

Darrick Wagg, Support Services Manager 8/15/2012 Revision 1.0

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An important evaluation to make when performing a QAQC analysis of a LIDAR data set is a control point comparison. When discussing control points and LIDAR data, there are typically two types of points that need to be considered independently.

Control Points: The monuments or markers used to control the LIDAR collection or validation point collection for a project.

Checkpoints (aka Validation Points): Those 3-dimensional point locations collected for use in the validation of the LIDAR point cloud over the project area.

The control points form a basis to evaluate the absolute vertical position of the data set, while the checkpoints are used to verify that the vertical accuracy throughout the project area meets the contractual specifications. Those specifications typically refer to the fundamental vertical accuracy derived from the QAQC checkpoints. The fundamental vertical accuracy, as defined by the ASPRS, is the vertical accuracy in open terrain at a 95% confidence level with a normal distribution of error.

LP360 provides a specific toolbar to perform the QA/QC of a LIDAR dataset using control points:

LP360 Control Points 🛛 🗸 🗙									
Control Points:	HSV_Control	✓ Elevation Field: Shape	• K	<	>	Ы 🗉			

Figure 1 - LP360 Control Points Toolbar

The control points are added via a shapefile with the elevation in the shape or a selected attribute. The name of the control points comes from the labeled field, typically Name, and must be unique. The arrows allow for a visual evaluation of the control point location, including elevation against the LIDAR data set (In figure 3 the control point is overlaid on the LIDAR data using the symbol . The visual QAQC allows for a qualitative review of the LIDAR and control points for possible errors as well. In addition the views will assist in determining the twenty (thirty recommended) distributed worse points to use in the analysis as per the ASPRS Vertical Accuracy Reporting Guidelines.

B LP360 Basic Edition
S LP360 Standard Edition
LP360 sUAS Edition
LP360 Advanced Edition



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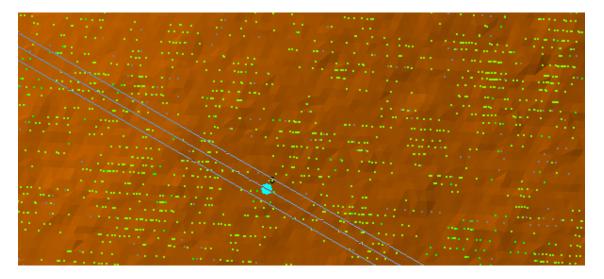


Figure 2 - Horizontal Control Point Location

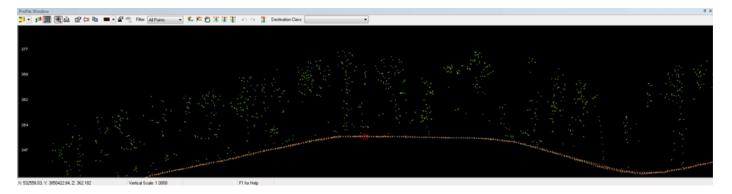


Figure 3 - Control Point Vertically Compared to LIDAR Data

Quantitative analysis is performed by executing a control point report against the ground surface generated using one of two methods, Triangulation (TIN) or Inverse Distance Weighting (IDW). The report yields the error calculated from the surface to the control point. For ease of analysis the control point report list is linked to the views and can be driven by double-clicking on a point in the list.



Surf	ace									
М	lethod: Tria	ngulation (TIN)			•		Filte	ſ		
							Calculate Err			
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Con	trol Points									
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✓	0	533570.495	3848	478.020	284.900	284.565	0.335	E		
~	1	532581.616	3850	410.490	351.510	351.502	0.008			
✓	2	533421.572	3850	347.059	361.530	361.570	-0.040			
✓	3	532664.858	3848	561.405	231.720	231.683	0.037			
✓	4	532651.552	3847	734.748	227.051	226.051	1.000			
✓	5	534809.884	3843	182.618	259.700	259.764	-0.064			
		534224 375			206.200	206 157	0.043	Ŧ		
	ints that exceed					Р	recision: 3			
Po	ints that exceed	limits of 95% CI								
Outp	put Summary									
Mean Error: 0.072		2	17 control points included in summary out of 17							
Error Range:		[-0.068,1.000	[-0.068,1.000]		0 control points turned off					
- Skew*:		3.02	3.026		0 control points returned no-data					
RMSE _z :		0.25	0.258		* The skew exceeds ±0.5. Further investigation of the error					
- NMAS/VMAS Accuracy ₇ (90% CI):		±0.4	±0.424		values are recommended to determine if vertical errors follow a normal error distribution.					
ASPRS/NSSDA Accuracy _z (95% CI):			±0.505							

Figure 4 - Control Point Report

The output summary contains statistical information to assist with the analysis. For instance, the skew (skewness or asymmetry of distribution) can be used to evaluate if there is a normal distribution of the reported errors. A skew close to zero with a mean equal to the median estimates a symmetric distribution.

Those points in the list which exceed the 90% and 95% confidence levels are highlighted for specific review by the user.

NMAS/VMAS Accuracy(z) (90% CI): The vertical accuracy of the surface for 90% confidence level. RMSE(z) \times 1.645

ASPRS/NSSDA Accuracy(z) (95% CI): The vertical accuracy of the surface for 95% confidence level. RMSE(z) \times 1.96



During the analysis points may be removed if there is a suitable explanation for their exclusion from the analysis. The result is an automatically updated summary and a resulting fundamental vertical accuracy calculated from the RMSEz.

Contr	ol Points Repo	ort					8	×		
Surf	ace									
м	Method: Triangulation (TIN)							Filter		
						_				
							Calculate Err	ors		
- Con	trol Points									
	▼ Name	▼ Control	- C	ontrol	✓ Control	✓ Surfac	- Error			
	0	533570.495	38484	78.020	284,900	284.565	0.335	Ξ		
	1	532581.616		10.490	351.510	351.502	0.008			
	2	533421.572	38503	47.059	361.530	361.570	-0.040	-		
	3	532664.858	38485	61.405	231.720	231.683	0.037			
	4	532651.552	38477	34.748	227.051	226.051	1.000			
☑	5	534809.884	38431	82.618	259.700	259.764	-0.064			
☑	6	534224 375	38440	93 21 9	206 200	206 157	0.043	Ψ.		
Po	ints that exceed	limits of 90% CI				F	recision: 3			
Po	ints that exceed	limits of 95% CI								
Outp	put Summary									
Me	ean Error:	-0.00	7	15 control points included in summary out of 17						
Err	or Range:	[-0.068,0.043]		2 control points turned off						
Skew:		-0.327		0 control points returned no-data						
RMSE _z :		0.035								
	NMAS/VMAS ±0.058 Accuracy- (90% CI):									
	ASPRS/NSSDA ±0.069 Accuracy _z (95% CI):			View Disclaimer Export Report						

Figure 5 - Fundamental Report

This report can be exported for inclusion within a project QAQC report.

In addition to the fundamental vertical accuracy the guidelines recommend supplemental and consolidated vertical accuracies be reported as well. Supplemental reporting covers each of the major land cover classes in a project area as agreed upon by the data vendor and user. The consolidated reporting is a combination of all of the supplemental points along with the fundamental ones. The inclusion of these additional vertical accuracy reporting allows for users of the data to have a better understanding of the data accuracy and how that applies to their intended use.

Supplemental vertical accuracy analysis requires executing the report and analysis for each supplemental category. The error results are then exported and an additional calculation executed to determine the accuracy(z) using the 95th percentile method as the supplemental, and similarly consolidated, do not follow a normal distribution of errors due to their nature. Likewise, to determine the consolidated vertical

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accuracy one would combine all of the supplemental and fundamental points into a single shapefile and perform the analysis.

For more information on the widely used standards for vertical accuracy reporting please refer to the following organizations:

American Society for Photogrammetry and Remote Sensing (ASPRS) Federal Geographic Data Committee (FGDC) United States Geological Survey (USGS)