



## **FUGRO GEOSPATIAL, INC.**

### **Accuracy Report**

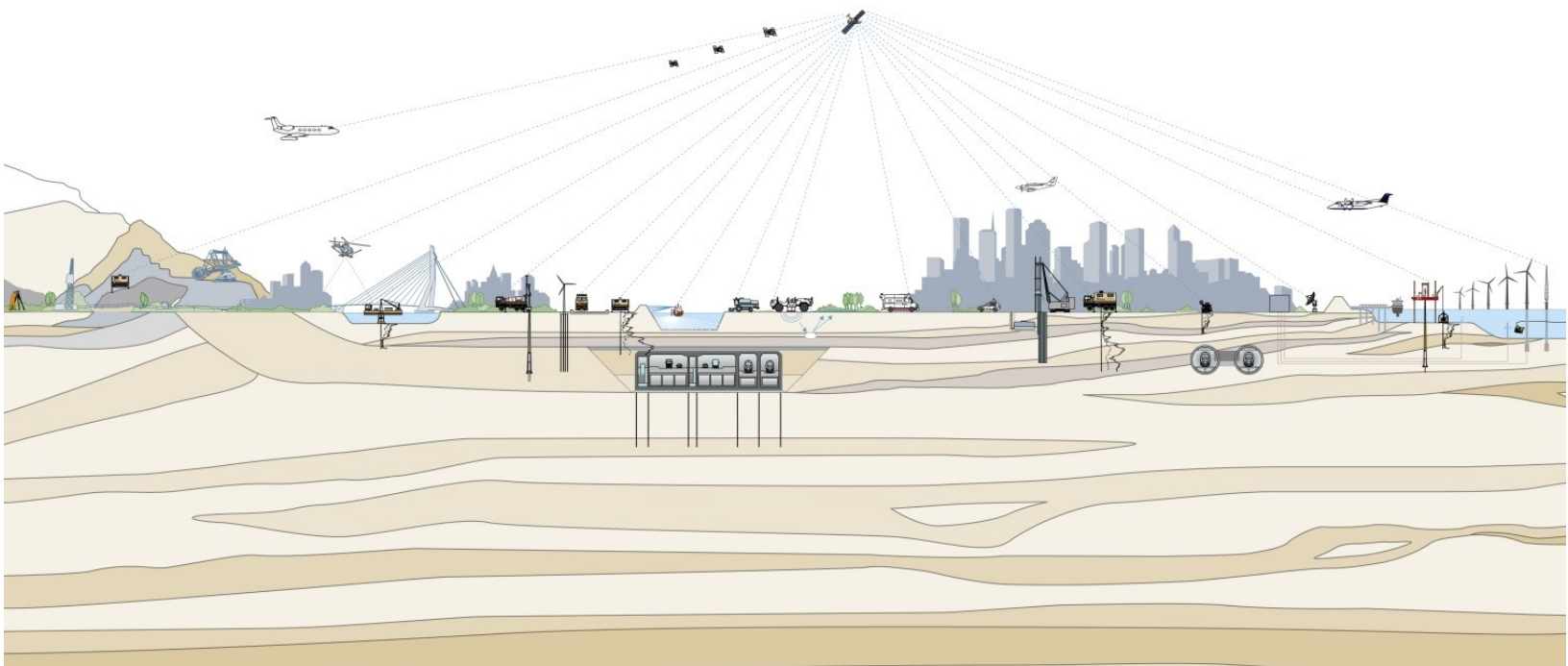
**SD\_FY17 NRCS Lidar FUGRO\_2017\_D17**

Prepared for:

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**1. ACCURACY REPORTING**

Data collected under this Task Order meets the National Standard for Spatial Database Accuracy (NSSDA) accuracy standards. The NSSDA standards specify that vertical accuracy be reported at the 95 percent confidence level for data tested by an independent source of higher accuracy.

**1.1 Positional Accuracy**

Before classification and development of derivative products from the point cloud, the absolute and relative vertical accuracies of the point cloud were verified.

**1.2 Absolute Vertical Accuracy**

**Unclassified Lidar Point Cloud Data:** The Non-Vegetated Vertical Accuracy (NVA) of the Lidar Point Cloud data was calculated against TINs derived from the final calibrated and controlled swath data. The required accuracy ( $ACC_z$ ) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on  $RMSE_z$  of 10 cm in the “open terrain” and/or “Urban” land cover categories. This is a required accuracy. Please refer to the table below for the achieved accuracies. The raw swath point cloud data met the required accuracy levels before point cloud classification and derivative product generation.

**Table 1: Accuracy of the Lidar Point Cloud Data**

Raw Flight Lines	$RMSE_z$ (non-vegetated)	NVA at 95-percent confidence level
Specification (cm)	$\leq 10$	$\leq 19.6$
Calculated Values (cm)	3.0	5.3
<i>Specification (m)</i>	$\leq 0.100$	$\leq 0.196$
<i>Calculated Values (m)</i>	0.030	0.053
Number of points	68	68

**Bare Earth Surface:** The accuracy ( $ACC_z$ ) of the derived DEM was calculated and is being reported in three (3) ways:

- 1.  $RMSE_z$  (Non-Vegetated):** The required  $RMSE_z$  is  $\leq 10$  cm.
- 2. Non-Vegetated Vertical Accuracy (NVA):** The required NVA is:  $\leq 19.6$  cm at a 95% confidence level, derived according to NSSDA, i.e., based on  $RMSE_z$  of 10 cm in the “open terrain” and/or “Urban” land cover categories. This is a required accuracy.
- 3. Vegetated Vertical Accuracy (VVA):** The required VVA is:  $\leq 29.4$  cm at a 95<sup>th</sup> percentile level, derived according to ASPRS Guidelines, Vertical Accuracy for Reporting LiDAR Data, i.e. based on the 95<sup>th</sup> percentile error in Vegetated land cover categories combined (Tall Grass, Brush, Forested Areas). This is a required accuracy.

Please refer to the table below for the achieved accuracies.

**Table 2: Accuracy of the Derived DEM**



DEM	RMSE <sub>z</sub> (non-vegetated)	NVA at 95-percent confidence level	VVA at 95th percentiles
Specification (cm)	≤ 10	≤ 19.6	≤ 29.4
Calculated Values (cm)	3.3	6.4	14
<i>Specification (m)</i>	<i>≤ 0.100</i>	<i>≤ 0.196</i>	<i>≤ 0.294</i>
<i>Calculated Values (m)</i>	<i>0.033</i>	<i>0.043</i>	<i>0.14</i>
Number of points	59	59	36

### 1.3 Relative Accuracy

**Smooth Surface Repeatability:** In ideal theoretical conditions, smooth surface repeatability is a measure of variations documented on a surface that would be expected to be flat and without variation. Users of lidar technology commonly refer to these variations as “noise.” Single-swath data was assessed using only single returns in non-vegetated areas. Repeatability was evaluated by measuring departures from planarity of single returns from hard planar surfaces, normalizing for actual variation in the surface elevation. Repeatability of only single returns was then assessed at multiple locations within hard surfaced areas (for example, parking lots or large rooftops).

Each sample area was evaluated using a signed difference raster (maximum elevation – minimum elevation) at a cell size equal to twice the ANPS, rounded up to the next integer. Sample areas were approximately 50 square meters (m<sup>2</sup>). The maximum acceptable variations within sample areas for this project is 6 cm. Isolated noise is expected within the sample areas and was disregarded.

The evaluation was done on 34 flat open sample areas over the entire Fall collection AOI. The results are shown in the table below, please also refer to

*USGS\_SD\_2017\_Fall\_Lidar\_Relative\_Accuracy\_Smooth\_Surface\_Repeatability.shp*

**Table 3: Relative Accuracy, Smooth Surface Repeatability**

Max_DZ (m)	Area (sq m)
0.04	73
0.04	51
0.04	102
0.04	70
0.03	85
0.05	86
0.06	55
0.06	70
0.03	58
0.03	58
0.05	65
0.05	47
0.06	62



0.05	58
0.05	57
0.03	55
0.05	79
0.04	56
0.04	60
0.06	57
0.06	67
0.06	57
0.04	32
0.03	55
0.06	64
0.04	57
0.03	53
0.04	61
0.05	78
0.04	83
0.04	97
0.03	55
0.03	56
0.05	71

**Overlap Consistency:** Overlap consistency is a measure of geometric alignment of two overlapping swaths; the principles used with swaths can be applied to overlapping lifts and projects as well. Overlap consistency is the fundamental measure of the quality of the calibration or boresight adjustment of the data from each lift, and is of particular importance as the match between the swaths of a single lift is a strong indicator of the overall geometric quality of the data, establishing the quality and accuracy limits of all downstream data and products.

Overlap consistency was assessed at multiple locations within overlap in non-vegetated areas of only single returns.

Each overlap area was evaluated using a signed difference raster with a cell size equal to twice the ANPS, rounded up to the next integer. The difference rasters are visually examined using a bicolor ramp from the negative acceptable limit to the positive acceptable limit. Although isolated excursions beyond the limits are expected and accepted, differences in the overlaps shall not exceed the following limits:

1. Swath overlap difference,  $RMSDz \leq 8$  cm
2. Swath overlap difference, maximum  $\pm 16$  cm



The difference rasters are also statistically summarized to verify that root mean square difference in z (RMSDz) values do not exceed the. Consideration will be given for the effect of the expected isolated excursions over limits.

The result of the evaluation over 46 samples throughout the entire Fall collection AOI is shown in the table below, please also refer to also refer to

*USGS\_SD\_2017\_Fall\_Lidar\_Relative\_Accuracy\_Flightline\_Overlap.shp.*

**Table 4: Relative Accuracy, Overlap Consistency**

RMS_DZ (m)	Max_DZ (m)	Min_DZ (m)	Area (sq m)
0.0471	-0.0208	-0.0713	767
0.0471	-0.0105	-0.0726	622
0.0101	0.0242	-0.0234	303
0.0151	0.0347	-0.0525	870
0.0144	0.001	-0.0317	771
0.0238	-0.0021	-0.0416	417
0.0352	-0.0088	-0.055	624
0.0118	0.0312	-0.0296	498
0.0204	0.0015	-0.0412	468
0.0176	0.0458	-0.0453	658
0.0129	0.0393	-0.0164	621
0.0135	0.0438	-0.0224	443
0.0183	0.0019	-0.0419	546
0.0159	0.0052	-0.0347	711
0.0245	0.044	0.0089	537
0.0073	0.018	-0.0205	499
0.016	0.0448	-0.0131	677
0.0161	0.0377	-0.0982	1112
0.017	0.0554	-0.0575	759
0.0181	0.0449	-0.0212	860
0.035	0.0892	-0.0191	738
0.0154	0.0465	-0.0223	999
0.0366	0.0684	-0.0029	1139
0.0178	0.0533	-0.0316	1273
0.0128	0.0332	-0.0438	1060
0.0151	0.0523	-0.057	859
0.0143	0.0368	-0.0143	884
0.0249	0.0705	-0.0135	877
0.0116	0.0344	-0.0497	1018

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0.0175	0.095	-0.0606	500
0.0168	0.0487	-0.071	612
0.0111	0.0405	-0.0399	903
0.0297	0.0768	-0.0204	715
0.021	0.0103	-0.0685	466
0.0103	0.029	-0.0178	581
0.0095	0.0295	-0.0321	623
0.0101	0.0279	-0.0292	468
0.0239	0.0753	-0.0208	635
0.0164	0.0125	-0.0465	548
0.0252	0.0508	-0.0369	464
0.0376	0.0657	0.004	727
0.0163	0.0521	-0.0158	549
0.0112	0.0148	-0.0345	477
0.034	-0.0052	-0.0675	600
0.0108	0.0271	-0.0363	851
0.0229	-0.0025	-0.0395	511