

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; \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	≤ 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 - Y:\Mapping\Projects\65220636_AZ_AubreyCherry\Production\Final_Client_Deliverables\Cherry\Work_Unit_Name\vertical_accuracy\checkpoints\Cherry_16NVA_11VVA_utm12.shp](Y:\Mapping\Projects\65220636_AZ_AubreyCherry\Production\Final_Client_Deliverables\Cherry\Work_Unit_Name\vertical_accuracy\checkpoints\Cherry_16NVA_11VVA_utm12.shp)

Units: Meter (/Feet)

Vertical Accuracy Class tested: 10-cm

Check Points in defined project area (DPA):	27
Check Points with Lidar Coverage	27
Check Points with Lidar Coverage (NVA)	16
Check Points with Lidar Coverage (VVA)	11
Average Z Error (NVA)	-0.001/-0.002
Maximum Z Error (NVA)	0.081/0.264
Median Z Error (NVA)	0.009/0.031
Minimum Z Error (NVA)	-0.091/-0.298
Standard deviation of Vertical Error (NVA)	0.056/0.185
Skewness of Vertical Error (NVA)	-0.087
Kurtosis of Vertical Error (NVA)	-1.345
Non-vegetated Vertical Accuracy (NVA) RMSE(z) ¹	0.054/0.179 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/- ¹	0.107/0.350 PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-	0.107/0.350
Non-vegetated Vertical Accuracy (NVA) RMSE(z) (DEM) ²	0.055/0.180 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level (DEM) +/- ²	0.108/0.353 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (TIN) +/- ¹	0.190/0.625 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (DEM) +/- ²	0.169/0.554 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 = 5.4cm, equating to +/- 10.7cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 16.9cm 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
2037	418336.483	3836281.916	Yes	1113.208	1113.272	0.064	1113.247	1113.266	1113.294	8514	-775	1,1,1		
2038	413171.099	3828853.338	Yes	1088.843	1088.905	0.062	1088.888	1088.908	1088.91	6116	-171	1,1,1		
2039	411439.483	3845143.337	Yes	1063.625	1063.575	-0.050	1063.561	1063.576	1063.607	2199	-2571	1,1,1		
2040	403260.749	3838771.513	Yes	1277.001	1276.957	-0.044	1276.947	1276.994	1277.016	4210	1871	1,1,1		
2041	407037.748	3831860.35	Yes	1295.099	1295.008	-0.091	1294.999	1295.032	1295.046	6723	973	1,1,1		
2042	406334.205	3845212.817	Yes	1013.832	1013.845	0.013	1013.826	1013.851	1013.859	2708	-979	1,1,1		
2043	422257.399	3825498.686	Yes	940.755	940.823	0.068	940.818	940.823	940.83	2889	-248	1,1,1		
2044	395969.882	3844023.77	Yes	1933.063	1933.011	-0.052	1932.987	1933.005	1933.032	4051	7	1,1,1		
2045	407178.856	3853235.104	Yes	1191.743	1191.711	-0.032	1191.692	1191.713	1191.728	8664	-368	1,1,1		
2046	395941.52	3840090.605	Yes	2292.614	2292.656	0.042	2292.647	2292.653	2292.665	4337	1170	1,1,1		
2047	401938.327	3847597.938	Yes	1127.624	1127.629	0.005	1127.62	1127.629	1127.644	3299	845	1,1,1		
2047A	403174.754	3850490.421	Yes	1039.651	1039.606	-0.045	1039.58	1039.611	1039.612	4446	2309	1,1,1		
2048	413603.738	3833275.731	Yes	989.583	989.617	0.034	989.612	989.618	989.629	2623	-546	1,1,1		
2048A	411242.554	3834958.353	Yes	1080.853	1080.934	0.081	1080.918	1080.93	1080.955	6830	-547	1,1,1		
2049	398239.506	3835616.151	Yes	1977.865	1977.881	0.016	1977.867	1977.891	1977.9	4571	137	1,1,1		
2050	404594.601	3827586.846	Yes	1506.385	1506.304	-0.081	1506.297	1506.312	1506.319	5699	-1300	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.

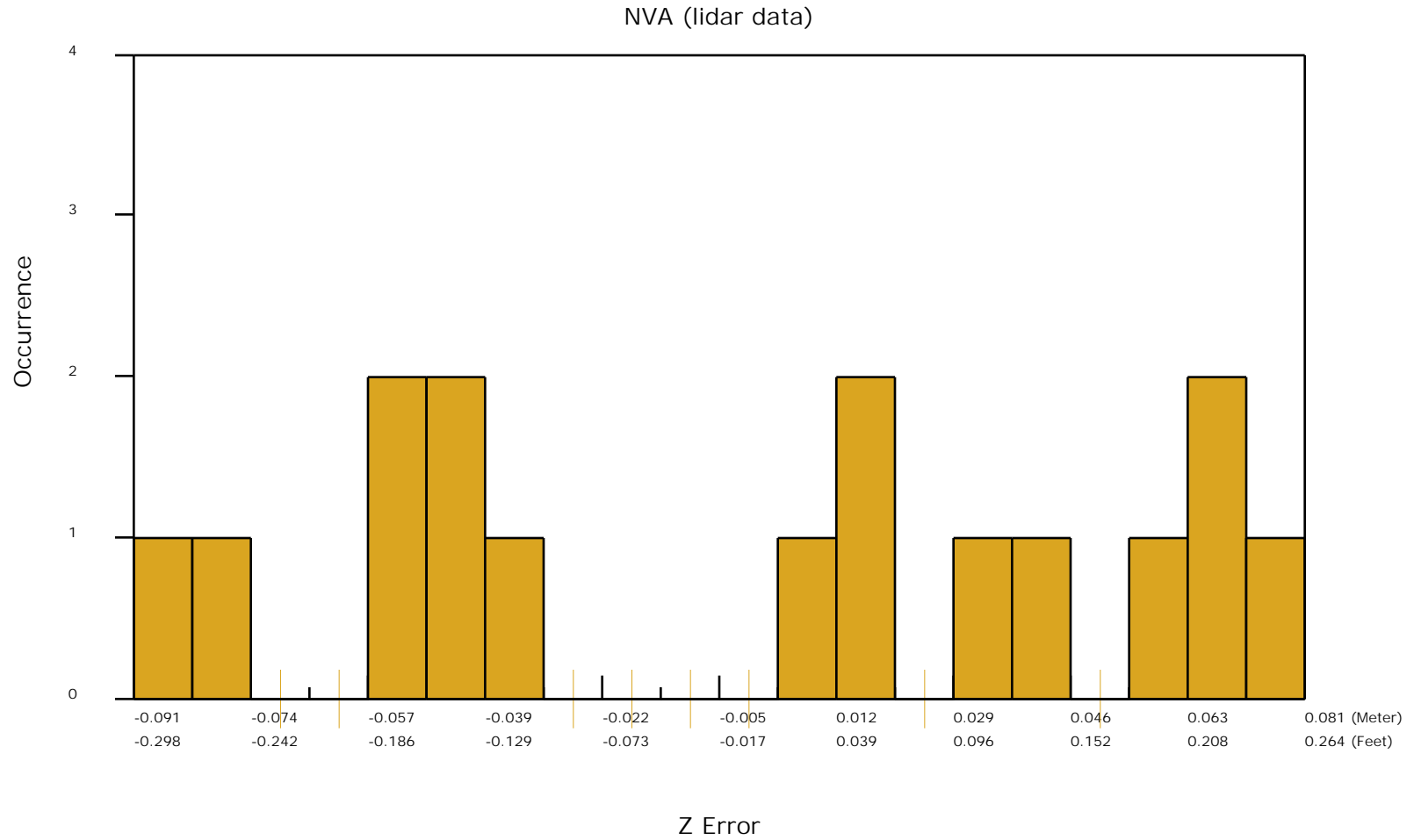
VVA (lidar data)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
3032	413166.653	3828871.095	Yes	1088.709	1088.796	0.087	1088.761	1088.804	1088.819	5412	-1139	1,1,2		
3033	411459.111	3845163.324	Yes	1063.077	1063.136	0.059	1063.1	1063.128	1063.161	5745	1503	1,1,1		
3034	403265.736	3838782.265	Yes	1277.332	1277.386	0.054	1277.378	1277.386	1277.397	5221	865	1,1,1		
3035	422262.027	3825476.313	Yes	940.454	940.5	0.046	940.477	940.5	940.505	6320	-427	1,1,1		
3036	395900.495	3844045.648	Yes	1939.729	1939.742	0.013	1939.697	1939.697	1939.762	6997	1241	1,1,1		
3037	407265.659	3853045.825	Yes	1210.634	1210.655	0.021	1210.646	1210.652	1210.696	6474	1672	1,1,1		
3038	401961.037	3847628.137	Yes	1128.596	1128.652	0.056	1128.628	1128.688	1128.706	4782	-604	1,1,1		
3038A	403152.785	3850528.532	Yes	1039.202	1039.179	-0.023	1039.142	1039.187	1039.206	5274	812	1,1,1		
3039	398241.531	3835576.27	Yes	1972.747	1972.792	0.045	1972.764	1972.801	1972.81	5493	652	1,1,1		
3040	404616.147	3827590.397	Yes	1509.721	1509.427	-0.294	1509.424	1509.438	1509.452	3195	2229	2,2,2		
3040A	407042.933	3831867.211	Yes	1294.612	1294.634	0.022	1294.563	1294.63	1294.635	5083	832	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.

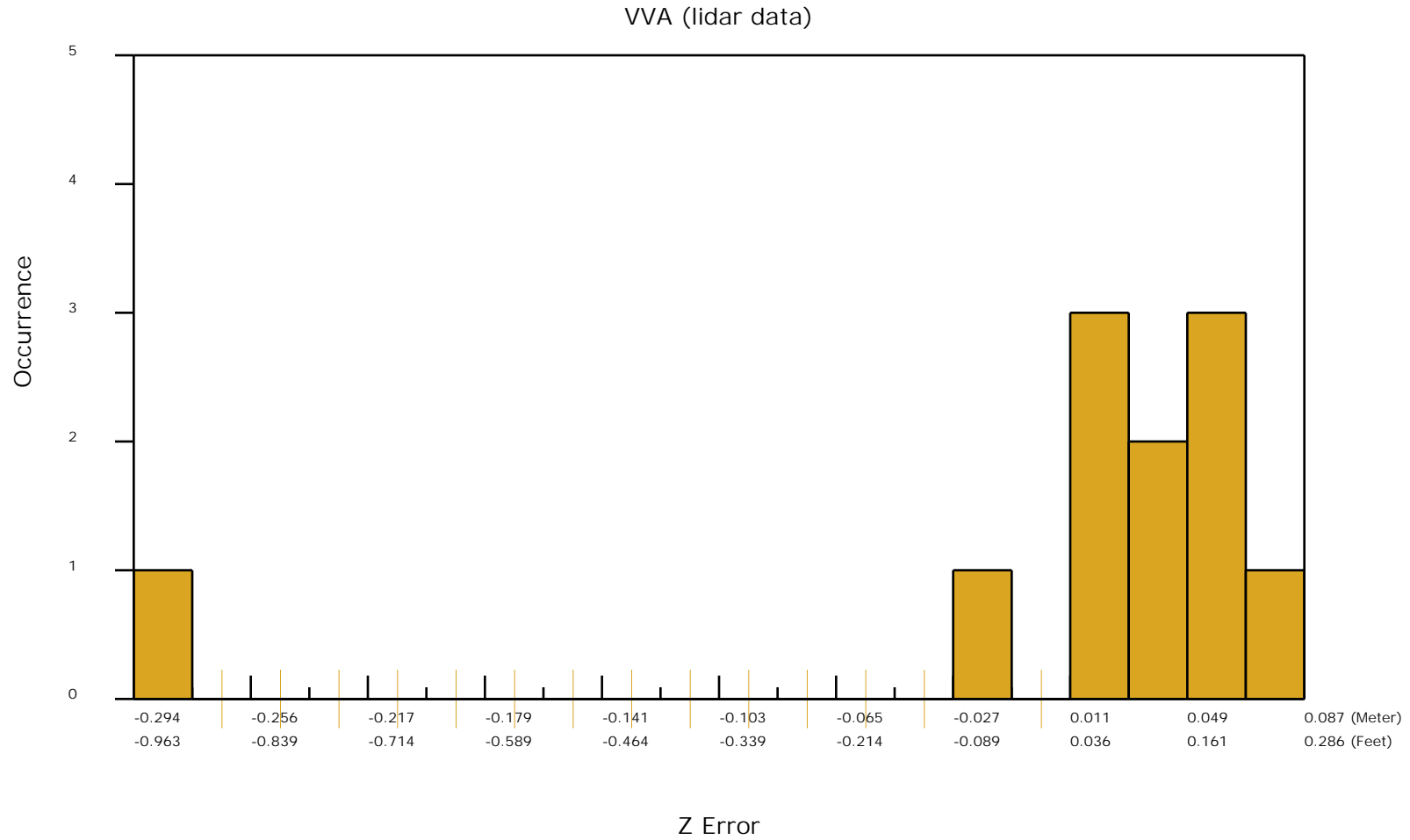
[Data Source - D:\00_Cherry\Client_LAS](#)



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_Cherry\Client_LAS](#)



DPH-11 Report on Absolute Vertical Accuracy - continued

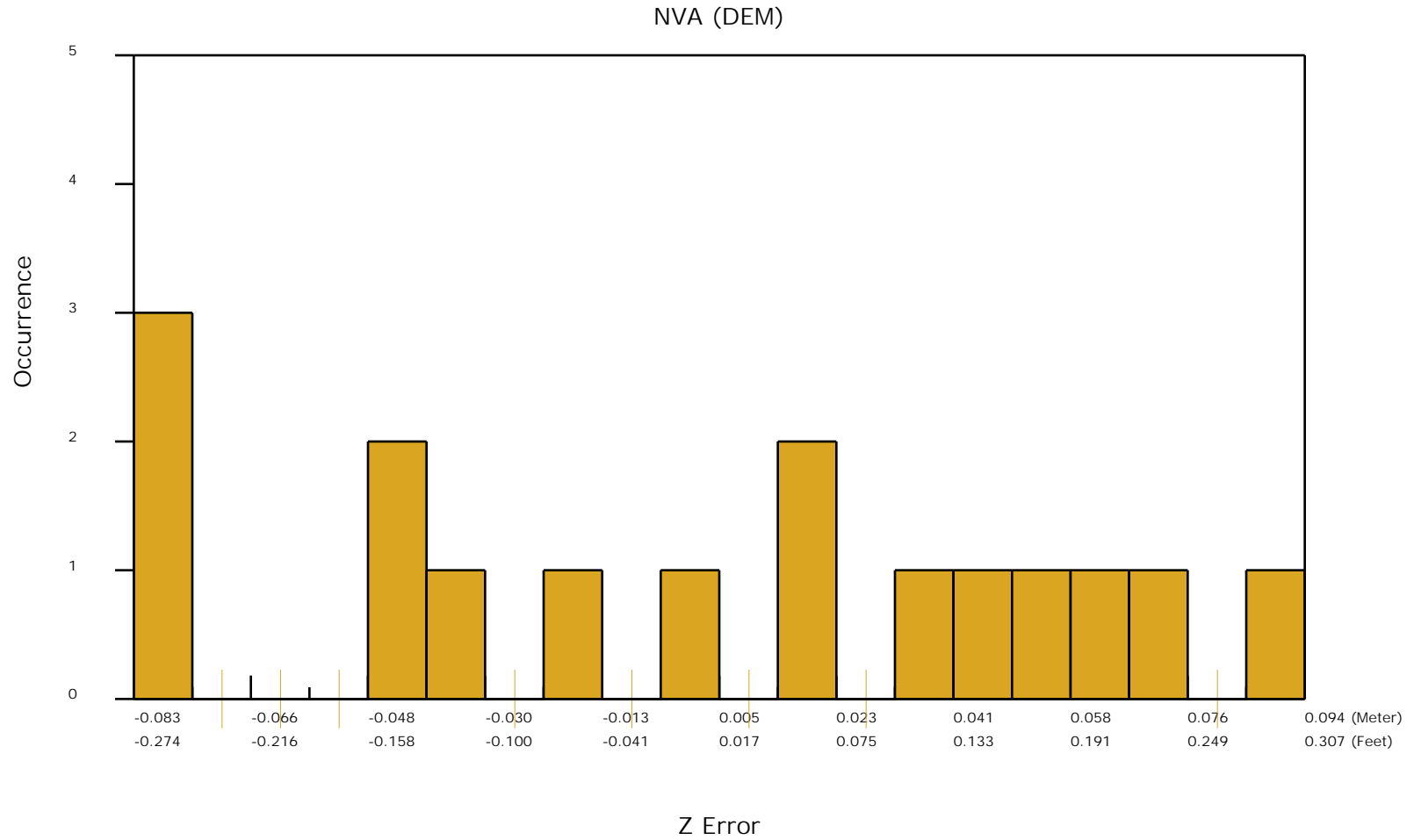
The purpose of this section is to report the results of measuring the DEM data against surveyed ground NVA (nonvegetated vertical accuracy) check points. All XY coordinates and Z values reported are in the selected data units.

NVA (DEM)								
ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
2037	418336.483	3836281.916	Yes	1113.208	1113.251	0.043		
2038	413171.099	3828853.338	Yes	1088.843	1088.899	0.056		
2039	411439.483	3845143.337	Yes	1063.625	1063.584	-0.041		
2040	403260.749	3838771.513	Yes	1277.001	1276.985	-0.016		
2041	407037.748	3831860.35	Yes	1295.099	1295.016	-0.083		
2042	406334.205	3845212.817	Yes	1013.832	1013.846	0.014		
2043	422257.399	3825498.686	Yes	940.755	940.823	0.068		
2044	395969.882	3844023.77	Yes	1933.063	1932.988	-0.075		
2045	407178.856	3853235.104	Yes	1191.743	1191.708	-0.035		
2046	395941.52	3840090.605	Yes	2292.614	2292.673	0.059		
2047	401938.327	3847597.938	Yes	1127.624	1127.627	0.003		
2047A	403174.754	3850490.421	Yes	1039.651	1039.605	-0.046		
2048	413603.738	3833275.731	Yes	989.583	989.616	0.033		
2048A	411242.554	3834958.353	Yes	1080.853	1080.947	0.094		
2049	398239.506	3835616.151	Yes	1977.865	1977.884	0.019		
2050	404594.601	3827586.846	Yes	1506.385	1506.302	-0.083		

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_Cherry\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.

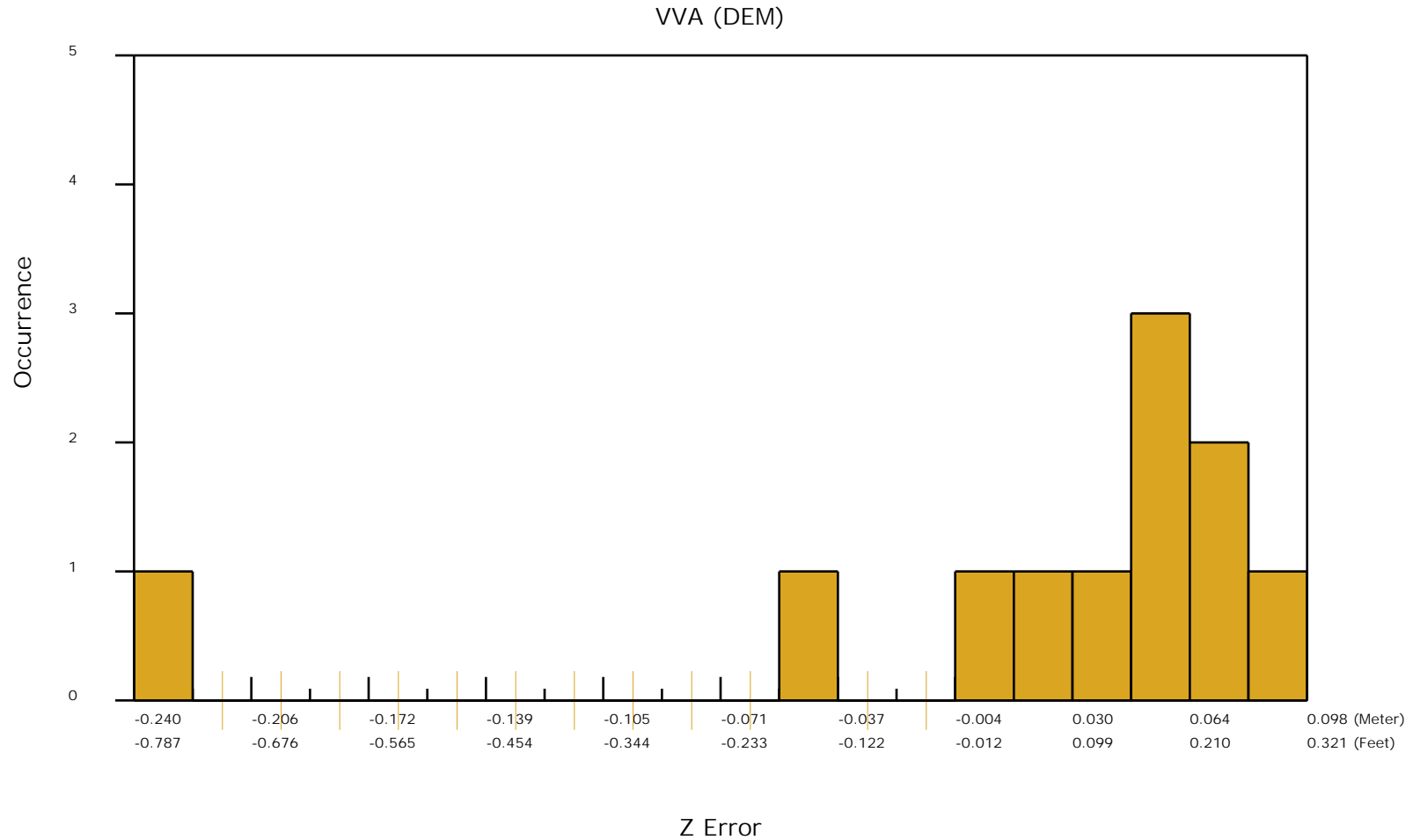
VVA (DEM)

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
3032	413166.653	3828871.095	Yes	1088.709	1088.807	0.098		
3033	411459.111	3845163.324	Yes	1063.077	1063.108	0.031		
3034	403265.736	3838782.265	Yes	1277.332	1277.387	0.055		
3035	422262.027	3825476.313	Yes	940.454	940.504	0.050		
3036	395900.495	3844045.648	Yes	1939.729	1939.803	0.074		
3037	407265.659	3853045.825	Yes	1210.634	1210.646	0.012		
3038	401961.037	3847628.137	Yes	1128.596	1128.665	0.069		
3038A	403152.785	3850528.532	Yes	1039.202	1039.153	-0.049		
3039	398241.531	3835576.27	Yes	1972.747	1972.766	0.019		
3040	404616.147	3827590.397	Yes	1509.721	1509.481	-0.240		
3040A	407042.933	3831867.211	Yes	1294.612	1294.663	0.051		

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_Cherry\Client_LAS](#)

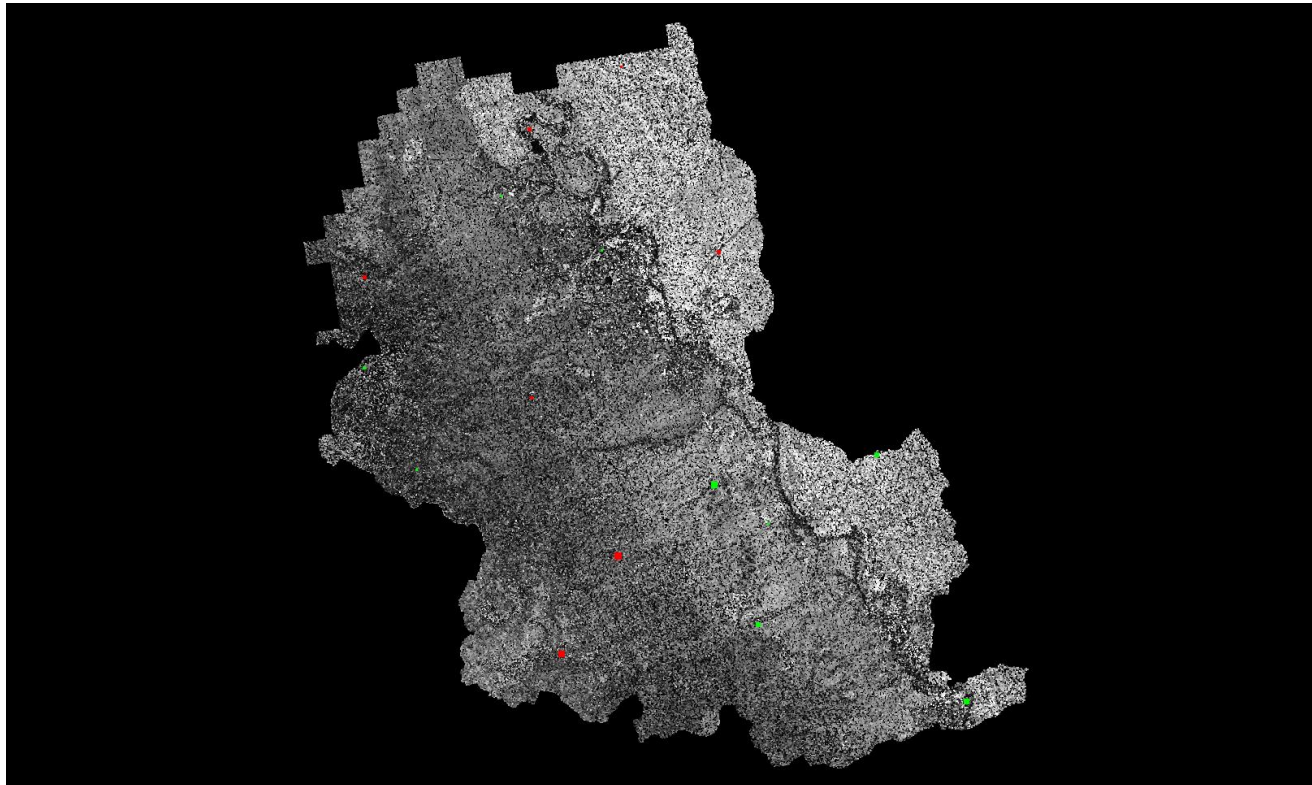


DPH-11 Report on Absolute Vertical Accuracy - continued

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 - Y:\Mapping\Projects\65220636_AZ_AubreyCherry\Production\Final_Client_Deliverables\195103\AZ_AubreyCherry_1_2020_210877\point_cloud\tilecls\Cherry](Y:\Mapping\Projects\65220636_AZ_AubreyCherry\Production\Final_Client_Deliverables\195103\AZ_AubreyCherry_1_2020_210877\point_cloud\tilecls\Cherry)

[Result Path - D:\00_Cherry\Cherry_OC\DPH_11\ColorByIntensity_CheckPoints_NVA.jpg](D:\00_Cherry\Cherry_OC\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).

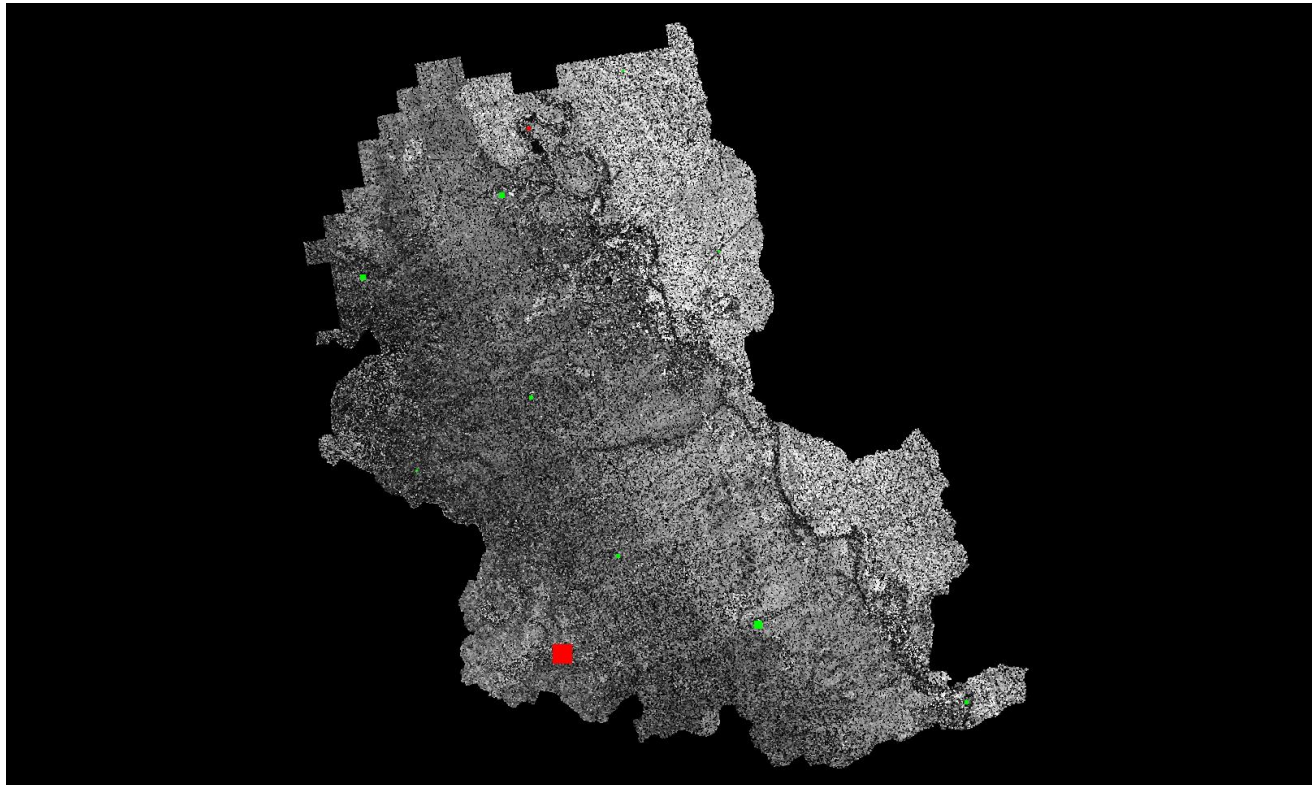
The size of the square symbol represents the absolute value magnitude of error.

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 - Y:\Mapping\Projects\65220636_AZ_AubreyCherry\Production\Final_Client_Deliverables\195103\AZ_AubreyCherry_1_2020_210877\point_cloud\tilecls\Cherry](Y:\Mapping\Projects\65220636_AZ_AubreyCherry\Production\Final_Client_Deliverables\195103\AZ_AubreyCherry_1_2020_210877\point_cloud\tilecls\Cherry)

[Result Path - D:\000_Cherry\Cherry_OC\DPH_11\ColorByIntensity_CheckPoints_VVA.jpg](D:\000_Cherry\Cherry_OC\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.