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:
5/29/2012

Project Type: GPSC

Project ID:

VA-FEMA Region3-Lot1(Loudoun Co.)_2012

Project Alias(es):

FEMA Region 3

Project Description:

1. This task order is for Planning, Acquisition, processing, and derivative products of lidar data to be collected at a nominal pulse spacing (NPS) of 1.0 meters. Specifications listed below are based on the ***"U.S. Geological Survey National Geospatial Program Base Lidar Specification, Version 13 (ILMF)",*** of which sections I through IV are incorporated by reference to this task order. This specification may be viewed at *http://lidar.cr.usgs.gov/USGS-NGP Lidar Guidelines and Base Specification v13(ILMF).pdf*. These lidar specifications are required baseline specifications. In addition to the requirements listed below, variations from the specifications will be shown and noted below. For any item which is not specifically addressed, the referenced Version 13 specifications will be the required specification authority. This task is for a ***high resolution data set of lidar of approximately 2,815 square miles in portions of Virginia, West Virginia, and Maryland. The location and square miles are outlined in Attachment's A and B.***

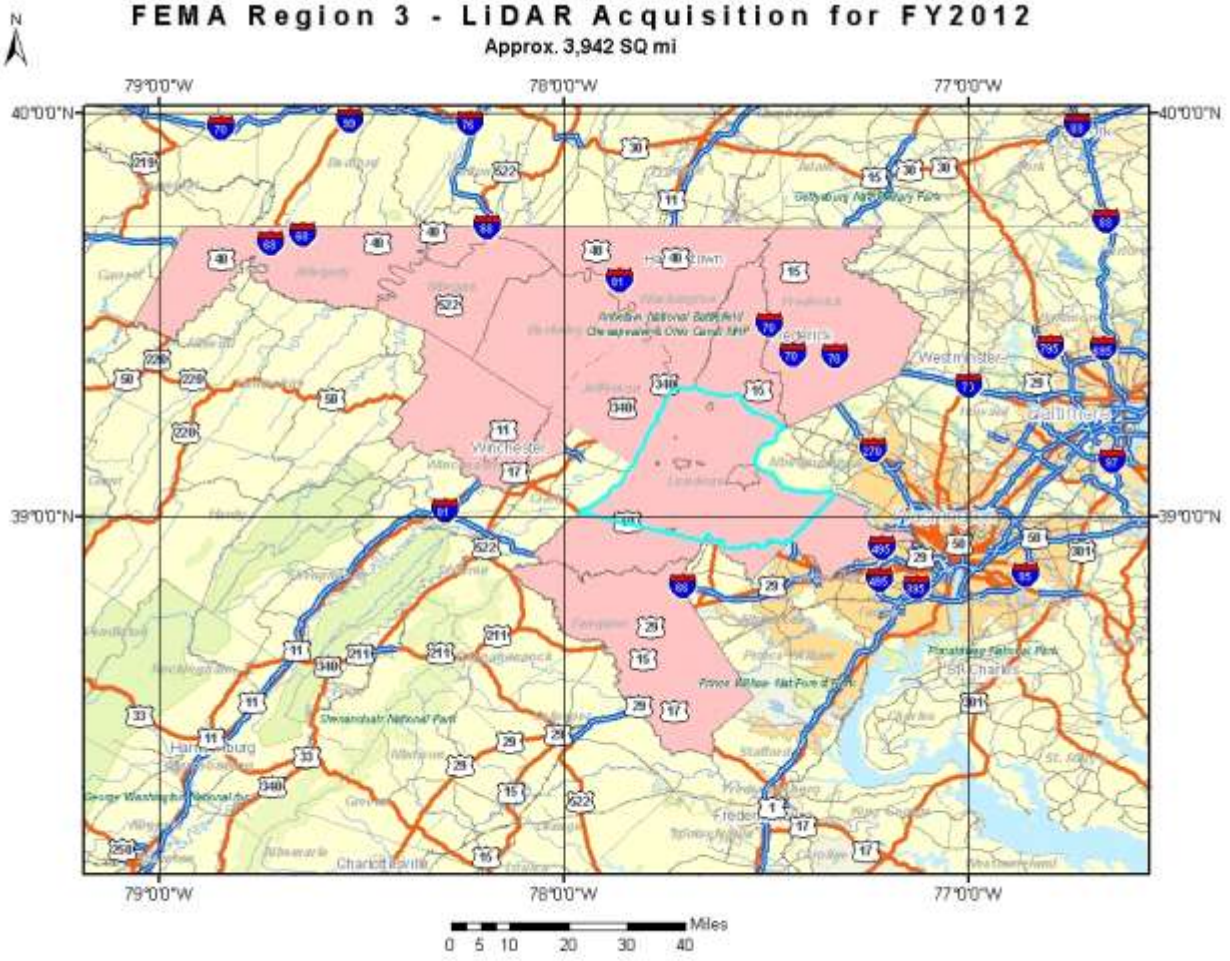
   This task order is amended to include ALL of Frederick, Washington, and Allegany County MD, all of Morgan and Jefferson County, WV, and all of Fauquier and Loudoun County, VA at the same specifications outlined in this task order. This amendment would add an additional 1,127 sq mi bringing the task order total to 3,942 sq mi. Included in Attachment A, is an updated project diagram.

Year of Collection: 2012

Lot 1 of 4 lots.

Project Extent:

☑ Project Extent image?



Project Tiling Scheme:

☑ Project Tiling Scheme image?

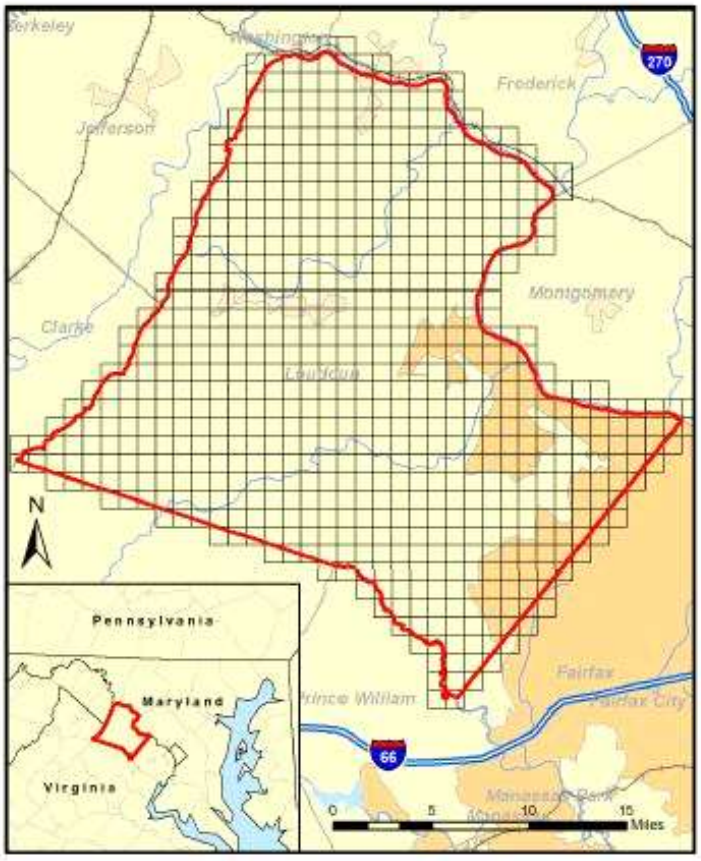


Figure 1 - Tile grid and project boundary of the Loudoun area.

Contractor:	Applicable Specification:
Dewberry	V13

Licensing Restrictions:

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Pat Emmett	CPT	573-308-3587	pemmett@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?	178
☑ Intensity Image Files ☑ Required?	694
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	694
☑ Breakline Files ☑ Required? ☑ XML Metadata?	2
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	694

Additional Deliverables

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

None.

Project Geographic Information

Areal Extent: 563.83 Sq Mi
Grid Size: 1.0 meters
Tile Size: 1500 x 1500 meters
Nominal Pulse Spacing: 1.0 meters
Vertical Datum: NAVD88 meters
Horizontal Datum: NAD83 meters

Project Projection/Coordinate Reference System: UTM zone 18N meters.

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

- ☑ Project Shapefile/Geodatabase
- ☑ Project Tiling Scheme Shapefile/Gdb
- ☑ Checkpoints Shapefile/Geodatabase
- ☑ Project XML Metadata File
- ☑ Swath LAS XML Metadata File
- ☑ Classified LAS XML Metadata File
- ☑ Breaklines XML Metadata File
- ☑ Bare-Earth DEM XML Metadata File
- ☑ Swath LAS Files
- ☑ Classified LAS Files
- ☑ Breaklines Files
- ☑ Bare-Earth DEM Files

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: B. Swain

Review Start Date: 6/5/2012

Action to Contractor Date	Issue Description	Return Date

Review Complete: 6/6/2012

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 Swath LAS 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 with errors.

```
Error (line 3): Lineage is not permitted in Metadata
Error (line 3): Identification_Information is required in Metadata
Error (line 3): Metadata_Reference_Information is required in Metadata
Error (line 3): Process_Step is required in Lineage
4 errors: 1 misplaced, 3 missing
```

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?

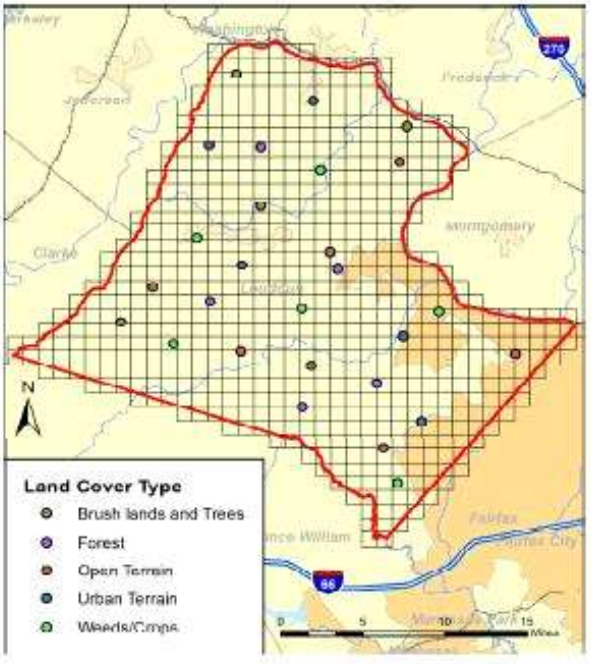


Figure 2 Checkpoint Map shows that checkpoints are well distributed throughout project area.

The following land cover classes are represented in this dataset (uncheck any that do not apply):

- [x] Bare Earth
- [x] Tall Weeds and Crops
- [x] Brush Lands and Low Trees
- [x] Forested Areas Fully Covered by Trees
- [x] 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?

This is only one portion (Loudoun County) of the entire AOI for this task, so tentative tests were performed on smaller subareas with fewer than 20 QA/QC checkpoints. Dewberry's final results will not be
official until all areas are merged for testing of the total area with all project checkpoints.

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: meters

Required FVA Value is 0.245 meters or less.
Target SVA Value is 0.363 meters or less.
Required CVA Value is 0.363 meters or less.

The reported FVA of the LAS Swath data is 0.18 meters.

The reported FVA of the Bare-Earth DEM data is 0.19 meters.

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	0.10	meters
Brush Lands and Low Trees	0.25	meters
Forested Areas Fully Covered by Trees	0.28	meters
Urban Areas with Dense Man-Made Structur...	0.05	meters

The reported CVA of this data set is: 0.24 meters.

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

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

The reported FVA of the LAS swath data is 0.18 meters.

Based on this review, the USGS accepts the LAS swath file data.

Errors, Anomalies, Other Issues to document? ( ) 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

- [x] Separate folder for Classified LAS tile files
- [x] Classified LAS tile files conform to Project Tiling Scheme
- [x] Quantity of Classified LAS tile files conforms to Project Tiling Scheme
- [x] Classified LAS tile files do not overlap
- [x] Classified LAS tile files are uniform in size
- [x] 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?

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

- [x] Separate folder for breakline files
- [x] All breaklines captured as PolylineZ or PolygonZ features
- [x] 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: Erdas Imagine *.img

Bare-Earth DEM Tile File Characteristics

- [x] Separate folder for bare-earth DEM files
- [x] DEM files conform to Project Tiling Scheme
- [x] Quantity of DEM files conforms to Project Tiling Scheme
- [x] DEM files do not overlap
- [x] DEM files are uniform in size
- [x] DEM files properly edge match
- [x] Independent check points are well distributed

All accuracy values reported in meters.

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval ($Accuracy_z$) Required FVA = 0.245 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 0.363 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 0.363 or less.
Open Terrain	20	0.19		
Tall Weeds and Crops			0.10	

Brush Lands and Low Trees			0.25	
Forested Areas Fully Covered by Trees			0.28	
Urban Areas with Dense Man-Made Structures			0.05	
Consolidated	20			0.24

☑ QA performed Accuracy Calculations?

Calculated Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval ($Accuracy_z$) Required FVA = 0.245 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 0.363 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 0.363 or less.
Open Terrain	6	.477		
Tall Weeds and Crops	6		.09	
Brush Lands and Low Trees	5		.25	
Forested Areas Fully Covered by Trees	5		.29	
Urban Areas with Dense Man-Made Structures	5		.05	
Consolidated	27			.24

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.

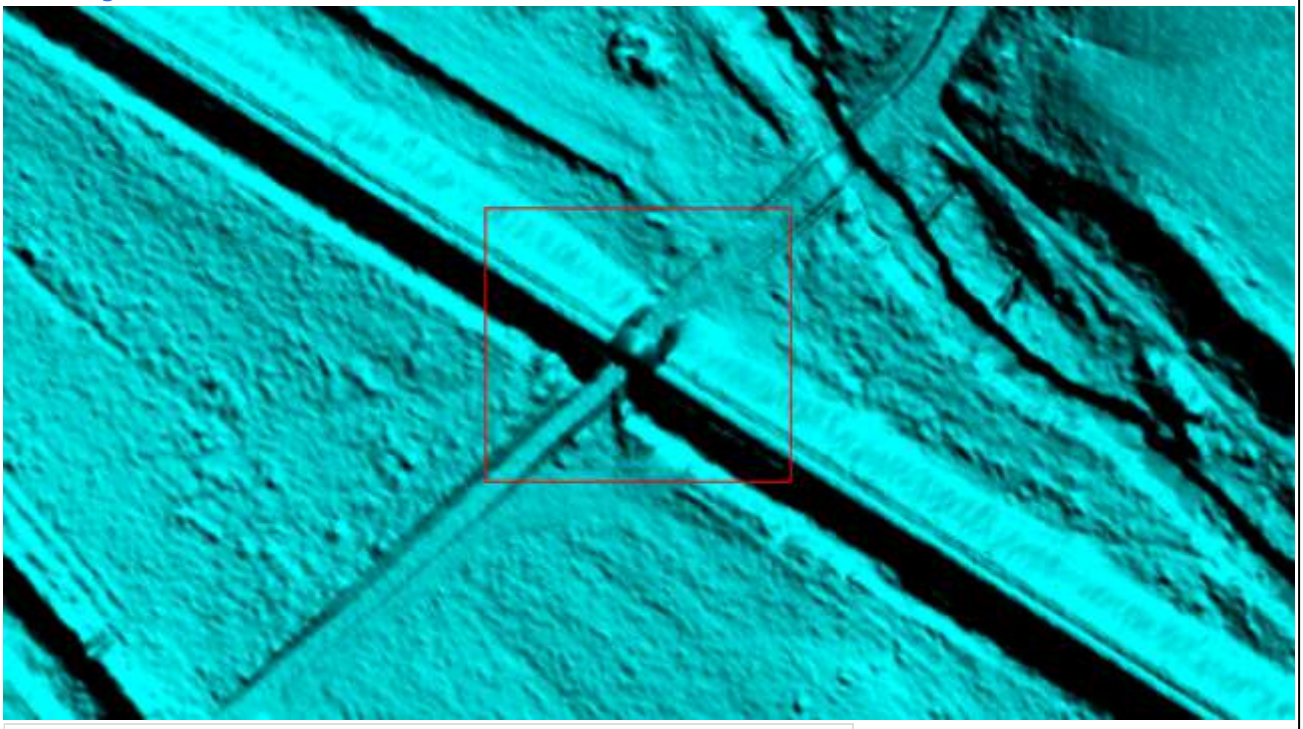
Bare-Earth DEM Anomalies, Errors, Other Issues

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

☐ Image?

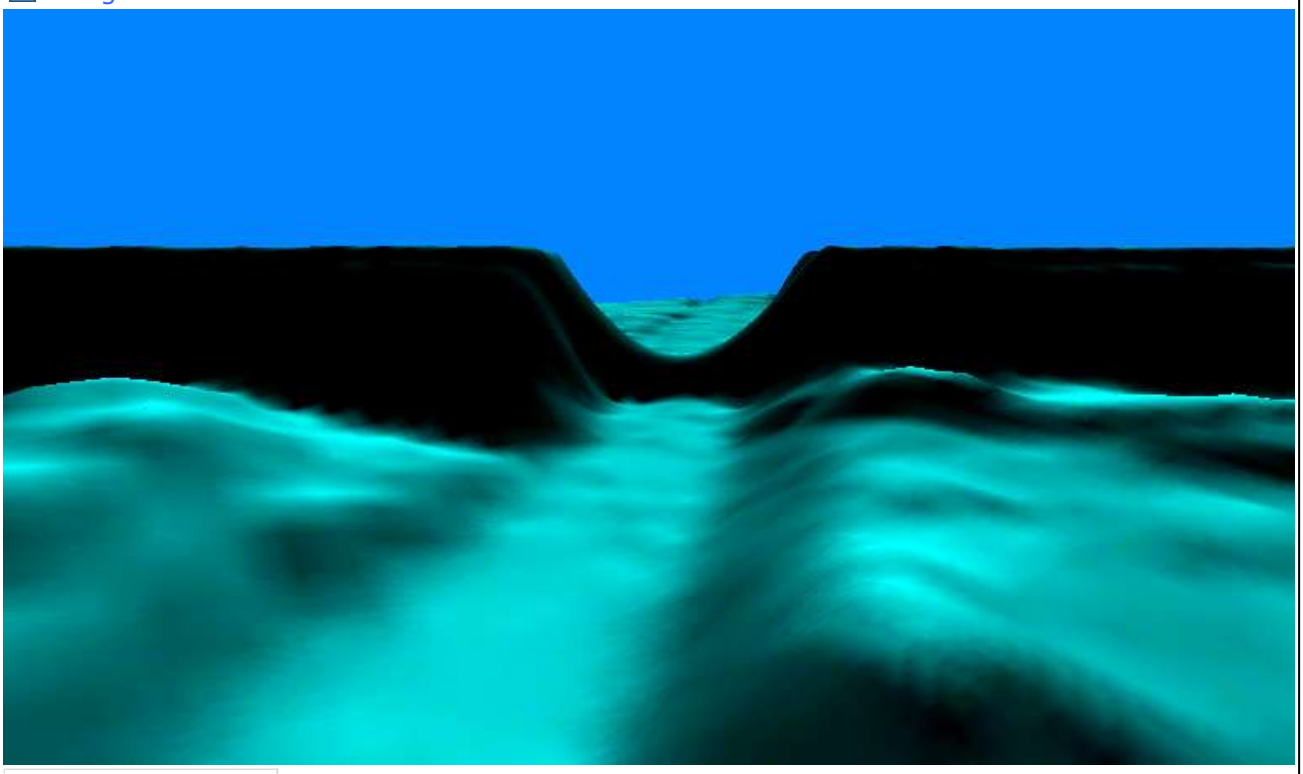
In total, five errors were found in this dataset. All errors were incomplete bridge removals, which Dewberry will not fix.

☑ Image?



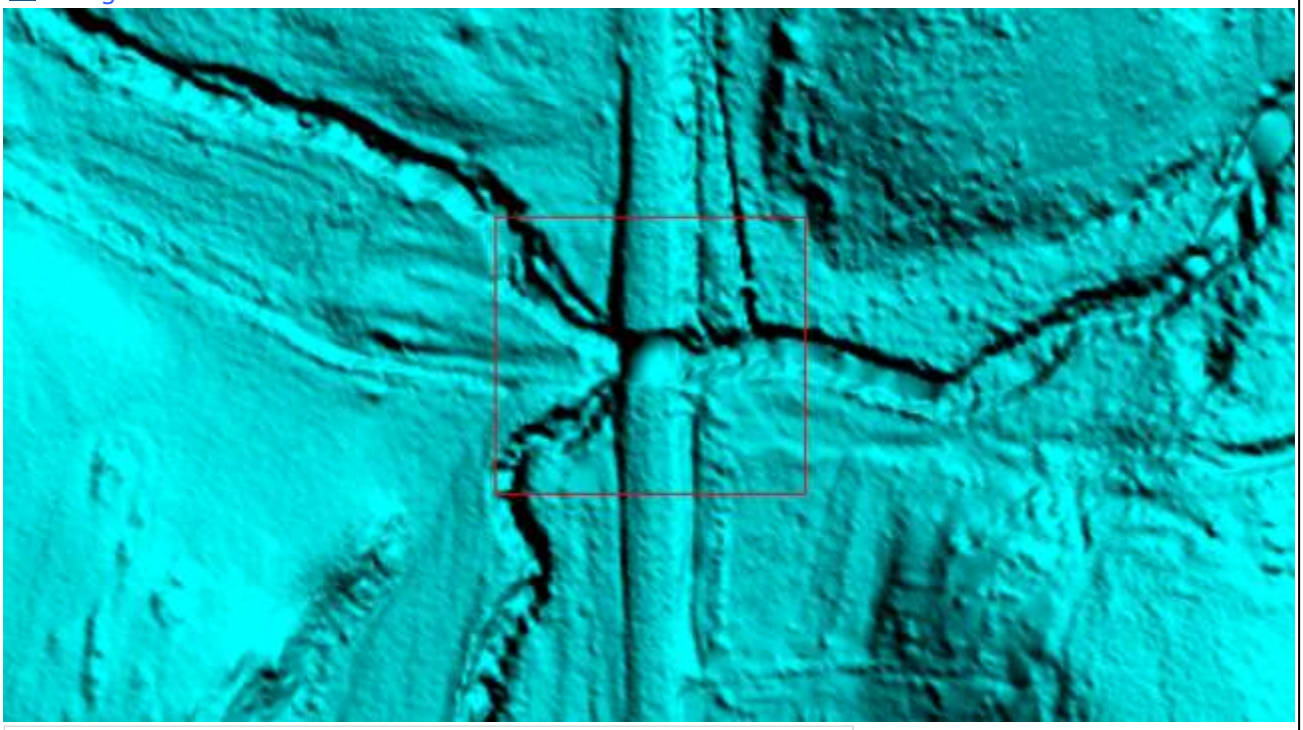
Bridge error at 39° 15' 4.5892" N, 77° 28' 51.5114" W

☑ Image?



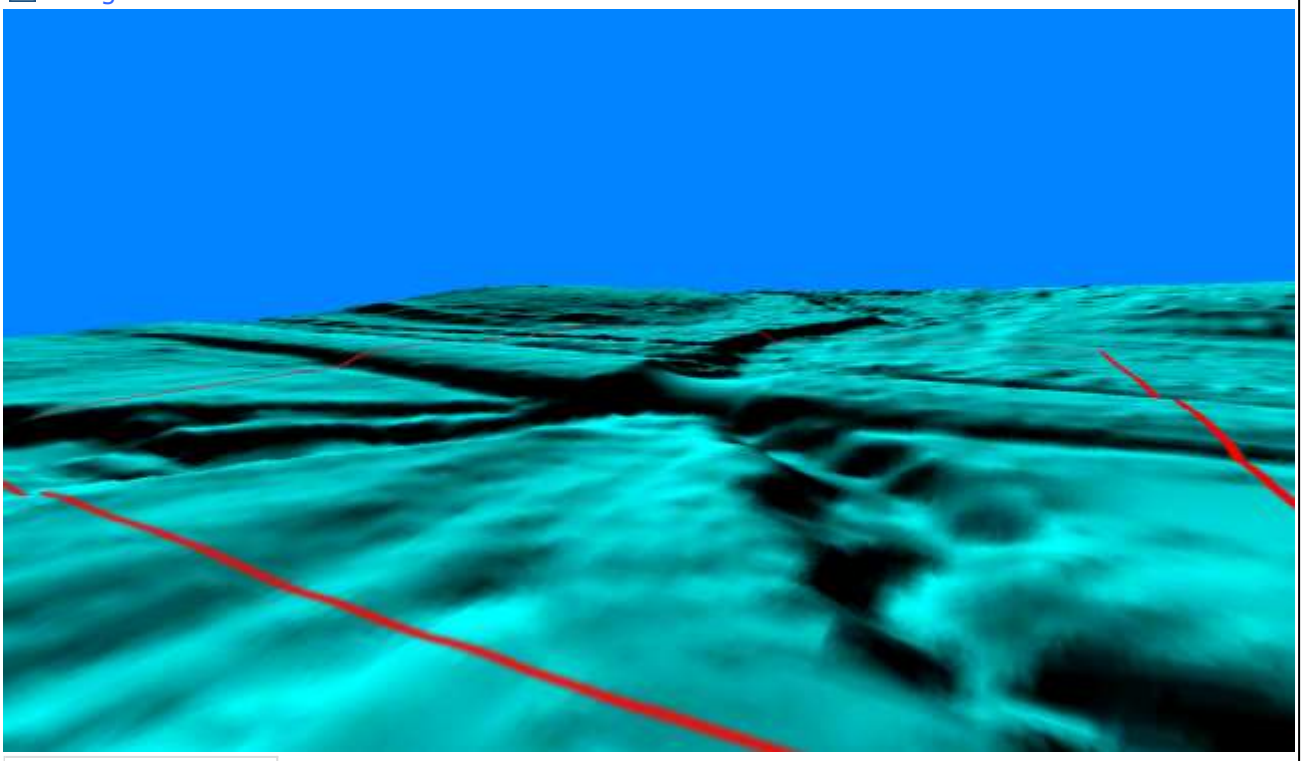
Above error in 3D

☑ Image?



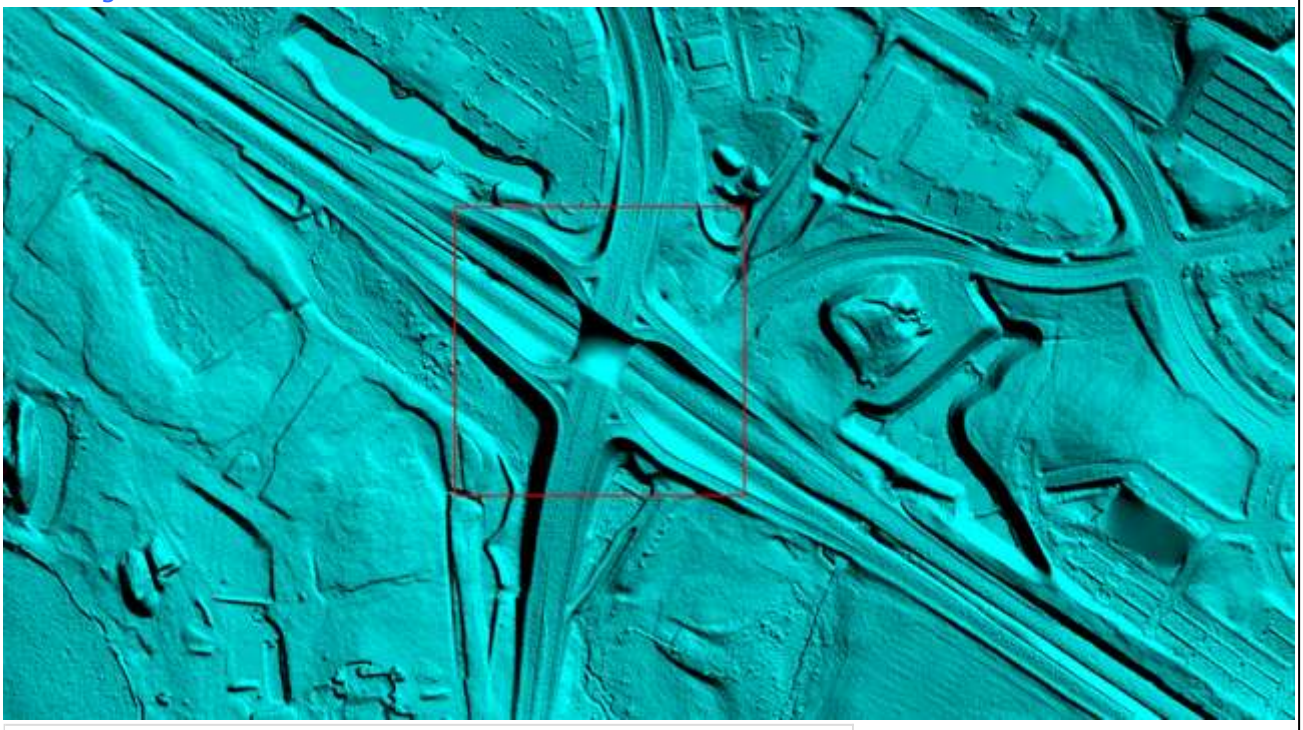
Bridge error at 39° 10' 3.3633" N, 77° 32' 10.1629" W

☑ Image?



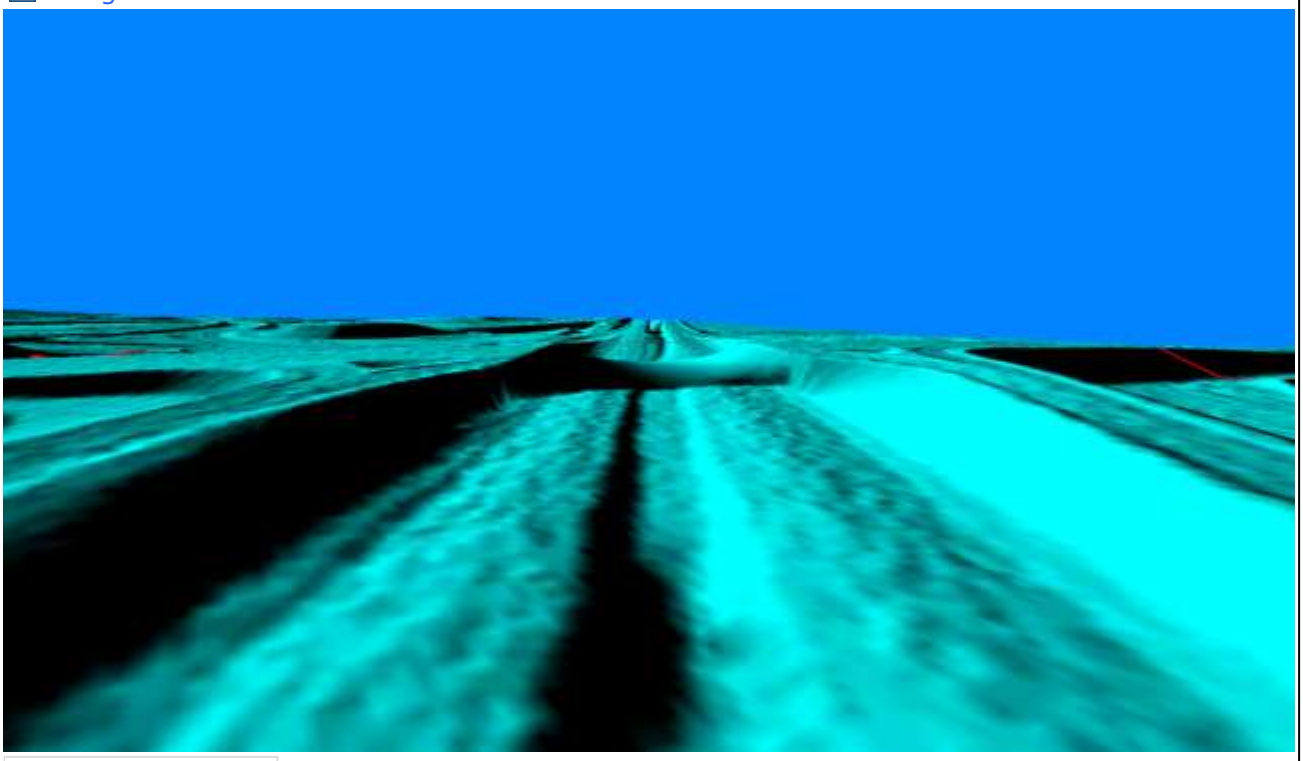
Above error in 3D

☑ Image?



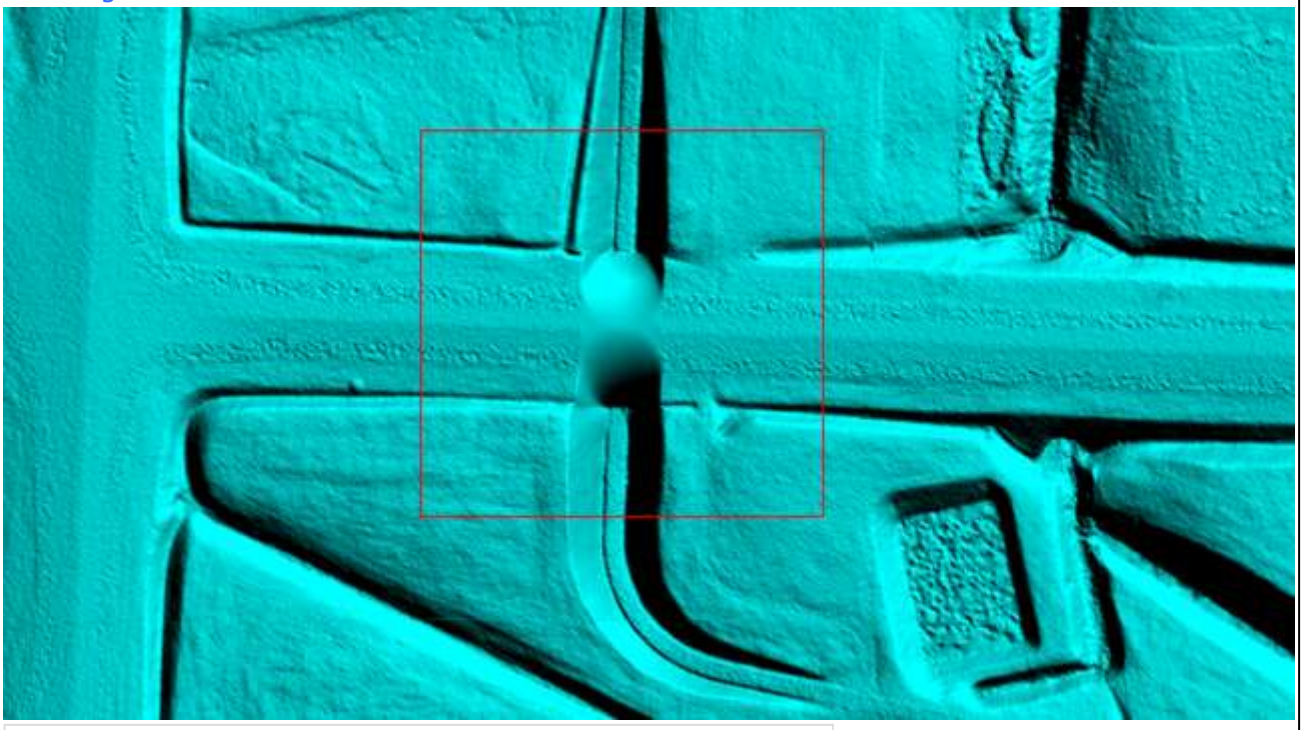
Bridge error at 39° 03' 22.3106" N, 77° 27' 3.0153" W

☑ Image?



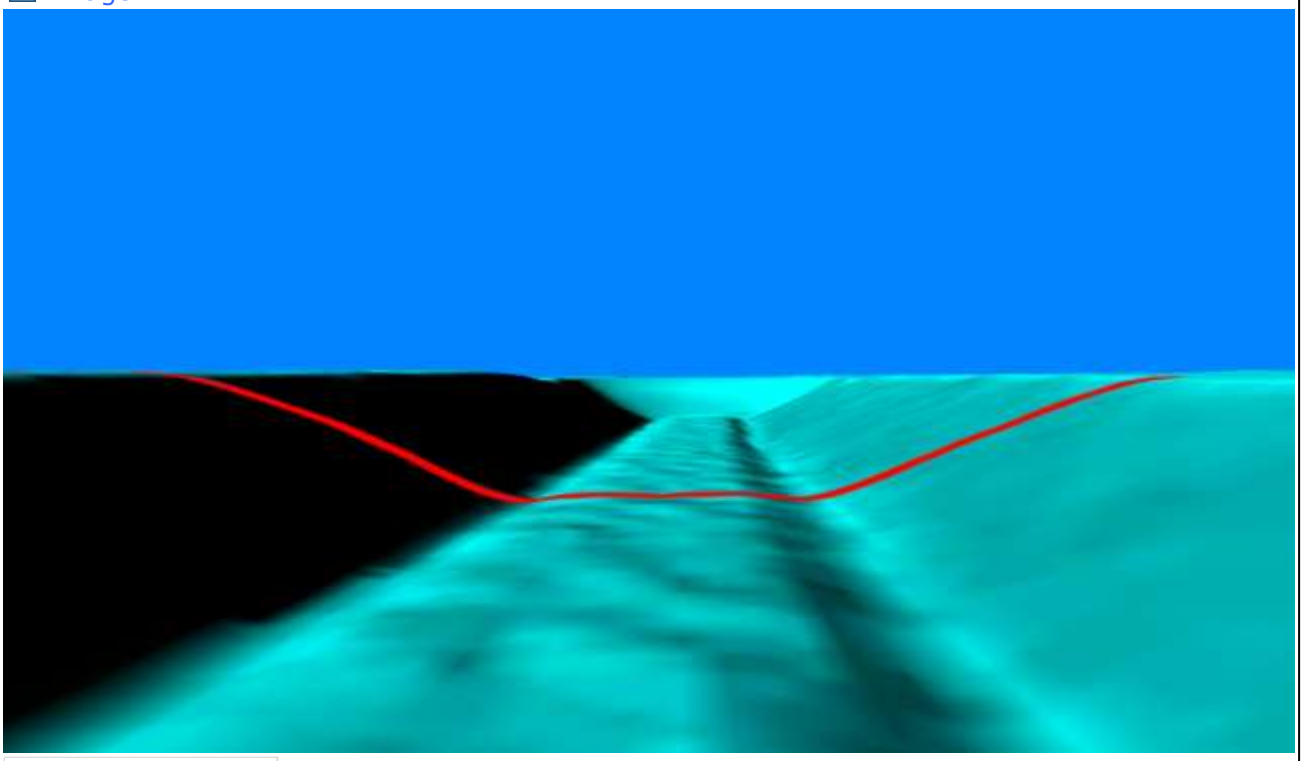
Above error in 3D

☑ Image?



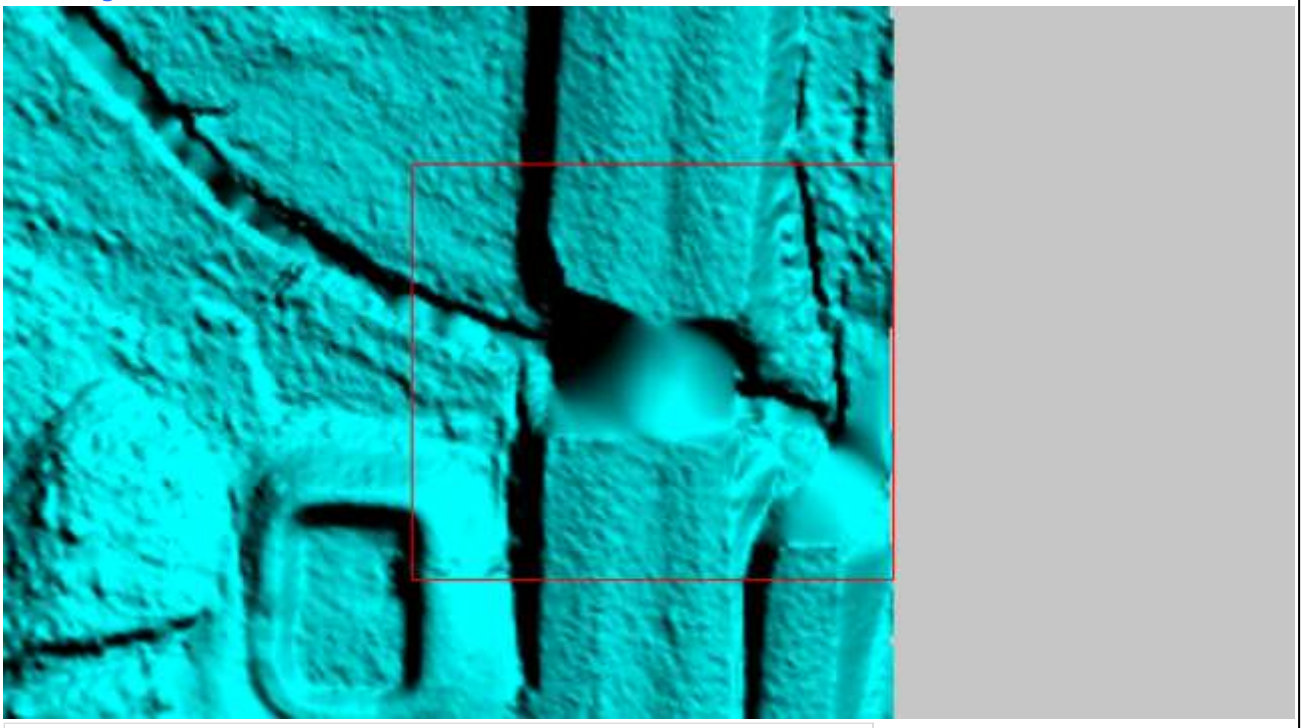
Bridge error at 38° 57' 1.8704" N, 77° 28' 8.8984" W

Image?



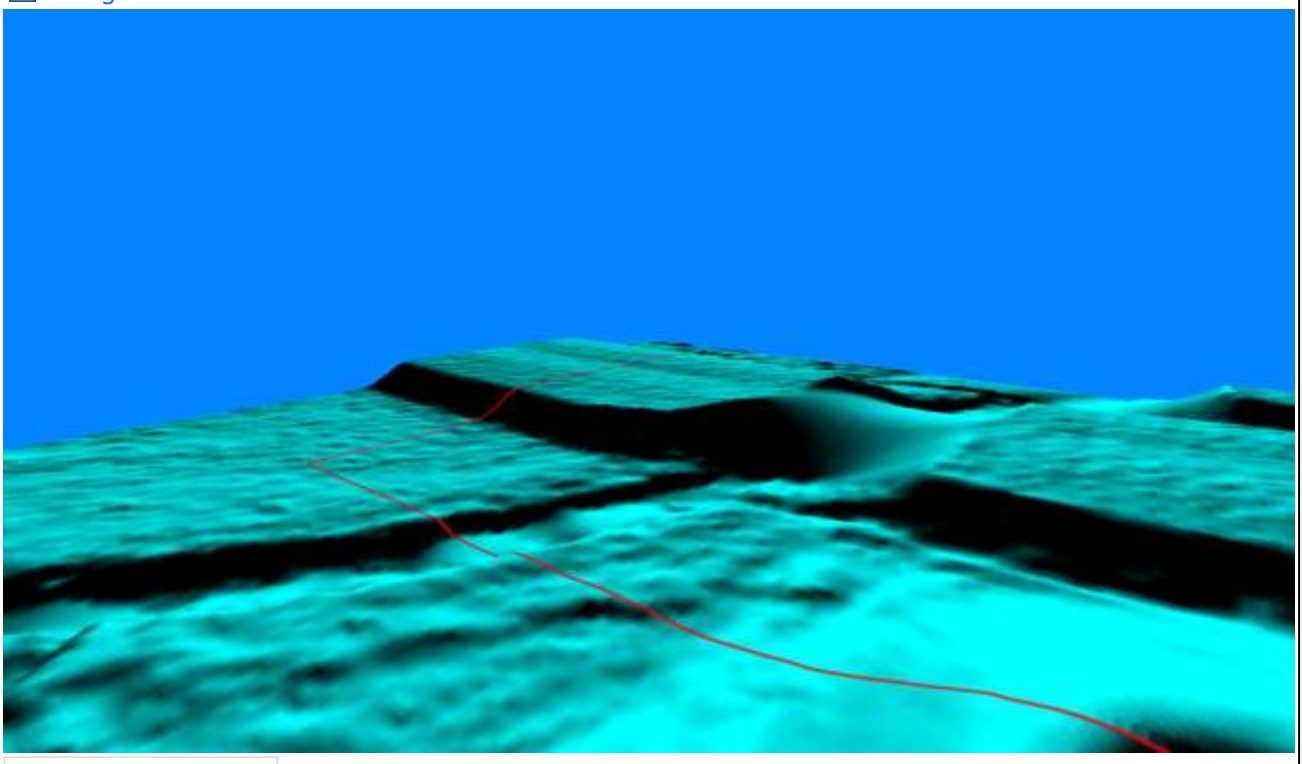
Above error in 3D

Image?



Bridge error at 38° 56' 47.7119" N, 77° 25' 46.7634" W

☑ Image?



Above error in 3D

Based on this review, the deliverables provided meet the Task Order requirements.

Internal Note:

1 meter Erdas Imagine DEM files were reviewed in Global Mapper. Five errors were found in the DEM and are all partial bridge removal errors as shown in the images. Dewberry has asserted they will not fix these issues, so project was passed in spite of these issues. Metadata and LAS were both checked with no issues.
Vertical accuracy was checked by NGTOC using the checkpoints given for this block, which amounted to 5 or 6 points per class. The entire project as a whole will include at least 20 points per class, but these are divided up with the lots, and each lot will be checked individually as well as the entire project when all other lots become available for review.
Dataset was accepted and recommended for the NED.

This is the end of the report.