

DPH-11 Report on Absolute Vertical Accuracy

The USGS Lidar Base Specification Version 2.1 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.

Three 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.

DPH-11 Report on Absolute Vertical Accuracy - continued

Data Source - [D:\00_San_Miguel\Client_Shapes\Co_SanLuisJuanMiguel_Block4_24NVA_26VVA_utm13.shp](#)

Units: Meter (/Feet)

Vertical Accuracy Class tested: 10-cm

Check Points in defined project area (DPA):	50
Check Points with Lidar Coverage	50
Check Points with Lidar Coverage (NVA)	24
Check Points with Lidar Coverage (VVA)	26
Average Z Error (NVA)	-0.024/-0.079
Maximum Z Error (NVA)	0.075/0.244
Median Z Error (NVA)	-0.030/-0.100
Minimum Z Error (NVA)	-0.128/-0.421
Standard deviation of Vertical Error (NVA)	0.055/0.182
Skewness of Vertical Error (NVA)	0.059
Kurtosis of Vertical Error (NVA)	-0.825
Non-vegetated Vertical Accuracy (NVA) RMSE(z) ¹	0.059/0.195 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/- ¹	0.116/0.382 PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-	0.116/0.382
Non-vegetated Vertical Accuracy (NVA) RMSE(z) (DEM) ²	0.053/0.174 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level (DEM) +/- ²	0.104/0.342 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (TIN) +/- ¹	0.122/0.401 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (DEM) +/- ²	0.097/0.317 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 = 5.9cm, equating to +/- 11.6cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 9.7cm 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 Version 2.1 (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
6009	261449.257	4197880.334	Yes	3378.528	3378.469	-0.059	3378.458	3378.469	3378.477	2729	2031	1,1,1		
6011	253438.444	4252063.71	Yes	1874.547	1874.48	-0.067	1874.48	1874.487	1874.525	5376	-1018	1,1,1		
6013	258568.399	4236656.109	Yes	2040.201	2040.208	0.007	2040.191	2040.199	2040.224	4081	-733	1,1,1		
6016	238797.034	4236288.2	Yes	2818.653	2818.728	0.075	2818.711	2818.727	2818.733	8335	-1120	1,1,1		
6021	265373.88	4212165.594	Yes	2347.47	2347.342	-0.128	2347.331	2347.337	2347.356	5120	441	1,1,1		
6023	262403.396	4219945.953	Yes	2194.896	2194.904	0.008	2194.889	2194.904	2194.912	5988	398	1,1,1		
6026	259397.421	4226246.214	Yes	2129.992	2129.979	-0.013	2129.957	2129.961	2130.01	4218	171	1,1,1		
6027	239584.625	4259140.251	Yes	1854.773	1854.843	0.070	1854.811	1854.839	1854.865	5097	-341	1,1,1		
6032	240011.364	4289103.092	Yes	1596.479	1596.443	-0.036	1596.44	1596.444	1596.457	3999	-1682	1,1,1		
6035	246628.356	4201544.947	Yes	2869.167	2869.08	-0.087	2869.053	2869.091	2869.094	3315	-434	1,1,1		
6035A	246016.137	4196578.864	Yes	2927.304	2927.217	-0.087	2927.202	2927.226	2927.246	1666	-1150	1,1,1		
6039	278859.305	4251893.377	Yes	2189.907	2189.866	-0.041	2189.855	2189.867	2189.883	3639	627	1,1,1		
6043	241674.838	4248729.196	Yes	2252.914	2252.936	0.022	2252.913	2252.939	2252.939	5080	319	1,1,1		
6048	254129.375	4202393.24	Yes	2687.135	2687.165	0.030	2687.154	2687.161	2687.194	3919	663	1,1,1		
6050	250898.119	4193807.028	Yes	2969.992	2969.908	-0.084	2969.889	2969.908	2969.952	8354	1433	1,1,1		
6051	236461.585	4209443.269	Yes	2305.413	2305.464	0.051	2305.449	2305.464	2305.472	5429	-1214	1,1,1		
6052	251655.368	4223439.127	Yes	2333.501	2333.533	0.032	2333.504	2333.52	2333.574	4366	-4	1,1,1		
6053	244184.865	4188898.71	Yes	3116.532	3116.484	-0.048	3116.475	3116.484	3116.487	7717	-264	1,1,1		
6054	267323.63	4207881.227	Yes	2700.192	2700.167	-0.025	2700.161	2700.169	2700.173	6838	863	1,1,1		
6055	242980.563	4221321.12	Yes	2637.059	2637.01	-0.049	2637.006	2637.02	2637.029	6437	37	1,1,1		
6057	257048.46	4245635.827	Yes	1946.47	1946.485	0.015	1946.478	1946.482	1946.492	3989	-1432	1,1,1		
6060	265015.095	4230844.515	Yes	2224.332	2224.293	-0.039	2224.264	2224.292	2224.306	7151	-526	1,1,1		
6060A	263845.227	4229161.671	Yes	2228.747	2228.64	-0.107	2228.636	2228.636	2228.644	5469	-1060	1,1,1		
6062A	238813.971	4277446.495	Yes	1654.535	1654.514	-0.021	1654.503	1654.521	1654.548	3349	1610	1,1,1		

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 VVA (vegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

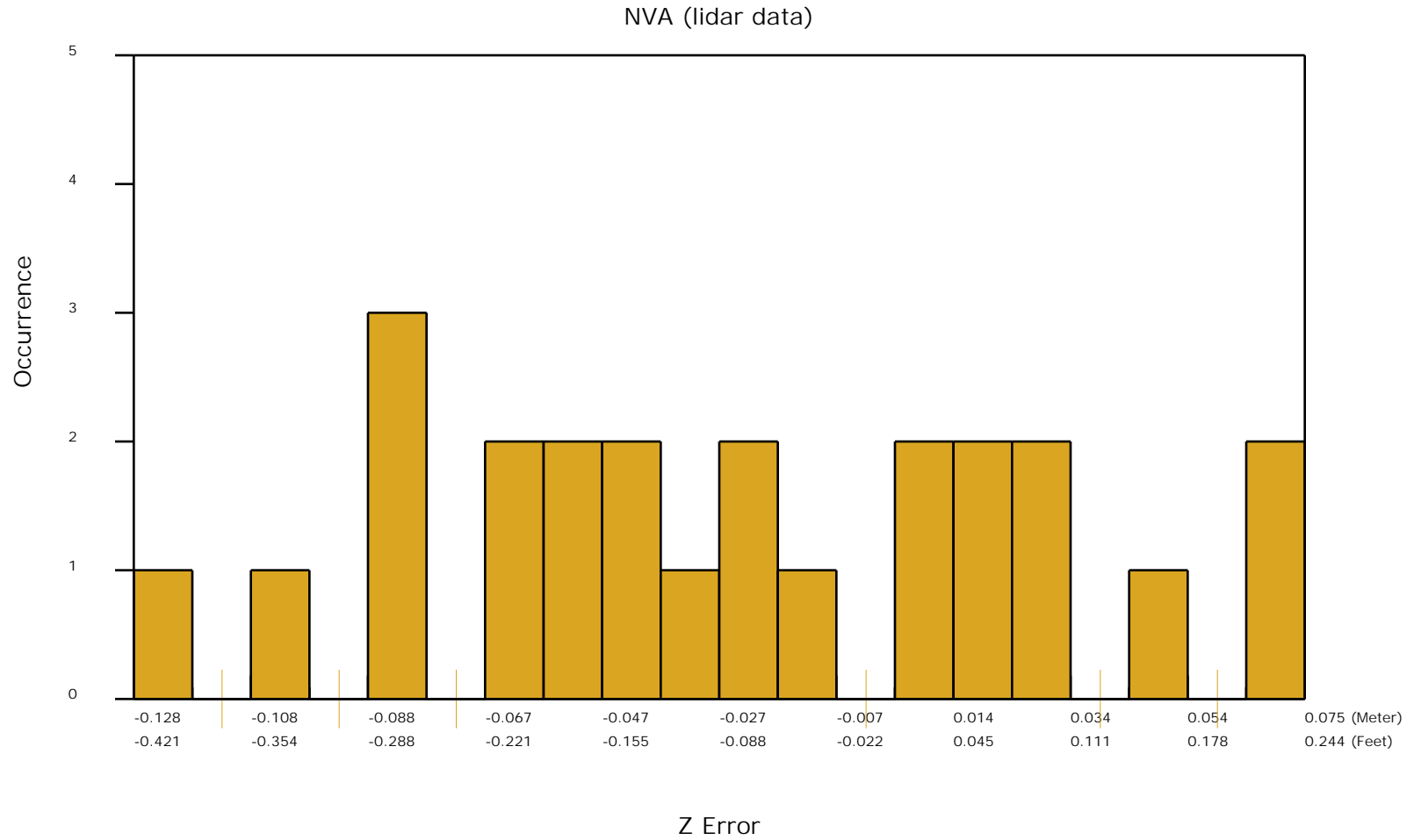
VVA (lidar data)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
7008	261462.721	4197864.802	Yes	3380.561	3380.483	-0.078	3380.418	3380.421	3380.497	6951	1588	1,1,1		
7010	253821.65	4251522.566	Yes	1879.866	1879.855	-0.011	1879.849	1879.862	1879.873	6148	-775	1,1,1		
7012	258574.771	4236685.603	Yes	2039.204	2039.192	-0.012	2039.183	2039.193	2039.206	7115	-1691	1,1,1		
7012A	258047.499	4240105.167	Yes	1993.625	1993.699	0.074	1993.684	1993.699	1993.703	8757	-1924	1,1,1		
7015	238766.972	4236136.007	Yes	2821.601	2821.58	-0.021	2821.575	2821.589	2821.601	9364	-201	1,1,1		
7020	265408.963	4212135.042	Yes	2348.17	2348.156	-0.014	2348.148	2348.16	2348.17	5469	562	1,1,1		
7022	262425.929	4219893.334	Yes	2194.301	2194.339	0.038	2194.322	2194.337	2194.344	8228	556	1,1,1		
7025	259401.87	4226230.581	Yes	2130.124	2130.166	0.042	2130.156	2130.168	2130.177	9031	109	1,1,1		
7026	239644.727	4258694.581	Yes	1869.114	1869.193	0.079	1869.175	1869.208	1869.227	6959	22	1,1,1		
7030	240025.637	4289042.185	Yes	1597.424	1597.435	0.011	1597.432	1597.437	1597.458	7224	-1872	1,1,1		
7033	246614.934	4201519.842	Yes	2869.042	2868.966	-0.076	2868.947	2868.971	2868.974	8256	-387	1,1,1		
7033A	246008.261	4196576.749	Yes	2927.174	2927.044	-0.130	2926.964	2927.035	2927.055	8411	-1133	1,1,2		
7037	278928.282	4252034.587	Yes	2187.137	2187.19	0.053	2187.18	2187.189	2187.202	7824	1228	1,1,1		
7040	241682.627	4249235.511	Yes	2235.985	2236.11	0.125	2236.099	2236.118	2236.146	9182	1923	1,1,1		
7045	254099.382	4202392.627	Yes	2686.32	2686.358	0.038	2686.345	2686.374	2686.41	8620	610	1,1,1		
7047	250915.889	4193578.842	Yes	2952.382	2952.46	0.078	2952.449	2952.456	2952.474	9704	649	1,1,1		
7048	236239.542	4209569.374	Yes	2312.293	2312.324	0.031	2312.254	2312.314	2312.332	8824	-1533	1,1,1		
7048A	236212.855	4209502.354	Yes	2315.788	2315.879	0.091	2315.842	2315.871	2315.93	7269	-1803	1,1,1		
7049	251665.446	4223393.261	Yes	2329.936	2330.051	0.115	2330.005	2330.042	2330.096	6870	-165	1,1,1		
7050	244198.877	4188908.566	Yes	3115.831	3115.796	-0.035	3115.773	3115.791	3115.853	9490	-263	1,1,1		
7051	266580.244	4205980.224	Yes	2851.745	2851.727	-0.018	2851.586	2851.725	2851.728	4782	-1138	2,2,1		
7052	242985.371	4221391.312	Yes	2640.93	2640.92	-0.010	2640.893	2640.934	2640.938	8082	-2666	1,1,1		
7054	257084.346	4246209.012	Yes	1930.904	1930.929	0.025	1930.921	1930.926	1930.967	8080	-89	1,1,1		
7057	264789.929	4230885.627	Yes	2223.577	2223.565	-0.012	2223.558	2223.565	2223.567	9579	41	1,1,1		
7057A	263854.138	4229174.111	Yes	2227.531	2227.483	-0.048	2227.442	2227.468	2227.495	7683	-1060	1,1,1		
7059A	238766.624	4275639.579	Yes	1674.433	1674.419	-0.014	1674.403	1674.429	1674.463	6564	1706	1,1,1		

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.

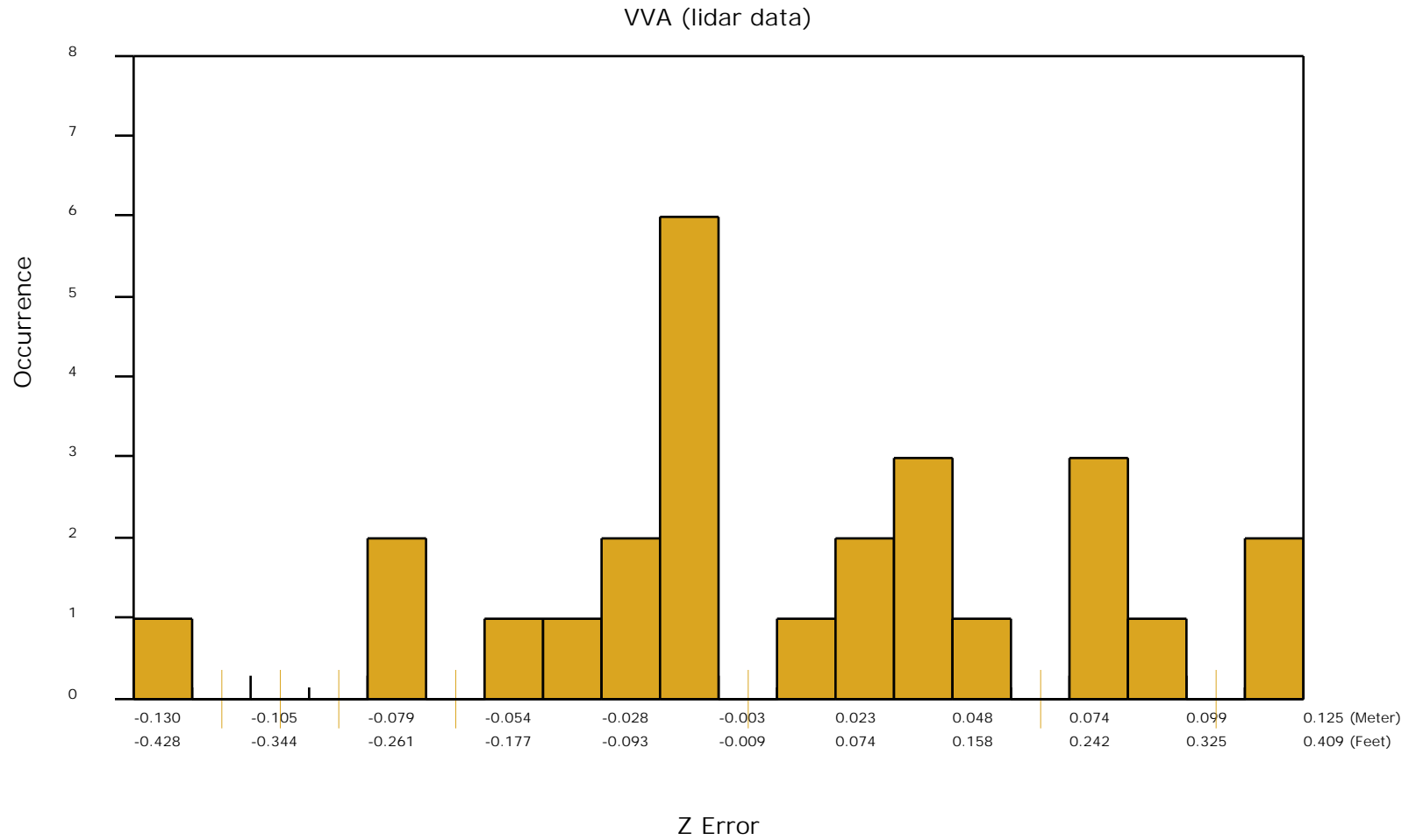
[Data Source - D:\00_San_Miguel\Client_LAS](#)



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 lidar point cloud data measured against surveyed ground check points.

[Data Source - D:\00_San_Miguel\Client_LAS](#)



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.

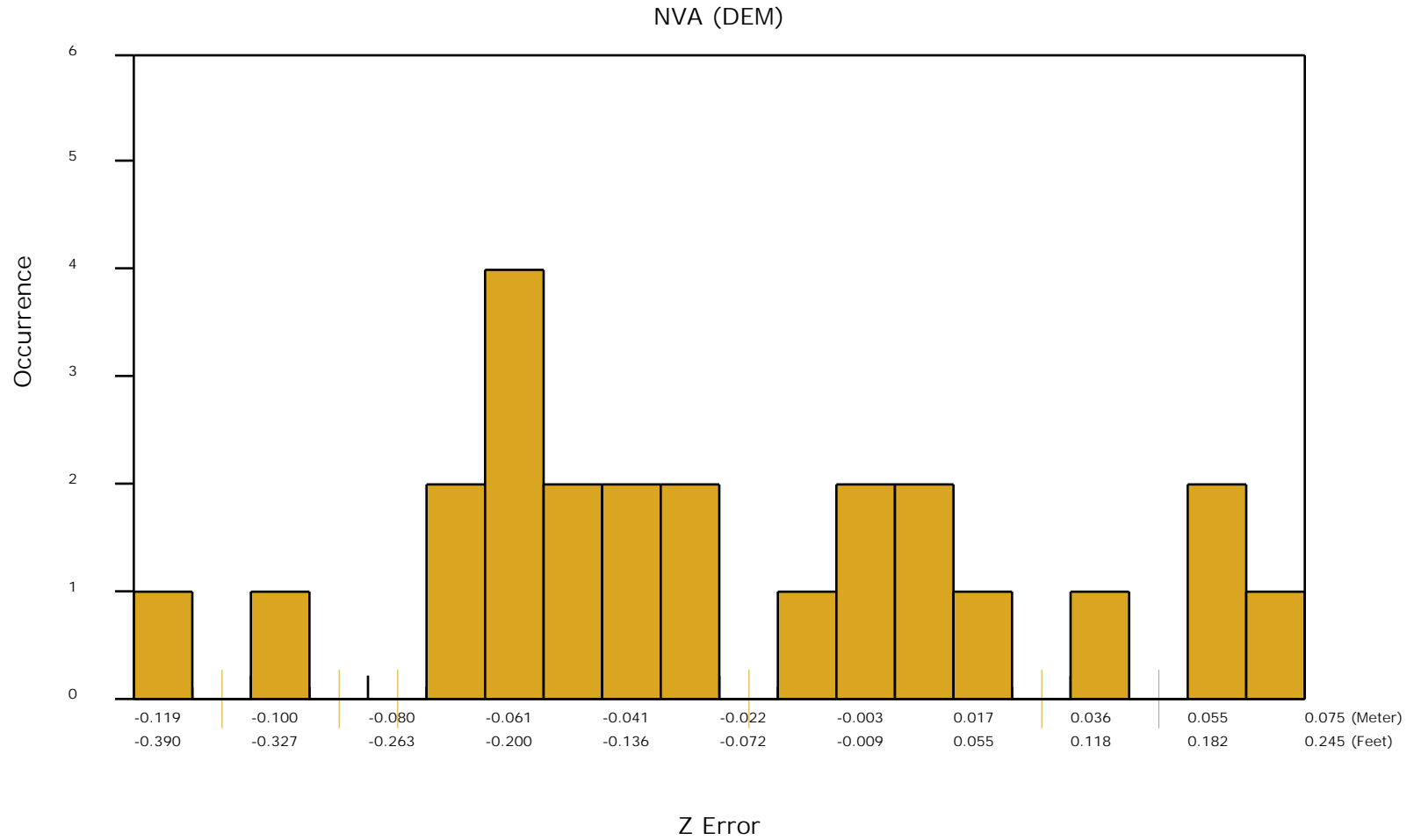
NVA (DEM)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
6009	261449.257	4197880.334	Yes	3378.528	3378.473	-0.055		
6011	253438.444	4252063.71	Yes	1874.547	1874.488	-0.059		
6013	258568.399	4236656.109	Yes	2040.201	2040.214	0.013		
6016	238797.034	4236288.2	Yes	2818.653	2818.728	0.075		
6021	265373.88	4212165.594	Yes	2347.47	2347.351	-0.119		
6023	262403.396	4219945.953	Yes	2194.896	2194.895	-0.001		
6026	259397.421	4226246.214	Yes	2129.992	2129.980	-0.012		
6027	239584.625	4259140.251	Yes	1854.773	1854.832	0.059		
6032	240011.364	4289103.092	Yes	1596.479	1596.453	-0.026		
6035	246628.356	4201544.947	Yes	2869.167	2869.112	-0.055		
6035A	246016.137	4196578.864	Yes	2927.304	2927.239	-0.065		
6039	278859.305	4251893.377	Yes	2189.907	2189.873	-0.034		
6043	241674.838	4248729.196	Yes	2252.914	2252.932	0.018		
6048	254129.375	4202393.24	Yes	2687.135	2687.173	0.038		
6050	250898.119	4193807.028	Yes	2969.992	2969.938	-0.054		
6051	236461.585	4209443.269	Yes	2305.413	2305.470	0.057		
6052	251655.368	4223439.127	Yes	2333.501	2333.507	0.006		
6053	244184.865	4188898.71	Yes	3116.532	3116.483	-0.049		
6054	267323.63	4207881.227	Yes	2700.192	2700.161	-0.031		
6055	242980.563	4221321.12	Yes	2637.059	2637.010	-0.049		
6057	257048.46	4245635.827	Yes	1946.47	1946.486	0.016		
6060	265015.095	4230844.515	Yes	2224.332	2224.268	-0.064		
6060A	263845.227	4229161.671	Yes	2228.747	2228.649	-0.098		
6062A	238813.971	4277446.495	Yes	1654.535	1654.502	-0.033		

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.

[Data Source - D:\00_San_Miguel\Client_LAS](#)



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.

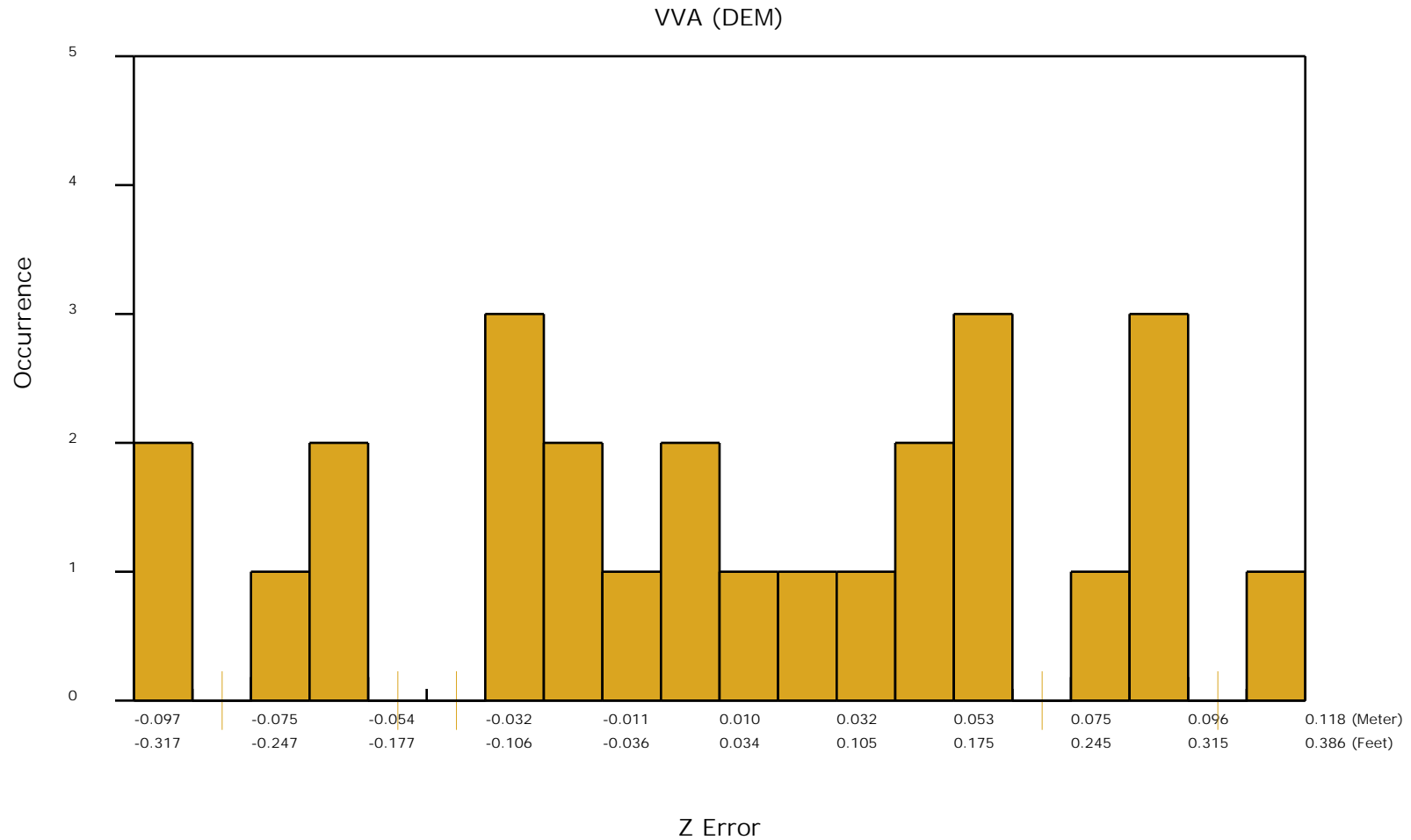
VVA (DEM)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
7008	261462.721	4197864.802	Yes	3380.561	3380.464	-0.097		
7010	253821.65	4251522.566	Yes	1879.866	1879.852	-0.014		
7012	258574.771	4236685.603	Yes	2039.204	2039.211	0.007		
7012A	258047.499	4240105.167	Yes	1993.625	1993.713	0.088		
7015	238766.972	4236136.007	Yes	2821.601	2821.579	-0.022		
7020	265408.963	4212135.042	Yes	2348.17	2348.146	-0.024		
7022	262425.929	4219893.334	Yes	2194.301	2194.323	0.022		
7025	259401.87	4226230.581	Yes	2130.124	2130.173	0.049		
7026	239644.727	4258694.581	Yes	1869.114	1869.203	0.089		
7030	240025.637	4289042.185	Yes	1597.424	1597.408	-0.016		
7033	246614.934	4201519.842	Yes	2869.042	2868.971	-0.071		
7033A	246008.261	4196576.749	Yes	2927.174	2927.077	-0.097		
7037	278928.282	4252034.587	Yes	2187.137	2187.183	0.046		
7040	241682.627	4249235.511	Yes	2235.985	2236.103	0.118		
7045	254099.382	4202392.627	Yes	2686.32	2686.354	0.034		
7047	250915.889	4193578.842	Yes	2952.382	2952.440	0.058		
7048	236239.542	4209569.374	Yes	2312.293	2312.348	0.055		
7048A	236212.855	4209502.354	Yes	2315.788	2315.863	0.075		
7049	251665.446	4223393.261	Yes	2329.936	2330.027	0.091		
7050	244198.877	4188908.566	Yes	3115.831	3115.831	0.000		
7051	266580.244	4205980.224	Yes	2851.745	2851.688	-0.057		
7052	242985.371	4221391.312	Yes	2640.93	2640.948	0.018		
7054	257084.346	4246209.012	Yes	1930.904	1930.959	0.055		
7057	264789.929	4230885.627	Yes	2223.577	2223.572	-0.005		
7057A	263854.138	4229174.111	Yes	2227.531	2227.468	-0.063		
7059A	238766.624	4275639.579	Yes	1674.433	1674.405	-0.028		

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 - D:\00_San_Miguel\Client_LAS](#)

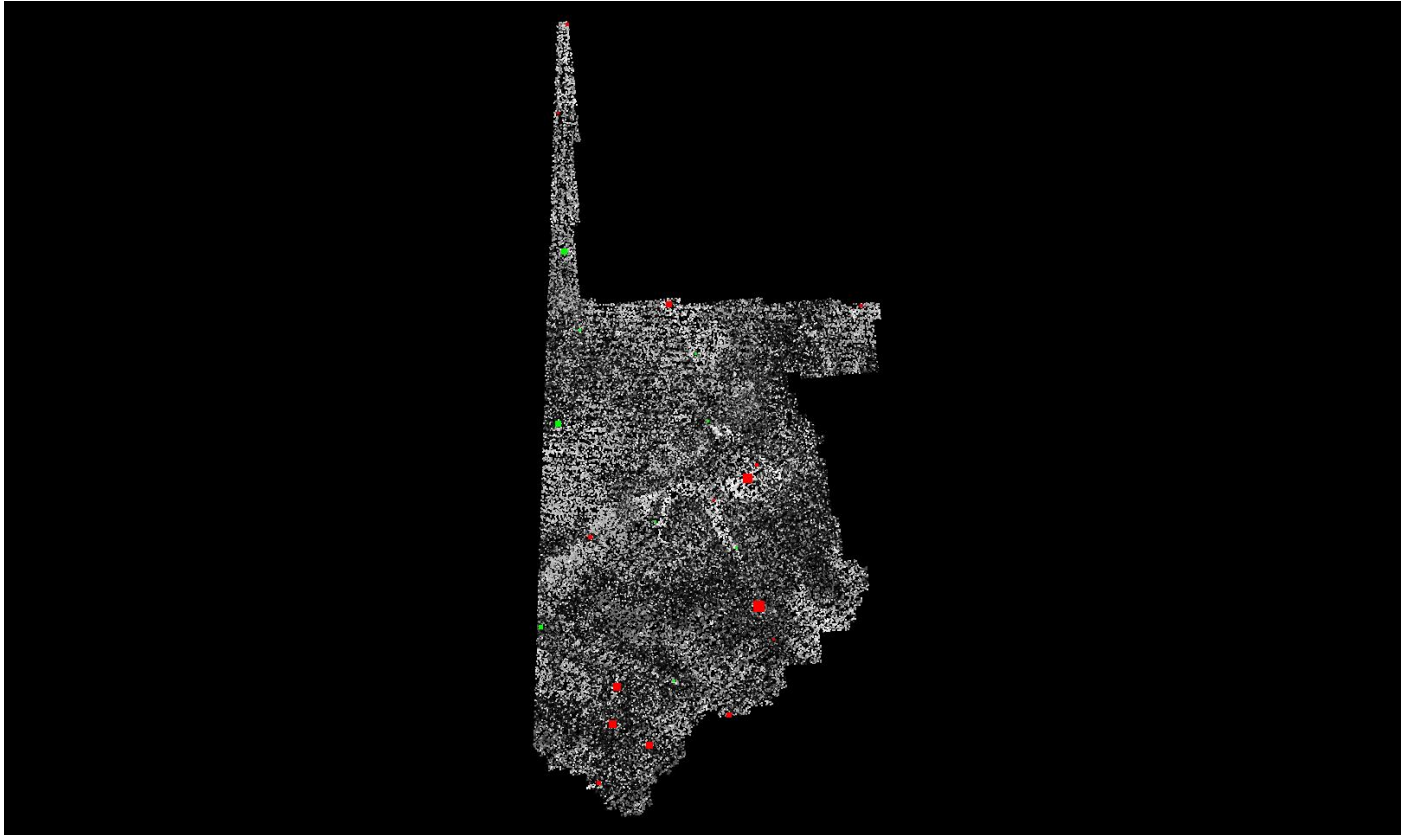


DPH-11 Report on Absolute Vertical Accuracy - continued

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 - D:\00_San_Miguel\Client_LAS](#)

[Result Path - D:\00_San_Miguel\San_Luis_Juan_Miguel_B4_UTM13\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).

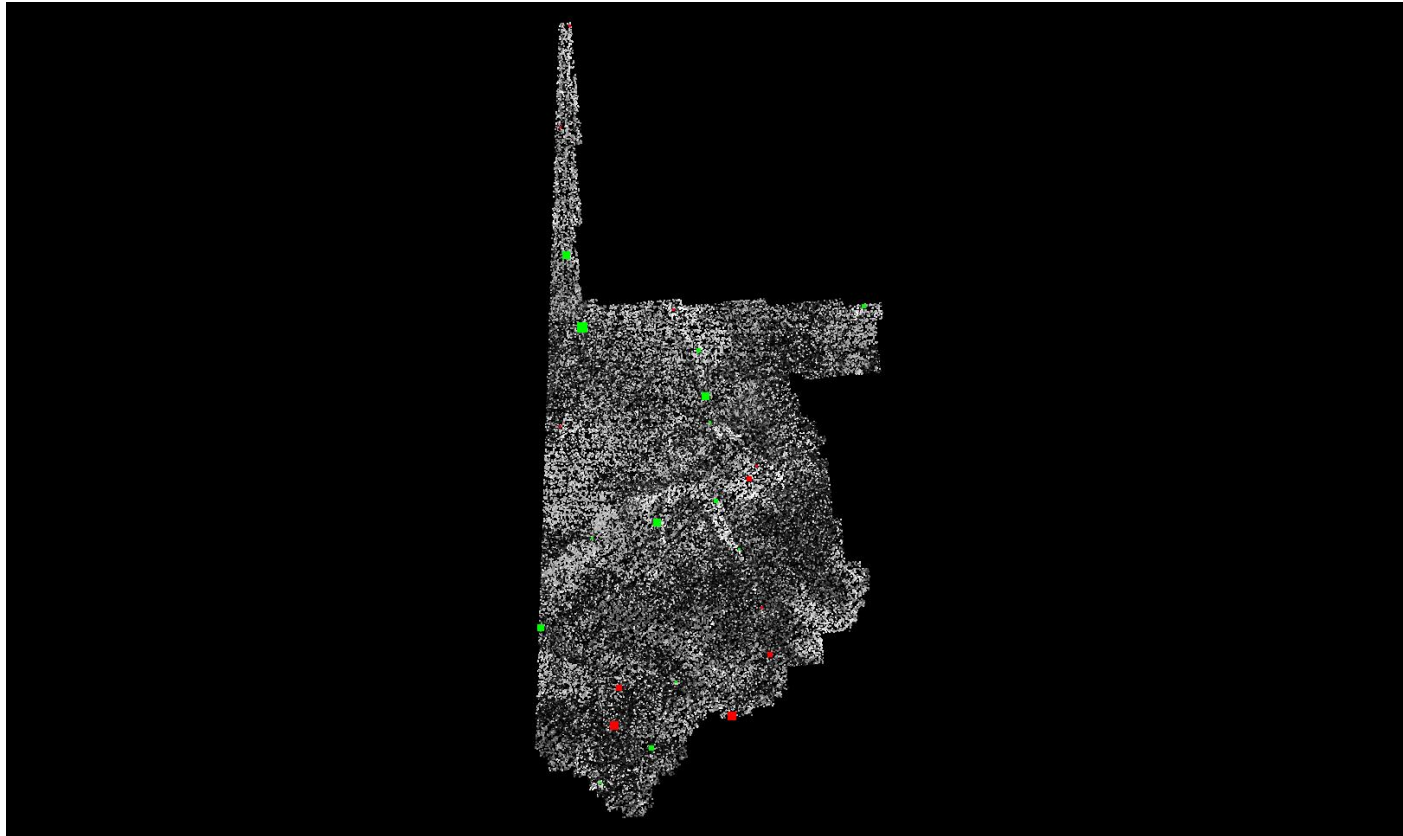
The size of the square symbol represents the absolute value magnitude of error.

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 - D:\00_San_Miguel\Client_LAS](#)

[Result Path - D:\00_San_Miguel\San_Luis_Juan_Miguel_B4_UTM13\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.