DPH-11 Report on Absolute Vertical Accuracy

The USGS Lidar Base Specification 2022 rev. A states: "Absolute vertical accuracy of the lidar data and the derived DEM will be assessed and reported in accordance with ASPRS (2014). Vegetated and nonvegetated land cover types shall be assessed for absolute vertical accuracy. Federal Emergency Management Agency (2003) identifies seven land cover types; National Digital Elevation Program (2004) and ASPRS (2004) reiterate the first five of those types. The way in which each of the seven classes was reported under the previous standards and how they are reported under the new ASPRS standards and by this specification are shown in table 3. Four absolute accuracy values shall be assessed and reported:

1. NVA for the point data

2. VVA for the point data

3. NVA for the DEM

4. VVA for the DEM

The minimum NVA and VVA requirements for all data, using the ASPRS methodology, are listed in table 4. Both the NVA and VVA required values shall be met. NVA for the point data shall be assessed by comparing check points surveyed for NVA assessment to a triangulated irregular network (TIN) constructed from ground-classified lidar points in those areas. VVA for the point data shall be assessed by comparing check points surveyed for VVA assessment to a triangulated irregular network (TIN) constructed from ground-classified lidar points in those areas. NVA and VVA for the DEM are assessed by comparing check points to the final bare-earth surface. The minimum required thresholds for absolute and relative accuracy may be increased by the USGS–NGP when any of the following conditions are met:

 - A demonstrable, substantial, and prohibitive increase in cost is needed to obtain this accuracy, which is often the case in heavily vegetated project areas.
 - An alternate specification is needed to conform to previously contracted phases of a single larger overall collection effort such as for multiyear statewide collections
 - The USGS–NGP agrees that the use of an alternate specification is reasonable and in the best interest of all stakeholders."

Table 4. Absolute vertical accuracy for light detection and ranging data and digital elevation models.

[QL, quality level, $RMSE_z$, root mean square error in the z direction; NVA, nonvegetated vertical accuracy; VVA, vegetated vertical accuracy; m, meter; ≤, less than or equal to]

Quality level	$RMSE_z$ (nonvegetated) (m)	NVA at the 95-percent confidence level (m)	VVA at the 95th percentile (m)
QL0	≤0.050	≤0.098	≤0.15
QL1	≤0.100	≤0.196	≤0.30
QL2	≤0.100	≤0.196	≤0.30
QL3	≤0.200	≤0.392	≤0.60

The purpose of this section is to report on the absolute vertical accuracy of the lidar data and DEMs generated from it by testing for NVA (Nonvegetated Vertical Accuracy) and VVA (Vegetated Vertical Accuracy) against surveyed ground check points.

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Units: Meter (/Feet)

Vertical Accuracy Class tested: 10-cm

Check Points in defined project area (DPA):	61
Check Points with Lidar Coverage	61
Check Points with Lidar Coverage (NVA)	37
Check Points with Lidar Coverage (VVA)	24
Average Z Error (NVA)	-0.030/-0.100
Maximum Z Error (NVA)	0.052/0.172
Median Z Error (NVA)	-0.030/-0.098
Minimum Z Error (NVA)	-0.107/-0.352
Standard deviation of Vertical Error (NVA)	0.036/0.118
Skewness of Vertical Error (NVA)	0.024
Kurtosis of Vertical Error (NVA)	-0.201
Non-vegetated Vertical Accuracy (NVA) RMSE(z) [1]	0.047/0.153 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/- [1]	0.091/0.300 PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-	0.091/0.300
Non-vegetated Vertical Accuracy (NVA) RMSE(z) (DEM) [2]	0.044/0.146 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level (DEM) +/- [2]	0.087/0.286 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (TIN) +/- [1]	0.099/0.324 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (DEM) +/- [2]	0.110/0.360 PASS

This data set was tested to meet ASPRS Positional Accuracy Standard for Digital Geospatial Data (2014) for a 10-cm RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be RMSEz = 4.7cm, equating to +/- 9.1cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 11.0cm at the 95th percentile.

[1] This value is calculated from TIN-based testing of the lidar point cloud data.

[2] This value is calculated from RAM-based grid testing of the lidar data. The grid cells are sized according to the Quality Level selected, and are defined in the USGS NGP Lidar Base Specification 2022 rev. A (Table 6).