



# 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 NGTOCooperations@usgs.gov.

Materials Received:

6/3/2013

Project Type: USGS Partnership

Project ID:

KY\_KYAPED-Area2\_2012

Project Description:

This report is for **Area-2** of the 2012 Kentucky Statewide lidar project. The area is 973 square-miles and includes Knott, Letcher, and Perry Counties.

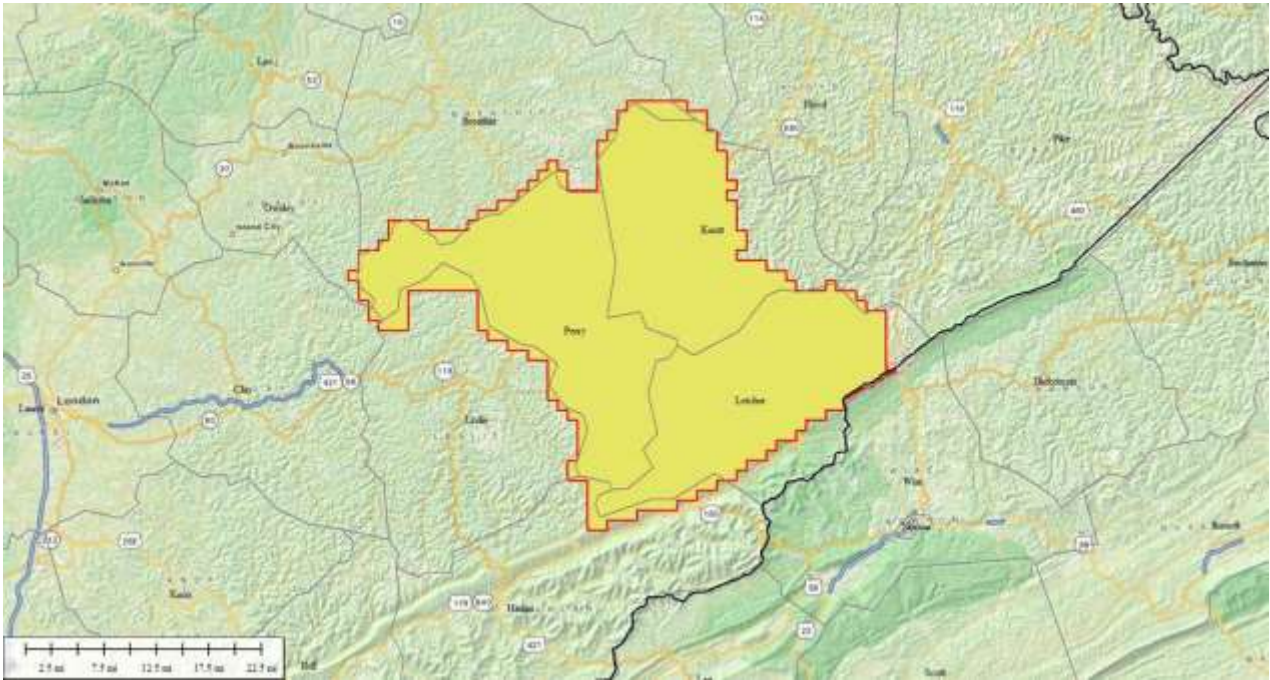
Project Alias(es):

Year of Collection: 2012

Lot 2 of 2 lots.

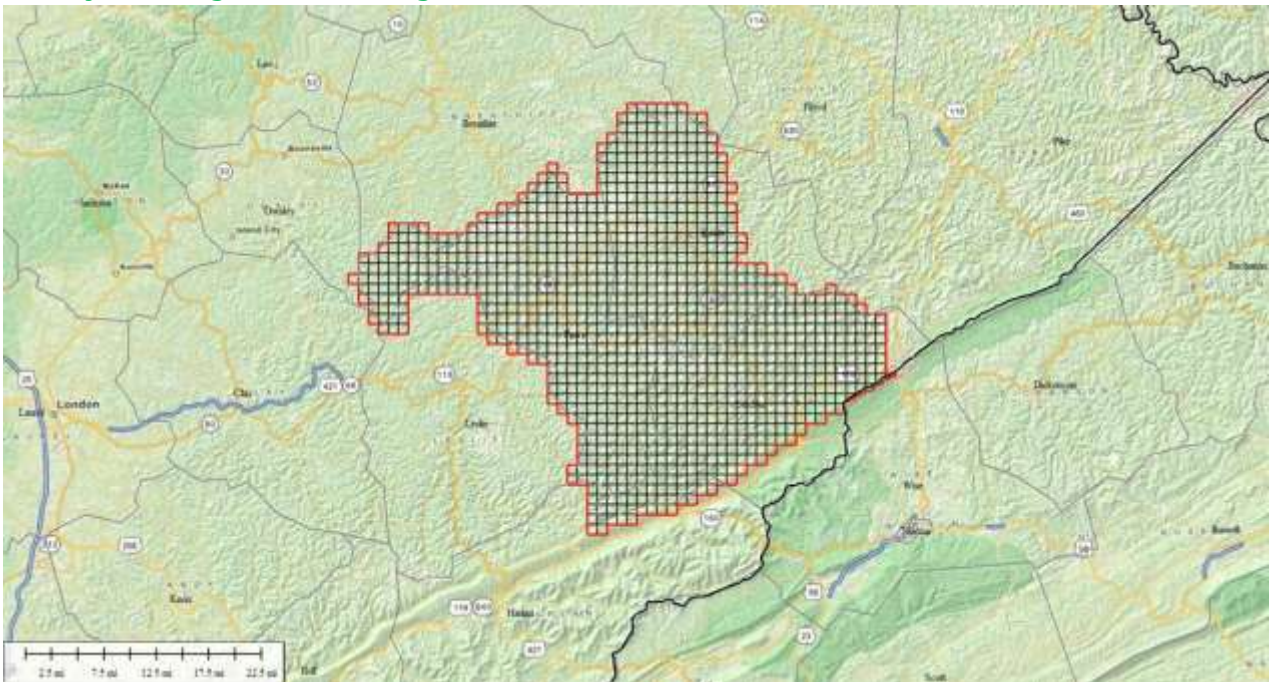
Project Extent:

Project Extent image?



Project Tiling Scheme:

Project Tiling Scheme image?



Contractor:

Photo Science, Inc.

Applicable Specification:

USGS Version 1.0

Licensing Restrictions:

Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
David Nail	NSDI Liaison	317-600-2722	dnail@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.

- |   |   |
|---|---|
| <input checked="" type="checkbox"/> Collection Report   | <input type="checkbox"/> Project Shapefile/Geodatabase                  |
| <input checked="" type="checkbox"/> Survey Report       | <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb |
| <input checked="" type="checkbox"/> Processing Report   | <input type="checkbox"/> Control Point Shapefile/Gdb                    |
| <input checked="" type="checkbox"/> QA/QC Report        | <input checked="" type="checkbox"/> Breakline Shapefile/Gdb             |
| <input type="checkbox"/> Control and Calibration Points | <input checked="" type="checkbox"/> Project XML Metadata                |

## Multi-File Deliverables

File Type	Quantity
<input checked="" type="checkbox"/> Swath LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	202
<input checked="" type="checkbox"/> Intensity Image Files <input checked="" type="checkbox"/> Required?	1,090
<input checked="" type="checkbox"/> Tiled LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	1,090
<input checked="" type="checkbox"/> Breakline Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	1
<input checked="" type="checkbox"/> Bare-Earth DEM Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	1,090

## Additional Deliverables

Errors, Anomalies, Other Issues to document?  Yes  No

None.

# Project Geographic Information

Areal Extent:

973.14

Sq Mi

Grid Size:

5.0

U.S. Feet

Tile Size:

5000 x 5000

U.S. feet

Nominal Pulse Spacing:

1.0

meters

Vertical Datum: NAVD88 U.S. feet

Horizontal Datum: NAD83 U.S. feet

Project Projection/Coordinate Reference System: State Plane Kentucky (FIPS 1600) / NAD83  
U.S. feet.

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

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Project Shapefile/Geodatabase       | <input type="checkbox"/> Breaklines XML Metadata File                |
| <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb | <input checked="" type="checkbox"/> Bare-Earth DEM XML Metadata File |
| <input type="checkbox"/> Checkpoints Shapefile/Geodatabase              | <input type="checkbox"/> Swath LAS Files                             |
| <input checked="" type="checkbox"/> Project XML Metadata File           | <input checked="" type="checkbox"/> Classified LAS Files             |
| <input type="checkbox"/> Swath LAS XML Metadata File                    | <input checked="" type="checkbox"/> Breaklines Files                 |
| <input checked="" type="checkbox"/> Classified LAS XML Metadata File    | <input checked="" type="checkbox"/> Bare-Earth DEM Files             |

Check Point Shapefile/Geodatabase CRS

Swath LAS XML Metadata CRS

Breakline XML Metadata CRS

Swath LAS Files CRS

UTM Zone 15 / WGS84 / meters, UTM Zone 17 / WGS84 / meters, and "unknown"

# 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:

T. Jerris

Review Start Date:

6/7/2013

Action to Contractor Date	Issue Description	Return Date
7/10/2013	Please see Summary of Errors at end of this report for details of errors encountered in this project.	

Review Complete:

## 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 Swath LAS XML Metadata file parsed [with errors](#).

No Swath LAS XML Metadata provided.

The Classified LAS XML Metadata file parsed [without errors](#).

The Breakline XML Metadata file parsed [with errors](#).

No Breakline XML Metadata provided.

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 not able to locate independent checkpoints for this analysis. USGS does not accept at this time the quality of the checkpoint data for these LiDAR datasets.

Errors, Anomalies, Other Issues to document?  Yes  No

Image?

No Checkpoints provided.

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:

Required FVA Value is   or less.

Target SVA Value is   or less.

Required CVA Value is   or less.

The reported FVA of the LAS Swath data is .

The reported FVA of the Bare-Earth DEM data is .

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	<input type="text"/>	<input type="text" value="centimeters"/>
Brush Lands and Low Trees	<input type="text"/>	<input type="text" value="centimeters"/>
Forested Areas Fully Covered by Trees	<input type="text"/>	<input type="text" value="centimeters"/>
Urban Areas with Dense Man-Made Structu...	<input type="text"/>	<input type="text" value="centimeters"/>

The reported CVA of this data set is: .

### LAS Swath File Review

LAS swath files or raw unclassified LiDAR data are reviewed to assess the quality control used by the data supplier during collection. Furthermore, LAS swath data are

checked for positional accuracy. The data supplier should have calculated the Fundamental Vertical Accuracy using ground control checkpoints measured in clear open terrain. The following was determined for LAS swath data for this project:

#### LAS Version

- LAS 1.2
- LAS1.3
- LAS 1.4

#### Swath File Characteristics

- Separate folder for LAS swath files
- Each swath files <= 2GB
- \*If specified, \*.wdp files for full waveform have been provided

The reported FVA of the LAS swath data is .

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

Yes  No

Image?

## 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

<input checked="" type="checkbox"/>	17	-	Overlap Default (Unclassified)
<input checked="" type="checkbox"/>	18	-	Overlap Bare-earth ground
<input checked="" type="checkbox"/>	25	-	Overlap water

Based on this review, the USGS accepts 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

None.

**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:

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 .

**Reported Accuracies**

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy <sub>z</sub> ) 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	<input type="text" value="20"/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>
Tall Weeds and Crops	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>

Brush Lands and Low Trees				
Forested Areas Fully Covered by Trees				
Urban Areas with Dense Man-Made Structures				
Consolidated	20			

QA performed Accuracy Calculations?

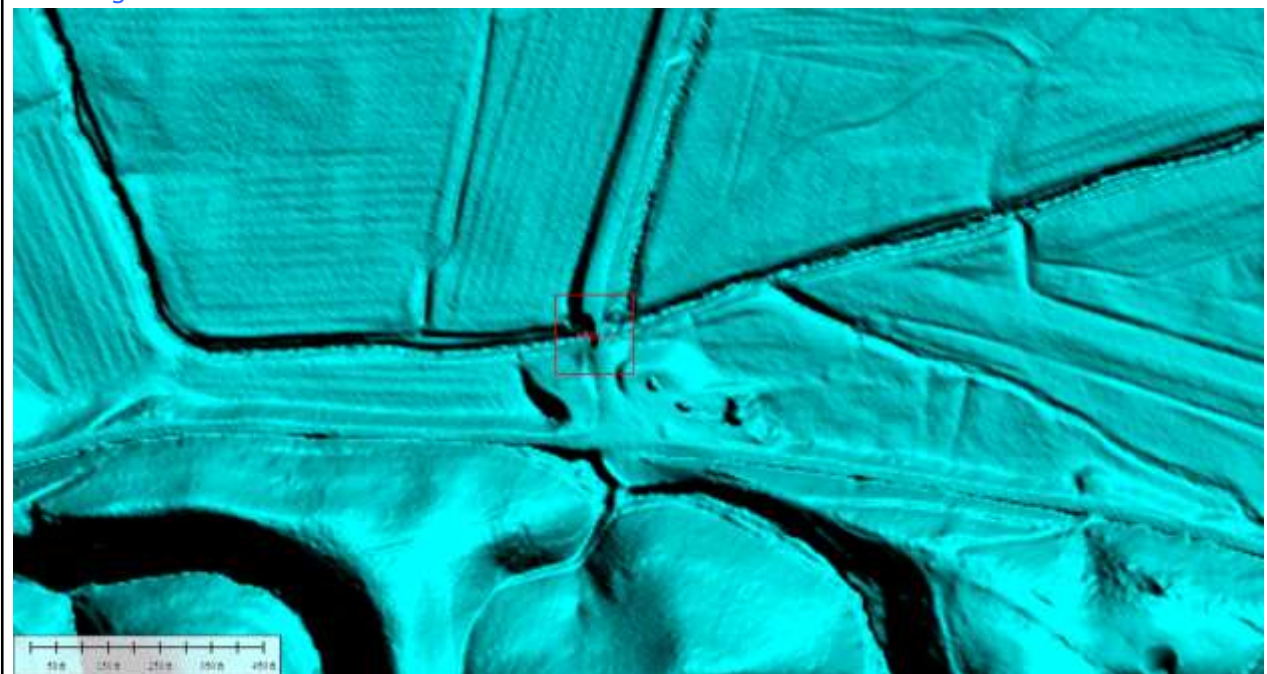
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

Based on this review, the USGS does not accept at this time the bare-earth DEM files.

#### Bare-Earth DEM Anomalies, Errors, Other Issues

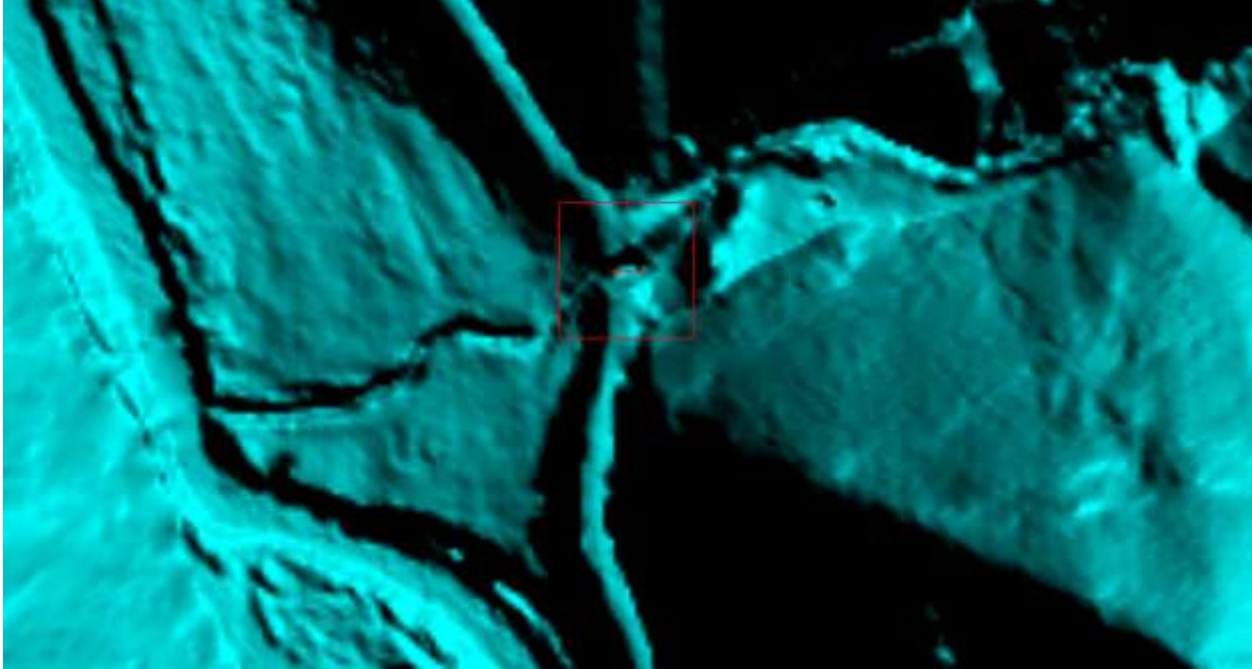
Errors, Anomalies, Other Issues to document?  Yes  No

Image?



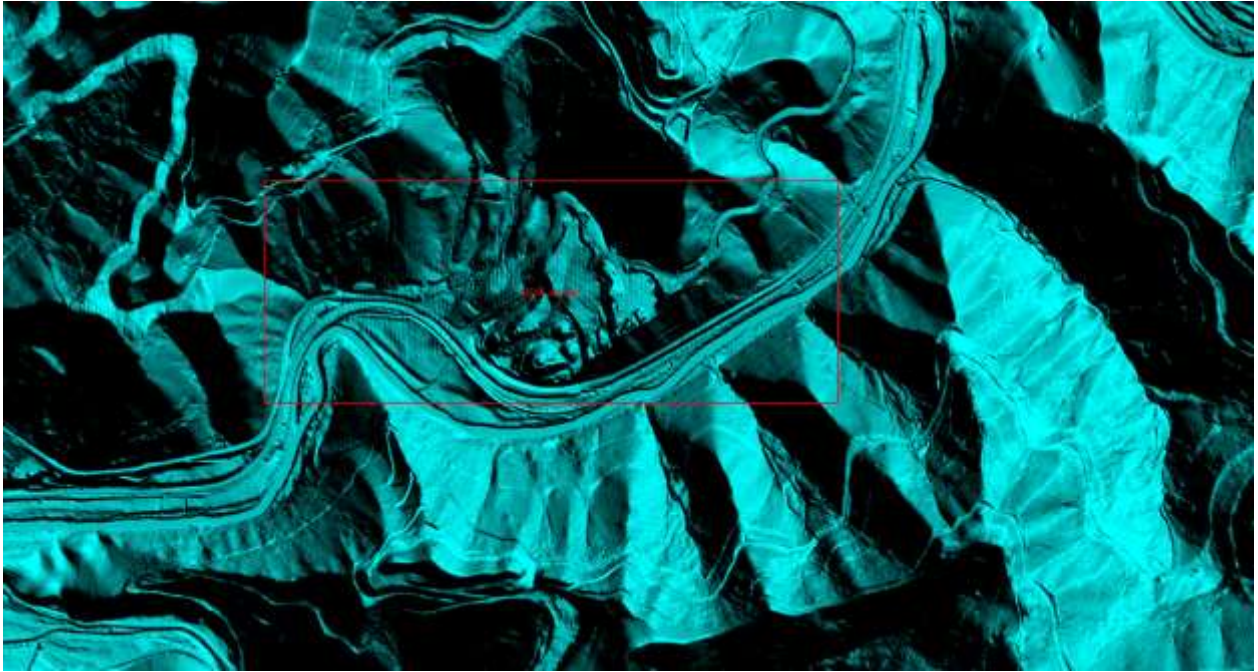
bridge\_3: The span across the trench has been identified as a bridge. As per USGS Lidar Base Specification Version 1.0, bridges are to be removed from the DEM. A total of 59 bridges have been identified that have not been removed from the DEM. Some bridges have only been partially removed from the DEM. (7/8/2013)

Image?



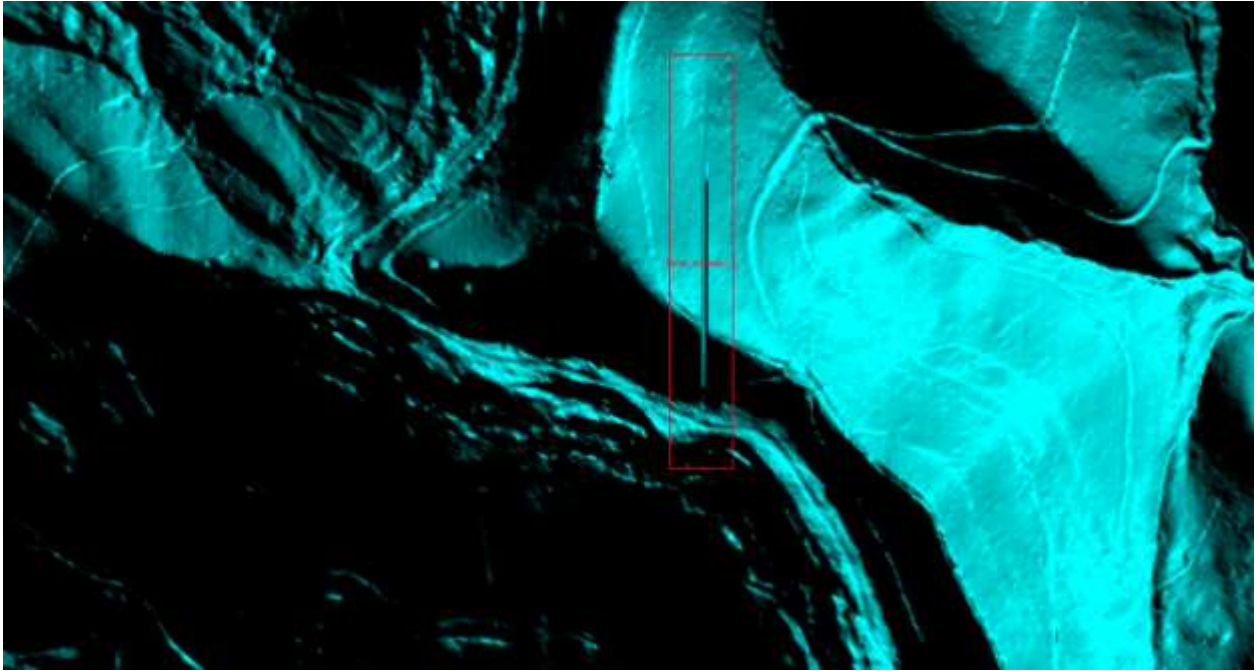
culvert\_4: The roadway across the trench has been identified as a culvert. As per USGS Lidar Base Specification Version 1.0, roadways over culverts should not be removed from the DEM. In some instances, the roadway has been partially removed above some culverts; these roadways should be completely restored. A total of 16 culverts have been identified as errors, whereas the roadway should be restored in the DEM. (7/8/2013)

Image?



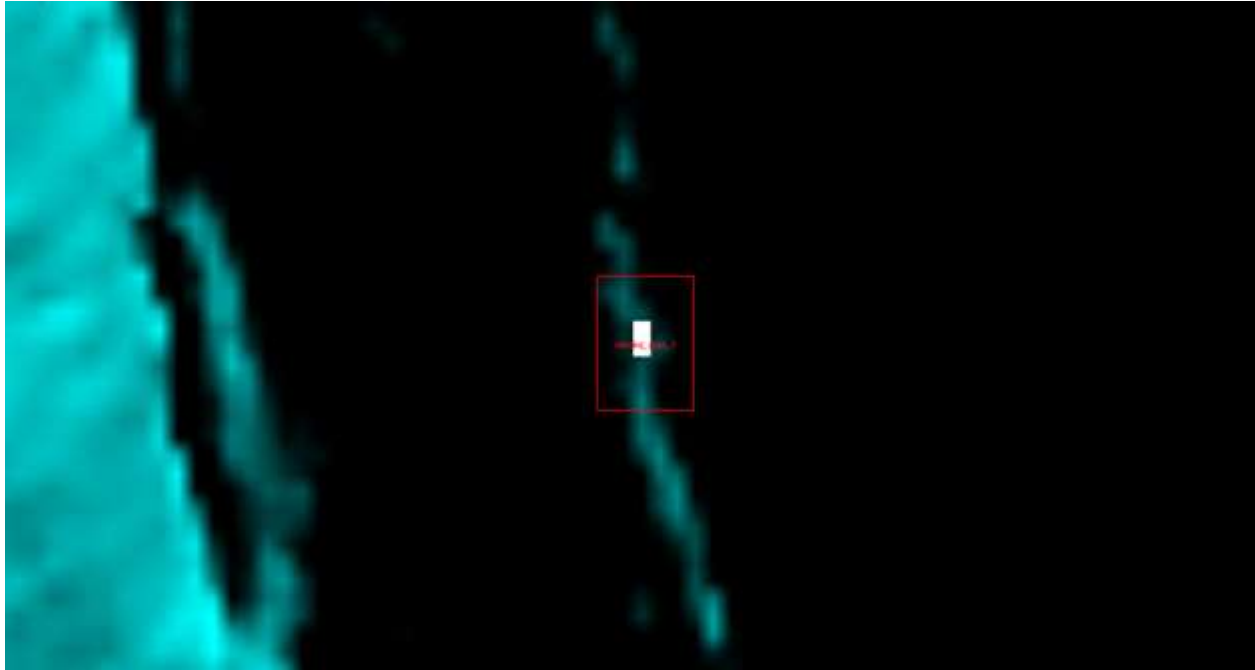
DEM\_anomaly: Parallel striations (north-south trending) - corn rowing - are present in the DEM. Two areas possessing this DEM-artifact have been identified within the DEM. (7/8/2013)

Image?



seam\_anomaly\_2: Lineations, mostly trending north-south, have been identified in the DEM; these occur at DEM seams and are predominate in the south and south-east portions of the DEM (mosaic). Some of the lineations occur along the same seam but have been identified in smaller areas. A total of 18 occurrences of these error-types have been identified in the DEM (mosaic). (7/8/2013)

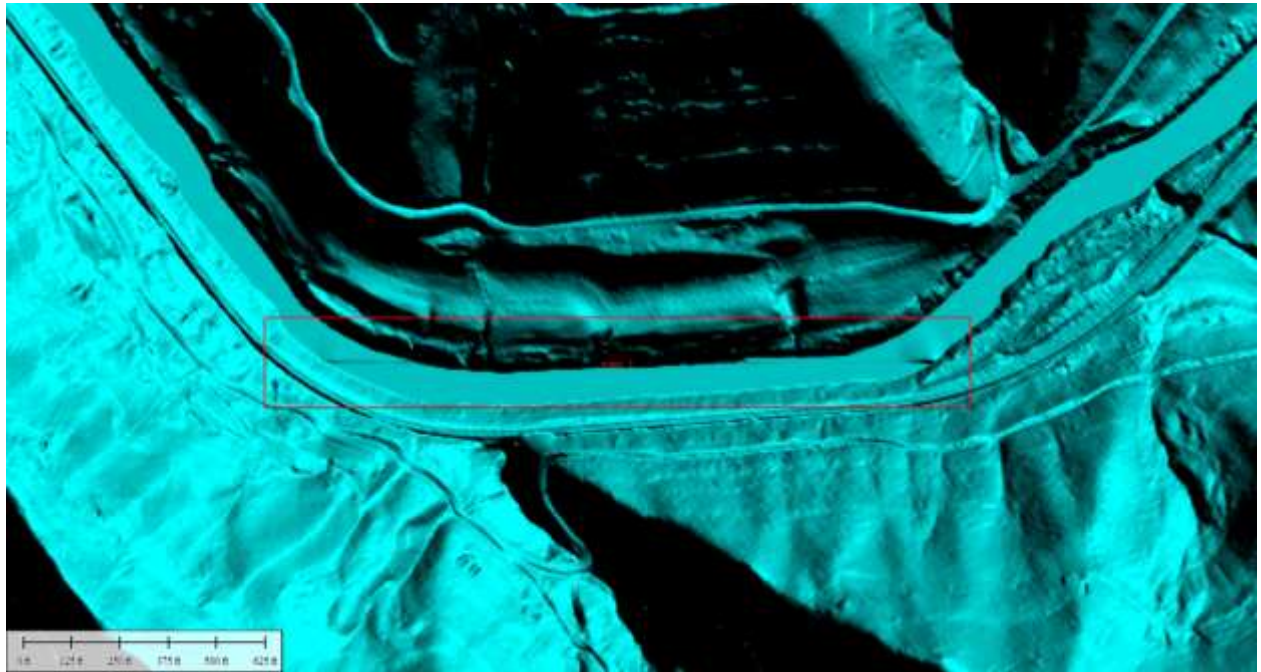
Image?



missing\_data\_1: Two areas have been identified in the DEM (mosaic) that have gaps in the data; these areas occur along seam lines, near the lineations mentioned above. (7/8/2013)

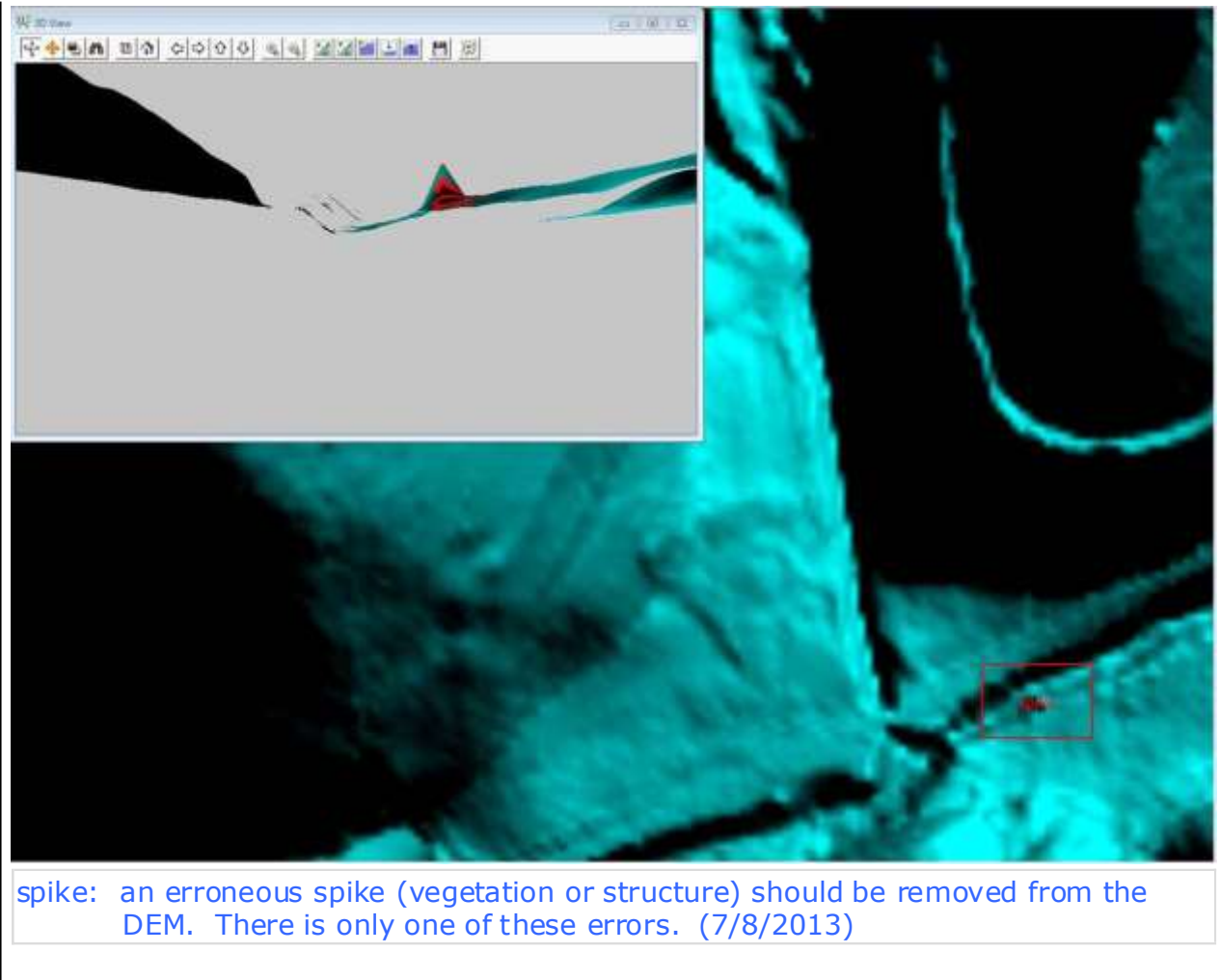
Image?



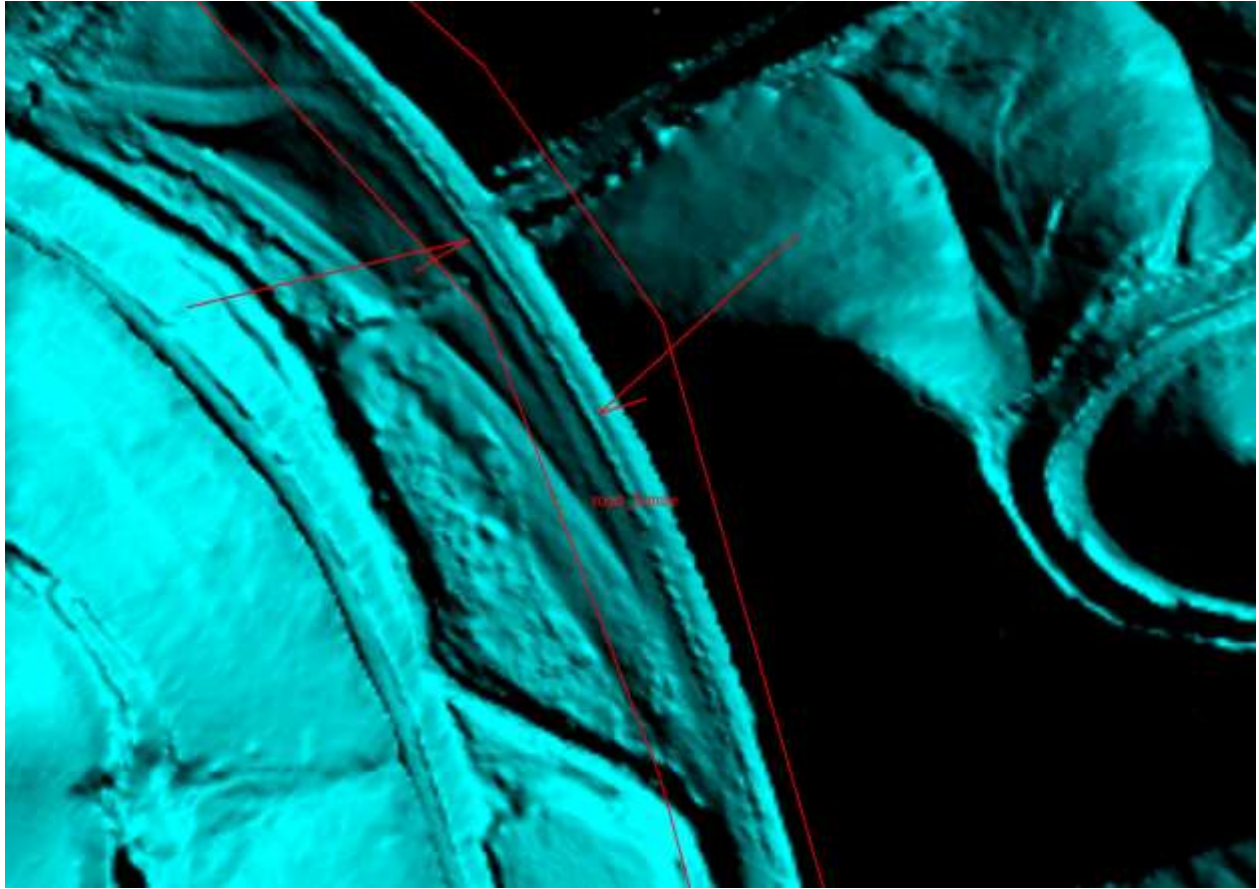


water\_1: Lineations in waterbodies that disrupt the hydroflattening of these waterbodies. There are two areas that have been identified in the DEM (mosaic). These error-types also occur along seam lines. (7/8/2013)

Image?



Image?



road\_feature: A curvilinear feature has been identified along a roadway. Imagery does not show this feature. Possible construction feature? There is only one area that hosts these features. (7/8/2013)

Internal Note:

## Summary of Errors:

### DEM

- FVA?
- 59 @ bridges that should be removed from DEM.
- 16 @ roadways removed above culverts.
- 2 @ areas that display parallel lineations in DEM.
- 18 @ lineations in DEM (mosaic) along seam lines.
- 2 @ gaps in DEM (mosaic); occur along seam lines.
- 2 @ waterbody errors; occur along seam lines.
- 1 @ spike in DEM (mosaic)
- 1 @ curvilinear feature on roadway in DEM (mosaic)

### SWATH

- FVA?
- Files either have no coordinate system or are different from one another; one swath folder contains LAS in UTM Zone 15, another is UTM Zone 17, the rest have an 'Unknown' coordinate system.
- Swath (raw LAS) contains more than one classification (1, 2, 3, and 4); this is found with folders 120320A\_234 and 12037A\_234.

### CHECK ('TRUING') POINTS (...not Control Points)

- None provided

### CONTROL POINTS

- Urban-category control points do not qualify as URBAN...according to the supplied photos in the Survey Report; 'Urban' areas refer to areas with dense man-made structures...photos show points collected on pavement in open areas.

### METADATA

- Inconsistent FVA specs: PDF notes lidar to be 12.5 cm (RMSEz) or better, XML notes lidar to be 18.0 cm (RMSEz) or better.
- DEM (XML): No mention of actual FVA, SVA, or CVA.
- Swath: No XML report for raw lidar provided.
- Breaklines: No XML report for breaklines provided.

**This is the end of the report.**

QA Form V1.4 12OCT11.xsn