Lidar Accuracy Assessment Report - Nueces County, TX

Introduction

URS Corporation (URS) performed lidar vertical accuracy assessment for Nueces County, TX, in accordance with section 1.5 of the *Guidelines for Digital Elevation Data*, published by the National Digital Elevation Program (NDEP). NDEP guidelines call for the mandatory determination of Fundamental Vertical Accuracy (FVA) and optional determination of Supplemental Vertical Accuracy (SVA) and Consolidated Vertical Accuracy (CVA).

The intended use of the lidar data is for floodplain mapping, therefore the project plan requires that the data meet standards set forth in the Federal Emergency Management Agency's (FEMA) *Guidelines and Specifications for Flood Hazard Mapping Partners*, Appendix A, Aerial Mapping and Surveying. The URS team conducted the vertical accuracy assessment *in the open terrain land cover category only*, using surveyed ground checkpoints collected in accordance with NDEP and FEMA. Neither FEMA nor NDEP guidelines require independent testing of horizontal accuracy for elevation products.

Fundamental Vertical Accuracy (FVA) is determined with checkpoints located only in open terrain (grass, dirt, sand, and rocks), where there is a very high probability that the lidar sensor will have detected the bare-earth ground surface, and where errors are expected to follow a normal error distribution. With a normal error distribution, the FVA at the 95 percent confidence level is computed as the vertical root mean square error (RMSE) of the checkpoints x 1.9600, as specified in Appendix 3-A of the *National Standard for Spatial Data Accuracy*, FGDC-STD-007.3-1998, see http://www.fgdc.gov/standards/projects/FGDC-standards-projects/accuracy/part3/chapter3. For Nueces County, the FVA standard is 1.19 feet, corresponding to an RMSE of 0.61 feet or 18.5 centimeters, which is equivalent to the accuracy expected from 2-foot contours.

Consolidated Vertical Accuracy (CVA) is determined with all checkpoints, representing open terrain and other land cover categories combined. Because elevation errors often vary based on the height and density of vegetation and structures, a normal distribution of error cannot be assumed, and RMSE cannot be used to calculate the 95 percent confidence level. A nonparametric testing method, based on the 95th percentile, is used to determine CVA at the 95 percent confidence level. NDEP guidelines state that errors larger than the 95th percentile should be documented in the quality control report and project metadata. For Nueces County, CVA was not calculated.

Supplemental Vertical Accuracy (SVA) is determined separately for each individual land cover category, recognizing that the lidar sensor and post-processing may not have mapped the bare-earth ground surface, and that errors may not follow a normal error distribution. For each land cover category, the SVA at the 95 percent confidence level equals the 95th percentile error for all checkpoints in that particular land cover category. For Nueces County, SVA was not calculated.

The primary quality control (QC) steps were as follows:

1. Spectrum Mapping (Spectrum), a member of MAPVI, Mapping Alliance Partnership for FEMA Region IV, acquired the raw lidar data in 2006 and performed post-processing to derive the bare-earth digital terrain model. Spectrum performed in-house quality assurance of its data following professional best practices and monitoring each technical phase of data processing.
2. Under subcontract to URS (the QC consultant), an independent field survey contractor, Frontier Surveying Company (Frontier), surveyed 19 ground checkpoints in accordance with the NDEP and FEMA specifications cited in paragraph one of this report. A detailed survey report has been provided as a separate deliverable.
3. Frontier provided URS with a table of horizontal coordinates and orthometric heights for all surveyed checkpoints, classified by land cover category. URS created a triangulated irregular network (TIN) from the bare-earth lidar points, and interpolated a z-value at each of the survey point locations.
4. URS compared the lidar-derived elevation to the surveyed orthometric height and computed descriptive statistics, as well as FVA, according to NDEP specifications. The URS computation workbook is attached as an appendix to this report.

The spatial distribution of ground checkpoints surveyed by Frontier for the open terrain land cover category is shown in Figure 1.

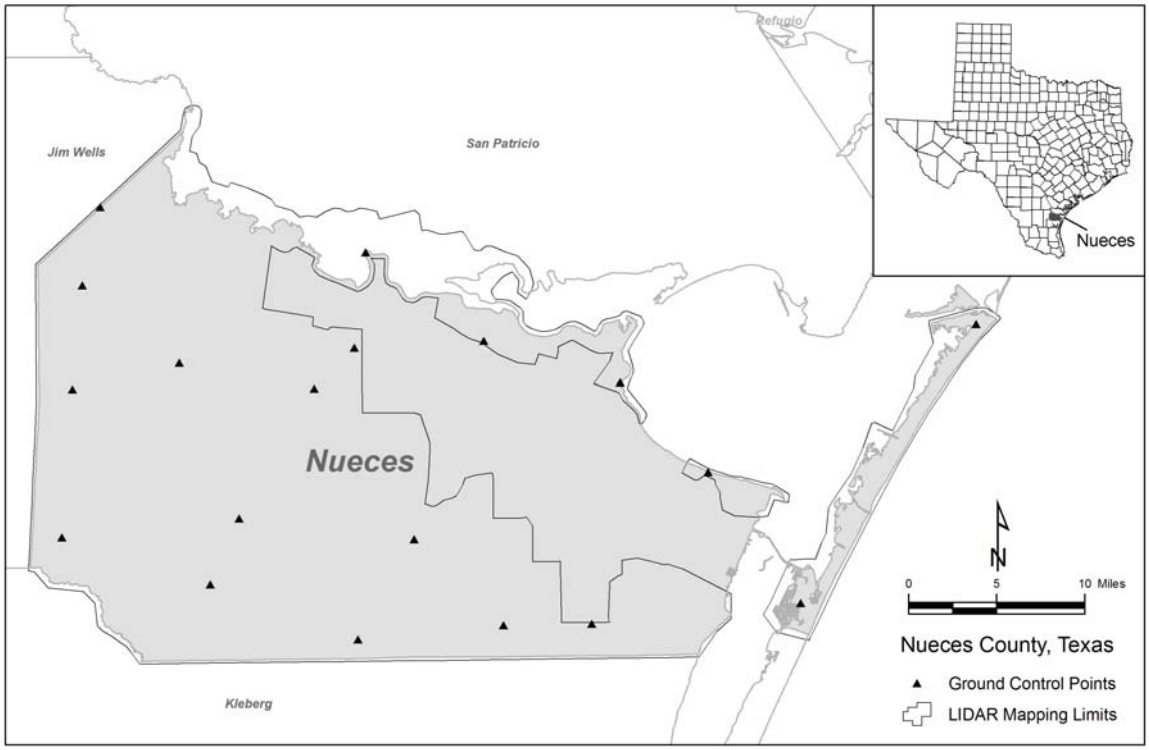

Figure 1: Nueces County lidar checkpoints by land cover category.

Descriptive Statistics

Descriptive statistics for ground checkpoints are summarized in Table 1.

Descriptive Statistics							
Land Cover Category	**Points**	**RMSE (feet)**	**Mean Error (feet)**	**Median Error (feet)**	**SKEW**	**STDEV (feet)**	**FVA (feet)**
Consolidated							
Open Terrain	19	0.33	0.12	0.20	-0.15	0.31	0.65
Weeds/Crops							
Scrub							
Forest							
Built Up							

Table 1: Descriptive statistics for Nueces County lidar compared to ground surveyed checkpoints. These calculations were performed in Microsoft Excel using formulas given by Maune (2001).

The mean and the median measure the central tendency of the errors; when they are close to zero it is unlikely that any systematic errors remain in the dataset. In all cases, for the combined dataset as well as for each land cover type, the mean and median indicate that the Nueces County lidar dataset has a slight positive bias that is within the specification tolerance, and will adequately serve the purpose of floodplain mapping for which it is intended. The pass-fail criterion for the Nueces County project is RMSE < 0.61 feet in open terrain; therefore, the dataset can be accepted. This reaffirms the conclusion that the dataset is of good quality and that it is adequate for the purposes of floodplain mapping.

The skew coefficient is a unitless number used to express the degree of asymmetry of the error distribution around the mean. Skew is zero when the error distribution is perfectly symmetrical, as is the case with a normal “bell curve.” FEMA guidelines state that mapping partners should investigate all datasets with skew values exceeding ±0.5, to determine why the errors are not normally distributed. The most common explanation is that one or a few outlier points affect the descriptive statistics for the entire class distribution. The skew value for Nueces County is within the acceptable tolerance.

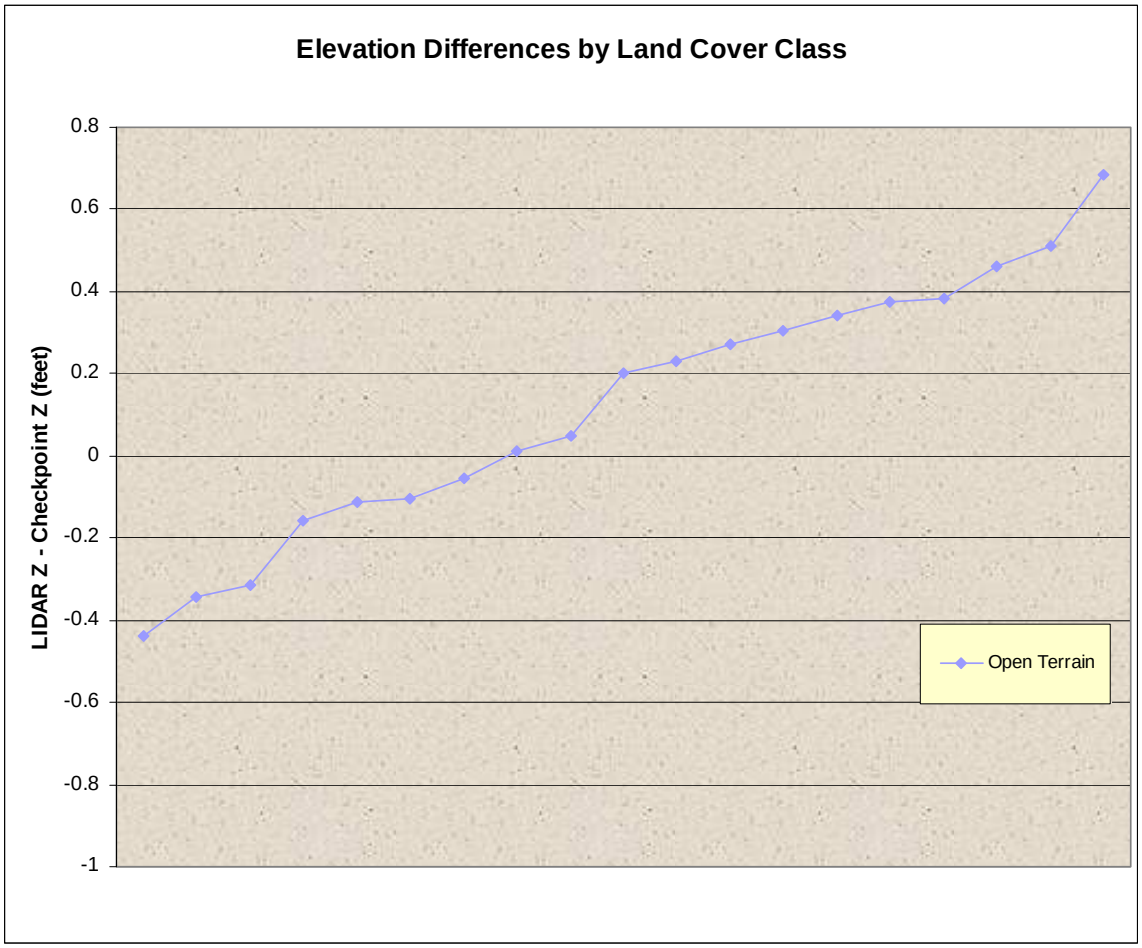

Figure 2: Elevation differences by land cover class for Nueces County, TX.

Accuracy Statements

The lidar data for Nueces County meets the project specifications, as demonstrated by the following accuracy statements.

1. Tested 0.65-foot FVA at 95 percent confidence level in open terrain using RMSEz * 1.96.

Credits

Organizations involved in the procurement, acquisition, processing, and quality control of the Nueces County lidar dataset are identified below.

Function	Responsible Organization
Lidar Procurement	FEMA
Lidar Acquisition and Processing	Spectrum Mapping
Checkpoint Surveys	Frontier Surveying Co.
Accuracy Assessment and Reporting	URS Corp.

References

American Society for Photogrammetry and Remote Sensing (May 2004), *ASPRS Guidelines: Vertical Accuracy Reporting for Lidar Data*, Version 1.0, http://www.asprs.org/society/committees/lidar/Downloads/Vertical_Accuracy_Reporting_for_Lidar_Data.pdf, accessed 21 August 2006.

Federal Emergency Management Agency (May 2003), *Guidelines and Specifications for Flood Hazard Mapping Partners*, Appendix A: Guidance for Aerial Mapping and Surveying, http://www.fema.gov/pdf/fhm/frm_gsaa.pdf, accessed 21 August 2006.

Maune, David F. (2001), *Digital Elevation Model Technologies and Applications: The DEM Users Manual*, American Society for Photogrammetry and Remote Sensing, Bethesda, MD, pp. 418-422.

National Digital Elevation Program (May 2004), *Guidelines for Digital Elevation Data*, Version 1.0, http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf, accessed 21 August 2006.

Id	NAME	CAT	X	Y	Z	FILENAME	DZ	Ordered DZ
7505	7505	Open Terrain	1185734.292	17228566.51	112.94	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7505.jpg	0.374	-0.437
7506	7506	Open Terrain	1180365.949	17205030.03	109.473	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7506.jpg	0.200	-0.343
7507	7507	Open Terrain	1177457.236	17174054.95	119.528	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7507.jpg	0.270	-0.314
7508	7508	Open Terrain	1209515.459	17181859.3	82.907	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7508.jpg	0.460	-0.157
7603	7603	Open Terrain	1227393.732	17135249.97	61.118	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7603.jpg	-0.343	-0.111
7604	7604	Open Terrain	1218766.07	17115459.48	64.729	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7604.jpg	0.013	-0.103
7605	7605	Open Terrain	1174221.767	17129622.9	104.754	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7605.jpg	0.684	-0.054
7703	7703	Open Terrain	1368064.466	17149224.49	0.755	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7703.jpg	0.047	0.013
7705	7705	Open Terrain	1333199.252	17103682.8	18.393	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7705.jpg	-0.157	0.047
7706	7706	Open Terrain	1306722.432	17103302.24	36.097	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7706.jpg	-0.054	0.200
7707	7707	Open Terrain	1263030.85	17098994.59	33.874	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7707.jpg	0.304	0.229
7708	7708	Open Terrain	1279927.685	17129021.41	48.421	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7708.jpg	-0.314	0.270
7710	7710	Open Terrain	1341718.939	17176060.85	13.853	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7710.jpg	0.383	0.304
7803	7803	Open Terrain	1448486.939	17193467.62	4.869	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7803.jpg	-0.437	0.340
7804	7804	Open Terrain	1395802.238	17109909.48	5.577	Z:\PROJECTS\24342653_Nueces\Survey\Survey_2\pt ID 7804.jpg	-0.111	0.374
7906	7906	Open Terrain	1265315.101	17215005.24	6.33	Z:\PROJECTS\24342653_Nueces\Survey\Survey_3\7906.jpg	0.340	0.383
7907	7907	Open Terrain	1300775.612	17188482.91	50.813	Z:\PROJECTS\24342653_Nueces\Survey\Survey_3\7907.jpg	-0.103	0.460
7908	7908	Open Terrain	1261995.232	17186316.29	72.608	Z:\PROJECTS\24342653_Nueces\Survey\Survey_3\7908.jpg	0.229	0.512
7909	7909	Open Terrain	1249959.548	17174222	74.795	Z:\PROJECTS\24342653_Nueces\Survey\Survey_3\7909.jpg	0.512	0.684
		RMSE					0.329	
		1.96 * RMSE					0.646	
		mean					0.121	
		median					0.200	
		skew					-0.148	
		std dev					0.315	