

# 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;  $\leq$ , 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 - Y:\Mapping\Projects\65221102\\_MN\\_BeckerCounty\Survey\\_Control\02\\_Laser\\_Control\01\\_FINAL\NVA\\_VVA\\_UT\\_M15\\_nad2011\\_g18\\_meters.shp](#)

Units: Meter (/Feet)

Vertical Accuracy Class tested: 10-cm

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Check Points in defined project area (DPA):	133
Check Points with Lidar Coverage	133
Check Points with Lidar Coverage (NVA)	77
Check Points with Lidar Coverage (VVA)	56
Average Z Error (NVA)	-0.020/-0.065
Maximum Z Error (NVA)	0.063/0.206
Median Z Error (NVA)	-0.016/-0.053
Minimum Z Error (NVA)	-0.092/-0.300
Standard deviation of Vertical Error (NVA)	0.031/0.102
Skewness of Vertical Error (NVA)	0.003
Kurtosis of Vertical Error (NVA)	-0.286
Non-vegetated Vertical Accuracy (NVA) RMSE(z) <sup>1</sup>	0.037/0.121 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/- <sup>1</sup>	0.072/0.237 PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-	0.072/0.237
Non-vegetated Vertical Accuracy (NVA) RMSE(z) (DEM) <sup>2</sup>	0.037/0.122 PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level (DEM) +/- <sup>2</sup>	0.073/0.239 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (TIN) +/- <sup>1</sup>	0.121/0.398 PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile (DEM) +/- <sup>2</sup>	0.121/0.397 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 = 3.7cm, equating to +/- 7.2cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 12.1cm 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 2022 rev. A (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
NVA1000	266542.361	5205697.965	Yes	373.557	373.566	0.009	373.56	373.568	373.568	2493	470	1,1,1	LIPT	
NVA1001	331718.423	5179380.945	Yes	451.595	451.551	-0.044	451.534	451.558	451.56	1220	-284	1,1,1	LIPT	
NVA1002	275404.591	5221436.332	Yes	379.071	378.979	-0.092	378.978	378.986	379.002	1782	656	1,1,1	LIPT	
NVA1003	304996.937	5204145.809	Yes	470.241	470.184	-0.057	470.178	470.184	470.202	2517	1464	1,1,1	LIPT	
NVA1004	303829.255	5218869.46	Yes	468.235	468.222	-0.013	468.177	468.222	468.226	1342	-1477	1,1,1	LIPT	
NVA1005	317220.565	5178005.026	Yes	452.249	452.312	0.063	452.287	452.305	452.33	2276	507	1,1,1	LIPT	
NVA1006	278606.458	5214804.84	Yes	390.147	390.077	-0.070	390.071	390.08	390.1	1450	1949	1,1,1	LIPT	
NVA1007	285590.516	5198496.866	Yes	433.979	433.975	-0.004	433.966	433.969	433.979	2299	-2411	1,1,1	LIPT	
NVA1008	327064.614	5190719.689	Yes	457.69	457.684	-0.006	457.675	457.678	457.704	1984	260	1,1,1	LIPT	
NVA1009	329021.857	5222806.29	Yes	485.926	485.919	-0.007	485.915	485.918	485.951	2529	153	1,1,1	LIPT	
NVA1010	302604.435	5193551.887	Yes	446.402	446.413	0.011	446.41	446.418	446.418	1393	-559	1,1,1	LIPT	
NVA1011	315927.064	5215175.224	Yes	495.407	495.323	-0.084	495.311	495.321	495.346	2889	-101	1,1,1	LIPT	
NVA1012	325335.547	5185834.963	Yes	463.387	463.355	-0.032	463.351	463.362	463.372	2056	423	1,1,1	LIPT	
NVA1013	296123.164	5195644.525	Yes	446.833	446.784	-0.049	446.778	446.78	446.794	2159	101	1,1,1	LIPT	
NVA1014	293100.203	5185215.818	Yes	431.406	431.366	-0.040	431.362	431.368	431.37	1953	2338	1,1,1	LIPT	
NVA1015	286522.613	5182297.416	Yes	415.613	415.542	-0.071	415.533	415.546	415.581	1248	-2753	1,1,1	LIPT	
NVA1016	261263.294	5196118.261	Yes	405.656	405.665	0.009	405.649	405.661	405.68	1626	516	1,1,1	LIPT	
NVA1017	311617.008	5232046.146	Yes	561.56	561.543	-0.017	561.526	561.545	561.547	2315	2543	1,1,1	LIPT	
NVA1017ALT	311631.094	5231796.117	Yes	556.064	556.021	-0.043	556.005	556.025	556.032	2290	1497	1,1,1	LIPT	
NVA1018	293408.199	5217740.216	Yes	465.412	465.393	-0.019	465.377	465.395	465.398	1979	-914	1,1,1	LIPT	
NVA1019	325498.842	5212430.038	Yes	478.215	478.198	-0.017	478.153	478.198	478.211	2314	2096	1,1,1	LIPT	
NVA1020	316383.554	5224079.929	Yes	503.458	503.473	0.015	503.461	503.473	503.475	1398	-577	1,1,1	LIPT	
NVA1021	263987.467	5183949.919	Yes	423.31	423.3	-0.010	423.267	423.317	423.325	822	1110	1,1,1	LIPT	
NVA1022	261958.483	5207413.385	Yes	372.124	372.097	-0.027	372.091	372.094	372.112	1885	2127	1,1,1	LIPT	
NVA1023	316775.841	5190859.579	Yes	482.398	482.358	-0.040	482.339	482.339	482.386	2156	486	1,1,1	LIPT	
NVA1024	330454.739	5218067.574	Yes	478.689	478.637	-0.052	478.626	478.652	478.655	2187	-1471	1,1,1	LIPT	
NVA1025	301831.955	5210922.287	Yes	460.322	460.299	-0.023	460.291	460.299	460.301	1847	-1355	1,1,1	LIPT	
NVA1026	277609.598	5184099.346	Yes	410.271	410.272	0.001	410.257	410.273	410.275	1018	622	1,1,1	LIPT	
NVA1027	313135.032	5204676.528	Yes	473.832	473.827	-0.005	473.823	473.847	473.864	1784	-2247	1,1,1	LIPT	
NVA1028	270376.058	5179793.948	Yes	436.468	436.469	0.001	436.445	436.449	436.473	1429	1555	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
NVA1029	326468.785	5198665.609	Yes	455.549	455.545	-0.004	455.525	455.546	455.564	2191	228	1,1,1	LIPT	
NVA1030	329064.9	5203613.671	Yes	454.425	454.419	-0.006	454.405	454.418	454.43	1202	731	1,1,1	LIPT	
NVA1031	291821.381	5203925.825	Yes	445.258	445.213	-0.045	445.209	445.234	445.246	2409	-241	1,1,1	LIPT	
NVA1032	308507.434	5186296.217	Yes	467.567	467.609	0.042	467.594	467.596	467.62	1637	382	1,1,1	LIPT	
NVA1033	310845.924	5181525.37	Yes	454.888	454.844	-0.044	454.839	454.85	454.858	901	-2509	1,1,1	LIPT	
NVA1034	298507.986	5203712.204	Yes	452.787	452.766	-0.021	452.762	452.765	452.777	3929	-348	1,1,1	LIPT	
NVA1035	264322.19	5192953.066	Yes	418.921	418.92	-0.001	418.918	418.92	418.922	1825	-700	1,1,1	LIPT	
NVA1036	307724.328	5210353.957	Yes	463.506	463.459	-0.047	463.449	463.471	463.478	1563	495	1,1,1	LIPT	
NVA1037	316132.242	5219986.806	Yes	495.86	495.819	-0.041	495.81	495.817	495.823	2638	984	1,1,1	LIPT	
NVA1038	293207.986	5179218.416	Yes	425.639	425.629	-0.010	425.598	425.627	425.633	1324	-1972	1,1,1	LIPT	
NVA1039	305856.251	5224567.438	Yes	491.762	491.772	0.010	491.754	491.767	491.783	1171	-54	1,1,1	LIPT	
NVA1040	283718.881	5216213.841	Yes	471.006	470.996	-0.010	470.965	470.985	471.003	1525	-288	1,1,1	LIPT	
NVA1041	282441.716	5189619.654	Yes	414.691	414.67	-0.021	414.658	414.67	414.695	1316	2356	1,1,1	LIPT	
NVA1042	257396.009	5178698.858	Yes	431.743	431.735	-0.008	431.698	431.73	431.741	1353	-1252	1,1,1	LIPT	
NVA1043	259249.347	5222006.355	Yes	356.815	356.785	-0.030	356.771	356.789	356.798	2521	1008	1,1,1	LIPT	
NVA1044	299370.386	5180143.243	Yes	427.677	427.661	-0.016	427.629	427.677	427.679	1461	-1355	1,1,1	LIPT	
NVA1045	287370.239	5225678.487	Yes	467.848	467.8	-0.048	467.797	467.8	467.804	2344	2401	1,1,1	LIPT	
NVA1046	266272.897	5199230.361	Yes	404.333	404.32	-0.013	404.312	404.321	404.346	2109	-2577	1,1,1	LIPT	
NVA1047	303716.342	5188865.021	Yes	463.239	463.286	0.047	463.261	463.277	463.288	1907	2451	1,1,1	LIPT	
NVA1048	312856.791	5195888.449	Yes	474.716	474.65	-0.066	474.643	474.666	474.677	2215	-1075	1,1,1	LIPT	
NVA1049	258397.188	5202856.987	Yes	366.573	366.565	-0.008	366.546	366.564	366.593	2808	1072	1,1,1	LIPT	
NVA1050	270643.029	5213544.986	Yes	381.74	381.679	-0.061	381.672	381.675	381.681	2944	1115	1,1,1	LIPT	
NVA1051	269345.549	5221662.211	Yes	373.787	373.733	-0.054	373.705	373.772	373.787	1625	738	1,1,1	LIPT	
NVA1052	281771.704	5205136.983	Yes	448.804	448.748	-0.056	448.724	448.746	448.757	1722	759	1,1,1	LIPT	
NVA1052ALT	281774.858	5205132.199	Yes	448.767	448.708	-0.059	448.7	448.712	448.712	2039	795	1,1,1	LIPT	
NVA1053	273863.657	5190095.405	Yes	407.81	407.815	0.005	407.796	407.812	407.819	890	1791	1,1,1	LIPT	
NVA1054	322185.825	5208537.832	Yes	472.302	472.328	0.026	472.321	472.322	472.34	611	2358	1,1,1	LIPT	
NVA1055	332112.968	5198692.929	Yes	450.302	450.307	0.005	450.288	450.297	450.327	2194	-628	1,1,1	LIPT	
NVA1056	293283.037	5223413.792	Yes	468.423	468.381	-0.042	468.36	468.389	468.402	2200	1383	1,1,1	LIPT	
NVA1057	274099.905	5208559.52	Yes	382.209	382.214	0.005	382.2	382.203	382.247	1562	-83	1,1,1	LIPT	
NVA1058	259117.332	5186310.242	Yes	425.17	425.145	-0.025	425.14	425.143	425.181	1051	1899	1,1,1	LIPT	
NVA1059	288642.144	5207853.702	Yes	458.694	458.701	0.007	458.671	458.71	458.72	1807	-747	1,1,1	LIPT	
NVA1060	334161.01	5185759.969	Yes	434.378	434.333	-0.045	434.33	434.332	434.335	1752	1419	1,1,1	LIPT	
NVA1061	258904.804	5212373.063	Yes	362.744	362.686	-0.058	362.651	362.664	362.692	3088	-688	1,1,1	LIPT	
NVA1061ALT	258907.06	5212364.248	Yes	362.731	362.675	-0.056	362.667	362.676	362.676	3459	-594	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
NVA1062	272782.95	5202225.117	Yes	383.636	383.644	0.008	383.632	383.641	383.665	1541	1554	1,1,1	LIPT	
NVA1063	332378.646	5210742.531	Yes	448.435	448.432	-0.003	448.416	448.43	448.436	2560	-210	1,1,1	LIPT	
NVA2011	302559.64	5193511.391	Yes	446.044	446.015	-0.029	445.997	446.022	446.031	3083	-372	1,1,1	LIPT	
NVA3001	266454.477	5204071.297	Yes	375.718	375.687	-0.031	375.683	375.688	375.693	2301	1041	1,1,1	LIPT	
NVA3002	331752.844	5177778.616	Yes	452.285	452.269	-0.016	452.239	452.272	452.285	2405	1458	1,1,1	LIPT	
NVA3005	306533.569	5224643.436	Yes	485.18	485.19	0.010	485.183	485.191	485.209	1611	439	1,1,1	LIPT	
NVA3006	317173.774	5179599.716	Yes	469.626	469.631	0.005	469.63	469.63	469.633	1690	-1215	1,1,1	LIPT	
NVA3011	303143.965	5193896.071	Yes	446.187	446.205	0.018	446.199	446.211	446.225	1991	-2026	1,1,1	LIPT	
NVA3012	322297.388	5211802.952	Yes	473.107	473.13	0.023	473.107	473.13	473.137	1455	-679	1,1,1	LIPT	
NVA3014	296068.952	5196016.123	Yes	447.853	447.78	-0.073	447.779	447.783	447.785	1876	-1597	1,1,1	LIPT	
NVA3018	309715.296	5224403.127	Yes	482.964	482.975	0.011	482.973	482.98	482.982	2670	-238	1,1,1	LIPT	
NVA3028	316543.736	5204653.704	Yes	467.875	467.896	0.021	467.892	467.899	467.924	1472	-1953	1,1,1	LIPT	

# 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
VVA2001	266464.461	5205680.016	Yes	369.68	369.766	0.086	369.759	369.771	369.782	3095	595	1,1,1	LIPT	
VVA2002	331744.068	5179320.321	Yes	451.234	451.376	0.142	451.368	451.381	451.388	2396	-587	1,1,2	LIPT	
VVA2002ALT	331743.171	5179303.023	Yes	451.329	451.334	0.005	451.319	451.344	451.384	1280	-700	2,2,1	LIPT	
VVA2003	275429.44	5221454.919	Yes	378.691	378.735	0.044	378.73	378.745	378.757	2888	578	1,1,1	LIPT	
VVA2004	305093.708	5204147.83	Yes	468.506	468.564	0.058	468.558	468.576	468.587	4103	1445	1,1,1	LIPT	
VVA2005	303734.296	5218853.826	Yes	471.379	471.445	0.066	471.435	471.438	471.471	2818	-1420	1,2,1	LIPT	
VVA2006	317238.355	5178036.166	Yes	451.178	451.29	0.112	451.275	451.303	451.309	3900	637	1,1,1	LIPT	
VVA2007	278550.236	5214835.789	Yes	390.139	390.179	0.040	390.159	390.174	390.181	3496	2701	1,1,1	LIPT	
VVA2008	285650.726	5198527.766	Yes	429.053	429.123	0.070	429.119	429.122	429.135	3649	-2337	1,1,1	LIPT	
VVA2009	327081.967	5190749.489	Yes	456.11	456.152	0.042	456.142	456.165	456.168	3467	126	1,1,1	LIPT	
VVA2010	329016.209	5222884.945	Yes	484.866	484.87	0.004	484.841	484.876	484.895	3501	-233	1,1,1	LIPT	
VVA2012	315942.072	5215158.25	Yes	494.327	494.312	-0.015	494.296	494.318	494.342	3329	-200	1,1,1	LIPT	
VVA2013	325316.579	5186226.525	Yes	464.177	464.278	0.101	464.244	464.286	464.291	1732	2314	2,1,3	LIPT	
VVA2014	296047.774	5195601.682	Yes	449.149	449.122	-0.027	449.105	449.109	449.159	2821	307	1,1,1	LIPT	
VVA2015	293068.028	5185223.992	Yes	430.95	430.936	-0.014	430.921	430.926	430.959	2797	2363	1,1,1	LIPT	
VVA2016	286545.944	5182249.213	Yes	415.97	415.994	0.024	415.979	416.009	416.018	2633	-2397	1,1,1	LIPT	
VVA2017	261235.236	5196086.668	Yes	403.278	403.351	0.073	403.347	403.348	403.404	3720	339	1,1,1	LIPT	
VVA2018	311604.485	5232059.086	Yes	560.614	560.626	0.012	560.591	560.618	560.629	2882	1852	1,1,1	LIPT	
VVA2019	293328.936	5217690.831	Yes	466.878	466.94	0.062	466.901	466.912	466.946	3782	-719	1,1,1	LIPT	
VVA2020	325508.807	5212506.624	Yes	479.67	479.706	0.036	479.691	479.703	479.719	3073	2266	1,1,2	LIPT	
VVA2021	316280.021	5223958.358	Yes	501.606	501.59	-0.016	501.582	501.588	501.604	2429	-1165	1,1,1	LIPT	
VVA2022	263992.85	5184000.344	Yes	422.517	422.518	0.001	422.517	422.527	422.546	2193	1375	1,1,1	LIPT	
VVA2023	262258.634	5207414.939	Yes	372.126	372.136	0.010	372.12	372.125	372.148	3153	2112	1,1,1	LIPT	
VVA2024	316892.023	5190884.733	Yes	481.431	481.472	0.041	481.416	481.457	481.496	3477	313	1,1,1	LIPT	
VVA2025	330514.3	5218132.266	Yes	480.633	480.629	-0.004	480.604	480.628	480.641	3339	-1804	1,1,1	LIPT	
VVA2026	301804.56	5210935.852	Yes	456.48	456.539	0.059	456.513	456.519	456.581	2827	-1394	1,1,1	LIPT	
VVA2027	277585.189	5184273.523	Yes	408.557	408.559	0.002	408.518	408.561	408.562	2873	-176	1,1,1	LIPT	
VVA2027ALT	277611.713	5184266.964	Yes	408.902	408.893	-0.009	408.878	408.895	408.896	2410	-82	2,3,2	LIPT	
VVA2028	313204.934	5204878.187	Yes	474.995	475.055	0.060	475.04	475.057	475.059	3086	-1340	1,1,1	LIPT	
VVA2029ALT	272412.17	5179671.935	Yes	422.036	422.041	0.005	422.038	422.038	422.08	3474	1083	1,1,1	LIPT	

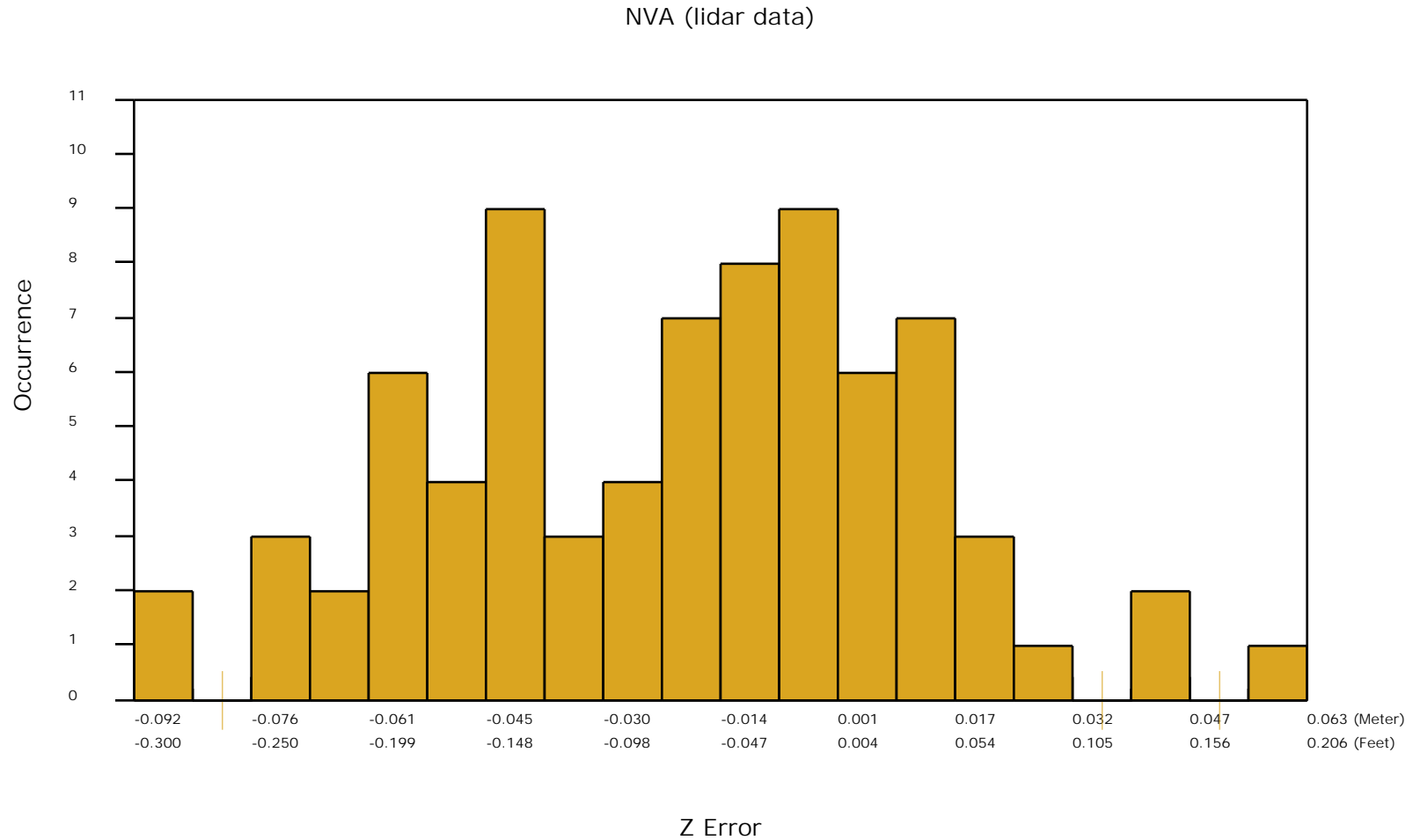
## Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Minimum Z	Median Z	Maximum Z	Intensity	Scan Angle Rank	Returns	Description	Comments
VVA2030	326666.863	5198782.57	Yes	453.792	454.222	0.430	454.207	454.243	454.246	2689	-276	1,1,1	LIPT	
VVA2030ALT	326663.599	5198778.298	Yes	454.226	454.34	0.114	454.286	454.345	454.353	2211	-319	1,1,1	LIPT	
VVA2031	329020.441	5203644.836	Yes	457.768	457.762	-0.006	457.754	457.759	457.775	3165	593	1,1,1	LIPT	
VVA2032	291695.48	5203976.691	Yes	442.805	442.891	0.086	442.872	442.894	442.896	4924	-436	1,1,1	LIPT	
VVA2032ALT	291598.952	5203972.108	Yes	442.899	442.903	0.004	442.89	442.897	442.914	3614	-353	1,1,1	LIPT	
VVA2033	308673.392	5186309.766	Yes	464.984	465.089	0.105	465.078	465.098	465.121	2908	525	1,1,1	LIPT	
VVA2034	310816.664	5181482.522	Yes	454.017	454.119	0.102	454.103	454.119	454.127	1883	-2360	2,2,1	LIPT	
VVA2035	298499.251	5203761.082	Yes	452.217	452.223	0.006	452.209	452.213	452.224	3758	-521	1,1,1	LIPT	
VVA2036	262562.566	5193042.449	Yes	413.248	413.443	0.195	413.4	413.458	413.458	3027	-749	1,1,1	LIPT	
VVA2037	307374.604	5210724.901	Yes	469.498	469.505	0.007	469.5	469.532	469.538	2955	-1171	1,1,1	LIPT	
VVA2038	316130.966	5219431.351	Yes	497.842	497.83	-0.012	497.817	497.833	497.839	3096	1147	1,1,1	LIPT	
VVA2039	293311.952	5179824.86	Yes	422.846	422.907	0.061	422.864	422.91	422.945	3000	597	1,1,1	LIPT	
VVA2040	305830.097	5224540.448	Yes	492.95	492.995	0.045	492.991	492.993	493.016	2771	-186	1,1,1	LIPT	
VVA2041	283614.133	5216436.457	Yes	472.858	472.856	-0.002	472.855	472.859	472.883	3387	705	1,1,1	LIPT	
VVA2042	282134.389	5189563.516	Yes	416.309	416.305	-0.004	416.297	416.309	416.324	2565	2398	1,1,1	LIPT	
VVA2043	257907.057	5178676.153	Yes	430.395	430.337	-0.058	430.31	430.329	430.362	3590	-1315	1,1,1	LIPT	
VVA2044	259318.208	5222021.814	Yes	356.344	356.33	-0.014	356.292	356.301	356.34	2992	880	1,1,1	LIPT	
VVA2044ALT	259267.412	5222001.091	Yes	355.873	355.906	0.033	355.901	355.91	355.912	2840	1009	1,1,1	LIPT	
VVA2044RE	259564.152	5222020.459	Yes	355.63	355.633	0.003	355.619	355.633	355.634	3068	905	1,1,1	LIPT	
VVA2045	299347.058	5180168.077	Yes	426.001	426.018	0.017	426.001	426.017	426.043	2041	-1241	1,1,1	LIPT	
VVA2046	287475.247	5225694.634	Yes	464.77	464.724	-0.046	464.711	464.716	464.767	3250	2538	1,1,1	LIPT	
VVA2047	266237.282	5199252.489	Yes	403.738	403.766	0.028	403.757	403.765	403.773	2907	-2125	1,1,1	LIPT	
VVA2048	303249.151	5188909.344	Yes	460.777	460.89	0.113	460.86	460.886	460.91	2351	2435	1,1,1	LIPT	
VVA2049	312823.177	5195843.557	Yes	472.117	472.136	0.019	472.123	472.142	472.18	3845	-1303	1,1,1	LIPT	
VVA2050	258339.636	5202838.413	Yes	366.056	366.127	0.071	366.1	366.127	366.161	3237	1117	1,1,1	LIPT	
VVA2051	270631.918	5213521.371	Yes	381.059	381.012	-0.047	381.001	381.02	381.022	2238	1163	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 - Y:\Mapping\Projects\65221102\\_MN\\_BeckerCounty\Production\Final\\_Client\\_Deliverables\223407\223404\\_MN\\_BeckerCo\\_1\\_2021\point\\_cloud\tilecls](#)



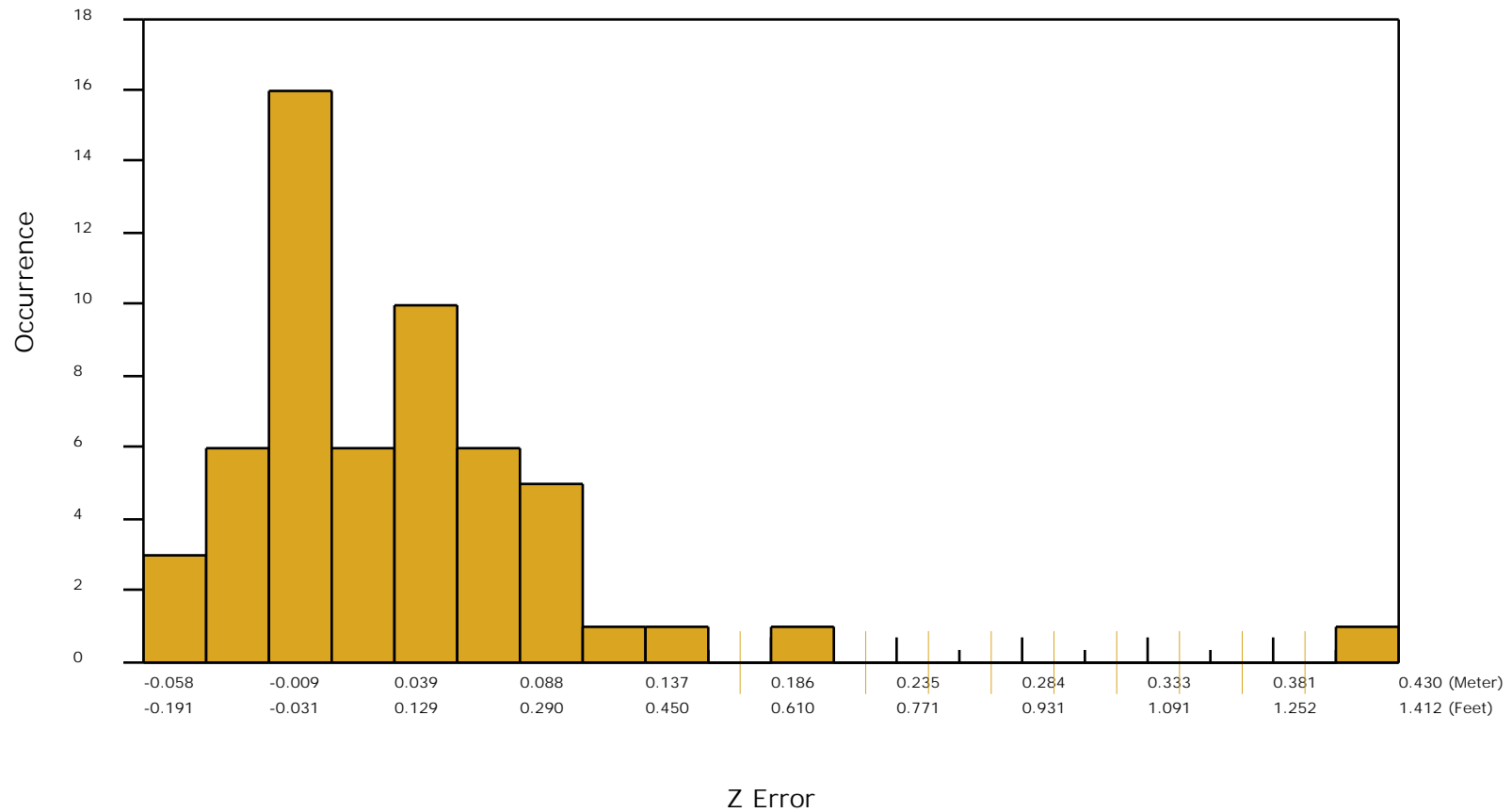


# DPH-11 Report on Absolute Vertical Accuracy - continued

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 - Y:\Mapping\Projects\65221102\\_MN\\_BeckerCounty\Production\Final\\_Client\\_Deliverables\223407\223404\\_MN\\_BeckerCo\\_1\\_2021\point\\_cloud\tilecls](#)

VVA (lidar data)



## 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
NVA1000	266542.361	5205697.965	Yes	373.557	373.562	0.005	LIPT	
NVA1001	331718.423	5179380.945	Yes	451.595	451.562	-0.033	LIPT	
NVA1002	275404.591	5221436.332	Yes	379.071	378.983	-0.088	LIPT	
NVA1003	304996.937	5204145.809	Yes	470.241	470.190	-0.051	LIPT	
NVA1004	303829.255	5218869.46	Yes	468.235	468.216	-0.019	LIPT	
NVA1005	317220.565	5178005.026	Yes	452.249	452.306	0.057	LIPT	
NVA1006	278606.458	5214804.84	Yes	390.147	390.095	-0.052	LIPT	
NVA1007	285590.516	5198496.866	Yes	433.979	433.976	-0.003	LIPT	
NVA1008	327064.614	5190719.689	Yes	457.69	457.685	-0.005	LIPT	
NVA1009	329021.857	5222806.29	Yes	485.926	485.910	-0.016	LIPT	
NVA1010	302604.435	5193551.887	Yes	446.402	446.402	0.000	LIPT	
NVA1011	315927.064	5215175.224	Yes	495.407	495.329	-0.078	LIPT	
NVA1012	325335.547	5185834.963	Yes	463.387	463.388	0.001	LIPT	
NVA1013	296123.164	5195644.525	Yes	446.833	446.788	-0.045	LIPT	
NVA1014	293100.203	5185215.818	Yes	431.406	431.368	-0.038	LIPT	
NVA1015	286522.613	5182297.416	Yes	415.613	415.569	-0.044	LIPT	
NVA1016	261263.294	5196118.261	Yes	405.656	405.664	0.008	LIPT	
NVA1017	311617.008	5232046.146	Yes	561.56	561.528	-0.032	LIPT	
NVA1017ALT	311631.094	5231796.117	Yes	556.064	556.024	-0.040	LIPT	
NVA1018	293408.199	5217740.216	Yes	465.412	465.398	-0.014	LIPT	
NVA1019	325498.842	5212430.038	Yes	478.215	478.183	-0.032	LIPT	
NVA1020	316383.554	5224079.929	Yes	503.458	503.480	0.022	LIPT	
NVA1021	263987.467	5183949.919	Yes	423.31	423.292	-0.018	LIPT	
NVA1022	261958.483	5207413.385	Yes	372.124	372.105	-0.019	LIPT	
NVA1023	316775.841	5190859.579	Yes	482.398	482.371	-0.027	LIPT	
NVA1024	330454.739	5218067.574	Yes	478.689	478.639	-0.050	LIPT	
NVA1025	301831.955	5210922.287	Yes	460.322	460.290	-0.032	LIPT	
NVA1026	277609.598	5184099.346	Yes	410.271	410.261	-0.010	LIPT	
NVA1027	313135.032	5204676.528	Yes	473.832	473.839	0.007	LIPT	
NVA1028	270376.058	5179793.948	Yes	436.468	436.442	-0.026	LIPT	

## Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
NVA1029	326468.785	5198665.609	Yes	455.549	455.538	-0.011	LIPT	
NVA1030	329064.9	5203613.671	Yes	454.425	454.424	-0.001	LIPT	
NVA1031	291821.381	5203925.825	Yes	445.258	445.221	-0.037	LIPT	
NVA1032	308507.434	5186296.217	Yes	467.567	467.620	0.053	LIPT	
NVA1033	310845.924	5181525.37	Yes	454.888	454.843	-0.045	LIPT	
NVA1034	298507.986	5203712.204	Yes	452.787	452.767	-0.020	LIPT	
NVA1035	264322.19	5192953.066	Yes	418.921	418.922	0.001	LIPT	
NVA1036	307724.328	5210353.957	Yes	463.506	463.422	-0.084	LIPT	
NVA1037	316132.242	5219986.806	Yes	495.86	495.816	-0.044	LIPT	
NVA1038	293207.986	5179218.416	Yes	425.639	425.624	-0.015	LIPT	
NVA1039	305856.251	5224567.438	Yes	491.762	491.765	0.003	LIPT	
NVA1040	283718.881	5216213.841	Yes	471.006	471.001	-0.005	LIPT	
NVA1041	282441.716	5189619.654	Yes	414.691	414.681	-0.010	LIPT	
NVA1042	257396.009	5178698.858	Yes	431.743	431.710	-0.033	LIPT	
NVA1043	259249.347	5222006.355	Yes	356.815	356.783	-0.032	LIPT	
NVA1044	299370.386	5180143.243	Yes	427.677	427.674	-0.003	LIPT	
NVA1045	287370.239	5225678.487	Yes	467.848	467.786	-0.062	LIPT	
NVA1046	266272.897	5199230.361	Yes	404.333	404.322	-0.011	LIPT	
NVA1047	303716.342	5188865.021	Yes	463.239	463.272	0.033	LIPT	
NVA1048	312856.791	5195888.449	Yes	474.716	474.657	-0.059	LIPT	
NVA1049	258397.188	5202856.987	Yes	366.573	366.587	0.014	LIPT	
NVA1050	270643.029	5213544.986	Yes	381.74	381.680	-0.060	LIPT	
NVA1051	269345.549	5221662.211	Yes	373.787	373.766	-0.021	LIPT	
NVA1052	281771.704	5205136.983	Yes	448.804	448.736	-0.068	LIPT	
NVA1052ALT	281774.858	5205132.199	Yes	448.767	448.708	-0.059	LIPT	
NVA1053	273863.657	5190095.405	Yes	407.81	407.804	-0.006	LIPT	
NVA1054	322185.825	5208537.832	Yes	472.302	472.320	0.018	LIPT	
NVA1055	332112.968	5198692.929	Yes	450.302	450.294	-0.008	LIPT	
NVA1056	293283.037	5223413.792	Yes	468.423	468.413	-0.010	LIPT	
NVA1057	274099.905	5208559.52	Yes	382.209	382.234	0.025	LIPT	
NVA1058	259117.332	5186310.242	Yes	425.17	425.144	-0.026	LIPT	
NVA1059	288642.144	5207853.702	Yes	458.694	458.702	0.008	LIPT	
NVA1060	334161.01	5185759.969	Yes	434.378	434.307	-0.071	LIPT	
NVA1061	258904.804	5212373.063	Yes	362.744	362.680	-0.064	LIPT	
NVA1061ALT	258907.06	5212364.248	Yes	362.731	362.671	-0.060	LIPT	

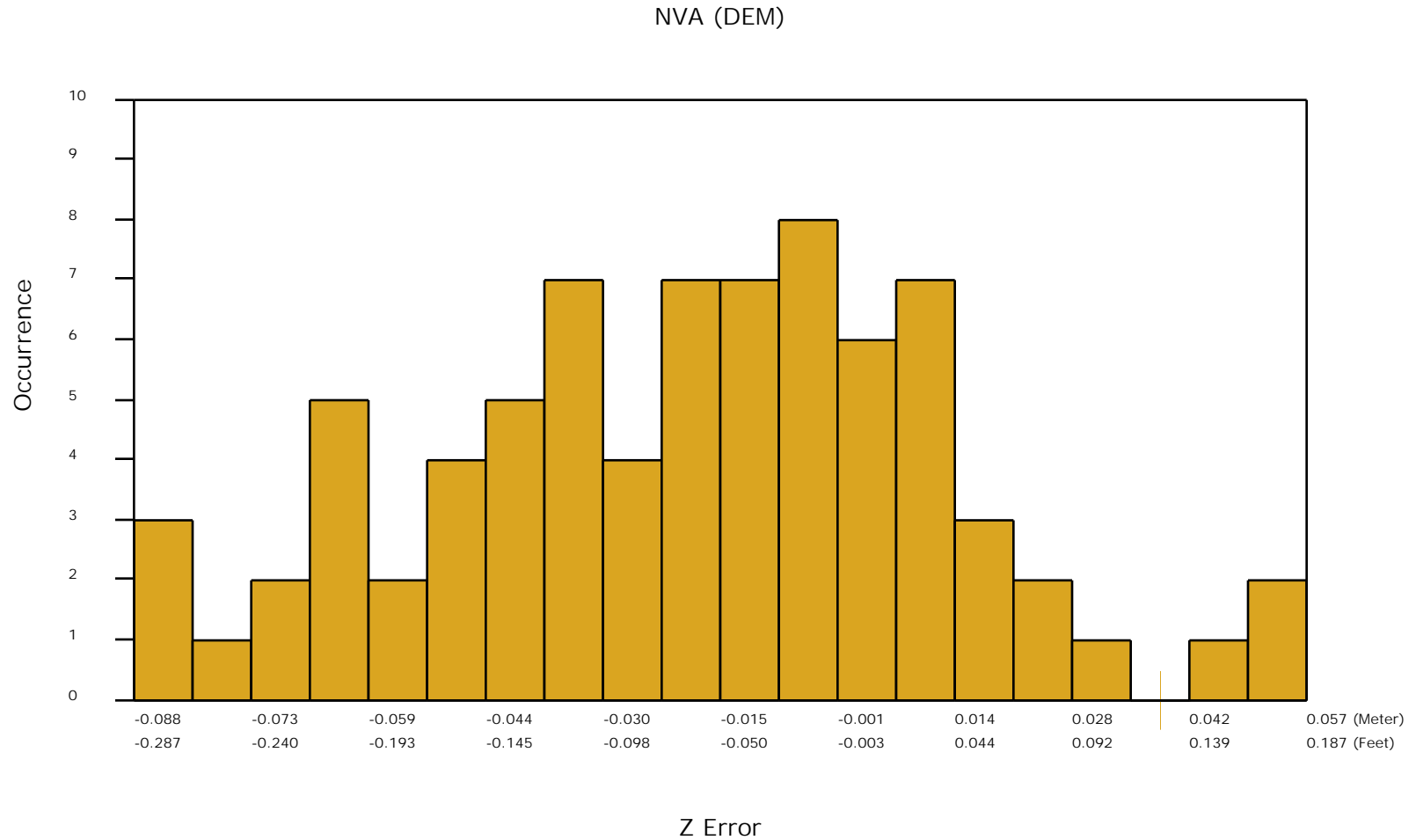
## Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
NVA1062	272782.95	5202225.117	Yes	383.636	383.645	0.009	LIPT	
NVA1063	332378.646	5210742.531	Yes	448.435	448.413	-0.022	LIPT	
NVA2011	302559.64	5193511.391	Yes	446.044	446.007	-0.037	LIPT	
NVA3001	266454.477	5204071.297	Yes	375.718	375.692	-0.026	LIPT	
NVA3002	331752.844	5177778.616	Yes	452.285	452.278	-0.007	LIPT	
NVA3005	306533.569	5224643.436	Yes	485.18	485.189	0.009	LIPT	
NVA3006	317173.774	5179599.716	Yes	469.626	469.631	0.005	LIPT	
NVA3011	303143.965	5193896.071	Yes	446.187	446.236	0.049	LIPT	
NVA3012	322297.388	5211802.952	Yes	473.107	473.120	0.013	LIPT	
NVA3014	296068.952	5196016.123	Yes	447.853	447.767	-0.086	LIPT	
NVA3018	309715.296	5224403.127	Yes	482.964	482.974	0.010	LIPT	
NVA3028	316543.736	5204653.704	Yes	467.875	467.895	0.020	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.

[Data Source - Y:\Mapping\Projects\65221102\\_MN\\_BeckerCounty\Production\Final\\_Client\\_Deliverables\223407\223404\\_MN\\_BeckerCo\\_1\\_2021\point\\_cloud\tilecls](Y:\Mapping\Projects\65221102_MN_BeckerCounty\Production\Final_Client_Deliverables\223407\223404_MN_BeckerCo_1_2021\point_cloud\tilecls)



## 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
VVA2001	266464.461	5205680.016	Yes	369.68	369.768	0.088	LIPT	
VVA2002	331744.068	5179320.321	Yes	451.234	451.371	0.137	LIPT	
VVA2002ALT	331743.171	5179303.023	Yes	451.329	451.383	0.054	LIPT	
VVA2003	275429.44	5221454.919	Yes	378.691	378.739	0.048	LIPT	
VVA2004	305093.708	5204147.83	Yes	468.506	468.560	0.054	LIPT	
VVA2005	303734.296	5218853.826	Yes	471.379	471.438	0.059	LIPT	
VVA2006	317238.355	5178036.166	Yes	451.178	451.290	0.112	LIPT	
VVA2007	278550.236	5214835.789	Yes	390.139	390.172	0.033	LIPT	
VVA2008	285650.726	5198527.766	Yes	429.053	429.123	0.070	LIPT	
VVA2009	327081.967	5190749.489	Yes	456.11	456.166	0.056	LIPT	
VVA2010	329016.209	5222884.945	Yes	484.866	484.868	0.002	LIPT	
VVA2012	315942.072	5215158.25	Yes	494.327	494.297	-0.030	LIPT	
VVA2013	325316.579	5186226.525	Yes	464.177	464.292	0.115	LIPT	
VVA2014	296047.774	5195601.682	Yes	449.149	449.119	-0.030	LIPT	
VVA2015	293068.028	5185223.992	Yes	430.95	430.929	-0.021	LIPT	
VVA2016	286545.944	5182249.213	Yes	415.97	416.011	0.041	LIPT	
VVA2017	261235.236	5196086.668	Yes	403.278	403.349	0.071	LIPT	
VVA2018	311604.485	5232059.086	Yes	560.614	560.611	-0.003	LIPT	
VVA2019	293328.936	5217690.831	Yes	466.878	466.945	0.067	LIPT	
VVA2020	325508.807	5212506.624	Yes	479.67	479.725	0.055	LIPT	
VVA2021	316280.021	5223958.358	Yes	501.606	501.580	-0.026	LIPT	
VVA2022	263992.85	5184000.344	Yes	422.517	422.528	0.011	LIPT	
VVA2023	262258.634	5207414.939	Yes	372.126	372.129	0.003	LIPT	
VVA2024	316892.023	5190884.733	Yes	481.431	481.489	0.058	LIPT	
VVA2025	330514.3	5218132.266	Yes	480.633	480.628	-0.005	LIPT	
VVA2026	301804.56	5210935.852	Yes	456.48	456.551	0.071	LIPT	
VVA2027	277585.189	5184273.523	Yes	408.557	408.518	-0.039	LIPT	
VVA2027ALT	277611.713	5184266.964	Yes	408.902	408.889	-0.013	LIPT	
VVA2028	313204.934	5204878.187	Yes	474.995	475.056	0.061	LIPT	
VVA2029ALT	272412.17	5179671.935	Yes	422.036	422.047	0.011	LIPT	

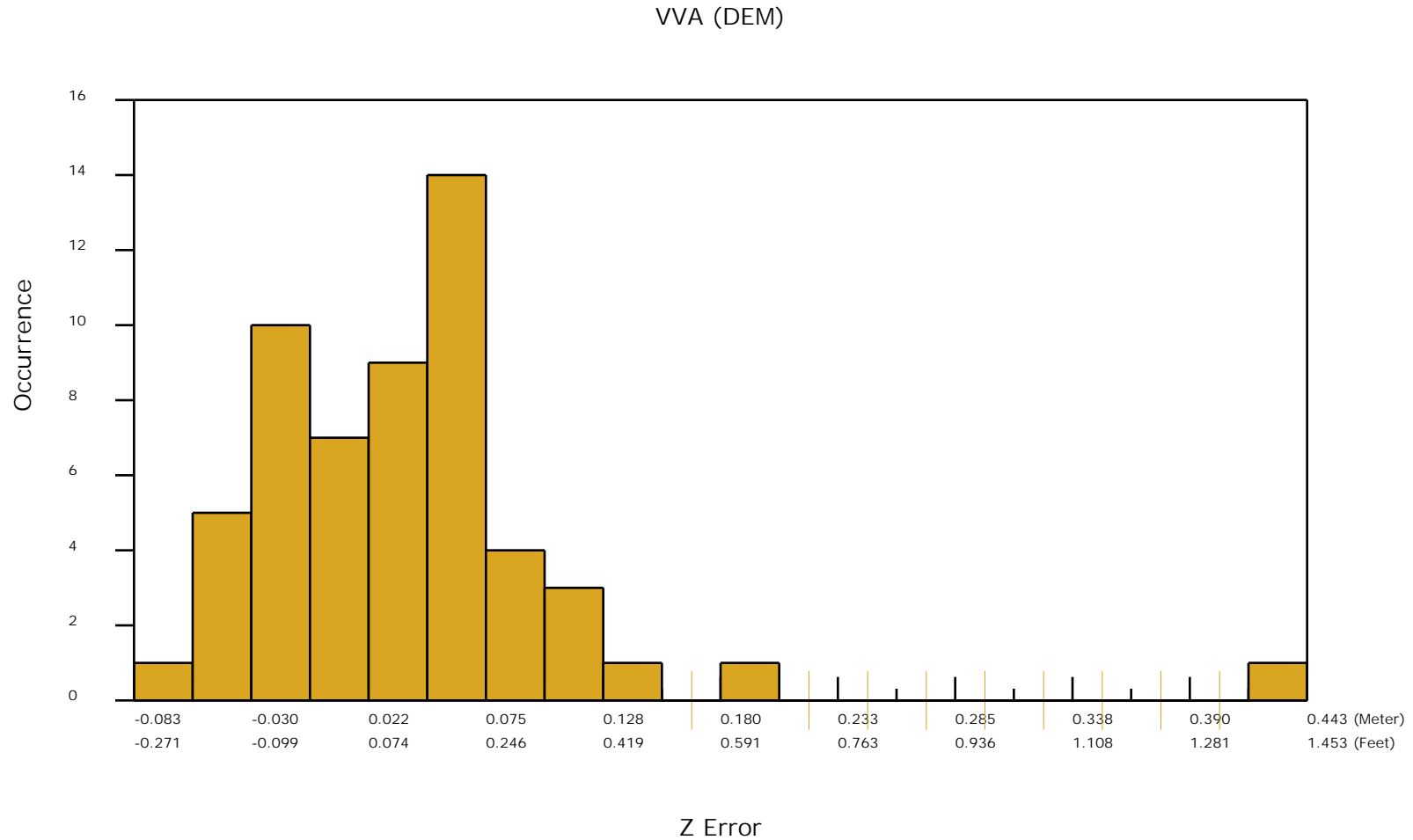
## Check Points Vertical Accuracy - continued

ID	X	Y	Coverage	Z	Z From Lidar	Z Error	Description	Comments
VVA2030	326666.863	5198782.57	Yes	453.792	454.235	0.443	LIPT	
VVA2030ALT	326663.599	5198778.298	Yes	454.226	454.318	0.092	LIPT	
VVA2031	329020.441	5203644.836	Yes	457.768	457.761	-0.007	LIPT	
VVA2032	291695.48	5203976.691	Yes	442.805	442.881	0.076	LIPT	
VVA2032ALT	291598.952	5203972.108	Yes	442.899	442.914	0.015	LIPT	
VVA2033	308673.392	5186309.766	Yes	464.984	465.081	0.097	LIPT	
VVA2034	310816.664	5181482.522	Yes	454.017	454.087	0.070	LIPT	
VVA2035	298499.251	5203761.082	Yes	452.217	452.215	-0.002	LIPT	
VVA2036	262562.566	5193042.449	Yes	413.248	413.452	0.204	LIPT	
VVA2037	307374.604	5210724.901	Yes	469.498	469.529	0.031	LIPT	
VVA2038	316130.966	5219431.351	Yes	497.842	497.827	-0.015	LIPT	
VVA2039	293311.952	5179824.86	Yes	422.846	422.893	0.047	LIPT	
VVA2040	305830.097	5224540.448	Yes	492.95	492.997	0.047	LIPT	
VVA2041	283614.133	5216436.457	Yes	472.858	472.846	-0.012	LIPT	
VVA2042	282134.389	5189563.516	Yes	416.309	416.286	-0.023	LIPT	
VVA2043	257907.057	5178676.153	Yes	430.395	430.312	-0.083	LIPT	
VVA2044	259318.208	5222021.814	Yes	356.344	356.321	-0.023	LIPT	
VVA2044ALT	259267.412	5222001.091	Yes	355.873	355.903	0.030	LIPT	
VVA2044RE	259564.152	5222020.459	Yes	355.63	355.619	-0.011	LIPT	
VVA2045	299347.058	5180168.077	Yes	426.001	426.050	0.049	LIPT	
VVA2046	287475.247	5225694.634	Yes	464.77	464.729	-0.041	LIPT	
VVA2047	266237.282	5199252.489	Yes	403.738	403.778	0.040	LIPT	
VVA2048	303249.151	5188909.344	Yes	460.777	460.883	0.106	LIPT	
VVA2049	312823.177	5195843.557	Yes	472.117	472.155	0.038	LIPT	
VVA2050	258339.636	5202838.413	Yes	366.056	366.128	0.072	LIPT	
VVA2051	270631.918	5213521.371	Yes	381.059	381.017	-0.042	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 - Y:\Mapping\Projects\65221102\\_MN\\_BeckerCounty\Production\Final\\_Client\\_Deliverables\223407\223404\\_MN\\_BeckerCo\\_1\\_2021\point\\_cloud\tilecls](#)



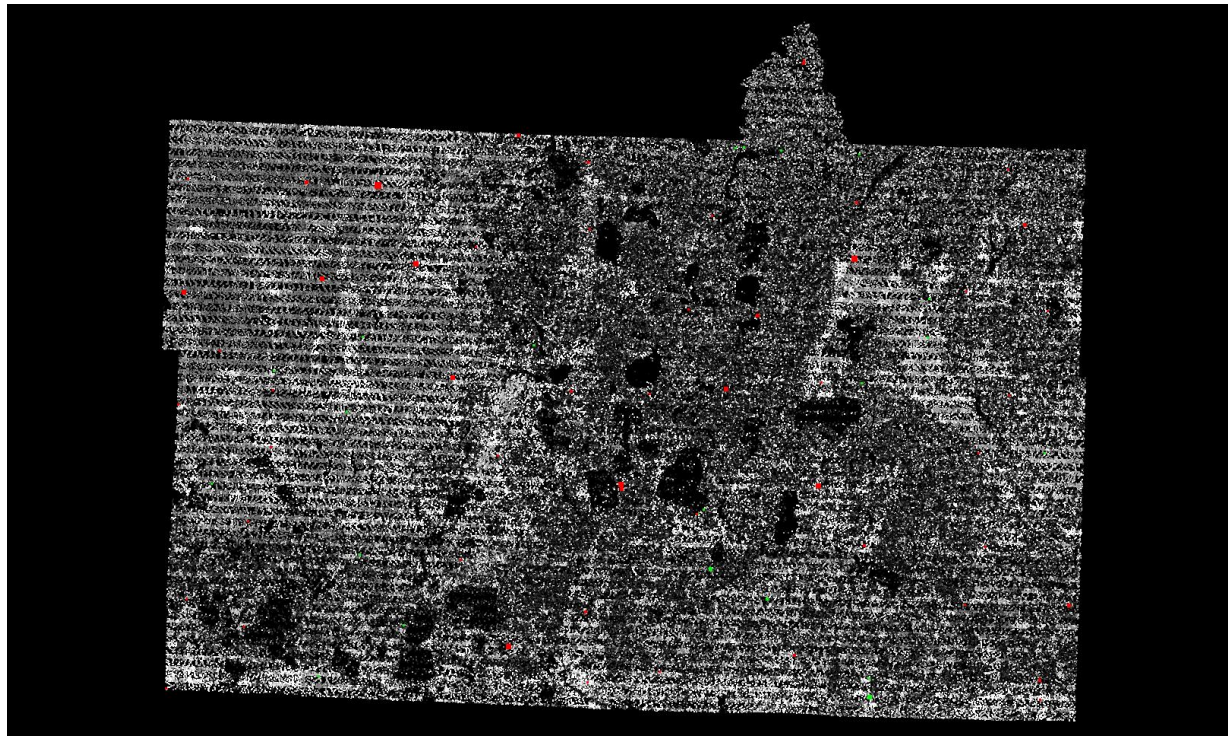


## *DPH-11 Report on Absolute Vertical Accuracy - continued*

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\65221102\\_MN\\_BeckerCounty\Production\Final\\_Client\\_Deliverables\223407\223404\\_MN\\_BeckerCo\\_1\\_2021\point\\_cloud\tilecls](Y:\Mapping\Projects\65221102_MN_BeckerCounty\Production\Final_Client_Deliverables\223407\223404_MN_BeckerCo_1_2021\point_cloud\tilecls)

[Result Path - Y:\Mapping\Projects\65221102\\_MN\\_BeckerCounty\Admin\QA\\_OC\MN\\_Becker\\_County\\_OC\\_USGS\DPH\\_11\ColorBy\\_Intensity\\_CheckPoints\\_NVA.jpg](Y:\Mapping\Projects\65221102_MN_BeckerCounty\Admin\QA_OC\MN_Becker_County_OC_USGS\DPH_11\ColorBy_Intensity_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).

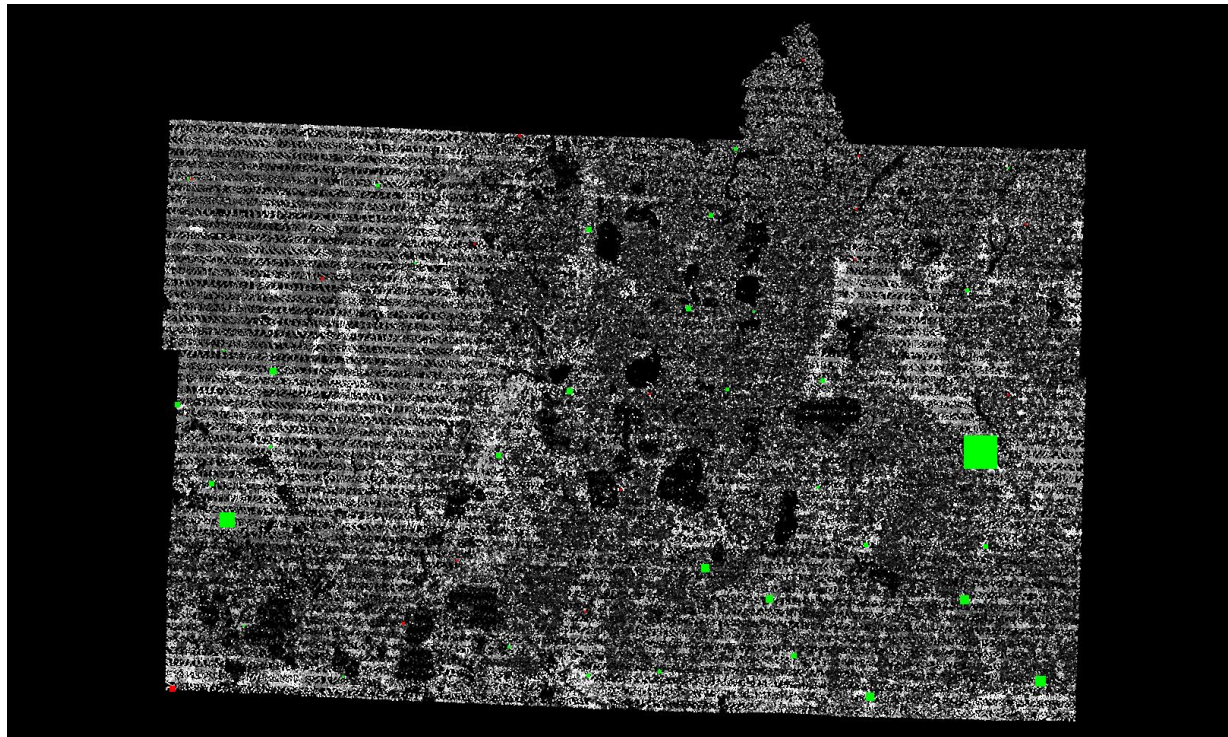
The size of the square symbol represents the absolute value magnitude of error.

## *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\65221102\\_MN\\_BeckerCounty\Production\Final\\_Client\\_Deliverables\223407\223404\\_MN\\_BeckerCo\\_1\\_2021\point\\_cloud\tilecls](Y:\Mapping\Projects\65221102_MN_BeckerCounty\Production\Final_Client_Deliverables\223407\223404_MN_BeckerCo_1_2021\point_cloud\tilecls)

[Result Path - Y:\Mapping\Projects\65221102\\_MN\\_BeckerCounty\Admin\QA\\_OC\MN\\_Becker\\_County\\_OC\\_USGS\DPH\\_11\ColorBy\\_Intensity\\_CheckPoints\\_VVA.jpg](Y:\Mapping\Projects\65221102_MN_BeckerCounty\Admin\QA_OC\MN_Becker_County_OC_USGS\DPH_11\ColorBy_Intensity_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.