEAR
22	906	140327_004859	24:48	:58		0	130	118	18	1.2	0.7	CLEAR
23	905	140327_010154	1:01	1:11		180	142	115	18	1.2	0.7	CLEAR
24	904	140327_011519	1:15	1:25		0	139	112	18	1.1	0.7	CLEAR
25	CR-27	140327_013251	1:32	2:36		270	132	110	18	1.1	0.7	X-Strip
26	UL001	140327_014049	1:40	1:45		90	140		19	1.0	0.6	X-strip



ALS60 LiDAR Flight Log														
Project		VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s			
Date/Julian:		3/27/2014		Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)				Base PID:		Pilot/s	
Hobbs End		565.7		7-600059211				140		TEMP		MWAZ		
Hobbs ST		561.6		LIFT A		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:	
Flight Time		4.1				4,300		VA-Sandy		1,500		421C 13RF	KOFP	
Lift	Flight Line	Mission	Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
				B:	E:						PDOP	HDOP		
A							-	-	147				Static Alignment	
1	903			15:18	15:28	4,390	180	139	144	16	1.2	0.7	CLEAR	
2	902			15:35	15:47		0	136	141	17	1.1	0.6	CLEAR	
3	901			15:52	16:05		180	134	137	16	1.1	0.7	CLEAR	
4	900			16:10	16:22		0	140	134	17	1.1	0.6	CLEAR	
5	899			16:27	16:39		180	137	131	18	1	0.7	CLEAR	
6	898			16:43	16:56		0	133	128	19	1.5	0.7	CLEAR	
7	897			17:00	17:12		180	142	125	17	1.5	0.7	CLEAR	
8	896			17:17	17:30		0	138	122	16	1.5	0.7	CLEAR	
9	895			17:34	17:47		180	135	119	17	1.2	0.7	CLEAR	
10	894			17:52	18:06		0	141	116	16	1.2	0.7	CLEAR	
11	893			18:11	18:25		180	136	113	16	1.3	0.7	CLEAR	
12	892			18:29	18:43		0	141	110	15	1.4	0.8	CLEAR	
13	CR-27			18:54	18:57		180	136	107	15	1.3	0.8	CLEAR	
14	CR-27			19:03	19:08		0	138	104	16	1.3	0.8	CLEAR	

ALS60 LiDAR Flight Log														
Project		VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s			
Date/Julian:		3/27/2014		Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)				Base PID:		Pilot/s	
Hobbs End		565.7		7-600059211				140		TEMP		MWAZ		
Hobbs ST		561.6		LIFT B		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:	
Flight Time		4.1				4,300		VA-Sandy		1,500		421C 13RF	KOFP	
Lift	Flight Line	Mission	Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
				B:	E:						PDOP	HDOP		
A							-	-	104				Static Alignment	
1	891			21:26	21:39	4,390	180	140	95	17	1.4	0.7	CLEAR	
2	890			21:44	21:58		0	139	91	17	1.2	0.6	CLEAR	
3	889			22:02	22:18		180	138	86	19	1.0	0.6	CLEAR	
4	888			22:22	22:38		0	140	81	18	1.2	0.7	CLEAR	
5	887			22:41	22:58		180	138	76	17	1.2	0.7	CLEAR	
6	886			23:02	23:19		0	139	71	18	1.3	0.7	CLEAR	
7	885			23:24	23:40		180	141	66	18	1.1	0.7	CLEAR	
8	884			23:44	24:00		0	140	61	18	1.1	0.7	CLEAR	
9	883			24:05	24:21		180	138	57	21	1.0	0.6	CLEAR	
10	882			24:24	24:41		0	144	52	20	1.9	0.6	CLEAR	
11	881			24:45	1:01		180	139	47	18	1.2	0.7	CLEAR	
12	880			1:05	1:13		0	143	42	18	1.1	0.7	CLEAR	
13	CR-27			1:17	1:21		272	140	44	18	1.1	0.7	CLEAR	
14	CR-27			1:25	1:29		92	145	42	19	1.0	0.6	CLEAR	

ALS60 LiDAR Flight Log													
Project		VA-Sandy_Lidar2014		ALS60		N6130_090724						Sensor Operator/s	
Date/Julian:		3/31/2014		Mem Drive MM60		Int. Time:		TAR AIRSPD (KNTS)		Base PID:		Pilot/s	
Hobbs End		574.0		5-600106700				140		TEMP		MWAZ	
Hobbs ST		570.1		LIFT A		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Airport Idnt:	
Flight Time		3.9				4,300		VA-Sandy		1,500		421C 13RF KOFP	
Lift	Flight Line	Mission	Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
				B:	E:						PDOP	HDOP	
A							-	-	149				Static Alignment
1	880			13:28	13:43	4,300	180	149	144	17	1.2	0.6	CLEAR
2	879			13:50	14:08		0	135	139	17	1.2	0.6	CLEAR
3	878			14:13	14:28		180	149	134	17	1.2	0.6	CLEAR
4	877			14:35	14:52		0	131	129	17	1.2	0.6	CLEAR
5	876			14:56	15:11		180	150	124	18	1.1	0.6	CLEAR
6	875			15:17	15:34		0	127	119	18	1.0	0.6	CLEAR
7	874			15:51	16:07		0	136	114	18	1.0	0.7	CLEAR
8	873			16:22	16:38		0	138	109	17	1.2	0.6	CLEAR
9	UL001	CR-27		16:43	16:45		90	128	108	16	1.3	0.7	X-Strip
10	UL002	CR-27		16:50	16:52		270	130	107	15	1.4	0.7	X-Strip

ALS60 LiDAR Flight Log													
Project		VA-Sandy_Lidar2014		ALS60		N6130_090724						Sensor Operator/s	
Date/Julian:		3/31/2014		Mem Drive MM60		Int. Time:		TAR AIRSPD (KNTS)		Base PID:		Pilot/s	
Hobbs End		578.0		6-600110120				140		TEMP		SVEN	
Hobbs ST		574.0		LIFT B		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Airport Idnt:	
Flight Time		4.0				4,300		VA-Sandy		1,500		421C 13RF KOFP	
Lift	Flight Line	Mission	Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
				B:	E:						PDOP	HDOP	
B							-	-	79				Static Alignment
1	872			23:22	23:37	4,300	180	147	75	19	1.1	0.6	CLEAR
2	871			23:42	23:56		0	142	70	20	1.0	0.6	CLEAR
3	870			24:01	24:16		180	143	65	18	1.2	0.7	CLEAR
4	869			24:20	24:35		0	144	60	18	1.2	0.7	CLEAR
5	868			24:39	24:54		180	144	57	17	1.2	0.6	CLEAR
6	867			24:59	1:13		0	145	52	18	1.1	0.6	CLEAR
7	866			1:18	1:32		180	141	47	18	1.0	0.6	CLEAR
8	865			1:38	1:52		0	146	42	17	1.2	0.6	CLEAR
9	864			1:56	2:10		180	145	37	17	1.1	0.7	X-Strip
10	863			2:15	2:29		0	145	32	18	1.1	0.6	X-Strip
11	862			2:33	2:47		180	143	27	17	1.1	0.7	
12	UL001	CR26		2:55	2:57		92	143	22	18	1.1	0.7	
	UL002	CR26		3:02	3:05		272	134	22	19	1.0	0.6	



**ALS60 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s		Bertin Evina-Ze
Date/Julian:	4/1/2014	Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)	Base PID:		Pilot/s		SVEN			
Hobbs End	582.4	3-600093051			140	TEMP							
Hobbs ST	578.1	LIFT A			TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:				
Flight Time	4.3				4,300	VA-Sandy	1,500	421C 13RF	KOFF				
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
			B:	E:						PDOP	HDOP		
A						-	-	66				Static Alignment	
1	861	140401_144722	14:47	15:01	4,300	180	145	62	17	1.2	0.6	CLEAR	
2	860	140401_150552	15:06	15:19		0	149	58	17	1.1	0.6	CLEAR	
3	859	140401_152307	15:23	15:36		180	149	54	17	1.2	0.6	CLEAR	
4	858	140401_154034	15:40	15:53		0	146	50	18	1.2	0.6	CLEAR	
5	857	140401_155811	15:58	16:11		180	148	46	17	1.0	0.6	CLEAR	
6	856	140401_161502	16:15	16:28		0	140	42	16	1.2	0.7	CLEAR	
7	855	140401_163236	16:32	16:45		180	148	38	16	1.3	0.7	CLEAR	
8	854	140401_164945	16:49	17:02		0	143	34	15	1.4	0.7	CLEAR	
9	853	140401_170647	17:06	17:19		180	146	30	15	1.2	0.7	X-Strip	
10	852	140401_172251	17:22	17:35		0	145	26	15	1.4	0.7	X-Strip	
11	851	140401_173910	17:39	17:51		180	147	22	15	1.1	0.7		
12	850	140401_175535	17:55	18:07		0	145	18	15	1.1	0.7		
13	849	140401_181135	18:11	18:24		180	143	14	15	1.1	0.7		
	UL001	140401_183238	18:32	18:35		92	146	12	15	1.2	0.7		
	UL002	140401_183820	18:38	18:40		272	125	12	15	1.2	0.7		



**ALS60 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s		Bertin Evina-Ze
Date/Julian:	4/1/2014	Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)	Base PID:		Pilot/s		MWAZ			
Hobbs End	586.5	3-600093051			140	TEMP							
Hobbs ST	582.4	LIFTB			TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:				
Flight Time	4.1				4,300	VA-Sandy	1,500	421C 13RF	KOFF				
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
			B:	E:						PDOP	HDOP		
B						-	-	90				Static Alignment	
1	848	140401_223628	22:36	22:48	4,300	180	140	86	9	1.9	1.2	CLEAR	
2	847	140401_225329	22:53	23:05		0	145	82	12	1.7	1.1	CLEAR	
3	846	140401_230929	23:09	23:21		180	142	78	12	1.3	0.6	CLEAR	
4	845	140401_232542	23:25	23:37		0	143	74	13	1.3	0.8	CLEAR	
5	844	140401_234117	23:41	23:53		180	143	70	14	1.2	0.7	CLEAR	
6	843	140401_235642	23:56	24:07		0	143	66	15	1.2	0.7	CLEAR	
7	842	140402_001203	24:12	24:23		180	142	62	14	1.3	0.7	CLEAR	
8	841	140402_002714	24:27	24:38		0	141	58	13	1.5	0.8	CLEAR	
9	840	140402_004240	24:42	24:53		180	141	54	13	1.4	0.8	X-Strip	
10	839	140402_005751	24:57	1:08		0	139	50	13	1.3	0.8	X-Strip	
11	838	140402_011302	1:13	12:23		180	139	46	13	1.3	0.8		
12	837	140402_012724	1:27	1:37		0	145	42	14	1.1	0.7		
13	836	140402_014151	1:41	1:53		180	131	38	12	1.3	0.8		
14	835	140402_015625	1:56	2:07		0	147	46	12	1.7	1.1		
15	CR-27	140402_021429	2:14	2:17		90	148	42	13	1.2	0.8		
16	UL001	140402_022033	2:20	2:24		270	138	42	13	1.3	0.8		



**ALS60 LiDAR Flight Log**

Project	VA-Sandy_Lidar2014		ALS60	N6130 090724						Sensor Operator/s			
Date/Julian:	4/2/2014		Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)			Base PID:	Bertin Evina-Ze			
Hobbs End	586.5		3-600093051			140			TEMP	Pilot/s			
Hobbs ST	586.5		LIFT A			TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:			
Flight Time	0.0					4,300	VA-Sandy	1,500	421C 13RF	KOFF			
Lift	Flight Line	Mission	Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
				B:	E:						PDOP	HDOP	
A							-	-	148				Static Alignment
1	834			14:24	14:35	4,300	180	148	145	17	1.2	0.6	CLEAR
2	833			14:37	14:47		0	146	142	17	1.2	0.6	CLEAR
3	832			14:51	15:01		180	145	139	17	1.1	0.6	CLEAR
4	831			15:04	15:14		0	146	136	15	1.2	0.7	CLEAR
5	830			15:18	15:27		180	147	133	16	1.1	0.7	CLEAR
6	829			15:31	15:40		0	145	130	16	1.1	0.7	CLEAR
7	828			15:45	15:53		180	145	127	18	1.8	0.7	CLEAR
8	827			15:56	16:02		0	144	128	16	1.2	0.7	CLEAR
9	826			16:06	16:12		180	149	125	17	1.2	0.7	CLEAR
10	825			16:15	16:21		0	144	123	16	1.3	0.7	CLEAR
11	824			16:25	16:30		180	145	121	16	1.3	0.7	CLEAR
12	823			16:34	16:39		0	143	120	16	1.3	0.7	CLEAR
13	822			16:43	16:48		180	145	118	15	1.4	0.8	CLEAR
14	821			16:51	16:56		0	145	117	15	1.3	0.7	CLEAR
15	820			17:00	17:04		180	146	115	15	1.3	0.7	CLEAR
16	819			17:08	17:12		0	149	114	15	1.2	0.7	CLEAR
17	818			17:16	17:21		180	144	112	16	1.1	0.7	CLEAR
18	817			17:24	17:28		0	145	111	15	1.1	0.7	CLEAR
19	816			17:32	17:36		180	147	110	15	1.1	0.7	CLEAR
20	815			17:40	17:43		0	149	109	14	1.2	0.7	CLEAR
21	814			17:47	17:51		180	144	108	15	1.1	0.7	CLEAR
22	813			17:54	17:57		0	145	107	15	1.1	0.7	CLEAR
23	812			18:01	18:04		180	142	106	14	1.3	0.8	CLEAR
24	811			18:07	18:11		0	137	105	15	1.1	0.7	CLEAR
25	810			18:14	18:17		180	146	104	16	1.0	0.6	CLEAR
26	CR-26			18:22	18:27		92	151	102	15	1.2	0.7	X-Strip
30	CR-26	UL001		18:34	18:38		272	140	100	15	1.2	0.7	X-Strip



**ALS60 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS60	N6130 090724				Sensor Operator/s		Bertin Evina-Ze	
Date/Julian:	4/2/2014	Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)	140		Base PID:		Pilot/s		MWAZ
Hobbs End	586.5	3-600093051		TAR ALT AGL (ft):		4,300		Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:	
Hobbs ST	586.5	LIFT B		VA-Sandy		1.500		421C 13RF		KPTB		
Flight Time	0.0	Block 3		Block 1								
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
B		<b>BLOCK3</b>				-	-	100				Static Alignment
1	809		22:16	22:18	4,300	180	146	99	16	1.2	0.7	CLEAR
2	808		22:23	22:26		0	137	99	17	1.2	0.7	CLEAR
3	807		22:30	22:33		180	140	97	17	1.2	0.7	CLEAR
4	806		22:36	22:38		0	136	97	16	1.2	0.7	CLEAR
5	805		22:42	22:44		180	141	96	16	1.2	0.7	CLEAR
6	804		22:48	22:50		0	150	96	17	1.2	0.7	CLEAR
7	803		22:54	22:55		180	146	95	17	1.1	0.7	CLEAR
8	802		23:00	23:01		0	135	94	18	1.1	0.6	CLEAR
9	801		23:05	23:06		180	139	95	18	1.1	0.6	CLEAR
10	800		23:10	23:10		0	139	95	18	1.1	0.7	CLEAR
11	799		23:13	23:14		180	135	95	18	1.1	0.7	CLEAR
12	CR_96		23:18	23:20		92	139	94	18	1.1	0.7	CLEAR
13	CR_26	UL001	23:24	23:27		272	136	94	19	1.0	0.6	CLEAR
		<b>BLOCK4_1</b>										
14	798		23:40	23:45		180	139	92	18	1.2	0.7	CLEAR
15	797		23:48	23:53		0	140	90	20	1.0	0.6	CLEAR
16	796		23:57	24:02		180	140	89	19	1.0	0.6	CLEAR
17	795		24:06	24:11		0	137	87	17	1.2	0.7	CLEAR
18	794		24:15	24:21		180	141	86	17	1.2	0.7	CLEAR
19	793		24:25	24:31		0	143	84	17	1.2	0.7	CLEAR
20	792		24:35	24:41		180	137	82	17	1.2	0.7	CLEAR
21	791		24:45	24:52		0	142	80	17	1.1	0.7	CLEAR
22	790		24:56	1:03		180	137	78	17	1.1	0.7	CLEAR
23	789		1:07	1:15		0	142	76	17	1.1	0.7	CLEAR
24	788		1:19	1:27		180	142	73	18	1.0	0.6	CLEAR
25	787		1:31	1:39		0	146	71	16	1.2	0.7	CLEAR
26	786		1:43	1:52		180	140	68	17	1.1	0.7	CLEAR
27	CR-22		1:59	2:01		0	144	67	17	1.1	0.7	CLEAR
28	CR-22	UL001	2:06	2:09		180	141	66	17	1.1	0.7	CLEAR



**ALS60 LiDAR Flight Log**

Project	VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s		
Date/Julian:	4/5/2014		Mem Drive MM60	Int. Time:	TAR AIRSPD (KNTS)			Base PID:	Bertin Evina-Ze			
Hobbs End	586.5		3-600093051		140			TEMP	Pilot/s			
Hobbs ST	586.5		LIFT A						MWAZ			
Flight Time	0.0		Block 5		4,300	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:		
						VA-Sandy		1,500	421C 13RF	KPTB		
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
A		<b>BLOCK5</b>				-	-					Static Alignment
								109				
1	500		17:43	17:48	4,300	058	145	107	15	1.2	0.7	CLEAR
2	501		17:53	17:59		257	130	105	15	1.2	0.7	CLEAR
3	502		18:02	18:09		058	138	103	15	1.2	0.7	CLEAR
4	503		18:13	18:19		257	143	101	15	1.2	0.7	CLEAR
5	504		18:23	18:30		058	142	99	15	1.2	0.7	CLEAR
6	505		18:34	18:42		257	135	97	15	1.2	0.7	CLEAR
7	506		18:45	18:52		058	139	95	14	1.1	0.7	CLEAR
8	507		18:56	19:04		257	140	93	15	1.1	0.6	CLEAR
9	508		19:07	19:16		058	133	90	16	1.1	0.6	CLEAR
10	509		19:19	19:28		257	140	88	16	1.1	0.6	CLEAR
11	510		19:31	19:40		058	143	86	14	1.1	0.7	CLEAR
12	511		19:43	19:52		257	135	84	16	1.1	0.6	CLEAR
13	512		19:56	20:06		058	149	82	18	1.0	0.6	CLEAR
14	513		20:08	20:18		257	143	80	18		0.6	
15	514		20:20	20:30		058	137	78	17	1.2	0.6	CLEAR
16	515		20:34	20:44		257	136	76	18	1.0	0.6	CLEAR
17	516		20:47	20:57		058	140	74	18	1.0	0.8	CLEAR
18	517		21:00	21:10		257	141	67	18	1.2	0.6	CLEAR
19	518		21:14	21:24		058	149	64	19	1.2	0.6	CLEAR
20	UL001		21:29	21:32		257	131	61	19	1.2	0.6	CLEAR
21	CR-21		21:37	21:40		058	136	59	19	1.2	0.6	CLEAR

ALS60 LiDAR Flight Log													
Project		VA-Sandy_Lidar2014		ALS60		N6130_090724						Sensor Operator/s	
Date/Julian:		4/6/2014		Mem Drive MM60		Int. Time:		TAR AIRSPD (KNTS)		Base PID:		Pilot/s	
Hobbs End		586.5		3-600093051				140		TEMP		SVEN	
Hobbs ST		586.5		LIFT A		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:
Flight Time		0.0		Block 5		4,300		VA-Sandy		1,500		421C 13RF	KPTB
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
			B:	E:						PDOF	HDOP		
A		BLOCK5				-	-	108				Static Alignment	
1	519		11:37	11:47	4,300	058	146	105	19	1.1	0.6	CLEAR	
2	520		11:51	12:02		257	140	102	18	1.2	0.6	CLEAR	
3	521		12:06	12:17		058	145	98	16	1.4	0.7	CLEAR	
4	522		12:21	12:32		257	142	95	17	1.2	0.6	CLEAR	
5	523		12:36	12:46		058	145	91	19	1.1	0.6	CLEAR	
6	524		12:50	13:01		257	145	88	17	1.2	0.7	CLEAR	
7	525		13:05	13:16		058	146	85	17	1.2	0.7	CLEAR	
8	526		13:20	13:31		257	142	82	17	1.2	0.7	CLEAR	
9	527		13:35	13:47		058	147	77	16	1.4	0.7	CLEAR	
10	528		13:51	14:03		257	147	74	16	1.4	0.7	CLEAR	
11	529		14:06	14:19		058	146	70	18	1.1	0.6	CLEAR	
12	530		14:22	14:35		257	146	66	18	1.2	0.7	CLEAR	
13	531		14:38	14:51		058	147	62	16	1.2	0.7	CLEAR	
14	CR21	UL001	14:58	15:01		338	137	62	17	1.1	0.7	X-Strip	
15	CR21	UL002	15:03	15:07		158	147	61	17	1.0	0.6	X-Strip	
16	532		15:21	15:34		257	138	58	20	1.0	0.6	CLEAR	

ALS60 LiDAR Flight Log													
Project		VA-Sandy_Lidar2014		ALS60		N6130_090724						Sensor Operator/s	
Date/Julian:		4/6/2014		Mem Drive MM60		Int. Time:		TAR AIRSPD (KNTS)		Base PID:		Pilot/s	
Hobbs End		586.5		4-600106558				140		TEMP		SVEN	
Hobbs ST		586.5		LIFT B		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:
Flight Time		0.0		Block 5		4,300		VA-Sandy		1,500		421C 13RF	KPTB
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
			B:	E:						PDOF	HDOP		
B		BLOCK5				-	-	146				Static Alignment	
1	533		17:11	11:47	4,300	058	142	142	16	1.0	0.7	CLEAR	
2	555		17:29	12:02		257	142	139	15	1.1	0.7	CLEAR	
3	554		17:45	12:17		058	144	136	16	1.0	0.7	CLEAR	
4	553		18:00	12:32		257	142	133	15	1.2	0.7	CLEAR	
5	552		18:16	12:46		058	144	130	15	1.2	0.7	CLEAR	
6	551		18:32	13:01		257	135	127	16	1.1	0.6	CLEAR	
7	550		18:48	19:00		058	140	125	17	1.1	0.7	CLEAR	
8	549		19:04	19:17		257	146	121	16	1.2	0.6	CLEAR	
9	548		19:20	19:33		058	143	117	17	1.2	0.6	CLEAR	
10	547		19:37	19:49		257	137	113	17	1.2	0.5	CLEAR	
11	546		19:53	20:06		058	143	109	19	1.3	0.6	CLEAR	
12	545		20:09	20:23		257	134	105	17	1.1	0.6	CLEAR	
13	544		20:30	20:32		058	137	101	18	1.3	0.6	CLEAR	
14	CR21	UL001	20:36	20:40		338	142	99	19	1.2	0.6	X-Strip	
15	CR21	UL002	20:47	20:51		158	138	98	17	1.4	0.6	X-Strip	



ALS60 LiDAR Flight Log

Project	VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s			
Date/Julian:	4/8/2014		Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)		Base PID:		Bertin Evina-Ze			
Hobbs End	855.8		3-600093051			140		TEMP		Pilot/s			
Hobbs ST	851.5		LIFT A			TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:
Flight Time	4.3		Block 5			4,300		VA-Sandy		1,500		421C 13RF	KPTB
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
			B:	E:						PDOP	HDOP		
A		BLOCK5				-	-					Static Alignment	
							146						
1	533	BLOCK4-1	16:58	17:11	4,300	058	151	142	14	13	0.7	CLEAR	
2	785		17:32	17:42	4,200	180	135	140	15	1.1	0.8	CLEAR	
3	784		17:46	17:55		0	141	137	18	1.0	0.6	CLEAR	
4	783		18:00	18:10		180	146	134	15	1.2	0.7	CLEAR	
5	782		18:14	18:24		0	135	131	17	1.1	0.7	CLEAR	
6	781		18:08	18:38		180	145	128	16	1.2	0.6	CLEAR	
7	780		18:41	18:52		0	139	125	16	1.3	0.7	CLEAR	
8	779		18:55	19:05		180	145	122	16	1.2	0.6	CLEAR	
9	778		19:09	19:19		0	139	119	17	1.1	0.6	CLEAR	
10	777		19:23	19:34		180	147	116	17	1.2	0.6	CLEAR	
11	776		19:37	19:48		0	147	113	17	1.3	0.6	CLEAR	
12	775		19:52	20:02		180	143	108	18	1.2	0.6	CLEAR	
14	774		20:06	20:17		0	145	106	17	1.3	0.6	X-Strip	
15	773		20:20	20:31		180	146	103	18	1.3	0.6	X-Strip	
16	CR22	UL003	20:40	20:42		90	148	103	17	1.4	0.6	CLEAR	
17	CR22		20:46	20:50		270	138	102	18	1.3	0.6		



ALS60 LiDAR Flight Log

Project	VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s			
Date/Julian:	4/8/2014		Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)		Base PID:		Bertin Evina-Ze			
Hobbs End	859.6		3-600093051			140		TEMP		Pilot/s			
Hobbs ST	855.8		LIFT B			TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:
Flight Time	3.8		Block4-1			4,300		VA-Sandy		1,500		421C 13RF	KPTB
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:	
			B:	E:						PDOP	HDOP		
B		BLOCK4-1						101					
1	760		22:45	22:56	4,200	180	141	97	19	1.1	0.6	CLEAR	
2	759		23:01	23:13		0	137	94	20	1.1	0.6	CLEAR	
3	758		23:17	23:29		180	140	90	20	1.0	0.6	CLEAR	
4	757		23:34	23:46		0	139	87	20	1.0	0.6	CLEAR	
5	756		23:50	24:01		180	144	83	18	1.1	0.7	CLEAR	
6	755		24:06	24:18		0	135	80	17	1.2	0.7	CLEAR	
7	754		24:22	24:33		180	138	77	18	1.1	0.7	CLEAR	
8	753		24:37	24:49		0	141	73	18	1.1	0.7	CLEAR	
9	752		24:53	1:05		180	146	70	17	1.1	0.7	CLEAR	
10	751		1:10	1:22		0	138	67	16	1.2	0.7	CLEAR	
11	750		1:25	1:37		180	147	62	17	1.1	0.7	CLEAR	
12	749		1:43	1:55		0	140	58	17	1.1	0.7	CLEAR	
13	CR23	UL001	1:59	2:03	4,450	91	134	58	17	1.1	0.7	X-Strip	
14	CR23		2:07	2:10	4,450	271	129	57	17	1.2	0.7	X-Strip	





**ALS60 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS60	N6130_090724				Sensor Operator/s			
Date/Julian:	4/9/2014		Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)		Base PID:		Pilot/s		
Hobbs End	586.4		3-600093051		140		TEMP		SVEN			
Hobbs ST	582.6		LIFT A		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:
Flight Time	3.8		Block 5		4,300		VA-Sandy		1,500		421C 13RF	KPTB
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
A		<b>BLOCK5</b>				-	-					Static Alignment
								98				
1	534		13:49	14:02	4,300	237	138	94	18	1.1	0.6	<b>CLEAR</b>
2	535		14:06	14:20		058	138	90	18	1.1	0.6	
3	536		14:24	14:37		237	143	86	17	1.2	0.6	
4	537		14:42	14:55		058	141	82	16	1.2	0.7	
5	538		14:59	15:12		237	135	78	17	1.0	0.7	
6	539		15:16	15:30		058	136	74	17	1.1	0.7	
7	540		15:34	15:47		237	143	70	16	1.1	0.7	
8	541		15:51	16:05		058	138	66	16	1.3	0.7	
9	542		15:08	16:22		237	150	62	16	1.2	0.7	
10	543		16:26	16:39		058	138	58	15	1.3	0.7	
11	544		16:43	16:56		237	144	54	15	1.2	0.7	
12	cR20	UL001	17:03	17:05			148	53	15	1.1	0.7	
13	CR20		17:09	17:12			142	52	15	1.1	0.7	



ALS60 LiDAR Flight Log

Project	VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s		
Date/Julian:	4/10/2014		Mem Drive MM60	Int. Time:	TAR AIRSPD (KNTS)			Base PID:		Bertin Evina-Ze		
Hobbs End	867.1		3-600093051		140			TEMP		Pilot/s		
Hobbs ST	863.4		LIFT A					Base Height:		Aircraft	Airport Idnt:	
Flight Time	3.7		Block4-1		4,300	VA-Sandy		1.500		421C 112MJ	KPTB	
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
A		BLOCK4-1					147					
1	772		8:59	9:10	4,200	180	140	144	10	1.3	0.8	CLEAR
2	771		9:15	9:26		0	140	141	18	1.0	0.6	CLEAR
3	770		9:32	9:42		180	147	138	15	1.1	0.7	CLEAR
4	769		9:47	9:58		0	137	135	17	1.0	0.7	CLEAR
5	768		10:03	10:14		180	142	132	15	1.2	0.7	CLEAR
6	767		10:19	10:28		0	138	129	16	1.2	0.7	CLEAR
7	766		10:34	10:45		180	143	126	17	1.2	0.7	CLEAR
8	765		10:50	11:01		0	139	123	19	1.0	0.6	CLEAR
9	764		11:07	11:18		180	140	120	19	1.1	0.6	CLEAR
10	763		11:22	11:33		0	140	117	20	1.1	0.7	CLEAR
11	762		11:38	11:49		180	140	114	19	1.1	0.6	CLEAR
12	761		11:54	12:05		0	145	111	18	1.2	0.7	CLEAR
13	CR23	UL001	12:10	12:13	4,450	91	131	108	18	1.2	0.7	X-Strip
14	CR23		12:17	12:20	4,450	271	130	105	20	1.1	0.7	X-Strip



ALS60 LiDAR Flight Log

Project	VA-Sandy_Lidar2014		ALS60	N6130_090724						Sensor Operator/s		
Date/Julian:	4/10/2014		Mem Drive MM60	Int. Time:	TAR AIRSPD (KNTS)			Base PID:		Bertin Evina-Ze		
Hobbs End	867.1		3-600093051		140			TEMP		Pilot/s		
Hobbs ST	863.4		LIFT B					Base Height:		Aircraft	Airport Idnt:	
Flight Time	3.7		Block4-1		4,300	VA-Sandy		1.500		421C 112MJ	KPTB	
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
B		BLOCK4-1					90					
1	748		14:22	14:34	4,200	180	139	85	16	1.2	0.7	CLEAR
2	747		14:38	14:50		0	142	82	17	1.0	0.6	CLEAR
3	746		14:54	15:06		180	138	79	14	1.2	0.7	CLEAR
4	745		15:10	15:21		0	145	76	16	1.2	0.7	CLEAR
5	744		15:26	15:37		180	130	72	16	1.1	0.7	CLEAR
6	743		15:42	15:53		0	139	69	16	1.2	0.7	CLEAR
7	742		15:58	16:08		180	148	65	16	1.3	0.7	CLEAR
8	741		16:13	16:25		0	150	61	15	1.3	0.7	CLEAR
9	740		16:29	16:41		180	147	58	15	1.2	0.7	CLEAR
10	739		16:45	16:57		0	140	54	16	1.1	0.7	CLEAR
11	738		11:38	17:13		180	141	50	15	1.1	0.7	CLEAR
12	737		11:54	17:29		0	136	47	15	1.1	0.7	CLEAR
13	CR23	UL001	12:10	17:33	4,450	91	153	46	15	1.1	0.7	X-Strip
14	CR23		12:17	17:44	4,450	271	142	44	15	1.1	0.7	X-Strip

ALS60 LiDAR Flight Log															
Project		VA-Sandy_Lidar2014		ALS60	N6130_090724					Sensor Operator/s					
Date/Julian:	4/11/2014		Mem Drive MM60		3-600093051		Int. Time:	TAR AIRSPD (KNTS)		140		Base PID:	Pilot/s		
Hobbs End	875.0		LIFT A		Block4-1		TAR ALT AGL (ft):	4,300		Flight Plan(s):	VA-Sandy		Base Height:	1,500	
Hobbs ST	870.8		Aircraft		421C 112MJ		Airport Idnt:		KPTB						
Flight Time	4.2		GPS Altitude: ASL:		4,200		Direction	180		Speed: kts:	141		Memory	94	
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:			
			B:	E:						PDDP	HDDP				
A		BLOCK4-1													
1	736		11:32	11:44	4,200	180	141	94	15	1.2	0.7	CLEAR			
2	735		11:49	12:00		0	145	90	15	1.4	0.7	CLEAR			
3	734		12:05	12:16		180	146	87	15	1.2	0.6	CLEAR			
4	733		12:20	12:32		0	145	84	17	1.1	0.6	CLEAR			
5	732		12:37	12:48		180	146	81	15	1.2	0.6	CLEAR			
6	731		12:52	13:03		0	148	78	15	1.2	0.7	CLEAR			
7	730		13:07	13:18		180	145	75	15	1.3	0.7	CLEAR			
8	729		13:22	13:33		0	147	72	14	1.5	0.8	CLEAR			
9	728		13:37	16:49		180	147	66	15	1.4	0.8	CLEAR			
10	727		13:52	14:04		0	146	63	15	1.2	0.7	CLEAR			
11	726		14:07	14:18		180	148	60	14	1.3	0.8	CLEAR			
12	725		14:22	14:33		0	143	55	14	1.3	0.8	CLEAR			
13	724		14:37	14:48		180	145	52	15	1.1	0.7	CLEAR			
14	723		14:52	15:03		0	146	49	16	1.1	0.7	CLEAR			
15	CR23	UL001	15:10	15:12	4,450	91	149	48	16	1.1	0.7	X-Strip			
16	CR23	UL002	15:16	15:20	4,450	271	136	47	18	1.1	0.6	X-Strip			

ALS60 LiDAR Flight Log															
Project		VA-Sandy_Lidar2014		ALS60	N6130_090724					Sensor Operator/s					
Date/Julian:	4/12/2014		Mem Drive MM60		3-600093051		Int. Time:	TAR AIRSPD (KNTS)		140		Base PID:	Pilot/s		
Hobbs End	879.0		LIFT A		Block4-1		TAR ALT AGL (ft):	4,300		Flight Plan(s):	VA-Sandy		Base Height:	1,500	
Hobbs ST	875.0		Aircraft		421C 112MJ		Airport Idnt:		KPTB						
Flight Time	4.0		GPS Altitude: ASL:		4,200		Direction	180		Speed: kts:	146		Memory	91	
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:			
			B:	E:						PDDP	HDDP				
A		BLOCK4-1													
1	682		11:42	11:55	4,200	180	146	91	16	1.2	0.6	CLEAR			
2	683		12:00	12:14		0	137	85	16	1.2	0.6	CLEAR			
3	684		12:18	12:31		180	148	83	17	1.1	0.6	CLEAR			
4	722		12:39	12:51		0	139	78	15	1.2	0.7	CLEAR			
5	721		12:55	13:06		180	140	76	15	1.3	0.8	CLEAR			
6	720		13:10	13:21		0	141	72	14	1.7	1.1	CLEAR			
7	719		13:25	13:37		180	142	69	15	1.3	0.8	CLEAR			
8	718		13:41	13:52		0	145	66	16	1.2	0.7	CLEAR			
9	717		13:56	14:07		180	144	63	16	1.2	0.7	CLEAR			
10	716		14:11	14:27		0	147	59	15	1.3	0.7	CLEAR			
11	715		14:26	14:38		180	141	56	16	1.1	0.6	CLEAR			
12	714		14:42	14:53		0	145	52	16	1.1	0.8	CLEAR			
13	CR23	UL001	15:00	15:05	4,450	271	145	51	16	1.1	0.6	X-Strip			
14	CR23	UL002	15:10	15:15	4,450	91	150	49	16	1.1	0.6	X-Strip			



**ALS60 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS60	N6130_090724				Sensor Operator/s		Bertin Evina-Ze	
Date/Julian:	4/13/2014	Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)		Base PID:		Pilot/s		SVEN	
Hobbs End	879.0	3-600093051			140		TEMP					
Hobbs ST	879.0	LIFT A		TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:			
Flight Time	0.0	Block4-1		4,300		VA-Sandy		1,500	421C 112MJ	KPTB		
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
A		<b>BLOCK4-1</b>					66					
1	R826		12:00	12:07	4,200	0	143	64	16	1.2	0.6	CLEAR
2	R827		12:11	12:17		180	131	62	17	1.1	0.6	CLEAR
3	R825		12:20	12:27		0	148	60	17	1.1	0.6	CLEAR
4	R824		12:30	12:37		180	142	58	17	1.1	0.6	CLEAR
5	R823		12:41	12:47		0	144	56	16	1.2	0.6	CLEAR
6	R822		12:51	12:59		180	140	54	16	1.4	0.6	CLEAR
7	R821		13:02	13:09		0	152	52	15	1.4	0.7	CLEAR
8	R820		13:13	13:20		180	139	50	16	1.3	0.7	CLEAR
9	R819		13:23	13:30		0	151	48	16	1.1	0.7	CLEAR
10	R818		13:35	13:43		180	133	46	17	1.2	0.6	CLEAR
11	R817		13:46	13:53		0	150	44	16	1.2	0.6	CLEAR
12	R816		13:57	14:05		180	134	42	16	1.1	0.6	CLEAR
13	R815		14:08	14:15		0	149	40	16	1.1	0.6	CLEAR
14	R814		14:19	14:27		180	138	38	16	1.1	0.6	CLEAR
15	R813		14:31	14:38		0	144	36	16	1.1	0.6	CLEAR
16	R812		14:42	14:50		180	133	34	15	1.2	0.7	CLEAR
17	R811		14:54	15:01		0	151	32	17	1.1	0.6	CLEAR
18	R810		15:05	15:13		180	134	30	18	1.1	0.6	CLEAR
19	R809		15:16	15:24		0	142	28	17	1.1	0.6	CLEAR
20	R808		15:27	15:34		180	134	26	17	1.2	0.6	CLEAR
21	CR23		15:40	15:43	4,450	91	155	25	16	1.3	0.7	X-Strip
22	CR23	UL001	15:46	15:51	4,450	271	138	20	16	1.3	0.7	X-Strip



**ALS60 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS60	N6130_090724				Sensor Operator/s		Bertin Evina-Ze	
Date/Julian:	4/13/2014	Mem Drive MM60		Int. Time:	TAR AIRSPD (KNTS)		Base PID:		Pilot/s		SVEN	
Hobbs End	885.7	3-600093051			140		TEMP					
Hobbs ST	883.3	LIFT B		TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:			
Flight Time	2.4	Block4-1		4,300		VA-Sandy		1,500	421C 112MJ	KPTB		
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
B		<b>BLOCK4-1</b>					105					
1	R807		17:25	17:33	4,200	0	144	102	15	1.1	0.7	CLEAR
2	R806		17:36	17:45		180	129	100	14	1.2	0.7	CLEAR
3	R805		17:48	17:56		0	142	98	14	1.2	0.7	CLEAR
4	R804		18:00	18:08		180	140	96	14	1.2	0.7	CLEAR
5	R803		18:11	18:18		0	142	93	13	1.4	0.7	CLEAR
6	R802		18:22	18:29		180	149	91	14	1.3	0.7	CLEAR
7	R801		18:33	18:41		0	148	89	15	1.2	0.7	CLEAR
8	R800		18:44	18:52		180	140	86	14	1.3	0.7	CLEAR
9	R799		18:56	19:03		0	139	84	14	1.3	0.7	CLEAR
10	CR23		19:14	19:16	4,450	91	150	25	14	1.6	0.7	X-Strip
11	CR23	UL001	19:19	19:23	4,450	271	146	20	14	1.6	0.7	X-Strip



**ALS70 LiDAR Flight Log**

Project	VA-Sandy_Lidar2014	ALS70	SN					Sensor Operator/s Bertin Evina-Ze			
Date/Julian:	4/16/2014	Mem Drive MM70		TAR AIRSPD (KNTS)		Base PID:		Pilot/s			
Hobbs End	2610.2			155		AA9201		SVEN			
Hobbs ST	2605.6	LIFT		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:
Flight Time	4.6	A		5,740		VA-Sandy		1,500		421C 13RF	KLKU

Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDDP	HDOP	
A		<b>BLOCK 2</b>					743					
1	55	140416_133558	13:36	13:49	6,100	0	150	738	16	1.2	0.7	
2	54	140416_135328	13:53	14:06		180	155	732	17	1.1	0.6	
3	53	140416_140938	14:09	14:23		0	147	726	16	1.1	0.6	
4	52	140416_142711	14:27	14:40		180	159	721	16	1.1	0.6	
5	51	140416_144400	14:44	14:58		0	152	715	17	1.0	0.6	
6	50	140416_150124	15:01	15:16		180	158	709	16	1.1	0.6	
7	49	140416_151919	15:19	15:33		0	153	703	15	1.4	0.8	
8	48	140416_153744	15:37	15:52		180	158	696	15	1.4	0.8	
9	47	140416_155631	15:56	16:11		0	152	690	14	1.5	0.8	
10	46	140416_161545	16:15	16:30		180	156	684	14	1.4	0.8	
11	45	140416_163501	16:35	16:49		0	156	677	14	1.2	0.7	
12	44	140416_165409	16:54	17:09		180	154	671	14	1.2	0.7	
13	43	140416_171311	17:13	17:28		0	158	664	14	1.2	0.7	
14	UL001	140416_173435	17:34	17:38		90	150	662	14	1.2	0.7	
15	CX1	140416_174300	17:43	17:46		270	154	661	16	1.0	0.6	



**ALS70 LiDAR Flight Log**

Project	VA-Sandy_Lidar2014	ALS70	SN					Sensor Operator/s Bertin Evina-Ze			
Date/Julian:	4/16/2014	Mem Drive MM70		TAR AIRSPD (KNTS)		Base PID:		Pilot/s			
Hobbs End	2614.1			155		AA9201		SVEN			
Hobbs ST	2610.2	LIFT		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft	Airport Idnt:
Flight Time	3.9	B		5,740		VA-Sandy		1,500		421C 13RF	KLKU

Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDDP	HDOP	
B		<b>BLOCK 2</b>					745					
1	42	140416_201316	20:13	20:29	6,190	180	153	738	18	1.2	0.6	
2	41	140416_203235	20:32	20:48		0	160	731	18	1.1	0.6	
3	40	140416_205213	20:52	21:07		180	152	725	19	1.1	0.6	
4	39	140416_211205	21:12	21:27		0	160	718	17	1.2	0.7	
5	38	140416_213121	21:31	21:47		180	158	711	18	1.1	0.6	
6	37	140416_215041	21:50	22:06		0	160	705	17	1.2	0.7	
7	36	140416_221009	22:10	22:25		180	159	698	18	1.1	0.6	
8	35	140416_222927	22:29	22:45		0	160	691	19	1.1	0.6	
9	34	140416_224914	22:49	23:04		180	160	684	20	1.1	0.6	
10	33	140416_230825	23:08	23:23		0	160	678	18	1.2	0.7	
11	UL001	140416_233020	23:30	23:33		90	159	677	17	1.3	0.7	Cross Strip
12	UL002	140416_233618	23:36	23:39		270	161	675	18	1.1	0.7	Cross Strip



**ALS70 LiDAR Flight Log**

<b>Project</b>	VA-Sandy_Lidar2014	<b>ALS70</b> SN										<b>Sensor Operator/s</b> Bertin Evin-Ze
<b>Date/Julia</b>	4/17/2014		<b>Mem Drive MM70</b>		<b>AR AIRSPD (KNTS)</b>				<b>Base PID:</b>			<b>Pilot/s</b> SVEN
<b>Hobbs En</b>	2619.3				155				AA9201			
<b>Hobbs ST</b>	2614.1		LIFT		<b>AR ALT AGL (ft):</b>	<b>Flight Plan(s):</b>	<b>Base Height</b>			<b>Aircraft</b>	<b>Airport Idnt:</b>	
<b>Flight Tim</b>	5.2		A		5,740	VA-Sandy	1,500			421C 13RF	KLKU	

Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memor	SVs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
A		<b>BLOCK 2</b>					675					
1	32	140417_123806	12:38	12:53	6,300	180	160	669	16	1.2	0.7	
2	31	140417_125708	12:57	13:12		0	160	662	16	1.4	0.7	
3	30	140417_131643	13:16	13:32		180	156	655	16	1.2	0.7	
4	56	140417_133820	13:38	13:38		0	161	655	16	1.2	0.7	
5	57	140417_134206	13:42	13:43		180	155	655	16	1.2	0.7	
6	58	140417_134718	13:47	13:49		0	158	654	15	1.3	0.7	
7	59	140417_135315	13:53	13:55		180	156	653	17	1.1	0.7	
8	60	140417_135943	13:59	14:02		0	159	651	16	1.1	0.7	
9	61	140417_140610	14:06	14:09		180	156	650	16	1.1	0.7	
10	62	140417_141254	14:12	14:16		0	159	649	15	1.2	0.7	
11	63	140417_142003	14:20	14:23		180	156	647	16	1.1	0.7	
12	64	140417_142804	14:28	14:31		0	159	645	15	1.2	0.7	
13	65	140417_143552	14:35	14:40		180	157	643	17	1.1	0.7	
14	66	140417_144423	14:44	14:49		0	159	642	16	1.1	0.7	
15	67	140417_145233	14:52	14:57		180	158	640	18	1.0	0.6	
16	68	140417_150117	15:01	15:06		0	158	638	15	1.2	0.7	
17	69	140417_151017	15:10	15:15		180	158	635	16	1.2	0.7	
18	25	140417_151938	15:19	15:35		0	160	629	15	1.3	0.7	
19	26	140417_153814	15:38	15:55		180	159	621	14	1.3	0.8	
20	27	140417_155756	15:57	16:13		0	160	615	14	1.3	0.8	
21	28	140417_161719	16:17	16:33		180	158	609	15	1.2	0.7	
22	29	140417_163615	16:36	16:52		0	159	602	13	1.6	1.0	
23	UL001	140417_170712	17:07	17:12		270	162	600	15	1.2	0.7	X-Strip
24	CX3	140417_171622	17:16	17:21		90	161	598	15	1.2	0.7	X-Strip



**ALS70 LiDAR Flight Log**

<b>Project</b>	VA-Sandy_Lidar2014	<b>ALS70 SN</b>										<b>Sensor Operator/s</b>
<b>Date/Julia</b>	4/17/2014	<b>Mem Drive MM70</b>		<b>AR AIRSPD (KNTS)</b>		<b>Base PID:</b>						<b>Pilot/s</b>
<b>Hobbs En</b>	2623.7			155		AA9201						SVEN
<b>Hobbs ST</b>	2619.3	<b>LIFT</b>		<b>AR ALT AGL (ft):</b>		<b>Flight Plan(s):</b>	<b>Base Height</b>	<b>Aircraft</b>	<b>Airport Idnt:</b>			
<b>Flight Tim</b>	4.4	B		5,740		VA-Sandy	1500	421C 13RF	KLKU			

Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memor	S/Ws:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
B		<b>BLOCK 2</b>					598					
1	24	140417_193243	19:32	19:40	6,300	180	158	595	17	1.4	0.6	
2	23	140417_194342	19:43	19:51		0	161	591	18	1.3	0.6	
3	22	140417_195442	19:54	20:02		180	154	588	18	1.3	0.6	
4	21	140417_200524	20:05	20:12		0	158	585	17	1.4	0.7	
5	20	140417_201611	20:16	20:23		180	158	582	18	1.2	0.6	
6	19	140417_202639	20:26	20:33		0	160	579	19	1.1	0.6	
7	18	140417_203709	20:37	20:44		180	159	576	19	1.0	0.6	
8	17	140417_204734	20:47	20:54		0	159	573	19	1.1	0.6	
9	16	140417_205758	20:57	21:04		180	158	570	18	1.1	0.6	
10	1	140417_211225	21:12	21:14	6,400	0	159	569	18	1.1	0.6	
11	2	140417_211758	21:17	21:20		180	160	568	17	1.2	0.7	
12	3	140417_212400	21:24	21:26		0	158	567	17	1.2	0.7	
13	4	140417_213033	21:30	21:33		180	157	566	17	1.2	0.7	
14	5	140417_213729	21:37	21:40		0	161	564	17	1.3	0.8	
15	6	140417_214443	21:44	21:48	6,300	180	158	563	18	1.2	0.8	
16	7	140417_215228	21:52	21:56		0	158	561	18	1.2	0.6	
17	8	140417_220007	22:00	22:05		180	159	559	18	1.3	0.6	
18	9	140417_220912	22:09	22:15		0	154	556	18	1.3	0.6	
19	10	140417_221828	22:18	22:24		180	160	554	18	1.3	0.6	
20	11	140417_222815	22:28	22:34		0	157	552	19	1.2	0.6	
21	12	140417_223744	22:37	22:43		180	160	549	18	1.4	0.8	
22	13	140417_224727	22:47	22:53		0	158	546	19	1.2	0.7	
23	14	140417_225736	22:57	23:03		180	160	544	19	1.1	0.6	
24	15	140417_230747	23:07	23:14		0	159	541	19	1.1	0.6	
25	UL001	140417_232030	23:20	23:25		180	160	539	18	1.2	0.6	X-Strip
26	CX1	140417_233015	23:30	23:35		0	162	547	18	1.1	0.6	X-Strip



**ALS70 LiDAR Flight Log**

<b>Project</b>	VA-Sandy_Lidar2014	<b>ALS70</b>	<b>SN</b>										<b>Sensor Operator/s</b>	Bertin Evina-Ze
<b>Date/Julia</b>	4/18/2014	<b>Mem Drive MM70</b>		<b>AR AIRSPD (KNTS)</b>	155	<b>Base PID:</b>	AA9201	<b>Pilot/s</b>		SVEN				
<b>Hobbs En</b>	2627.7			<b>FAR ALT AGL (ft):</b>	5,740	<b>Flight Plan(s):</b>	VA-Sandy	<b>Base Height</b>	1500	<b>Aircraft</b>	421C 13RF	<b>Airport Idnt:</b>	KLKU	
<b>Hobbs ST</b>	2623.7	<b>LIFT</b>												
<b>Flight Tim</b>	4.0	<b>A</b>												

Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
A		<b>Block 1</b>					661					
1	25	140418_182524	18:25	18:32	6,400	45	156	658	17	1.2	0.6	
2	24	140418_183651	18:36	18:44		225	154	654	15	1.4	0.7	
3	23	140418_184805	17:48	18:56		45	158	651	17	1.3	0.6	
4	22	140418_185941	18:59	19:07		225	159	647	18	1.2	0.6	
5	21	140418_191141	19:11	19:19		45	157	644	18	1.2	0.6	
6	20	140418_192323	19:23	19:31		225	160	641	17	1.3	0.6	
7	19	140418_193517	19:35	19:43		45	158	638	17	1.4	0.6	
8	18	140418_194720	18:47	19:53		225	158	634	18	1.3	0.6	
9	17	140418_195724	19:57	20:02		45	160	632	17	1.4	0.6	
10	16	140418_200547	20:05	20:10		225	159	630	18	1.2	0.6	
11	15	140418_201350	20:13	20:17		45	160	629	18	1.2	0.6	
12	14	140418_202224	20:22	20:25		225	156	627	17	1.2	0.7	
13	13	140418_202907	20:29	20:32		45	160	626	17	1.2	0.7	
14	12	140418_203552	20:35	20:39		225	159	625	17	1.3	0.8	
15	11	140418_204247	20:42	20:45		45	158	624	18	1.2	0.8	
16	10	140418_204911	20:49	20:52		225	158	623	18	1.2	0.6	
17	9	140418_205607	20:56	20:59		45	157	622	18	1.3	0.6	
18	8	140418_210331	21:03	21:05		225	158	621	18	1.3	0.6	
19	7	140418_210905	21:09	21:11		45	160	620	18	1.3	0.6	
20	6	140418_211456	21:14	21:17		225	155	619	19	1.2	0.6	
21	5	140418_212027	21:20	21:21		45	154	618	18	1.4	0.8	
22	4	140418_212515	21:25	21:26		225	155	617	19	1.2	0.7	
23	3	140418_213007	21:30	21:31		45	156	616	19	1.1	0.6	
24	2	140418_213455	21:34	21:36		225	160	615	19	1.1	0.6	
25	1	140418_214004	21:40	21:41		45	152	615	18	1.2	0.6	
26	UL001	140418_214529	21:45	21:50		225	156	613	18	1.1	0.6	X-Strip
27	BIX	140418_215426	21:54	21:59		45	160	610	18	1.1	0.6	X-Strip





**ALS70 LiDAR Flight Log**

Project	VA-Sandy_Lidar2014	ALS70	SN									Sensor Operator/s Bertin Evina-Ze
Date/Julian:	4/20/2014		Mem Drive MM70		TAR AIRSPD (KNTS)	155		Base PID:	AA9201			Pilot/s SVEN
Hobbs End	2632.9				TAR ALT AGL (ft):	5,740	Flight Plan(s):	VA-Sandy	Base Height:	1,500	Aircraft	421C 13RF
Hobbs ST	2628.2		LIFT									Airport Idnt: KFVX
Flight Time	4.7		A	Block 4-2								

Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
A		<b>Block 4-2</b>					610					
1	65	140420_134907	13:49	13:59	6,250	180	160	605	17	1.1	0.6	
2	64	140420_140321	14:03	14:14		0	156	601	18	1.0	0.6	
3	63	140420_141803	14:18	14:28		180	160	596	18	1.0	0.6	
4	62	140420_143234	14:32	14:43		0	154	591	17	1.1	0.6	
5	61	140420_144729	14:47	14:57		180	158	586	16	1.2	0.7	
6	60	140420_150138	15:01	15:13		0	156	581	16	1.3	0.7	
7	59	140420_151557	15:15	15:26		180	159	576	16	1.3	0.7	
8	58	140420_153022	15:30	15:40		0	160	571	15	1.4	0.7	
9	57	140420_154433	15:44	15:54		180	160	566	15	1.4	0.8	
10	56	140420_155832	15:58	16:08		0	159	561	16	1.3	0.8	
11	55	140420_161230	16:12	16:22		180	158	556	15	1.1	0.7	
12	54	140420_162556	16:25	16:36		0	157	557	14	1.2	0.7	
13	53	140420_163926	16:39	16:48		180	156	553	15	1.1	0.7	
14	52	140420_165252	16:52	17:01		0	160	549	15	1.1	0.7	
15	51	140420_170602	17:06	17:14		180	160	545	15	1.2	0.7	
16	50	140420_171824	17:18	17:26		0	159	542	15	1.2	0.7	
17	49	140420_173036	17:30	17:38		180	158	538	17	1.0	0.6	
18	48	140420_174155	17:41	17:49		0	158	535	15	1.3	0.7	
19	UL001	140420_175359	17:53	17:59		90	148	533	17	1.3	0.7	X-Strip
20	CX3	140420_180309	18:03	18:04		270	161	530	17	1.4	0.7	X-Strip



**ALS70 LiDAR Flight Log**

Project		VA-Sandy_Lidar2014		ALS70	SN								Sensor Operator/s	
Date/Julian:		4/20/2014		Mem Drive MM70		TAR AIRSPD (KNTS)				Base PID:		Pilot/s		
Hobbs End		2637.0				155				GW2384		SVEN		
Hobbs ST		2632.9		LIFT		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft		
Flight Time		4.1		B		Block 4-2		VA-Sandy		1,500		421C 13RF		
						5,740						KFXV		
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	SVs:	Position Acc.		Comments and Conditions:		
			B:	E:						PDOP	HDOP			
B		Block 4-2					530							
1	47	140420_201924	20:19	20:26	6,250	0	158	527	19	1.1	0.6			
2	46	140420_203021	20:30	20:37		180	160	524	18	1.1	0.6			
3	45	140420_204043	20:40	20:47		0	158	521	18	1.1	0.6			
4	44	140420_205100	20:51	20:57		180	158	518	17	1.2	0.7			
5	43	140420_210111	21:01	21:07		0	160	516	17	1.2	0.7			
6	42	140420_211105	21:11	21:17		180	156	513	16	1.2	0.7			
7	41	140420_212034	21:20	21:26		0	157	511	16	1.3	0.7			
8	40	140420_213022	21:30	21:36		180	160	508	16	1.3	0.7	Error		
9	39	140420_213942	21:39	21:45		0	157	505	16	1.3	0.7			
10	38	140420_214900	21:49	21:54		180	160	501	17	1.2	0.7			
11	37	140420_215811	21:58	22:03		0	159	499	18	1.1	0.7			
12	36	140420_220729	22:07	22:13		180	159	496	18	1.1	0.7			
13	35	140420_221642	22:16	22:22		0	160	494	19	1.0	0.6			
14	34	140420_222602	22:26	22:31		180	156	492	19	1.0	0.6			
15	33	140420_223505	22:35	22:40		0	159	489	20	1.0	0.6			
16	32	140420_224428	22:44	22:50		180	156	486	20	1.1	0.6			
17	31	140420_225415	22:54	23:00		0	158	484	19	1.1	0.6			
18	30	140420_230404	23:04	23:10		180	157	481	18	1.2	0.7			
19	29	140420_231353	23:13	23:20		0	159	478	17	1.3	0.7			
20	28	140420_232357	23:23	23:29		180	158	476	18	1.2	0.7			
21	40	140420_233420	23:34	23:40		0	159	474	18	1.1	0.6	REFLY		
22	UL001	140420_234441	23:44	23:49		270	153	474	18	1.1	0.6	X-Strip		
23	UL002	140420_235242	23:52	23:58		90	151	471	18	1.1	0.6	X-Strip		



**ALS70 LiDAR Flight Log**

<b>Project</b>	VA-Sandy_Lidar2014	<b>ALS70</b>	<b>SN</b>									<b>Sensor Operator/s</b>
<b>Date/Julia</b>	4/21/2014	<b>Mem Drive MM70</b>		<b>AR AIRSPD (KNTS)</b>		-	<b>Base PID:</b>	<b>Pilot/s</b>				
<b>Hobbs En</b>	2641.4			155			GW2384	SVEN				
<b>Hobbs ST</b>	2637.0	<b>LIFT</b>		<b>TAR ALT AGL (ft):</b>	5,740	<b>Flight Plan(s):</b>	<b>Base Height</b>	<b>Aircraft</b>	<b>Airport Idnt:</b>			
<b>Flight Tim</b>	4.4	<b>A</b>	Block 4-2 and R6602			VA-Sandy	1500	421C 13RF	KFBX			

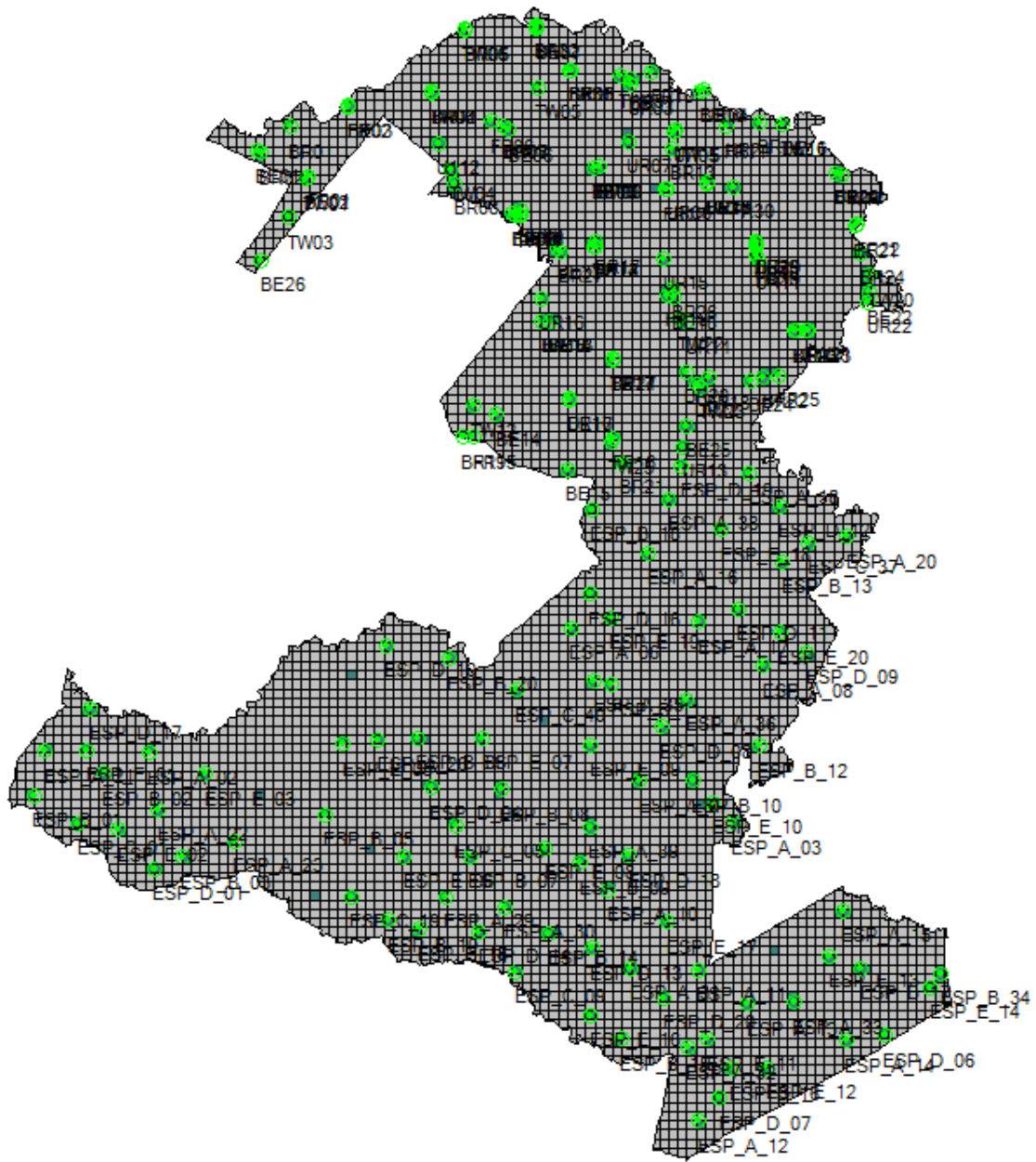
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memor	SIVs:	Position Acc.		Comments and Conditions:
			B:	E:						PDOP	HDOP	
<b>A</b>		<b>Block 4-1</b>					471					
1	R01	140421_140826	14:08	14:13	6,300	180	158	469	16	1.2	0.7	
2	R02	140421_141709	14:17	14:22		0	152	467	17	1.2	0.7	
3	R03	140421_142610	14:26	14:31		180	159	465	17	1.1	0.6	
4	R04	140421_143448	14:34	14:40		0	158	463	18	1.0	0.6	
5	R05	140421_144343	14:43	14:49		180	160	460	18	1.0	0.6	
6	R06	140421_145224	14:52	14:57		0	158	457	16	1.2	0.7	
7	R07	140421_150121	15:01	15:06		180	161	455	16	1.3	0.7	
8	R08	140421_151019	15:10	15:15		0	160	453	16	1.3	0.7	
9	R09	140421_151921	15:19	15:24		180	158	450	15	1.4	0.8	
10	R10	140421_152811	15:28	15:33		0	159	448	15	1.4	0.8	
11	R11	140421_153704	15:37	15:42		180	160	446	15	1.3	0.7	
12	R12	140421_154541	15:45	15:50		0	160	444	15	1.2	0.7	
13	R13	140421_155437	15:54	15:59		180	159	441	16	1.2	0.7	
14	R14	140421_160323	16:03	16:08		0	159	439	16	1.1	0.7	
15	R15	140421_161213	16:12	16:17		180	159	437	15	1.2	0.7	
16	UL001	140421_162322	16:23	16:26		270	159	435	15	1.3	0.7	X-Strip
17	UL002	140421_163050	16:30	16:34		90	150	433	15	1.2	0.7	X-Strip
18		<b>Block 4-2</b>										
19	72	140421_164303	16:43	16:54		0	156	429	14	1.4	0.8	
20	71	140421_165809	16:58	17:09		180	158	424	15	1.2	0.7	
21	70	140421_171245	17:12	17:24		0	156	419	15	1.2	0.7	
22	69	140421_172746	17:27	17:39		180	159	414	16	1.1	0.7	
23	68	140421_174230	17:42	17:53		0	158	409	15	1.3	0.7	
	UL001	140421_175908	17:59	18:01		270	150	408	17	1.2	0.7	X-Strip
	X42	140421_180611	18:06	18:07		90	160	407	17	1.2	0.7	X-Strip



**ALS70 LiDAR Flight Log**

Project	VA-Sandy_Lidar2014		ALS70	SN									Sensor Operator/s Bertin Evina-Ze	
Date/Julian:	4/21/2014	Mem Drive MM70		TAR AIRSPD (KNTS)		Base PID:		Pilot/s						
Hobbs End	2644.2			155		GW2384		SVEN						
Hobbs ST	2641.4	LIFT		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:		Aircraft		Airport Idnt:		
Flight Time	2.8	B Block 4-2		5,740		VA-Sandy		1,500		421C 13RF		KFVX		
Lift	Flight Line	Mission Line	UTC time:		GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc.		Comments and Conditions:		
			B:	E:						PDOP	HDOP			
B		Block 4-2					407							
1	D25	140421_203400	20:34	20:40	6,250	180	159	405	18	1.1	0.6			
2	D26	140421_204407	20:44	20:50		0	160	402	18	1.1	0.6			
3	D27	140421_205414	20:54	21:00		180	160	399	17	1.2	0.7			
4	D66	140421_211024	21:10	21:21		0	155	394	16	1.2	0.8			
5	D67	140421_212515	21:25	21:36		180	156	389	16	1.4	0.8			
6	UL001	140421_214339	21:43	21:44		90	158	389	17	1.3	0.8	X-Strip		
7	X41	140421_214847	21:48	22:02		270	155	383	17	1.3	0.7	X-Strip		
8	D01	140421_220558	22:05	22:07		0	150	382	19	1.2	0.7			
9	D02	140421_221121	22:11	22:13		180	159	381	20	1.1	0.7			
10	D03	140421_221717	22:17	22:19		0	151	380	20	1.1	0.7			
11	D04	140421_222307	22:23	22:25		180	157	379	20	1.2	0.7			
12	D05	140421_222927	22:29	22:32		0	144	378	20	1.1	0.7			
13	D06	140421_223600	22:36	22:40		180	145	376	20	1.1	0.7			
14	D07	140421_224332	22:43	22:47		0	146	374	19	1.1	0.7			
15	X41	140421_225432	22:54	23:00		90	157	371	19	1.1	0.6	X-Strip		

## APPENDIX B. Vertical Accuracy Calculations



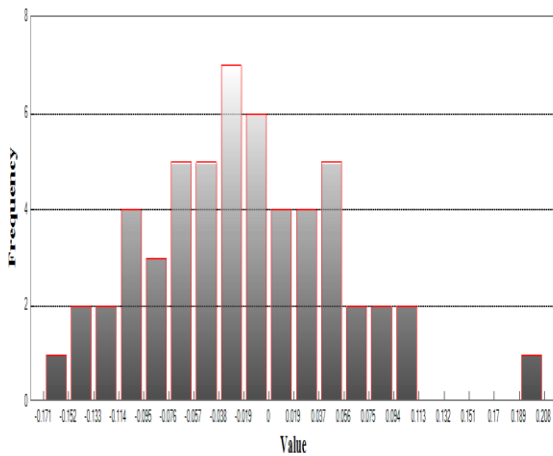

  
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<b>LiDAR Accuracy Assessment Summary</b>				
<b>LC Type</b>	<b>No of Points</b>	<b>FVA</b>	<b>SVA</b>	<b>CVA</b>
<b>LAS</b>				
ALL	209			0.183
Bare Earth	55	0.147		
Brush Land	31		0.189	
Forested	40		0.18	
Tall Weeds	45		0.196	
Urban	38		0.156	
Total	209			
<b>DEM</b>				
ALL	209			0.187
Bare Earth	55	0.144		
Brush Land	31		0.205	
Forested	40		0.231	
Tall Weeds	45		0.202	
Urban	38		0.166	
Total	209			
Units: Meters				

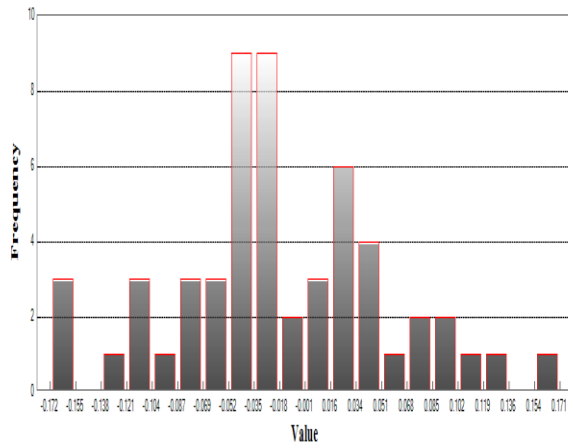
### Fundamental Vertical Accuracy

LAS	DEM
LandCover Type: Bare Earth Minimum DZ: -0.17 Maximum DZ: 0.208 Mean DZ: -0.02 Mean Magnitude DZ: 0.247 Number Observations: 55 Standard Deviation DZ: 0.073 RMSE Z: 0.075 95% Confidence Level Z: 0.147 Units: Meters	LandCover Type: Bare Earth Minimum DZ: -0.173 Maximum DZ: 0.17 Mean DZ: -0.018 Mean Magnitude DZ: 0.243 Number Observations: 55 Standard Deviation DZ: 0.072 RMSE Z: 0.074 95% Confidence Level Z: 0.144 Units: Meters

## Histogram



Min: -0.17  
 Max: 0.208  
 Number Of Bins: 20  
 Bin Interval: 0.019



Min: -0.173  
 Max: 0.17  
 Number Of Bins: 20  
 Bin Interval: 0.017



LAS	DEM
<p>LandCover Type: Brush Land  Minimum DZ: -0.19  Maximum DZ: 0.236  Mean DZ: -0.025  Mean Magnitude DZ: 0.272  Number Observations: 31  Standard Deviation DZ: 0.097  RMSE Z: 0.099  95th Percentile: 0.189  Units: Meters</p>	<p>LandCover Type: Brush Land  Minimum DZ: -0.205  Maximum DZ: 0.21  Mean DZ: -0.02  Mean Magnitude DZ: 0.278  Number Observations: 31  Standard Deviation DZ: 0.102  RMSE Z: 0.103  95th Percentile: 0.205  Units: Meters</p>
<p>LandCover Type: Forested  Minimum DZ: -0.248  Maximum DZ: 0.191  Mean DZ: 0.019  Mean Magnitude DZ: 0.295  Number Observations: 40  Standard Deviation DZ: 0.106  RMSE Z: 0.106  95th Percentile: 0.18  Units: Meters</p>	<p>LandCover Type: Forested  Minimum DZ: -0.255  Maximum DZ: 0.24  Mean DZ: 0.022  Mean Magnitude DZ: 0.31  Number Observations: 40  Standard Deviation DZ: 0.117  RMSE Z: 0.118  95th Percentile: 0.231  Units: Meters</p>
<p>LandCover Type: Tall Weeds  Minimum DZ: -0.238  Maximum DZ: 0.25  Mean DZ: -0.033  Mean Magnitude DZ: 0.276  Number Observations: 45  Standard Deviation DZ: 0.095  RMSE Z: 0.099  95th Percentile: 0.196  Units: Meters</p>	<p>LandCover Type: Tall Weeds  Minimum DZ: -0.21  Maximum DZ: 0.296  Mean DZ: -0.024  Mean Magnitude DZ: 0.28  Number Observations: 45  Standard Deviation DZ: 0.1  RMSE Z: 0.101  95th Percentile: 0.202  Units: Meters</p>
<p>LandCover Type: Urban  Minimum DZ: -0.18  Maximum DZ: 0.129  Mean DZ: -0.021  Mean Magnitude DZ: 0.242  Number Observations: 38  Standard Deviation DZ: 0.077  RMSE Z: 0.079  95th Percentile: 0.166  Units: Meters</p>	<p>LandCover Type: Urban  Minimum DZ: -0.18  Maximum DZ: 0.129  Mean DZ: -0.021  Mean Magnitude DZ: 0.242  Number Observations: 38  Standard Deviation DZ: 0.077  RMSE Z: 0.079  95th Percentile: 0.166  Units: Meters</p>

Consolidated Vertical Accuracy	
LAS	DEM
LandCover Type: ALL Minimum DZ: -0.248 Maximum DZ: 0.25 Mean DZ: -0.017 Mean Magnitude DZ: 0.264 Number Observations: 209 Standard Deviation DZ: 0.089 RMSE Z: 0.091 95th Percentile: 0.183 Units: Meters	LandCover Type: ALL Minimum DZ: -0.255 Maximum DZ: 0.296 Mean DZ: -0.012 Mean Magnitude DZ: 0.27 Number Observations: 209 Standard Deviation DZ: 0.094 RMSE Z: 0.095 95th Percentile: 0.187 Units: Meters

PID	Survey X	Survey Y	Z1	Z DEM	Z LAS	ΔZ DEM	ΔZ LAS	LC Type
ESP_A_2	195171.069	4131578.566	142.409	142.333	142.316	-0.076	-0.093	Bare Earth
ESP_A_3	290588.408	4120094.811	40.904	40.881	40.890	-0.023	-0.014	Bare Earth
ESP_A_6	264053.433	4151894.094	82.156	82.093	82.128	-0.063	-0.028	Bare Earth
ESP_A_7	275275.255	4126946.442	76.042	76.100	76.098	0.058	0.056	Bare Earth
ESP_A_8	295556.039	4145789.633	37.710	37.663	37.652	-0.047	-0.058	Bare Earth
ESP_A_10	270111.845	4109217.959	94.150	94.049	94.055	-0.101	-0.095	Bare Earth
ESP_A_11	284851.335	4096133.212	43.227	43.250	43.281	0.023	0.054	Bare Earth
ESP_A_12	285002.370	4071395.837	41.633	41.745	41.731	0.112	0.098	Bare Earth
ESP_A_13	292988.211	4090479.508	31.026	31.114	31.105	0.088	0.079	Bare Earth
ESP_A_14	309002.972	4084526.145	31.138	31.118	31.127	-0.020	-0.011	Bare Earth
ESP_A_15	308494.137	4105746.442	36.533	36.483	36.483	-0.050	-0.050	Bare Earth
ESP_A_16	276672.410	4164106.161	90.376	90.343	90.348	-0.033	-0.028	Bare Earth
ESP_A_17	284984.673	4152915.770	15.773	15.804	15.810	0.031	0.037	Bare Earth
ESP_A_18	293177.728	4177304.766	55.209	55.297	55.312	0.088	0.103	Bare Earth
ESP_A_20	309182.358	4166824.461	47.528	47.537	47.539	0.009	0.011	Bare Earth
ESP_A_21	178135.639	4131884.300	220.877	220.883	220.870	0.006	-0.007	Bare Earth
ESP_A_22	196653.949	4122286.153	155.357	155.244	155.263	-0.113	-0.094	Bare Earth
ESP_A_23	209074.512	4117131.686	171.624	171.494	171.480	-0.130	-0.144	Bare Earth
ESP_A_26	232620.420	4133664.325	111.484	111.473	111.364	-0.011	-0.120	Bare Earth
ESP_A_29	243518.678	4108029.098	107.262	107.106	107.119	-0.156	-0.143	Bare Earth
ESP_A_30	253303.922	4106318.617	92.894	93.018	92.972	0.124	0.078	Bare Earth
ESP_A_31	273855.489	4096405.525	57.589	57.759	57.797	0.170	0.208	Bare Earth
ESP_A_32	283169.246	4083412.775	27.780	27.828	27.836	0.048	0.056	Bare Earth
ESP_A_33	300451.240	4090869.058	17.797	17.764	17.778	-0.033	-0.019	Bare Earth
ESP_A_35	267887.803	4143392.631	70.244	70.293	70.289	0.049	0.045	Bare Earth
ESP_A_36	283013.788	4140231.651	32.483	32.560	32.538	0.077	0.055	Bare Earth
ESP_A_38	280153.755	4172977.865	66.453	66.470	66.463	0.017	0.010	Bare Earth
ESP_A_39	267177.598	4119481.279	87.563	87.586	87.585	0.023	0.022	Bare Earth
BE01	212778.406	4229827.021	155.316	155.365	155.380	0.049	0.064	Bare Earth
BE02	220747.558	4225377.772	152.948	152.991	152.977	0.043	0.029	Bare Earth
BE03	227700.372	4237129.255	152.672	152.650	152.645	-0.022	-0.027	Bare Earth
BE05	263995.725	4243050.038	124.061	124.026	124.017	-0.035	-0.044	Bare Earth
BE06	253977.454	4233167.656	133.590	133.417	133.420	-0.173	-0.170	Bare Earth
BE08	254437.112	4219608.285	104.041	103.932	103.962	-0.109	-0.079	Bare Earth
BE09	267772.986	4227114.406	97.169	97.061	97.067	-0.108	-0.102	Bare Earth
BE10	285320.307	4239686.058	24.379	24.371	24.361	-0.008	-0.018	Bare Earth
BE11	298585.978	4234188.955	12.297	12.261	12.262	-0.036	-0.035	Bare Earth
BE12	267966.259	4214219.913	116.540	116.520	116.519	-0.020	-0.021	Bare Earth
BE13	260654.503	4202057.358	87.789	87.865	87.863	0.076	0.074	Bare Earth
BE14	251937.987	4186844.098	96.525	96.486	96.467	-0.039	-0.058	Bare Earth
BE15	263489.750	4177854.753	98.335	98.287	98.271	-0.048	-0.064	Bare Earth
BE16	263747.609	4189203.061	97.974	97.916	97.899	-0.058	-0.075	Bare Earth

BE17	270927.142	4195849.202	84.849	84.788	84.737	-0.061	-0.112	Bare Earth
BE18	280848.431	4205814.304	69.464	69.423	69.413	-0.041	-0.051	Bare Earth
BE19	294351.352	4214903.756	56.495	56.498	56.510	0.003	0.015	Bare Earth
BE20	307360.767	4226287.841	11.009	11.039	11.042	0.030	0.033	Bare Earth
BE21	310439.476	4217587.424	51.288	51.237	51.236	-0.051	-0.052	Bare Earth
BE22	312764.804	4206678.006	57.822	57.746	57.721	-0.076	-0.101	Bare Earth
BE23	300464.900	4200394.566	58.433	58.450	58.435	0.017	0.002	Bare Earth
BE24	293404.090	4192392.415	60.623	60.575	60.594	-0.048	-0.029	Bare Earth
BE25	283045.173	4184869.916	61.983	61.964	61.951	-0.019	-0.032	Bare Earth
BE26	213489.801	4212048.181	142.309	142.285	142.297	-0.024	-0.012	Bare Earth
BE27	286243.313	4224606.051	40.600	40.558	40.558	-0.042	-0.042	Bare Earth
BE31	258518.292	4249902.564	108.342	108.268	108.269	-0.074	-0.073	Bare Earth
BE33	261928.074	4214022.929	83.979	83.813	83.855	-0.166	-0.124	Bare Earth
ESP_C_01	183612.800	4120040.598	156.765	156.975	156.823	0.210	0.058	Brush Land
ESP_C_05	245217.240	4119557.738	114.163	113.993	113.980	-0.170	-0.183	Brush Land
ESP_C_09	255091.264	4095760.495	78.072	78.244	78.220	0.172	0.148	Brush Land
ESP_C_19	228140.117	4108084.571	114.995	114.821	114.805	-0.174	-0.190	Brush Land
ESP_C_37	302971.062	4165888.364	46.540	46.557	46.561	0.017	0.021	Brush Land
ESP_C_40	255260.829	4141727.593	103.596	103.549	103.535	-0.047	-0.061	Brush Land
BR01	218198.602	4233770.417	128.768	128.730	128.730	-0.038	-0.038	Brush Land
BR02	213293.923	4229538.288	144.976	144.889	144.855	-0.087	-0.121	Brush Land
BR04	241380.784	4239439.299	150.060	149.919	149.916	-0.141	-0.144	Brush Land
BR05	246830.119	4249791.845	107.712	107.563	107.578	-0.149	-0.134	Brush Land
BR06	263911.990	4243015.445	126.913	126.748	126.762	-0.165	-0.151	Brush Land
BR07	253115.640	4233826.490	141.345	141.140	141.156	-0.205	-0.189	Brush Land
BR08	245127.085	4224540.731	99.897	99.945	99.982	0.048	0.085	Brush Land
BR09	255828.302	4220094.131	104.773	104.710	104.710	-0.063	-0.063	Brush Land
BR10	268534.741	4227253.200	94.423	94.495	94.487	0.072	0.064	Brush Land
BR11	273930.859	4241605.198	96.174	96.126	96.150	-0.048	-0.024	Brush Land
BR13	280490.462	4230265.416	79.333	79.263	79.260	-0.070	-0.073	Brush Land
BR14	294851.292	4234552.901	16.066	16.271	16.302	0.205	0.236	Brush Land
BR15	286343.910	4224607.472	40.457	40.421	40.434	-0.036	-0.023	Brush Land
BR16	259360.652	4202034.104	89.475	89.485	89.471	0.010	-0.004	Brush Land
BR17	268147.273	4215050.645	103.886	103.867	103.876	-0.019	-0.010	Brush Land
BR19	246332.538	4183025.787	108.769	108.796	108.773	0.027	0.004	Brush Land
BR20	282831.542	4193793.670	45.704	45.728	45.732	0.024	0.028	Brush Land
BR21	272352.274	4178890.685	92.333	92.266	92.254	-0.067	-0.079	Brush Land
BR22	295497.695	4192976.302	61.299	61.279	61.274	-0.020	-0.025	Brush Land
BR23	302700.501	4200388.701	56.436	56.438	56.450	0.002	0.014	Brush Land
BR24	311494.123	4213127.096	59.544	59.576	59.566	0.032	0.022	Brush Land
BR25	294434.740	4214928.692	51.068	51.108	51.097	0.040	0.029	Brush Land
BR26	280664.957	4207379.679	52.436	52.440	52.486	0.004	0.050	Brush Land
BR27	262301.924	4213351.291	92.725	92.743	92.736	0.018	0.011	Brush Land

BR32	258338.587	4250328.749	105.070	105.061	105.051	-0.009	-0.019	Brush Land
ESP_D_01	195990.213	4112553.852	156.302	156.313	156.313	0.011	0.011	Forested
ESP_D_04	241296.643	4125791.761	77.057	77.055	77.067	-0.002	0.010	Forested
ESP_D_06	315270.837	4085428.061	30.410	30.517	30.519	0.107	0.109	Forested
ESP_D_07	288366.394	4075171.931	39.609	39.739	39.731	0.130	0.122	Forested
ESP_D_08	278901.352	4135803.351	59.116	59.183	59.185	0.067	0.069	Forested
ESP_D_09	302686.829	4147857.628	42.114	42.270	42.290	0.156	0.176	Forested
ESP_D_10	233878.084	4149104.508	111.569	111.400	111.416	-0.169	-0.153	Forested
ESP_D_11	291343.743	4155032.315	48.686	48.832	48.859	0.146	0.173	Forested
ESP_D_12	298238.479	4171908.348	52.919	52.926	52.933	0.007	0.014	Forested
ESP_D_13	267449.284	4099653.246	94.610	94.850	94.695	0.240	0.085	Forested
ESP_D_14	249030.303	4102411.753	94.415	94.360	94.433	-0.055	0.018	Forested
ESP_D_16	267153.368	4157461.898	111.493	111.610	111.624	0.117	0.131	Forested
ESP_D_17	185521.307	4138805.403	154.220	154.340	154.258	0.120	0.038	Forested
ESP_D_18	273629.322	4114810.293	76.596	76.495	76.519	-0.101	-0.077	Forested
ESP_D_19	282145.114	4178324.760	63.950	63.957	63.959	0.007	0.009	Forested
ESP_D_20	279245.037	4091532.643	39.435	39.666	39.614	0.231	0.179	Forested
FR01	221187.292	4225698.467	157.697	157.775	157.783	0.078	0.086	Forested
FR02	227766.271	4237095.177	151.439	151.413	151.456	-0.026	0.017	Forested
FR03	241368.900	4239357.759	147.630	147.539	147.545	-0.091	-0.085	Forested
FR06	251146.499	4234570.517	157.962	158.154	158.153	0.192	0.191	Forested
FR08	254887.911	4219450.422	99.200	99.116	99.088	-0.084	-0.112	Forested
FR09	268715.208	4227178.862	97.706	97.699	97.699	-0.007	-0.007	Forested
FR10	277329.344	4242807.372	82.198	81.943	81.950	-0.255	-0.248	Forested
FR11	289399.839	4233773.547	23.391	23.239	23.247	-0.152	-0.144	Forested
FR12	279427.920	4223530.984	77.181	76.965	77.003	-0.216	-0.178	Forested
FR13	268191.905	4214259.098	114.827	114.716	114.708	-0.111	-0.119	Forested
FR14	260680.705	4202062.268	88.010	88.065	88.078	0.055	0.068	Forested
FR15	248224.857	4183046.391	107.103	107.200	107.178	0.097	0.075	Forested
FR16	271059.475	4183016.252	61.472	61.586	61.591	0.114	0.119	Forested
FR17	270848.239	4195888.529	82.444	82.485	82.468	0.041	0.024	Forested
FR18	286606.143	4192784.509	20.717	20.817	20.778	0.100	0.061	Forested
FR19	279769.591	4206335.240	74.285	74.252	74.239	-0.033	-0.046	Forested
FR20	294310.308	4212859.580	61.316	61.328	61.336	0.012	0.020	Forested
FR22	310824.056	4217859.432	56.853	57.002	56.985	0.149	0.132	Forested
FR24	307442.553	4226274.394	9.454	9.553	9.551	0.099	0.097	Forested
FR25	297944.427	4193222.595	57.743	57.693	57.693	-0.050	-0.050	Forested
FR26	286378.407	4224559.737	40.497	40.549	40.545	0.052	0.048	Forested
FR29	294415.843	4214943.546	52.114	52.071	52.050	-0.043	-0.064	Forested
FR30	290509.787	4223958.251	62.705	62.729	62.738	0.024	0.033	Forested
FR31	264047.703	4243069.278	124.462	124.364	124.371	-0.098	-0.091	Forested
ESP_B_01	176338.624	4124590.477	178.174	178.277	178.193	0.103	0.019	Tall Weeds
ESP_B_02	187699.379	4128151.093	151.440	151.430	151.419	-0.010	-0.021	Tall Weeds

ESP_B_03	200594.530	4114487.700	160.965	160.891	160.885	-0.074	-0.080	Tall Weeds
ESP_B_05	223930.227	4121405.420	125.651	125.947	125.901	0.296	0.250	Tall Weeds
ESP_B_06	238971.066	4133898.687	106.641	106.504	106.508	-0.137	-0.133	Tall Weeds
ESP_B_07	247504.081	4114663.885	112.724	112.597	112.574	-0.127	-0.150	Tall Weeds
ESP_B_08	252619.848	4125515.490	81.077	80.869	80.839	-0.208	-0.238	Tall Weeds
ESP_B_09	265580.392	4113655.322	90.184	90.175	90.161	-0.009	-0.023	Tall Weeds
ESP_B_10	283916.533	4127048.418	48.768	48.752	48.755	-0.016	-0.013	Tall Weeds
ESP_B_11	270783.089	4142618.368	43.373	43.433	43.424	0.060	0.051	Tall Weeds
ESP_B_12	294729.896	4132674.205	21.955	21.901	21.879	-0.054	-0.076	Tall Weeds
ESP_B_13	298610.591	4162737.005	55.760	55.833	55.779	0.073	0.019	Tall Weeds
ESP_B_14	260495.735	4102094.372	89.886	89.957	89.915	0.071	0.029	Tall Weeds
ESP_B_15	272256.327	4084888.198	66.867	66.951	66.963	0.084	0.096	Tall Weeds
ESP_B_16	290213.574	4079963.750	38.548	38.581	38.573	0.033	0.025	Tall Weeds
ESP_B_17	311481.442	4096356.142	34.189	34.031	34.053	-0.158	-0.136	Tall Weeds
ESP_B_18	267460.125	4171315.643	64.862	65.000	64.967	0.138	0.105	Tall Weeds
ESP_B_19	234328.970	4104247.613	120.963	120.800	120.804	-0.163	-0.159	Tall Weeds
ESP_B_20	244167.168	4146861.745	98.990	98.812	98.790	-0.178	-0.200	Tall Weeds
ESP_B_34	324584.397	4095482.512	33.059	32.980	32.977	-0.079	-0.082	Tall Weeds
TW01	220690.020	4225220.216	153.917	153.949	153.955	0.032	0.038	Tall Weeds
TW02	241345.277	4239331.694	147.942	147.830	147.844	-0.112	-0.098	Tall Weeds
TW03	218028.480	4218918.204	151.283	151.257	151.248	-0.026	-0.035	Tall Weeds
TW04	244557.359	4226801.104	104.270	104.171	104.118	-0.099	-0.152	Tall Weeds
TW05	258693.781	4240238.934	128.561	128.468	128.401	-0.093	-0.160	Tall Weeds
TW06	246642.061	4249639.989	110.160	109.950	109.977	-0.210	-0.183	Tall Weeds
TW07	258446.978	4250027.437	106.577	106.506	106.482	-0.071	-0.095	Tall Weeds
TW08	253113.250	4233836.242	141.631	141.523	141.560	-0.108	-0.071	Tall Weeds
TW09	272199.336	4242032.836	84.037	84.025	84.017	-0.012	-0.020	Tall Weeds
TW10	267940.335	4227053.293	100.016	99.932	99.923	-0.084	-0.093	Tall Weeds
TW11	255502.191	4219310.095	81.539	81.392	81.430	-0.147	-0.109	Tall Weeds
TW12	248039.083	4188204.576	105.621	105.610	105.606	-0.011	-0.015	Tall Weeds
TW13	259375.557	4202067.335	90.059	90.060	90.062	0.001	0.003	Tall Weeds
TW14	267954.819	4214226.864	116.326	116.259	116.273	-0.067	-0.053	Tall Weeds
TW15	281335.822	4233163.672	71.509	71.595	71.592	0.086	0.083	Tall Weeds
TW16	298595.953	4234191.596	12.275	12.254	12.245	-0.021	-0.030	Tall Weeds
TW17	308141.875	4225970.790	12.030	12.041	12.034	0.011	0.004	Tall Weeds
TW18	286275.819	4224583.643	40.434	40.408	40.404	-0.026	-0.030	Tall Weeds
TW19	294352.331	4212892.968	62.777	62.791	62.814	0.014	0.037	Tall Weeds
TW20	312879.566	4209527.688	53.876	53.928	53.918	0.052	0.042	Tall Weeds
TW21	302558.713	4200530.978	56.215	56.247	56.229	0.032	0.014	Tall Weeds
TW22	281845.243	4202435.621	66.110	66.185	66.205	0.075	0.095	Tall Weeds
TW23	285232.139	4191270.825	31.978	32.004	32.001	0.026	0.023	Tall Weeds
TW24	270900.761	4195779.131	84.455	84.450	84.440	-0.005	-0.015	Tall Weeds
TW25	270527.231	4182209.190	69.011	69.039	69.043	0.028	0.032	Tall Weeds

ESP_E_01	185036.260	4131931.126	165.168	165.187	165.188	0.019	0.020	Urban
ESP_E_02	190076.488	4119065.161	165.467	165.540	165.463	0.073	-0.004	Urban
ESP_E_03	204348.060	4128166.980	143.668	143.538	143.577	-0.130	-0.091	Urban
ESP_E_05	226857.360	4133034.559	130.205	130.296	130.231	0.091	0.026	Urban
ESP_E_06	236821.921	4114663.422	124.112	124.080	124.093	-0.032	-0.019	Urban
ESP_E_07	249687.677	4134022.287	88.545	88.395	88.416	-0.150	-0.129	Urban
ESP_E_08	259863.106	4115961.861	102.773	102.790	102.772	0.017	-0.001	Urban
ESP_E_09	267304.239	4132805.879	93.623	93.601	93.604	-0.022	-0.019	Urban
ESP_E_10	287207.071	4123395.063	8.117	8.110	8.118	-0.007	0.001	Urban
ESP_E_11	286463.586	4084839.735	36.924	37.030	37.028	0.106	0.104	Urban
ESP_E_12	296026.909	4080155.062	33.351	33.413	33.425	0.062	0.074	Urban
ESP_E_13	306375.394	4098345.241	36.579	36.570	36.562	-0.009	-0.017	Urban
ESP_E_14	322899.362	4093267.971	29.169	29.186	29.183	0.017	0.014	Urban
ESP_E_15	239272.487	4102845.995	110.231	110.101	110.099	-0.130	-0.132	Urban
ESP_E_16	267311.388	4088690.633	92.708	92.837	92.813	0.129	0.105	Urban
ESP_E_17	279776.485	4103957.536	41.401	41.454	41.434	0.053	0.033	Urban
ESP_E_18	288602.510	4167955.278	56.254	56.261	56.258	0.007	0.004	Urban
ESP_E_19	270592.072	4153580.703	100.313	100.279	100.281	-0.034	-0.032	Urban
ESP_E_20	298151.425	4151156.589	43.373	43.326	43.324	-0.047	-0.049	Urban
U112	242452.740	4231059.489	115.976	115.807	115.802	-0.169	-0.174	Urban
UR03	273666.095	4240719.586	100.126	99.946	99.981	-0.180	-0.145	Urban
UR04	285833.250	4239757.934	22.350	22.279	22.276	-0.071	-0.074	Urban
UR05	280945.774	4233022.267	69.830	69.877	69.872	0.047	0.042	Urban
UR06	279782.236	4223719.265	73.406	73.421	73.424	0.015	0.018	Urban
UR07	273507.456	4231294.367	93.482	93.336	93.329	-0.146	-0.153	Urban
UR08	255810.472	4219415.173	76.918	76.752	76.726	-0.166	-0.192	Urban
UR09	307260.757	4226215.347	11.494	11.533	11.525	0.039	0.031	Urban
UR10	294222.647	4214080.851	66.219	66.209	66.210	-0.010	-0.009	Urban
UR11	294441.614	4212257.420	62.466	62.462	62.463	-0.004	-0.003	Urban
UR12	284514.001	4191682.260	40.756	40.727	40.729	-0.029	-0.027	Urban
UR13	282341.833	4181477.949	64.763	64.771	64.759	0.008	-0.004	Urban
UR14	282918.510	4201888.803	70.244	70.275	70.274	0.031	0.030	Urban
UR15	279257.810	4212206.510	62.683	62.654	62.625	-0.029	-0.058	Urban
UR16	259153.306	4205709.459	106.600	106.580	106.579	-0.020	-0.021	Urban
UR17	263740.629	4189286.330	99.407	99.411	99.416	0.004	0.009	Urban
UR21	300803.743	4200492.236	59.383	59.332	59.324	-0.051	-0.059	Urban
UR22	312574.921	4205202.107	48.169	48.123	48.099	-0.046	-0.070	Urban
UR24	289482.813	4233945.350	22.359	22.340	22.331	-0.019	-0.028	Urban