



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:

2/14/2013

Project ID:

ME_Aroostook_2012

Project Alias(es):

Maine Statewide Lidar

Project Type: Partnership

Project Description:

This lidar project, Aroostook, is part of three, non-contiguous areas as part of the Maine Statewide Lidar and Orthoimagery project. The other two areas are referred to as Mid-Coastal Cleanup.

FVA was calculated utilizing all three areas, thus the FVA values for this report will be the same for the Southern Areas (MidCoastal Cleanup).

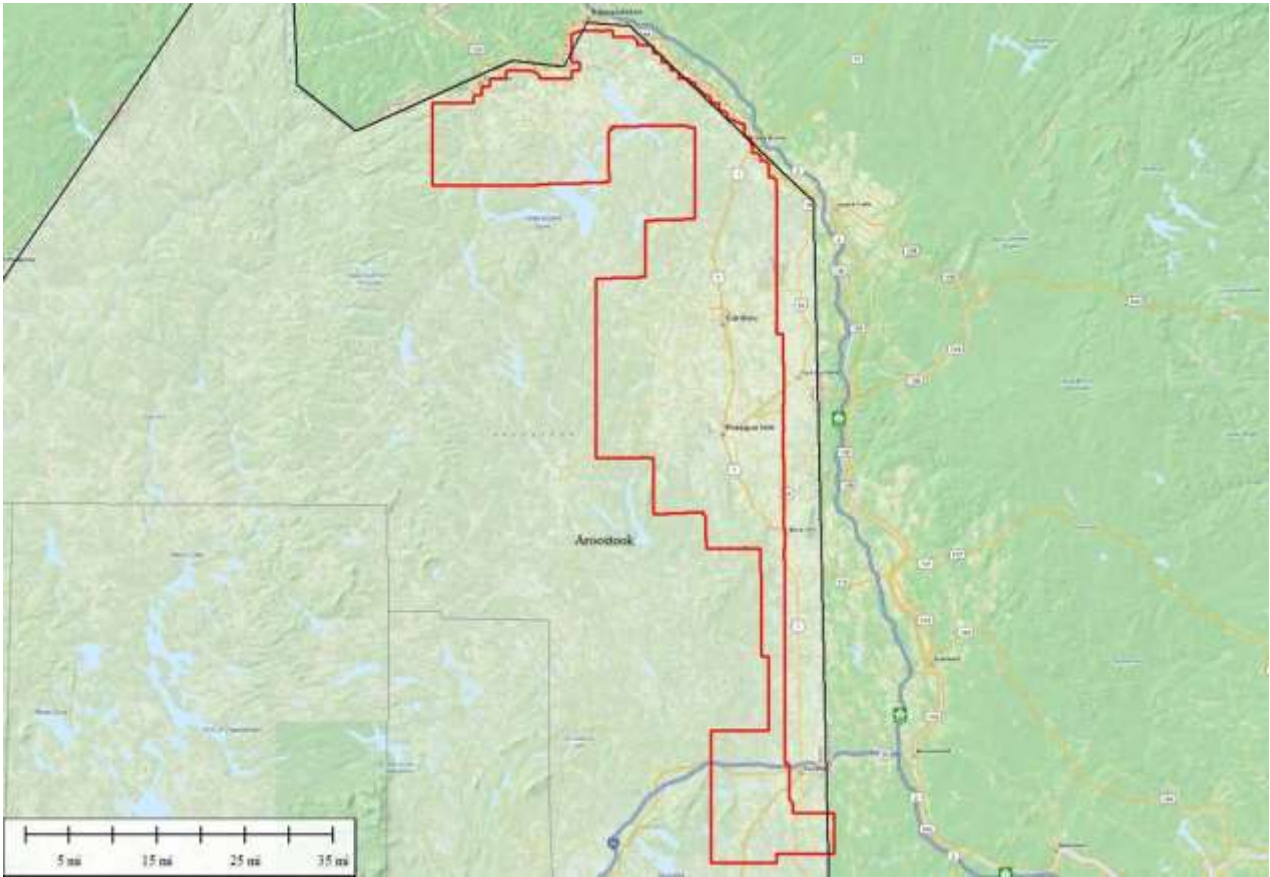
Aroostook is only a portion of Aroostook County, Maine.

Year of Collection: 2012

Lot 1 of 1 lots.

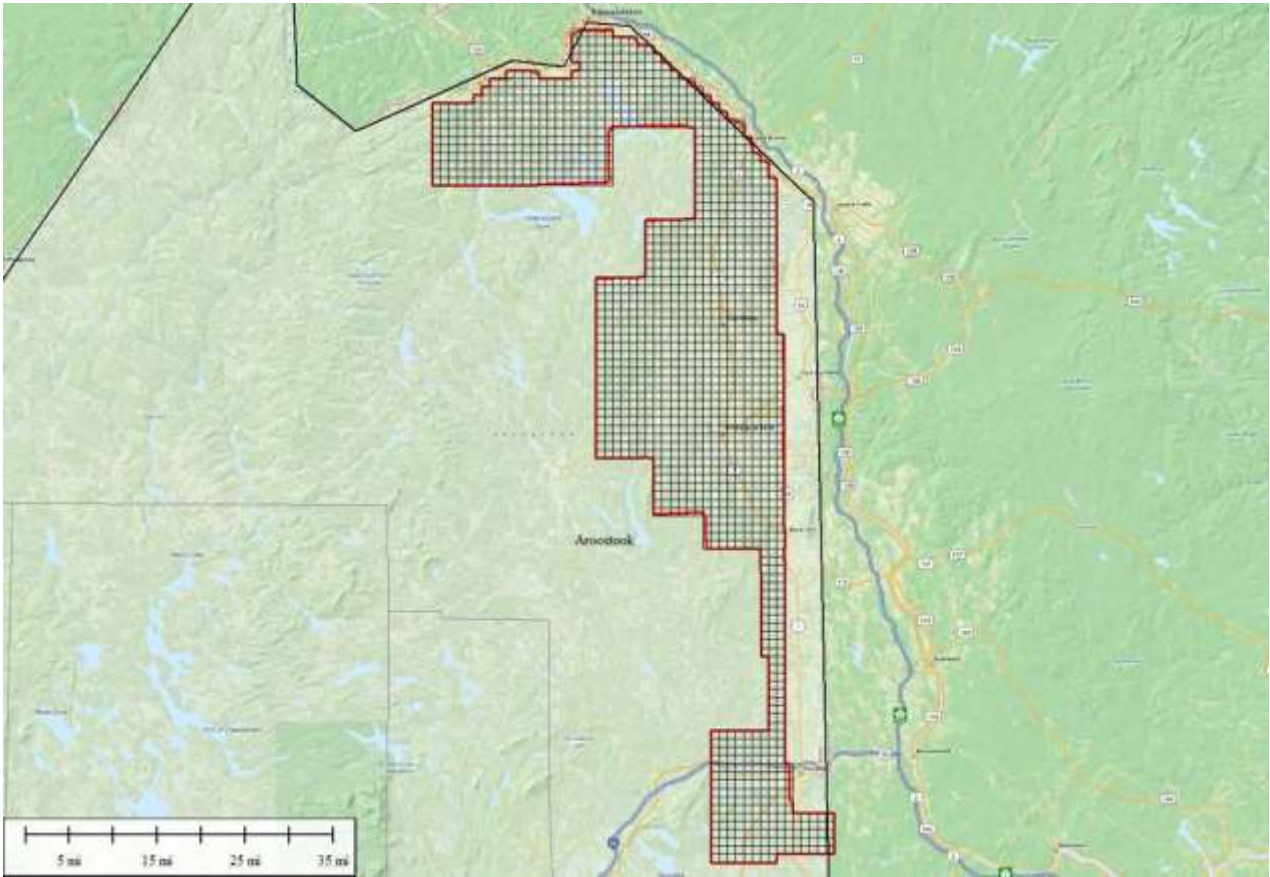
Project Extent:

Project Extent image?



Project Tiling Scheme:

Project Tiling Scheme image?



Contractor:

Woolpert, Inc.

Applicable Specification:

V13

Licensing Restrictions:

Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Dan Walters	NSDI Liaison	207-622-8201 x128	danwalters@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 type="checkbox"/> Survey Report | <input checked="" type="checkbox"/> Project Tiling Scheme Shapefile/Gdb |
| <input checked="" type="checkbox"/> Processing Report | <input checked="" type="checkbox"/> Control Point Shapefile/Gdb |
| <input checked="" type="checkbox"/> QA/QC Report | <input checked="" type="checkbox"/> Breakline Shapefile/Gdb |
| <input checked="" 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?	160
<input type="checkbox"/> Intensity Image Files <input type="checkbox"/> Required?	
<input checked="" type="checkbox"/> Tiled LAS Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	1501
<input checked="" type="checkbox"/> Breakline Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	2
<input checked="" type="checkbox"/> Bare-Earth DEM Files <input checked="" type="checkbox"/> Required? <input checked="" type="checkbox"/> XML Metadata?	1501

Additional Deliverables

	Item
<input checked="" type="checkbox"/>	Flight Line shapes

Errors, Anomalies, Other Issues to document? Yes No

None.

Project Geographic Information

Areal Extent:

1304

Sq Mi

Grid Size:

1

meters

Tile Size:

1500 x 1500

meters

Nominal Pulse Spacing:

1.5

meters

Vertical Datum: NAVD88 meters

Horizontal Datum: NAD83 (NSRS2007) meters

Project Projection/Coordinate Reference System:

Universal Transverse Mercator (UTM), Zone 19 meters.

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

- | | |
|---|--|
| <input type="checkbox"/> Project Shapefile/Geodatabase | <input checked="" 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 checked="" 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 checked="" 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 |

Project Shapefile/Geodatabase CRS

Swath LAS Files CRS

WGS84 UTM Zone19N and Unknown Coordinate System

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:

3/7/2013

Action to Contractor Date	Issue Description	Return Date
4/18/2013	Summary of errors: Raw Swath is not all in the correct coordinate system. **Corrected	9/19/2013

Review Complete: 9/25/2013

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 without errors.

Project QA/QC Report Review

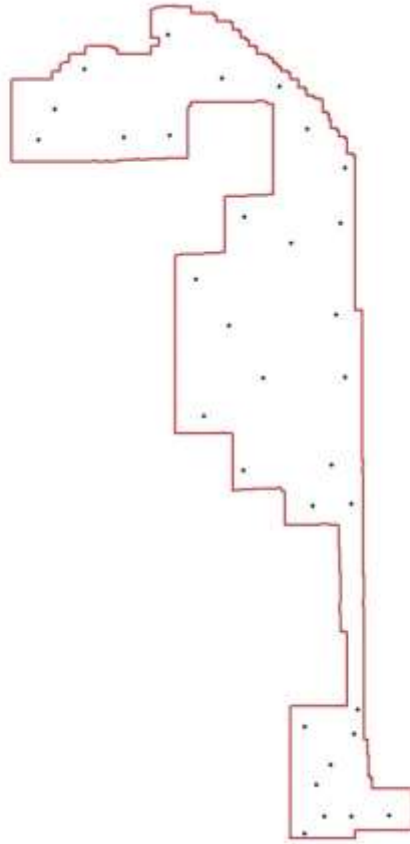
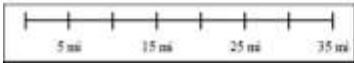
ASPRS recommends that checkpoint surveys be used to verify the vertical accuracy of LiDAR data sets. Checkpoints are to be collected by an independent survey firm licensed in the particular state(s) where the project is located. While subjective, checkpoints should be well distributed throughout the 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?

Only Bare Earth points are presented; no other classifications of points are part of the QA.

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
<i>Tall Weeds and Crops</i>		N/A
<i>Brush Lands and Low Trees</i>		N/A
<i>Forested Areas Fully Covered by Trees</i>		N/A
<i>Urban Areas with Dense Man-Made Structu...</i>		N/A

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 accepts the LAS swath file data.

Errors, Anomalies, Other Issues to document? Yes No

Image?



Raw Swath: This image shows the Raw LAS within and outside of the Aroostook footprint area. There are inconsistencies with the projection and coordinate systems of the delivered Raw LAS files. Some of the data within the folders are WGS84_UTM19N while others are Unknown Coordinate System.

**Corrected

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?

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.

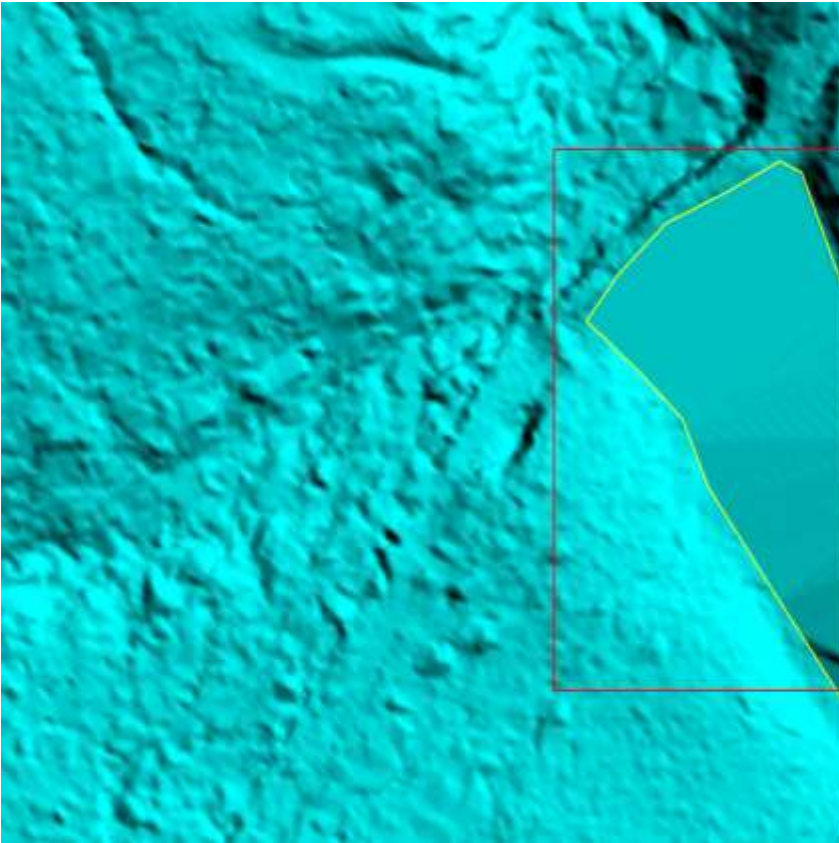
Breakline File Characteristics

- 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

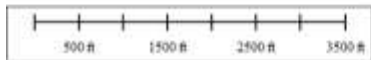
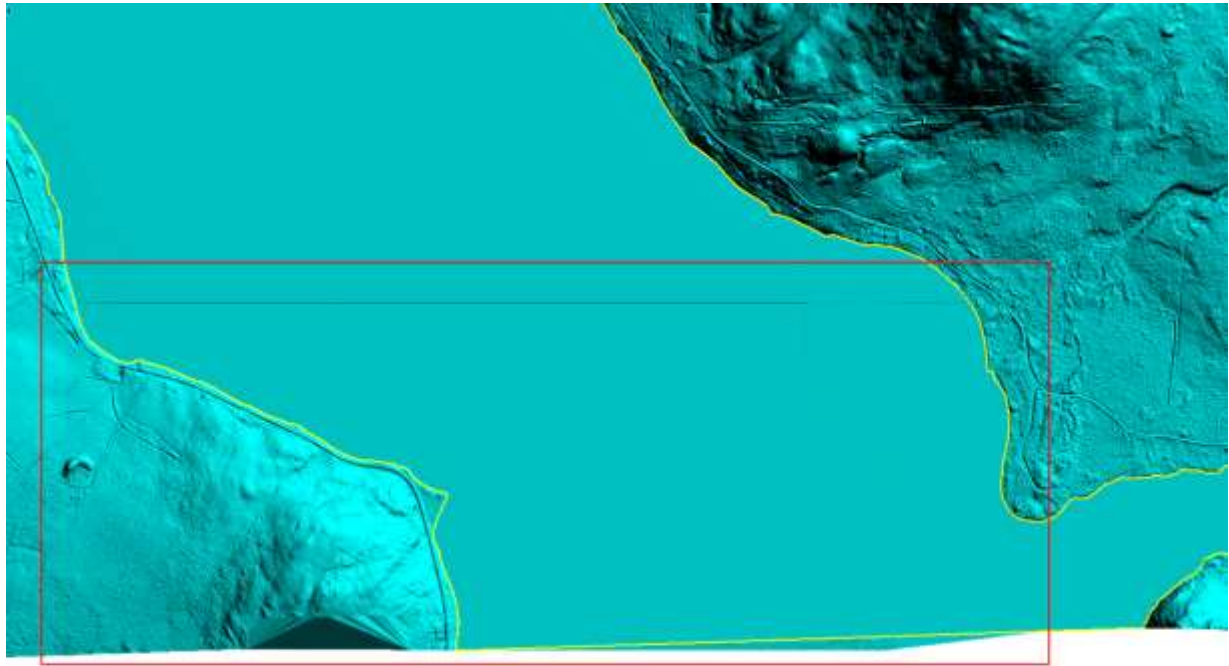
Image for error?



water_1: This is a representative image of water errors whereas breaklines are provided for a waterbody, however, elevation of the waterbody is not constant (specifically for ponds/lakes). There are five of this error type.

**This error has been fixed by contractor.

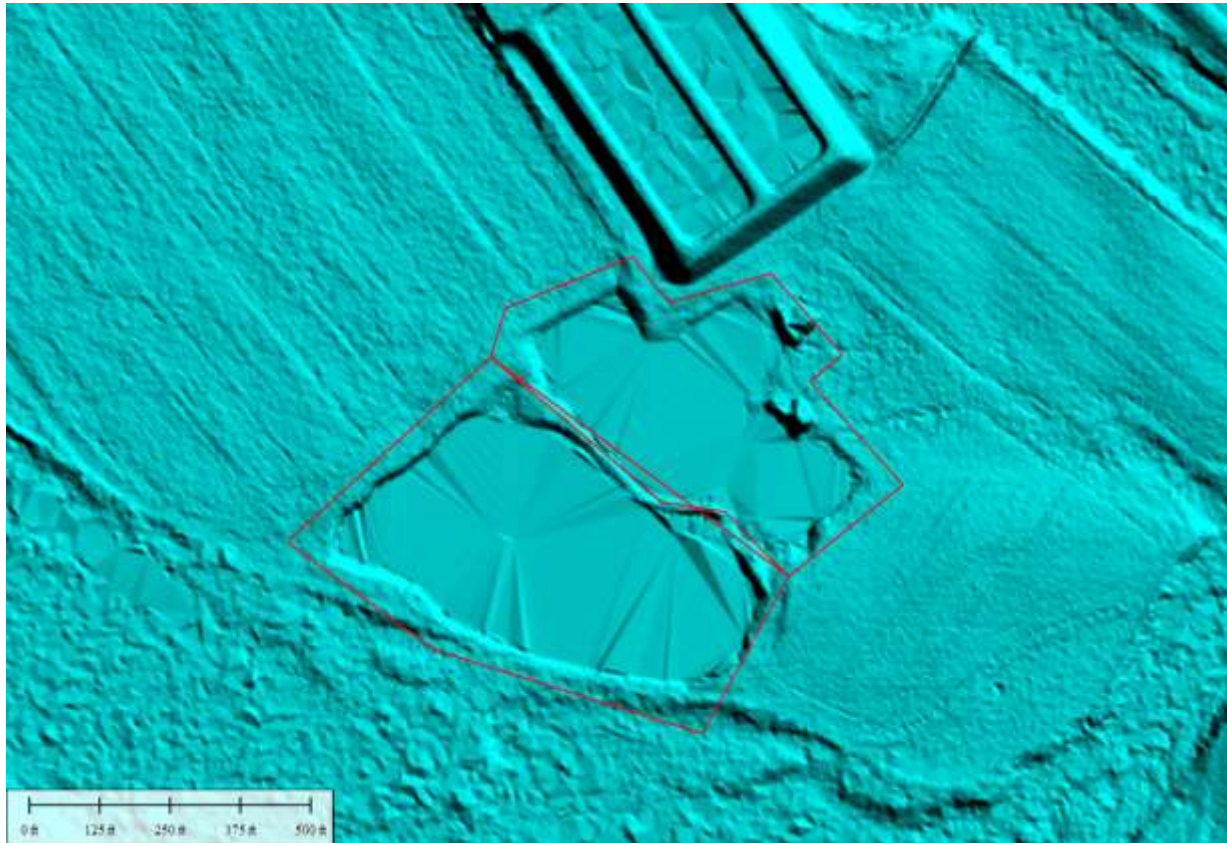
Image for error?



water_3: Another representative image demonstrating water elevation errors with waterbodies utilizing breaklines.

**This error has been fixed by contractor.

Image for error?



unflattened_wb_2-3: This is a representative image of two waterbodies (>2 acres) that are not flattened. There are four errors of this type (two are presented here). These error-types are also related to why the "No missing or misplaced breaklines" box is not checked.

**These errors have been fixed by contractor.

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 .

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 = or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = or less.
Open Terrain	25	12.0		
Tall Weeds and Crops	1			
Brush Lands and Low Trees	1			
Forested Areas Fully Covered by Trees	1			
Urban Areas with Dense Man-Made Structures	1			
Consolidated	25			

- 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 = or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = or less.
Open Terrain	21	12.7		
Tall Weeds and Crops	1			
Brush Lands and Low Trees	1			
Forested Areas Fully Covered by Trees	1			
Urban Areas with Dense	1			

Man-Made Structures				
Consolidated	21			

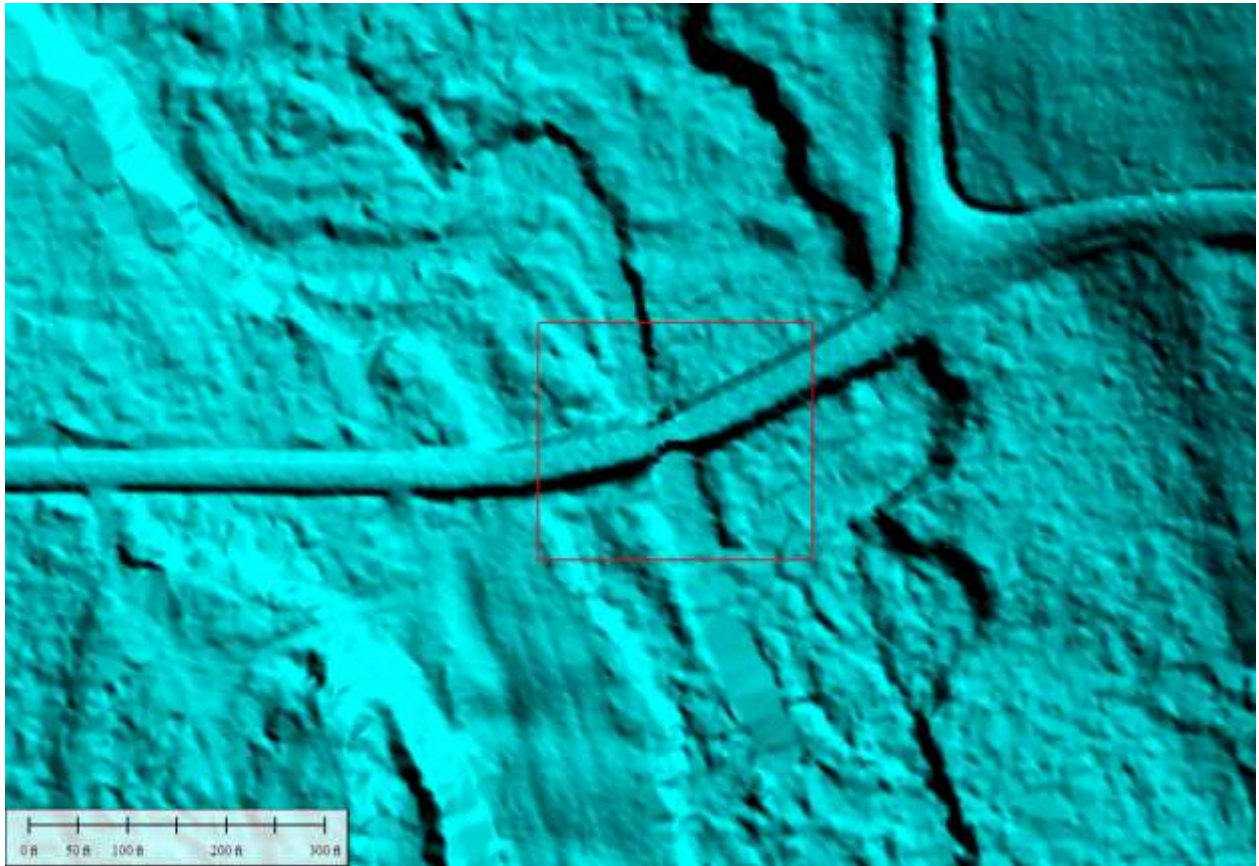
Based on this review, the USGS recommends the bare-earth DEM files for inclusion in the 1/3 Arc-Second National Elevation Dataset.

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

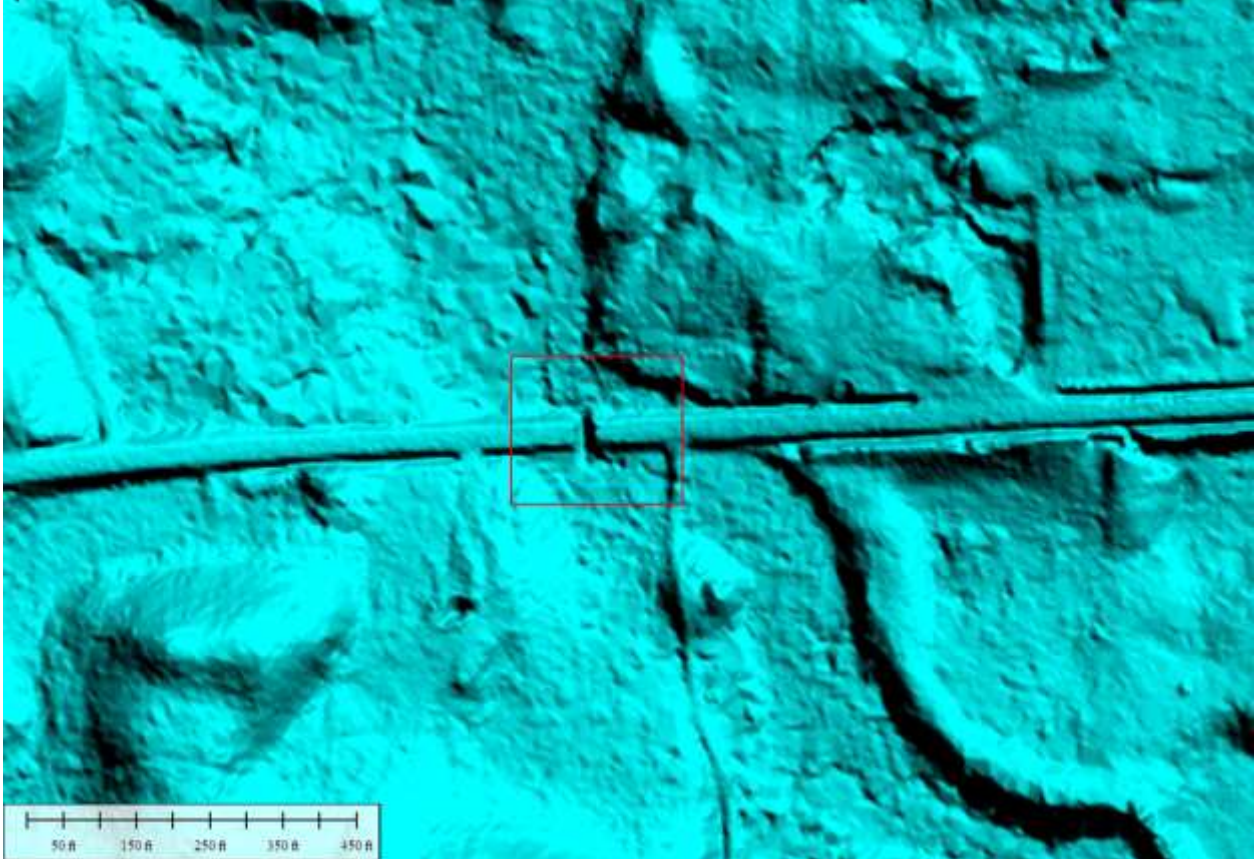
Image?



bridge_1: Imagery suggests the presence of a bridge (not a culvert) at this location; the roadway was not removed. There are two of the this error type.

**These errors have been fixed by contractor.

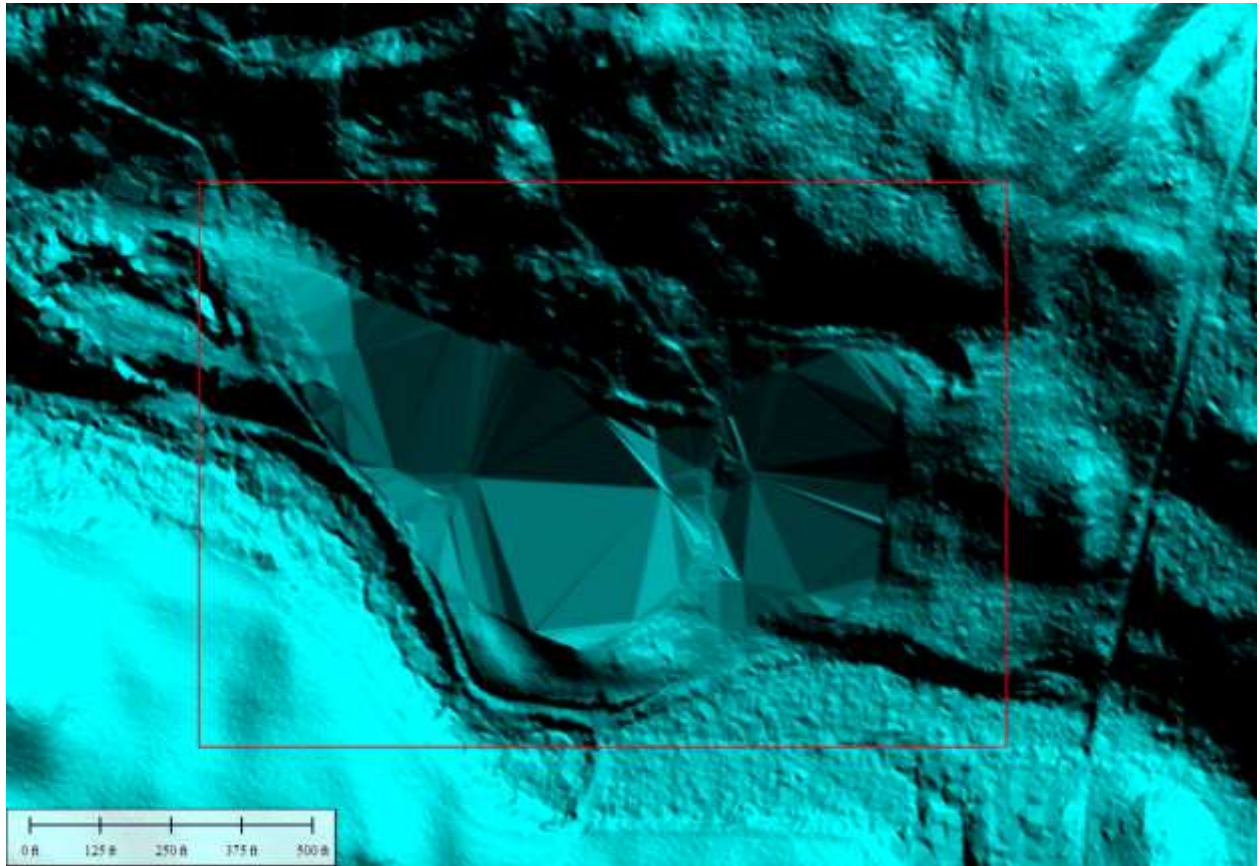
Image?



culvert_1: Imagery suggests that the roadway removed in the red box covers a culvert and that the location is not a bridge. Roadways over culverts are not to be removed according to USGS Lidar Guidelines and Base Specifications Version 13. This is the only error of this type.

**This error has been fixed by contractor.

Image?



TIN_area_3: This is a representative image of areas that are TIN'd (with respect to the surrounding area). There are 15 areas that have been flagged as highly TIN'd. Others are present throughout the DEM, however, the most 'severe' have been flagged.

They are not flagged as ERRORS; they are highlighted to bring attention to these areas.

Internal Note:

Original Errors encountered with this dataset:

- 2 @ bridges not removed from DEM
- 1 @ roadway removed above culvert (i.e., not a bridge)
- 15 @ very TIN'd areas (not flagged as errors...just being pointed out)
- 4 @ unflattened waterbodies (>2 acres)
- 5 @ water elevation errors of waterbodies with breaklines
- No Project-Level metadata provided with dataset

Errors corrected:

**Bridge, culvert, and water errors have been fixed by the contractor.

**Project-Level metadata has been provided.

**Areas of NO-DATA were present in some locations on the outer edges of the project error. These errors have been 'dipped' out of the Final-to-NED DEM. The footprint was created by NGTOC personnel.

Errors with the Raw LAS files (unknown coordinate system) were encountered after the final review of the other deliverables. Some of the provided Swath files are in WGS84-UTMzone19N and Unknown Coordinate System.

**Corrected

This is the end of the report.

QA Form V1.4 12OCT11.xsn