

# DPH-11 Report on Absolute Vertical Accuracy

The USGS Lidar Base Specification Version 1.3 states: "Absolute vertical accuracy of the lidar data and the derived DEM will be assessed and reported in accordance with the ASPRS (2014). Two broad land cover types shall be assessed: vegetated and nonvegetated. Three absolute accuracy values shall be assessed and reported: (1) NVA for the point data, (2) NVA for the DEM, and (3) 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."

**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;  $\leq$ , 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	$\leq 0.050$	$\leq 0.098$	$\leq 0.15$
QL1	$\leq 0.100$	$\leq 0.196$	$\leq 0.30$
QL2	$\leq 0.100$	$\leq 0.196$	$\leq 0.30$
QL3	$\leq 0.200$	$\leq 0.392$	$\leq 0.60$

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.

# DPH-11 Report on Absolute Vertical Accuracy - continued

[Data Source - Z:\MARS\\_OC\2900112\\_Lot\\_8\Check\\_Points\TX\\_WestTexas\\_Lot8\\_54NVA\\_39VVA\\_pts\\_u14.csv](#)

Units: Meter (/Feet)

Vertical Accuracy Class tested: 10-cm

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Check Points in defined project area (DPA):	93
Check Points with Lidar Coverage	93
Check Points with Lidar Coverage (NVA)	54
Check Points with Lidar Coverage (VVA)	39
Average Z Error (NVA)	0.041/0.136
Maximum Z Error (NVA)	0.189/0.620
Median Z Error (NVA)	0.039/0.127
Minimum Z Error (NVA)	-0.038/-0.124
Standard deviation of Vertical Error (NVA)	0.040/0.130
Skewness of Vertical Error (NVA)	0.907
Kurtosis of Vertical Error (NVA)	2.186
Non-vegetated Vertical Accuracy (NVA) RMSE(z) <sup>1</sup>	0.057/0.187 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/- <sup>1</sup>	0.112/0.367 PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-	0.112/0.367
Non-vegetated Vertical Accuracy (NVA) RMSE(z) (DEM) <sup>2</sup>	0.058/0.190 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level (DEM) +/- <sup>2</sup>	0.113/0.372 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (DEM) +/- <sup>2</sup>	0.225/0.737 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 = 5.708cm, equating to +/- 11.188cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 22.469cm at the 95th percentile.

<sup>1</sup> This value is calculated from TIN-based testing of the lidar point cloud data.

<sup>2</sup> 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 Version 1.3 (page 24, Table 6).

# DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to report the results of measuring the lidar point cloud data against surveyed ground NVA (nonvegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

## NVA (lidar data)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
1099	212749.655	3402608.494	Yes	852.06	852.076	0.016	852.072	852.079	852.081	25262	789	1,1,1	LIPT	
1122	211201.162	3352089.918	Yes	690.057	690.084	0.027	690.083	690.09	690.141	14112	2478	1,1,1	LIPT	
1170	214528.019	3395458.929	Yes	833.996	834.01	0.014	833.991	834.011	834.012	21140	2155	1,1,1	LIPT	
1310	213722.429	3412133.923	Yes	747.02	747.075	0.055	747.017	747.088	747.094	54200	-3199	1,1,1	LIPT	
1358	259447.347	3425243.384	Yes	768.891	768.932	0.041	768.914	768.934	768.94	5796	-1093	1,1,1	LIPT	
1359	268354.214	3411057.348	Yes	807.68	807.696	0.016	807.694	807.702	807.705	8222	-2479	1,1,1	LIPT	
1360	245359.781	3389242.351	Yes	606.732	606.771	0.039	606.765	606.772	606.774	12868	-17	1,1,1	LIPT	
1364	249943.427	3433224.996	Yes	872.573	872.607	0.034	872.598	872.607	872.623	10902	-2219	1,1,1	LIPT	
1370	268517.52	3374465.311	Yes	648.468	648.657	0.189	648.647	648.658	648.681	8751	3027	1,1,1	LIPT	
1371	228675.255	3373824.187	Yes	637.175	637.166	-0.009	637.121	637.147	637.168	8694	485	1,1,1	LIPT	
1374	256761.116	3378945.757	Yes	667.388	667.413	0.025	667.399	667.401	667.429	18374	-2301	1,1,1	LIPT	
1375	258197.673	3359083.888	Yes	566.775	566.814	0.039	566.778	566.805	566.829	19840	2406	1,1,1	LIPT	
1375A	258206.254	3359080.37	Yes	567.171	567.24	0.069	567.227	567.235	567.269	13424	2359	1,1,1	LIPT	
1388	255043.088	3430563.388	Yes	806.533	806.639	0.106	806.63	806.641	806.649	14736	-213	1,1,1	LIPT	
1392	260241.366	3410141.279	Yes	743.425	743.488	0.063	743.479	743.492	743.499	3990	1196	1,1,1	LIPT	
1394	229765.764	3350399.076	Yes	704.505	704.493	-0.012	704.471	704.475	704.503	28370	1759	1,1,1	LIPT	
1396	277983.385	3383495.875	Yes	759.854	759.938	0.084	759.916	759.937	759.944	12103	-334	1,1,1	LIPT	
1402	283548.623	3355915.906	Yes	590.908	590.926	0.018	590.919	590.923	590.935	7410	192	1,1,1	LIPT	
1407	267834.607	3355421.612	Yes	641.525	641.538	0.013	641.531	641.535	641.55	19685	3063	1,1,1	LIPT	
1416	230948.82	3362588.387	Yes	747.601	747.638	0.037	747.626	747.65	747.656	25496	-3244	1,1,1	LIPT	
1420	270833.079	3377026.989	Yes	663.141	663.203	0.062	663.199	663.202	663.205	12183	-853	1,1,1	LIPT	
1427	229829.796	3388095.893	Yes	813.963	814.018	0.055	814.011	814.012	814.027	28431	1260	1,1,1	LIPT	
1444	221650.954	3395348.836	Yes	731.463	731.5	0.037	731.49	731.501	731.525	4329	-1049	1,1,1	LIPT	
1452	254151.608	3351679.281	Yes	549.466	549.563	0.097	549.55	549.552	549.591	21791	299	1,1,1	LIPT	
1453	264283.733	3392714.182	Yes	667.744	667.856	0.112	667.856	667.857	667.858	13540	1336	1,1,1	LIPT	
1457	243743.443	3373303.342	Yes	605.159	605.21	0.051	605.204	605.208	605.216	13412	1107	1,1,1	LIPT	
1461	261690.592	3366223.309	Yes	593.949	593.999	0.050	593.996	593.998	594	8767	3396	1,1,1	LIPT	
1462	217430.22	3356709.407	Yes	736.799	736.808	0.009	736.795	736.815	736.82	14328	1634	1,1,1	LIPT	
1463	277050.791	3396815.456	Yes	724.18	724.242	0.062	724.232	724.237	724.265	22643	707	1,1,1	LIPT	
1464	237808.722	3380588.858	Yes	762.43	762.469	0.039	762.454	762.455	762.471	13966	1664	1,1,1	LIPT	

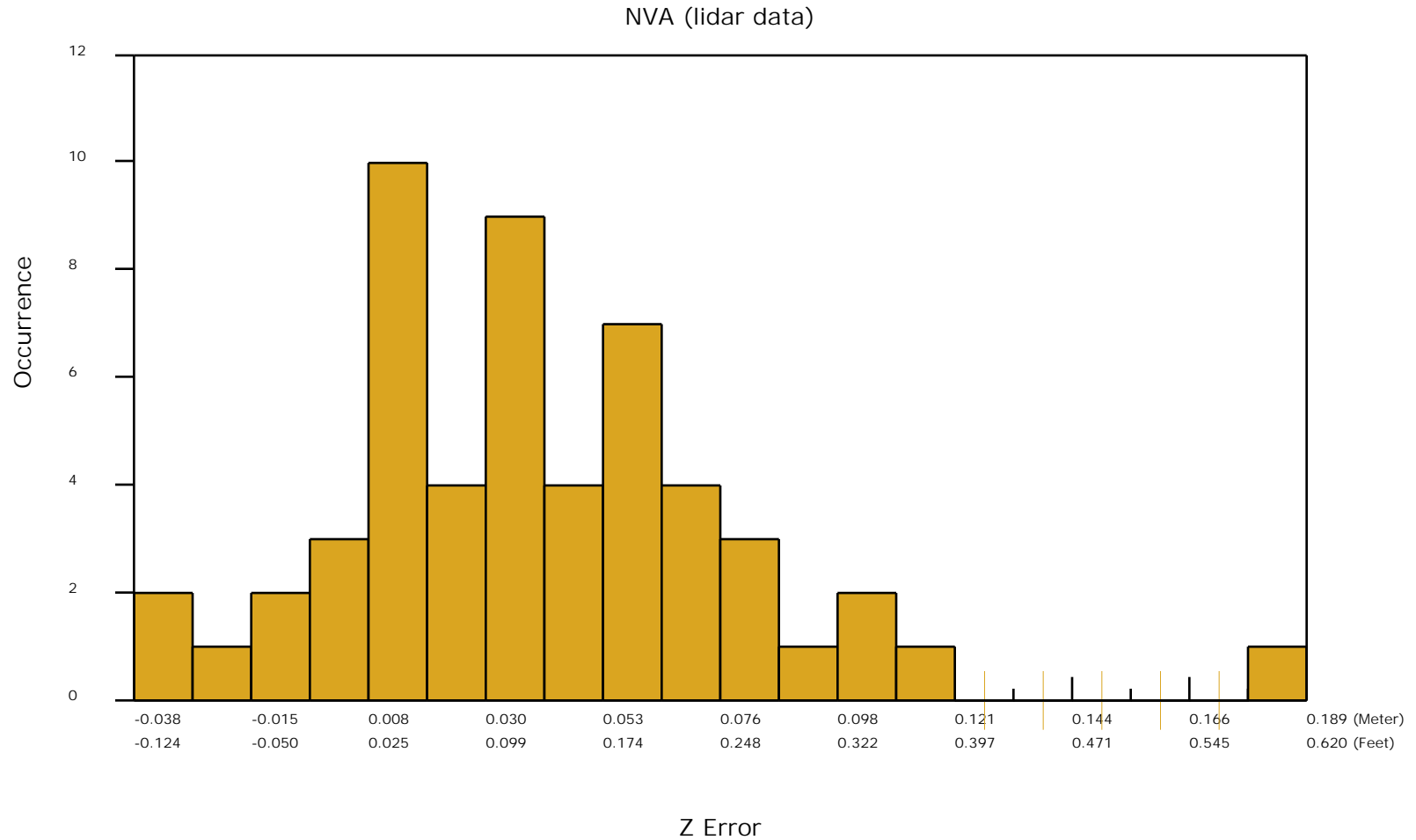
## Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
1465	248790.272	3418005.577	Yes	813.963	813.974	0.011	813.964	813.996	813.996	7352	3543	1,1,1	LIPT	
1466	242833.98	3429772.457	Yes	754.645	754.72	0.075	754.716	754.726	754.726	5096	1157	1,1,1	LIPT	
1481	273788.16	3433433.105	Yes	793.784	793.836	0.052	793.823	793.827	793.843	32875	-1328	1,1,1	LIPT	
1487	221870.176	3382941.055	Yes	680.926	680.908	-0.018	680.882	680.933	680.944	5595	-2209	1,1,1	LIPT	
1492	301248.555	3390831.721	Yes	744.392	744.395	0.003	744.389	744.39	744.408	15630	834	1,1,1	LIPT	
1495	271050.553	3422002.542	Yes	770.721	770.83	0.109	770.813	770.834	770.864	4512	-727	1,1,1	LIPT	
1498	275384.625	3438215.316	Yes	822.594	822.664	0.070	822.66	822.674	822.692	21488	2666	1,1,1	LIPT	
1499	269298.399	3402394.078	Yes	712.063	712.144	0.081	712.122	712.125	712.15	7300	2078	1,1,1	LIPT	
1511	245835.419	3365825.951	Yes	609.633	609.655	0.022	609.651	609.655	609.659	21722	814	1,1,1	LIPT	
1521	285083.433	3364163.046	Yes	613.383	613.401	0.018	613.381	613.403	613.412	5131	-1105	1,1,1	LIPT	
1527	262089.57	3383286.323	Yes	645.069	645.041	-0.028	645.031	645.049	645.058	5496	2492	1,1,1	LIPT	
1529	300061.298	3394181.587	Yes	748.263	748.307	0.044	748.298	748.306	748.308	13007	46	1,1,1	LIPT	
1532	222497.42	3365827.455	Yes	755.079	755.091	0.012	755.072	755.085	755.105	23795	1403	1,1,1	LIPT	
1541	276984.298	3436092.918	Yes	822.32	822.382	0.062	822.379	822.38	822.387	25389	832	1,1,1	LIPT	
1545	265083.936	3438880.263	Yes	794.043	794.071	0.028	794.059	794.073	794.076	3908	563	1,1,1	LIPT	
1546	280143.68	3426818.762	Yes	804.009	804.093	0.084	804.082	804.105	804.109	4622	-1187	1,1,1	LIPT	
1547	242403.457	3352889.552	Yes	712.849	712.915	0.066	712.904	712.914	712.917	30552	-1583	1,1,1	LIPT	
761001	221757.828	3369399.208	Yes	662.503	662.505	0.002	662.494	662.509	662.51	24242	-830	1,1,1	LIPT	
761004	220021.859	3387438.37	Yes	806.801	806.855	0.054	806.842	806.855	806.865	5514	-881	1,1,1	LIPT	
761005	219842.056	3388018.935	Yes	808.879	808.913	0.034	808.912	808.915	808.917	17278	-2035	1,1,1	LIPT	
761006	225255.458	3396083.928	Yes	695.29	695.307	0.017	695.305	695.309	695.324	6536	3183	1,1,1	LIPT	
761007	225266.479	3396064.783	Yes	694.642	694.683	0.041	694.676	694.687	694.696	23452	3026	1,1,1	LIPT	
791000	227948.678	3403914.478	Yes	670.746	670.745	-0.001	670.727	670.745	670.756	8236	1379	1,1,1	LIPT	
791002	227943.27	3403890.204	Yes	670.723	670.685	-0.038	670.682	670.683	670.712	4328	1407	1,1,1	LIPT	

# DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a frequency distribution chart of the non-vegetated vertical accuracy (NVA) of the lidar point cloud data measured against surveyed ground check points.

[Data Source - Z:\MARS\\_OC\2900112\\_Lot\\_8\Classified\\_LAS\\_Files](#)



## DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to report the results of measuring the DEM data against surveyed ground NVA (nonvegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

### NVA (DEM)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
1099	212749.655	3402608.494	Yes	852.06	852.078	0.018	LIPT	
1122	211201.162	3352089.918	Yes	690.057	690.079	0.022	LIPT	
1170	214528.019	3395458.929	Yes	833.996	833.985	-0.011	LIPT	
1310	213722.429	3412133.923	Yes	747.02	747.048	0.028	LIPT	
1358	259447.347	3425243.384	Yes	768.891	768.927	0.036	LIPT	
1359	268354.214	3411057.348	Yes	807.68	807.709	0.029	LIPT	
1360	245359.781	3389242.351	Yes	606.732	606.779	0.047	LIPT	
1364	249943.427	3433224.996	Yes	872.573	872.630	0.057	LIPT	
1370	268517.52	3374465.311	Yes	648.468	648.652	0.184	LIPT	
1371	228675.255	3373824.187	Yes	637.175	637.180	0.005	LIPT	
1374	256761.116	3378945.757	Yes	667.388	667.402	0.014	LIPT	
1375	258197.673	3359083.888	Yes	566.775	566.799	0.024	LIPT	
1375A	258206.254	3359080.37	Yes	567.171	567.249	0.078	LIPT	
1388	255043.088	3430563.388	Yes	806.533	806.651	0.118	LIPT	
1392	260241.366	3410141.279	Yes	743.425	743.479	0.054	LIPT	
1394	229765.764	3350399.076	Yes	704.505	704.483	-0.022	LIPT	
1396	277983.385	3383495.875	Yes	759.854	759.926	0.072	LIPT	
1402	283548.623	3355915.906	Yes	590.908	590.934	0.026	LIPT	
1407	267834.607	3355421.612	Yes	641.525	641.532	0.007	LIPT	
1416	230948.82	3362588.387	Yes	747.601	747.637	0.036	LIPT	
1420	270833.079	3377026.989	Yes	663.141	663.208	0.067	LIPT	
1427	229829.796	3388095.893	Yes	813.963	814.026	0.063	LIPT	
1444	221650.954	3395348.836	Yes	731.463	731.503	0.040	LIPT	
1452	254151.608	3351679.281	Yes	549.466	549.578	0.112	LIPT	
1453	264283.733	3392714.182	Yes	667.744	667.828	0.084	LIPT	
1457	243743.443	3373303.342	Yes	605.159	605.210	0.051	LIPT	
1461	261690.592	3366223.309	Yes	593.949	593.995	0.046	LIPT	
1462	217430.22	3356709.407	Yes	736.799	736.810	0.011	LIPT	
1463	277050.791	3396815.456	Yes	724.18	724.259	0.079	LIPT	
1464	237808.722	3380588.858	Yes	762.43	762.474	0.044	LIPT	

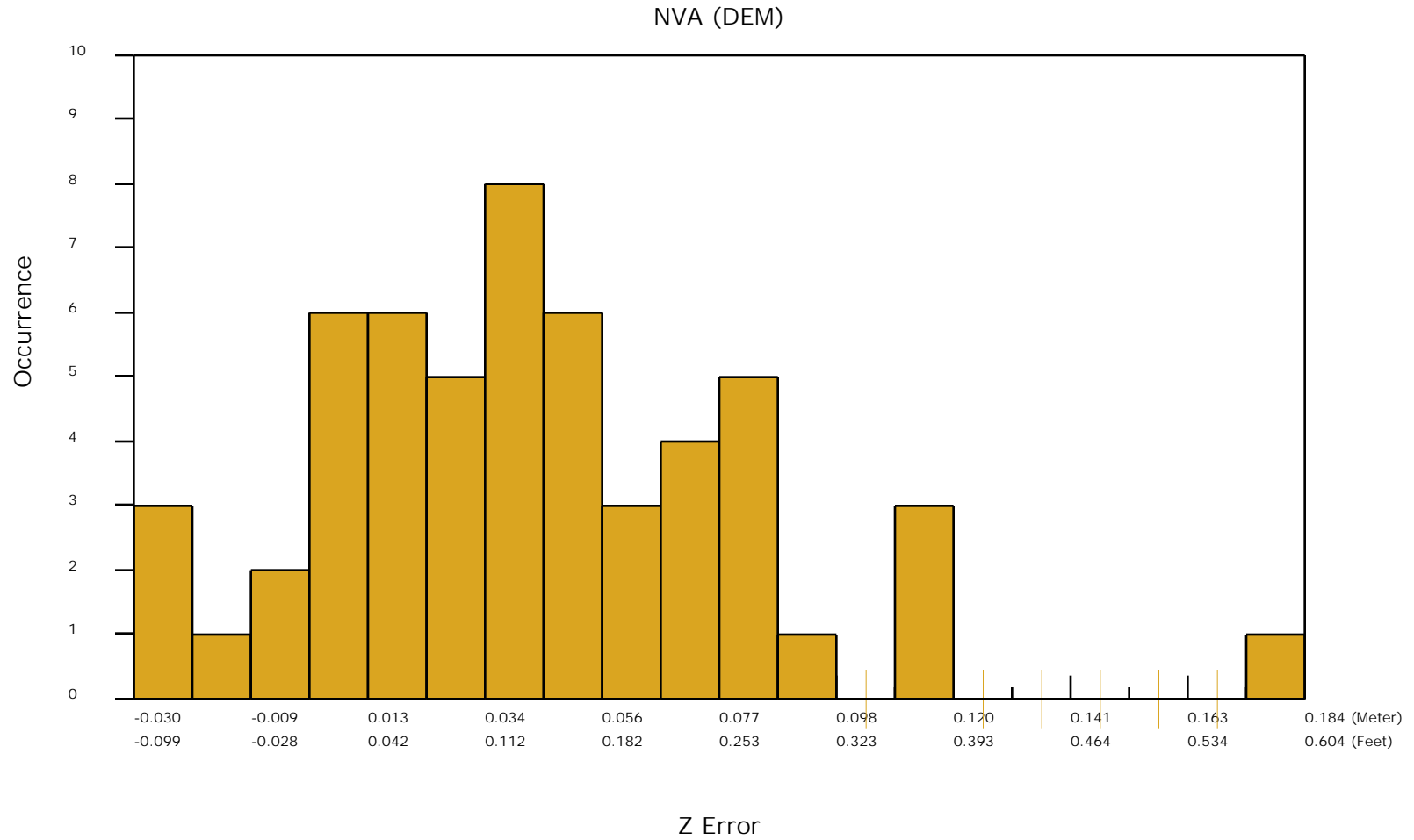
## Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
1465	248790.272	3418005.577	Yes	813.963	813.984	0.021	LIPT	
1466	242833.98	3429772.457	Yes	754.645	754.726	0.081	LIPT	
1481	273788.16	3433433.105	Yes	793.784	793.830	0.046	LIPT	
1487	221870.176	3382941.055	Yes	680.926	680.933	0.007	LIPT	
1492	301248.555	3390831.721	Yes	744.392	744.391	-0.001	LIPT	
1495	271050.553	3422002.542	Yes	770.721	770.831	0.110	LIPT	
1498	275384.625	3438215.316	Yes	822.594	822.660	0.066	LIPT	
1499	269298.399	3402394.078	Yes	712.063	712.141	0.078	LIPT	
1511	245835.419	3365825.951	Yes	609.633	609.650	0.017	LIPT	
1521	285083.433	3364163.046	Yes	613.383	613.399	0.016	LIPT	
1527	262089.57	3383286.323	Yes	645.069	645.043	-0.026	LIPT	
1529	300061.298	3394181.587	Yes	748.263	748.305	0.042	LIPT	
1532	222497.42	3365827.455	Yes	755.079	755.087	0.008	LIPT	
1541	276984.298	3436092.918	Yes	822.32	822.385	0.065	LIPT	
1545	265083.936	3438880.263	Yes	794.043	794.079	0.036	LIPT	
1546	280143.68	3426818.762	Yes	804.009	804.107	0.098	LIPT	
1547	242403.457	3352889.552	Yes	712.849	712.915	0.066	LIPT	
761001	221757.828	3369399.208	Yes	662.503	662.509	0.006	LIPT	
761004	220021.859	3387438.37	Yes	806.801	806.856	0.055	LIPT	
761005	219842.056	3388018.935	Yes	808.879	808.911	0.032	LIPT	
761006	225255.458	3396083.928	Yes	695.29	695.330	0.040	LIPT	
761007	225266.479	3396064.783	Yes	694.642	694.687	0.045	LIPT	
791000	227948.678	3403914.478	Yes	670.746	670.746	0.000	LIPT	
791002	227943.27	3403890.204	Yes	670.723	670.693	-0.030	LIPT	

# DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a frequency distribution chart of the non-vegetated vertical accuracy (NVA) of the DEM data measured against surveyed ground check points.

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# DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to report the results of measuring the DEM data against surveyed ground VVA (vegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

## VVA (DEM)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
2094	212757.854	3402628.25	Yes	852.132	852.183	0.051	LIPT	
2117	211558.707	3352206.974	Yes	705.989	706.205	0.216	LIPT	
2198	215655.888	3387483.76	Yes	719.856	720.010	0.154	LIPT	
2243	259332.826	3425380.201	Yes	769.614	769.716	0.102	LIPT	
2244	268341.557	3411047.64	Yes	807.228	807.317	0.089	LIPT	
2245	245332.811	3389400.521	Yes	606.063	606.207	0.144	LIPT	
2248	249736.48	3433121.151	Yes	866.112	866.269	0.157	LIPT	
2254	268472.46	3374469.601	Yes	650.039	650.298	0.259	LIPT	
2255	227955.089	3374310.453	Yes	636.013	636.076	0.063	LIPT	
2258	256768.571	3378935.606	Yes	667.494	667.510	0.016	LIPT	
2259	258277.975	3359190.809	Yes	567.067	567.196	0.129	LIPT	
2259A	258272.058	3359184.285	Yes	566.978	567.099	0.121	LIPT	
2274	260254.206	3410158.739	Yes	742.695	742.918	0.223	LIPT	
2276	229758.584	3350420.334	Yes	704.288	704.307	0.019	LIPT	
2277	278011.23	3383496.411	Yes	759.726	759.928	0.202	LIPT	
2283	283541.645	3356049.124	Yes	590.236	590.369	0.133	LIPT	
2287	267821.353	3355431.876	Yes	641.783	641.840	0.057	LIPT	
2294	230961.238	3362584.752	Yes	747.169	747.409	0.240	LIPT	
2303	229879.737	3387943.746	Yes	814.679	814.733	0.054	LIPT	
2319	221641.769	3395364.608	Yes	731.446	731.602	0.156	LIPT	
2327	254139.911	3351672.889	Yes	549.41	549.519	0.109	LIPT	
2328	264288.793	3392726.272	Yes	667.768	667.991	0.223	LIPT	
2330	215600.864	3363562.262	Yes	772.545	772.574	0.029	LIPT	
2331	215615.054	3363553.014	Yes	772.266	772.256	-0.010	LIPT	
2332	243729.036	3373303.682	Yes	605.022	605.115	0.093	LIPT	
2336	261689.156	3366245.524	Yes	593.272	593.333	0.061	LIPT	
2337	217299.43	3356566.329	Yes	733.286	733.379	0.093	LIPT	
2338	276749.314	3396746.292	Yes	726.336	726.500	0.164	LIPT	
2339	237837.993	3380568.178	Yes	760.806	760.865	0.059	LIPT	
2340	248807.775	3418017.369	Yes	813.294	813.495	0.201	LIPT	

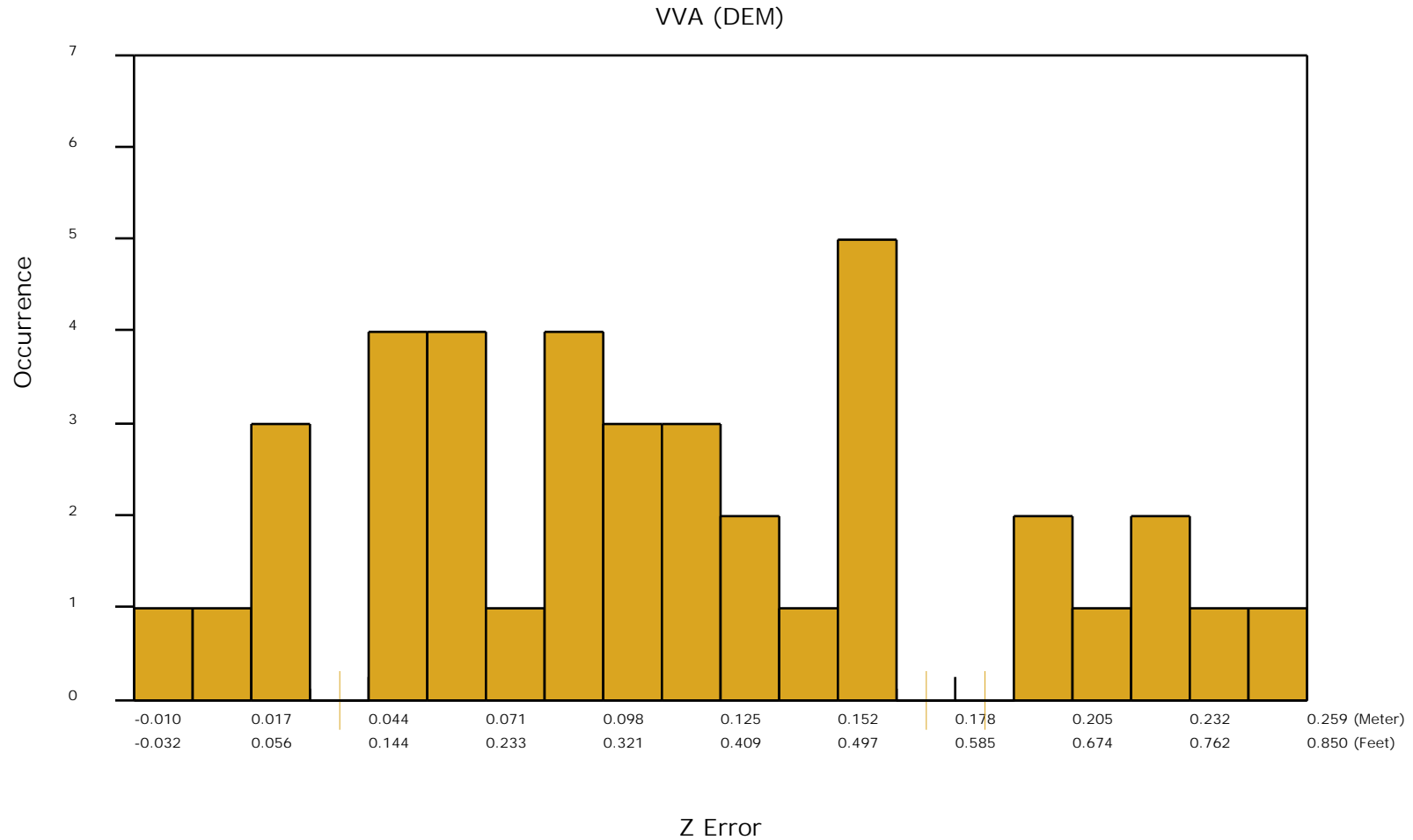
## Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
2341	242904.51	3429210.466	Yes	751.394	751.487	0.093	LIPT	
2362	301294.343	3390818.678	Yes	744.82	744.870	0.050	LIPT	
2372	264994.95	3439087.456	Yes	796.88	797.001	0.121	LIPT	
2373	280137.672	3426805.577	Yes	804.479	804.643	0.164	LIPT	
761000	221707.973	3369404.924	Yes	663.557	663.584	0.027	LIPT	
761002	221755.201	3369409.261	Yes	662.85	662.934	0.084	LIPT	
761003	220005.406	3387433.249	Yes	806.535	806.657	0.122	LIPT	
761008	225246.265	3396061.971	Yes	694.6	694.659	0.059	LIPT	
791001	227932.902	3403934.851	Yes	668.286	668.390	0.104	LIPT	

## DPH-11 Report on Absolute Vertical Accuracy - continued

The purpose of this section is to show a frequency distribution chart of the vegetated vertical accuracy (VVA) of the DEM data measured against surveyed ground check points.

[Data Source - Z:\MARS\\_OC\2900112\\_Lot\\_8\Classified\\_LAS\\_Files](#)

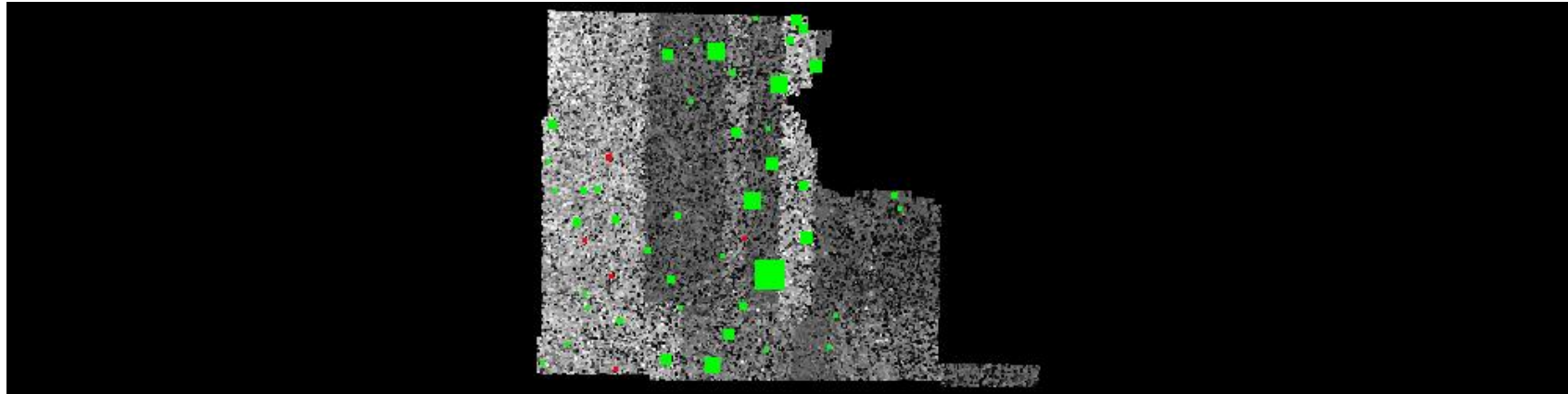


## *DPH-11 Report on Absolute Vertical Accuracy - continued*

The purpose of this section is to show a graphic of lidar data points colored by intensity with NVA check points rendered "thematically" showing the green and red squares sized by Z error.

[Data Source - Z:\MARS\\_OC\2900112\\_Lot\\_8\Classified\\_LAS\\_Files](#)

[Result Path - Z:\MARS\\_OC\2900112\\_Lot\\_8\Output\\_Full\DPH\\_11\ColorByIntensity\\_CheckPoints\\_NVA.jpg](#)



■ Green represents where the lidar surface is above the check point (positive elevation error).

■ Red represents where the lidar surface is below the check point (negative elevation error).

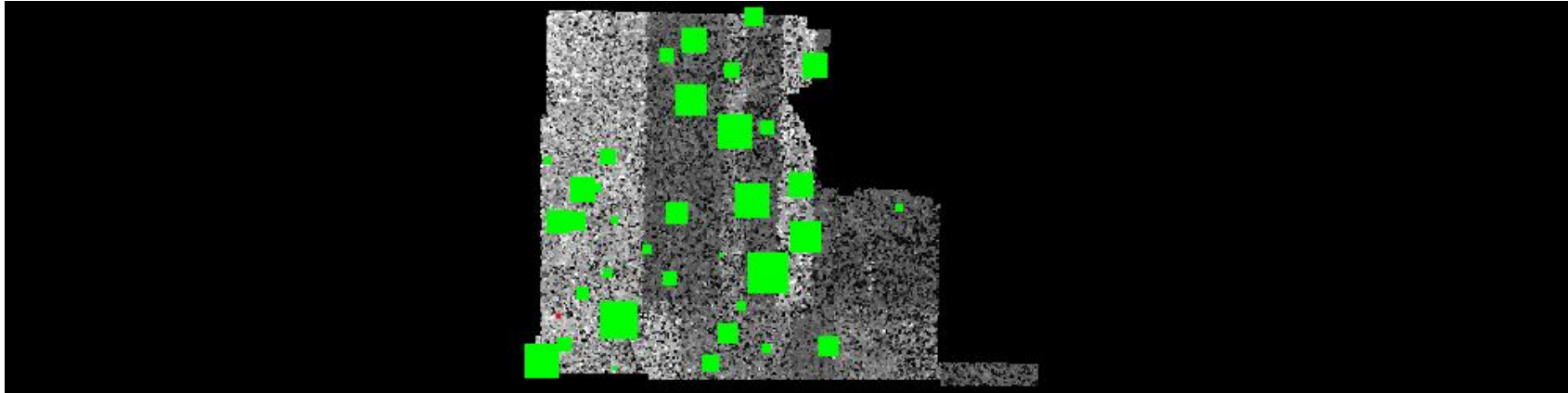
The size of the square symbol represents the absolute value magnitude of error.

## *DPH-11 Report on Absolute Vertical Accuracy - continued*

The purpose of this section is to show a graphic of lidar data points colored by intensity with VVA check points rendered "thematically" showing the green and red squares sized by Z error.

[Data Source - Z:\MARS\\_OC\2900112\\_Lot\\_8\Classified\\_LAS\\_Files](#)

[Result Path - Z:\MARS\\_OC\2900112\\_Lot\\_8\Output\\_Full\DPH\\_11\ColorByIntensity\\_CheckPoints\\_VVA.jpg](#)



■ Green represents where a DEM of the lidar surface is above the check point (positive elevation error).

■ Red represents where a DEM of the lidar surface is below the check point (negative elevation error).

The size of the square symbol represents the absolute value magnitude of error.