LiDAR Quality Assessment Report

The USGS National Geospatial Technical Operations Center, Data Operations Branch is responsible for conducting reviews of all Light Detection and Ranging (LiDAR) point-cloud data and derived products delivered by a data supplier before it is approved for inclusion in the National Elevation Dataset and the Center for LiDAR Information Coordination and Knowledge. The USGS recognizes the complexity of LiDAR collection and processing performed by the data suppliers and has developed this Quality Assessment (QA) procedure to accommodate USGS collection and processing specifications with flexibility. The goal of this process is to assure LiDAR data are of sufficient quality for database population and scientific analysis. Concerns regarding the assessment of these data should be directed to the Chief, Data Operations Branch, 1400 Independence Road, Rolla, Missouri 65401 or NGTOCoperations@usgs.gov.

Materials Received:
1/6/2012

Project Type: NSDI Agreement

Project ID:
MN_MNRiverBasin-Phase1_2010

Project Description:
Murray County is one of the 25 counties as part of the Minnesota River Basin - Phase 1 lidar project.

Project Alias(es):
MN_MurrayCo_2010
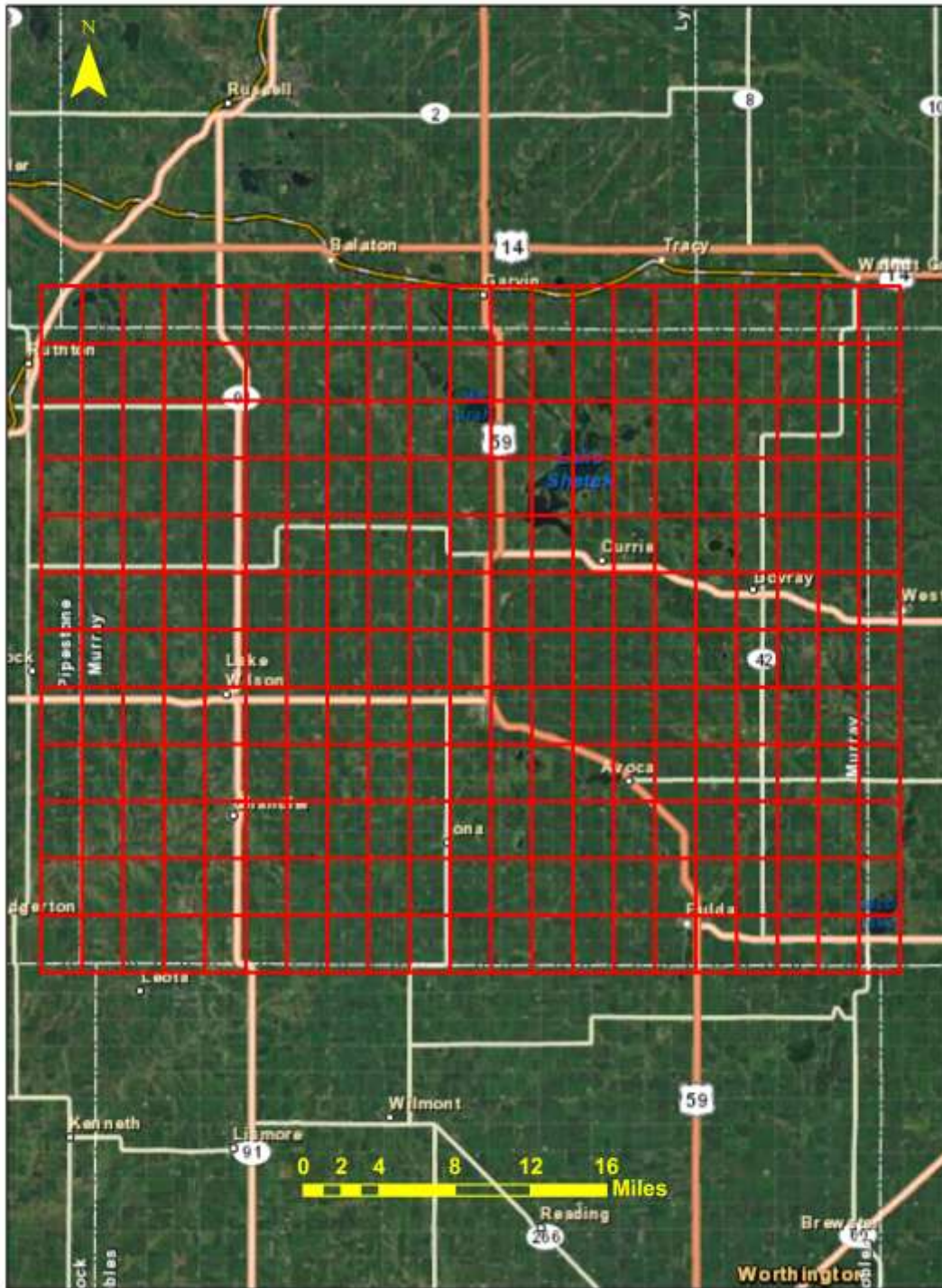
Year of Collection: 2010

Lot 13 of 25 lots.

Project Extent:
☑ Project Extent image?

Project Tiling Scheme:

☑ Project Tiling Scheme image?

Contractor: Applicable Specification:

| Aerometric, Inc. | V13 |

Licensing Restrictions:

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☑ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Ron Wencl	NSDI Liaison	763-783-3207	rwencl@usgs.gov

Project Deliverables

All project deliverables must be supplied according to collection and processing specifications. The USGS will postpone the QA process when any of the required deliverables are missing. When deliverables are missing, the Contracting Officer Technical Representative (COTR) will be contacted by the Elevation/Orthoimagery Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

☐ Collection Report
☐ Survey Report
☐ Processing Report
☐ QA/QC Report
☐ Control and Calibration Points

☐ Project Shapefile/Geodatabase
☑ Project Tiling Scheme Shapefile/Gdb
☑ Control Point Shapefile/Gdb
☑ Breakline Shapefile/Gdb
☑ Project XML Metadata

Multi-File Deliverables

File Type	Quantity
☐ Swath LAS Files ☐ Required? ☐ XML Metadata?	
☐ Intensity Image Files ☐ Required?	
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	252
☑ Breakline Files ☑ Required? ☑ XML Metadata?	1
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	1

Additional Deliverables

	Item
☑	Contours (in geodatabase)

Errors, Anomalies, Other Issues to document? ⦿ Yes ○ No

No RAW las files were delivered with the dataset.

Project Geographic Information

Areal Extent:

858.3

Sq Mi

Grid Size:

1

meters

Tile Size:

Select...

Nominal Pulse Spacing:

1.3

meters

Vertical Datum: NAVD88 meters

Horizontal Datum: NAD83 (NSRS 2007) Select...

Project Projection/Coordinate Reference System:

Universal Transverse Mercator, Zone 15 North meters.

This Projection Coordinate Reference System is consistent across the following deliverables:

☐ Project Shapefile/Geodatabase   ☑ Breaklines XML Metadata File

☑ Project Tiling Scheme Shapefile/Gdb   ☑ Bare-Earth DEM XML Metadata File

☑ Checkpoints Shapefile/Geodatabase   ☐ Swath LAS Files

☑ Project XML Metadata File   ☑ Classified LAS Files

☐ Swath LAS XML Metadata File   ☑ Breaklines Files

☑ Classified LAS XML Metadata File   ☑ Bare-Earth DEM Files

Project Shapefile/Geodatabase CRS

Swath LAS XML Metadata CRS

Swath LAS Files CRS

Review Cycle

This section documents who performed the QA Review on a project as well as when QA reviews were started, actions passed, received, and completed.

Reviewer:
Swain/Jerris

Review Start Date:
7/5/2012

Action to Contractor Date	Issue Description	Return Date

Review Complete: 10/30/2012

Metadata Review

Provided metadata files have been parsed using 'mp' metadata parser. Any errors generated by the parser are documented below for reference and/or corrective action.

The Project XML Metadata file parsed without errors.

The Classified LAS XML Metadata file parsed without errors.

The Breakline XML Metadata file parsed without errors.

The Bare-Earth DEM XML Metadata file parsed without errors.

Project QA/QC Report Review

ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the dataset. National Standards for Spatial Data Accuracy (NSSDA) guidance states that checkpoints may be distributed more densely in the vicinity of important features and more sparsely in areas that are of little or no interest. Checkpoints should be distributed so that points are spaced at intervals of at least ten percent of the diagonal distance across the dataset and at least twenty percent of the points are located in each quadrant of the dataset.

NSSDA and ASPRS require that a minimum of twenty checkpoints (thirty is preferred) are collected for each major land cover category represented in the LiDAR data. Checkpoints should be selected on flat terrain, or on uniformly sloping terrain in all directions from each checkpoint. They should not be selected near severe breaks in slope, such as bridge abutments, edges of roads, or near river bluffs. Checkpoints are an important component of the USGS QA process. There is the presumption that the checkpoint surveys are error free and the discrepancies are attributable to the LiDAR dataset supplied.

For this dataset, USGS checked the spatial distribution of checkpoints with an emphasis on the bare-earth (open terrain) points; the number of points per class; the methodology used to collect these points; and the relationship between the data supplier and checkpoint collector. When independent control data are available, USGS has incorporated this into the analysis.

Checkpoint Shapefile or Geodatabase:
☑ Checkpoint Distribution Image?
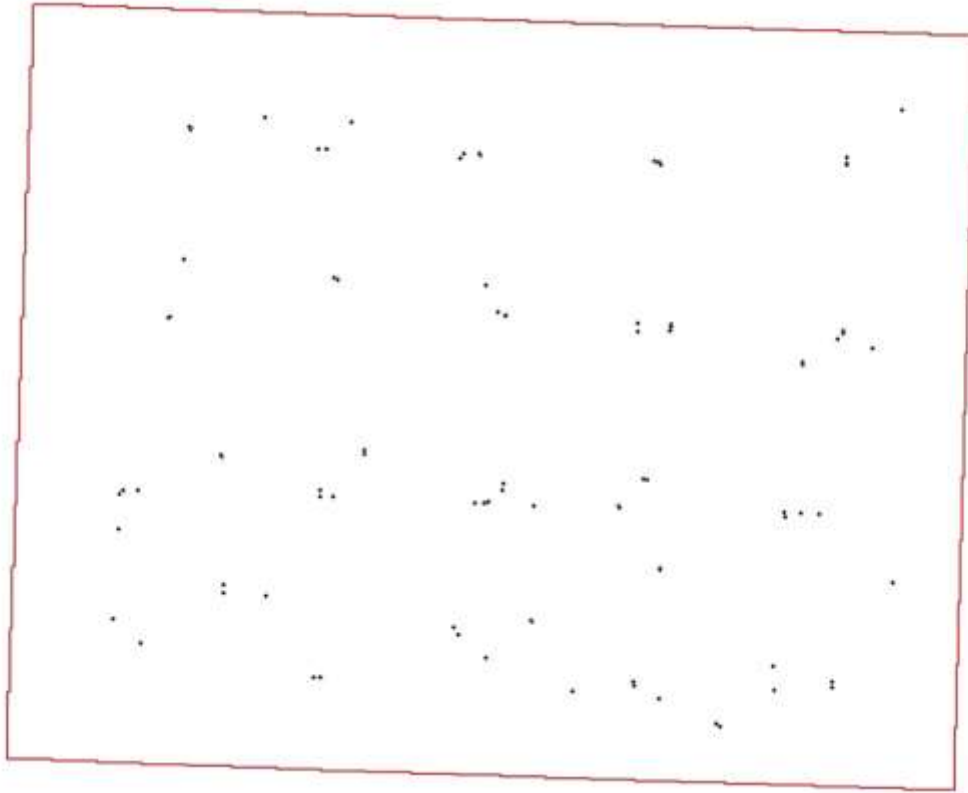
The following land cover classes are represented in this dataset (uncheck any that do not apply):

☑ Bare Earth

☑ Tall Weeds and Crops

☑ Brush Lands and Low Trees

☑ Forested Areas Fully Covered by Trees

☑ Urban Areas with Dense Man-Made Structures

There are a minimum of 20 checkpoints for each land cover class represented. Points within each class are uniformly distributed throughout the dataset. USGS was able to locate independent checkpoints for this analysis. USGS accepts the quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document? ◉ Yes ○ No

☐ Image?

The reported SVA and CVA are calculated incorrectly; only RMSEz/NSSDA are reported. These values are to be reported as the 95th percentile.

The FVA and CVA are reported as RMSE-z only on the website.

FVA should be reported as NSSDA … (RMSE-z * 1.96).
CVA should be reported as 95th percentile.

Accuracy values are reported in terms of Fundamental Vertical Accuracy (FVA), Supplemental Vertical Accuracy(s) (SVA), and Consolidated Vertical Accuracy (CVA).

Accuracy values are reported in: centimeters

Required FVA Value is 24.5 centimeters or less.
Target SVA Value is 36.3 centimeters or less.
Required CVA Value is 36.3 centimeters or less.

The reported FVA of the LAS Swath data is ‖ centimeters .

The reported FVA of the Bare-Earth DEM data is 21.56 centimeters .
SVA are required for each land cover type present in the data set with the exception of bare-earth. SVA is calculated and reported as a 95th Percentile Error.

Land Cover Type		SVA Value		Units
Tall Weeds and Crops				centimeters
Brush Lands and Low Trees				centimeters
Forested Areas Fully Covered by Trees				centimeters
Urban Areas with Dense Man-Made Structu...				centimeters

The reported CVA of this data set is: 09.3 RMSEz centimeters .

LAS Tile File Review

Classified LAS tile files are used to build digital terrain models using the points classified as ground. Therefore, it is important that the classified LAS are of sufficient quality to ensure that the derivative product accurately represents the landscape that

was measured. The following was determined for classified LAS files for this project:

Classified LAS Tile File Characteristics
- ☑ Separate folder for Classified LAS tile files
- ☑ Classified LAS tile files conform to Project Tiling Scheme
- ☑ Quantity of Classified LAS tile files conforms to Project Tiling Scheme
- ☐ Classified LAS tile files do not overlap
- ☑ Classified LAS tile files are uniform in size
- ☑ Classified LAS tile files have no points classified as '12'

☑ Point classifications are limited to the standard values listed below:

Code	Description
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high, manually identified, if needed)
9	Water
10	Ignored ground (breakline proximity)
11	Withheld (if the "Withheld" bit is not implemented in processing software)

☑ Buy up?

Additional classifications in this data set.
- ☐ 3 - Tall weeds and crops (low vegetation)
- ☑ 4 - Brush lands and low trees (medium vegetation)
- ☐ 5 - Forested areas fully covered by trees
- ☑ 6 - Urban area with dense man-made structures

☑ 14	-	Bridges
☑ 15	-	

Based on this review, the USGS does not accept at this time the classified LAS tile file data.

Errors, Anomalies, Other Issues to document? ○ Yes ● No

None.

Breakline File Review

Breaklines are vector feature classes that are used to hydro-flatten the bare earth Digital Elevation Models.
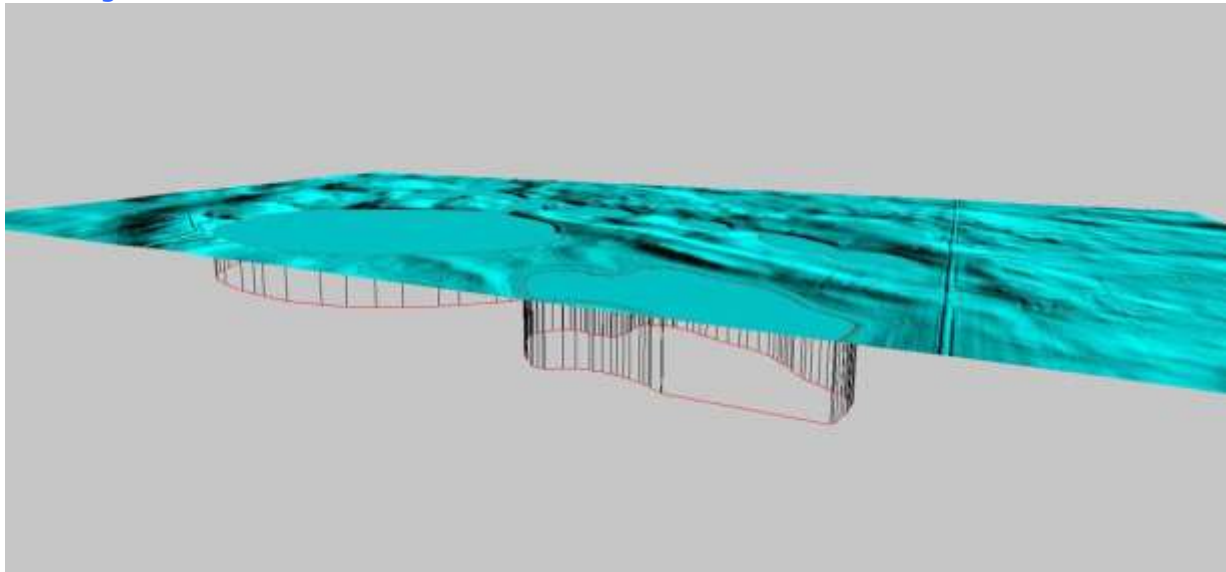
Breakline File Characteristics

☑ Separate folder for breakline files
☐ All breaklines captured as PolylineZ or PolygonZ features
☑ No missing or misplaced breaklines

Based on this review, the USGS accepts the breakline files.

Errors, Anomalies, Other Issues to document? ◉ Yes ○ No

☑ Image for error?

Breaklines are Polygon ZM however there is no elevation information associated with them. Water bodies are flattened.

Bare-Earth DEM Tile File Review

The derived bare-earth DEM file receives a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by USGS using supplied and independent checkpoints, and a manual check of the appearance of the DEM layer.

Bare-Earth DEM files provided in the following format: ArcGrid

Bare-Earth DEM Tile File Characteristics
- ☑ Separate folder for bare-earth DEM files
- ☐ DEM files conform to Project Tiling Scheme
- ☐ Quantity of DEM files conforms to Project Tiling Scheme
- ☐ DEM files do not overlap
- ☐ DEM files are uniform in size
- ☐ DEM files properly edge match
- ☑ Independent check points are well distributed

All accuracy values reported in centimeters .

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 24.5 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 36.3 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 36.3 or less.
Open Terrain	20	21.56		
Tall Weeds and Crops	20			
Brush Lands and Low Trees	20			
Forested Areas Fully Covered by Trees	20			
Urban Areas with Dense Man-Made Structures	20			
Consolidated	100			09.3 RMSEz

☑ QA performed Accuracy Calculations?

Calculated Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 24.5 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 36.3 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 36.3 or less.
Open Terrain				

		20	21.7		
Tall Weeds and Crops		20		16.3	
Brush Lands and Low Trees		20		19.8	
Forested Areas Fully Covered by Trees		20		15.0	
Urban Areas with Dense Man-Made Structures		20		15.3	
Consolidated		100			18.5

Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

Based on this review, the USGS accepts the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

Errors, Anomalies, Other Issues to document? ○ Yes ● No

None.

Internal Note:

Summary of Errors:

● FVA and CVA were reported in RMSEz.
  - The FVA, reported as 11.0 RMSEz = 21.56 cm Accuracy_z at 95% confidence
    interval; the NGTOC calculated FVA at the 95% confidence interval is 21.7 cm…
    which is less than the target 24.5 cm, thus it passes.
  - The CVA reported at 9.3 RMSEz was not reported at the 95th percentile; the
    NGTOC calculated CVA at the 95th percentile at 18.5 cm…which is less than
    the target 36.3 cm, thus it passes.

  A third-party QA was provided for this project and this documentation may be
  found in the METADATA\Documents folder. The Validation values were provided
  by this third- party and were used for the calculations as provided in the
  Calculated Accuracies section of this report.

● More information about this project may be found here:
  http://www.mngeo.state.mn.us/committee/elevation/mn_elev_mapping.html

<u>This is the end of the report.</u>

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