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:
11/28/2012

Project ID:
Sussex and Warren County LiDAR Processing

Project Alias(es):

Project Type: GPSC

Project Description:
This task is for the processing of a high resolution LiDAR data set of 577 square miles in Sussex and Warren counties New Jersey, to obtain a bare earth DEM suitable for inclusion in the National Elevation Dataset.
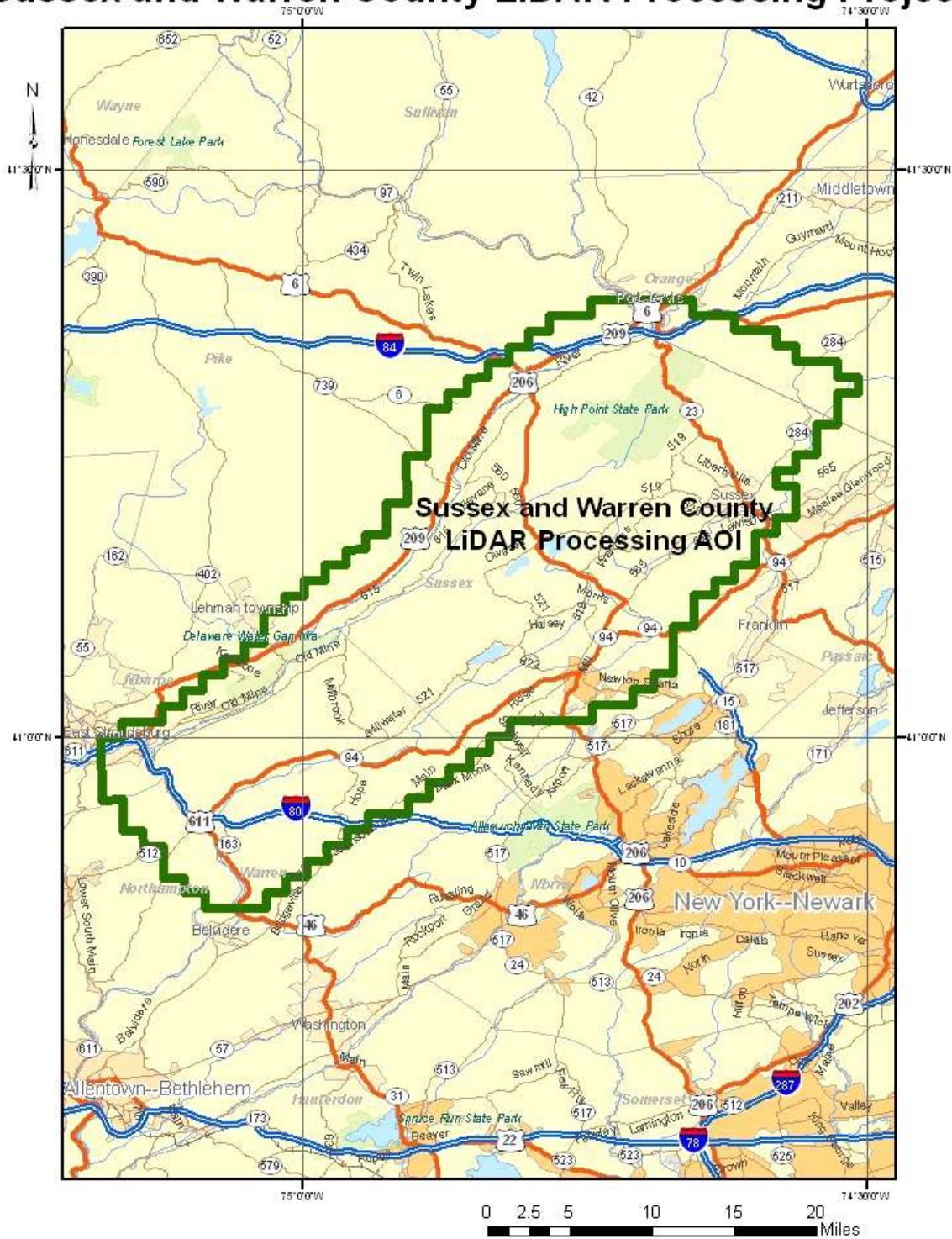
Year of Collection: 2008

Lot 3 of 3 lots.

Project Extent:
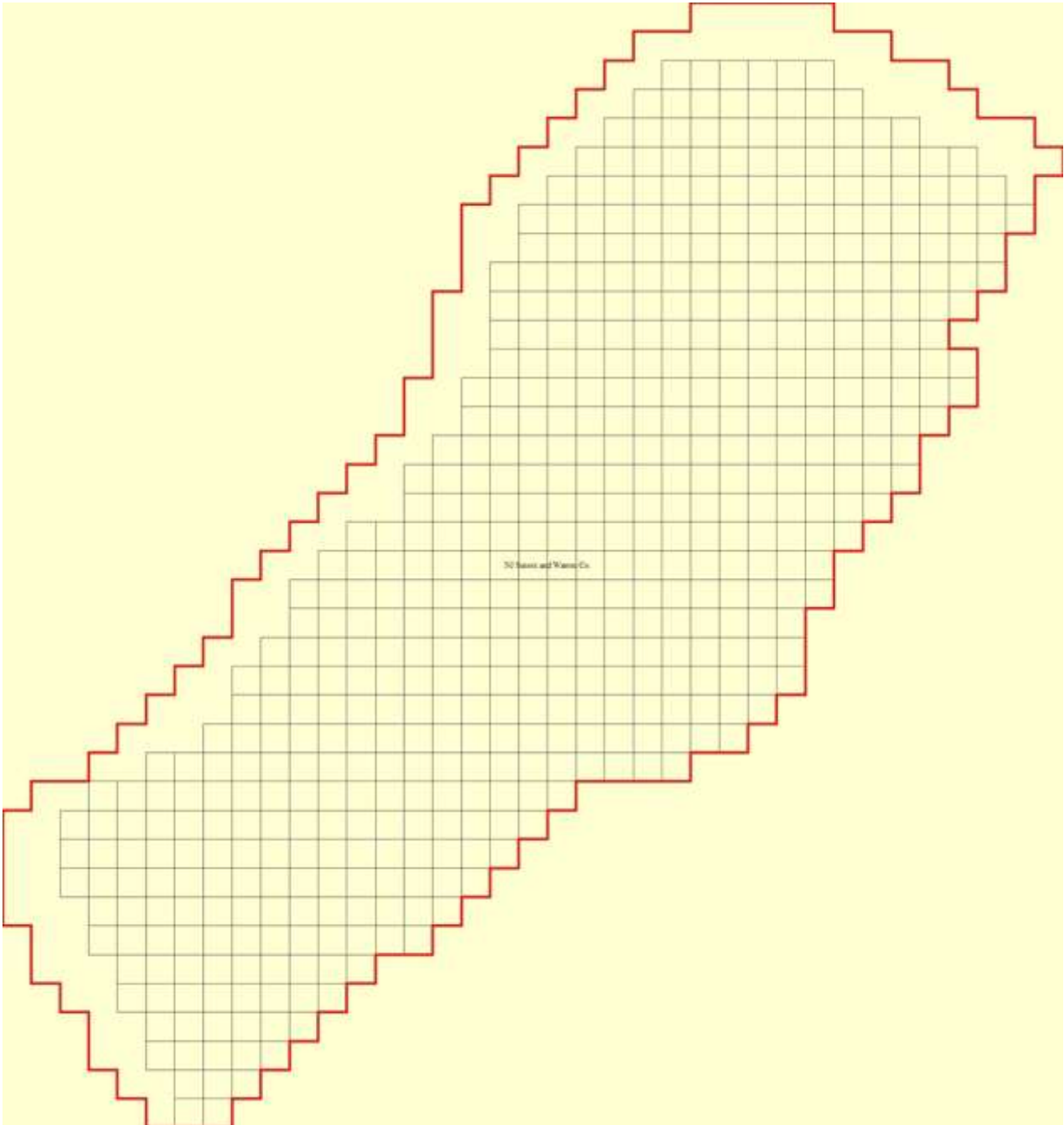☑ Project Extent image?

Sussex and Warren County LiDAR Processing Project

Sussex and Warren County LiDAR Processing AOI

Project Tiling Scheme:

☑ Project Tiling Scheme image?

Contractor:

Aerometric, Inc.

Applicable Specification:

V13

Licensing Restrictions:

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Mike Duncan	CPT	573-308-3799	jduncan@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   ☑ Project Shapefile/Geodatabase
☑ Survey Report   ☑ Project Tiling Scheme Shapefile/Gdb
☑ Processing Report   ☑ Control Point Shapefile/Gdb
☑ QA/QC Report   ☑ Breakline Shapefile/Gdb
☑ Control and Calibration Points   ☑ Project XML Metadata

Multi-File Deliverables

File Type	Quantity
☑ Swath LAS Files ☑ Required? ☑ XML Metadata?	31
☐ Intensity Image Files ☐ Required?	
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	535
☑ Breakline Files ☑ Required? ☑ XML Metadata?	2
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	535

Additional Deliverables

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

The DEM metadata states that the final deliverable for the DEM is on a client specified 1500 meter by 1500 meter tiling scheme.   The requirement is for the DEM to be on the 5000 foot by 5000 foot NJ tiling scheme that was supplied to the vendor.   I think the data is correct, and the error is with the metadata.

Project Geographic Information

Areal Extent:

414.97

Sq Mi
Grid Size:

5

U.S. Feet
Tile Size:

5000x5000

 U.S. feet

Nominal Pulse Spacing: 1.4   meters

Vertical Datum: NAVD88 U.S. feet

Horizontal Datum: NAD83 U.S. feet

Project Projection/Coordinate Reference System: New Jersey State Plane U.S. feet.

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.

Review Start Date:

12/4/2012

Action to Contractor Date	Issue Description	Return Date
12/6/2012	Metadata Problems: 1. All metadata appears to be the same metadata. Please correct. 2. Swath metadata was not delivered with the project. 3. All metadata reports vertical accuracies as being calculated on the bare earth classified files (LAS) data. ***Metadata corrected by Vendor*** Please update Breakline and Classified LAS metadata with required information for Breaklines and LAS and re-deliver. Please deliver Swath metadata with reported FVA accuracies for Swath. ***Metadata corrected by Vendor*** Vertical Accuracy: The reported FVA vertical accuracy of .143 is suspect due to metadata indicating this accuracy as being calculated on Classified LAS. NGTOC calculation for FVA checkpoints on the Bare Earth DEM = .391 @ 95%confidence. Please calculate accuracy on the Bare Earth DEM, correct metadata, and re-deliver. Also check and correct if needed the SVAs and CVA on the bare earth DEM, update the DEM and Project metadata with DEM accuracies and	

re-deliver.

Vertical Accuracy calculations and reporting corrected by Vendor

LAS Problems:

1. The LP360 Point Cloud Statistics indicate Minimum and Maximum Scan Angle to equal 0 for Classified and Swath LAS.

2. GPS Min/Max time (TIMN/TIMX) = 0 in Classified and Swath.

**0 values for Scan Angle and GPS Times still exist ***See LAS review sections for explanation.

3. The coordinate reference system for Sussex-Warren Co is NJ State Plane zone 2900. The Classified and Swath LAS are reported to be New York East.

Reference System corrected by Vendor

Please correct all LAS errors and re-deliver.

Project Boundary Problems:

The project boundary does not match the data. Please re-deliver new project boundary.

Project Boundary corrected by vendor*

DEM Problems:

1. Bad or missing data exists on the edge of exterior tiles.
edge corrected by vendor.*
2. one floating island
floating islands corrected by vendor.*
3. one unverifiable string of pits in

surface
pits not addressed by vendor
4. one water body with deep
shoreline.
corrected by vendor
5. FYI-culverts have been removed
throughout the project. It is not
required to remove culverts in
hydro-flattened projects.

Review Complete: 1/24/2013

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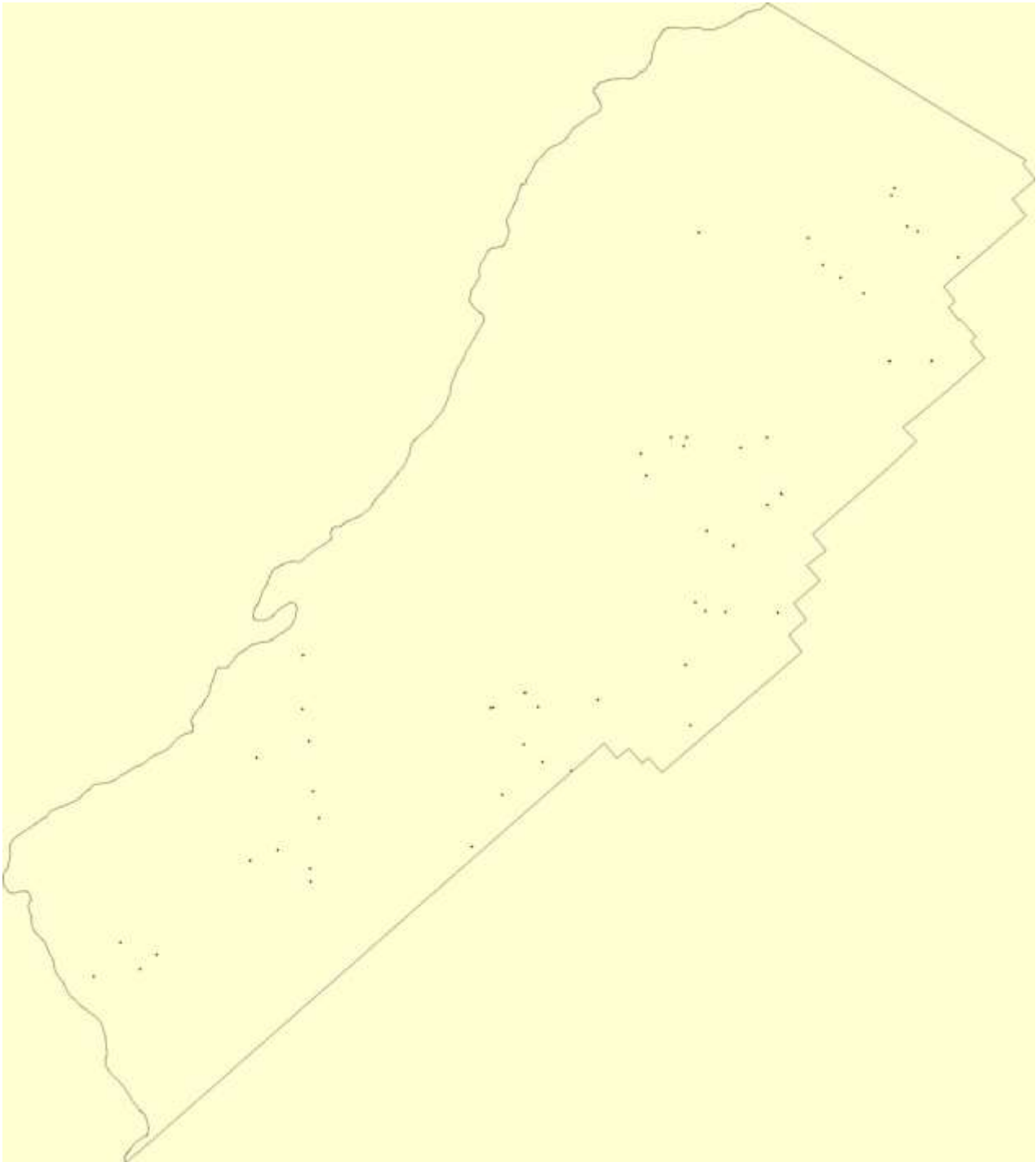
The following land cover classes are represented in this dataset (uncheck any that do not apply):

☑ 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 Select...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

None.

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: U.S. feet

Required FVA Value is .804 U.S. feet or less.
Target SVA Value is 1.1909 U.S. feet or less.
Required CVA Value is 1.1909 U.S. feet or less.

The reported FVA of the LAS Swath data is .511 U.S. feet .

The reported FVA of the Bare-Earth DEM data is .503 U.S. feet .
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		.510		U.S. feet
Brush Lands and Low Trees		.605		U.S. feet
Forested Areas Fully Covered by Trees		.427		U.S. feet
Urban Areas with Dense Man-Made Structu...		.503		U.S. feet

The reported CVA of this data set is: .528 U.S. feet .

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 ⬚.511 ⬚U.S. feet .

Based on this review, the USGS <u>accepts</u> the LAS swath file data.

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

☑ Image?

SAMN	SAMX	TIMN	TIMX
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0000	0.0000

1.The LP360 Point Cloud Statistics indicate Minimum and Maximum Scan Angle to equal 0 for Classified and Swath LAS.

0 values still exist in scan angle (SAMN/SAMX) and GPS (TIMN/TIMX) times and is noted in LAS and Swath metadata as a condition of the original LAS data. The original data were processed in LAS version 1.0. Version 1.0 did not store these values.

2. The coordinate reference system for Sussex-Warren Co is NJ State Plane zone 2900. The Classified and Swath LAS are reported to be New York East.
corrected by vendor

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 <u>accepts</u> the classified LAS tile file data.

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

☑ Image?

SAMX	TIMN	TIMX
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000

1.The LP360 Point Cloud Statistics indicate Minimum and Maximum Scan Angle to equal 0 for Classified and Swath LAS.

0 values still exist in scan angle (SAMN/SAMX) and GPS (TIMN/TIMX) times and is noted in LAS and Swath metadata as a condition of the original LAS data. The original data were processed in LAS version 1.0. Version 1.0 did not store these values.

2. The coordinate reference system for Sussex-Warren Co is NJ State Plane zone 2900. The Classified and Swath LAS are reported to be New York East.
corrected by vendor

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: Erdas Imagine *.img

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 U.S. feet .

Reported Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = 0.804 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 1.1909 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 1.1909 or less.
Open Terrain	20	0.503		
Tall Weeds and Crops	21		0.510	
Brush Lands and Low Trees	20		0.605	
Forested Areas Fully Covered by Trees	20		.427	
Urban Areas with Dense Man-Made Structures	20		.503	
Consolidated	101			.528

☑ QA performed Accuracy Calculations?

Calculated Accuracies

Land Cover Category	# of Points	Fundamental Vertical Accuracy @95% Confidence Interval (Accuracy$_z$) Required FVA = .804 or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = 1.1909 or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = 1.1909 or less.
Open Terrain	20	.391		
Tall Weeds and Crops	21		.496	
Brush Lands and Low Trees	20		.463	

Forested Areas Fully Covered by Trees	20			.428		
Urban Areas with Dense Man-Made Structures	20			.436		
Consolidated	101					.485

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

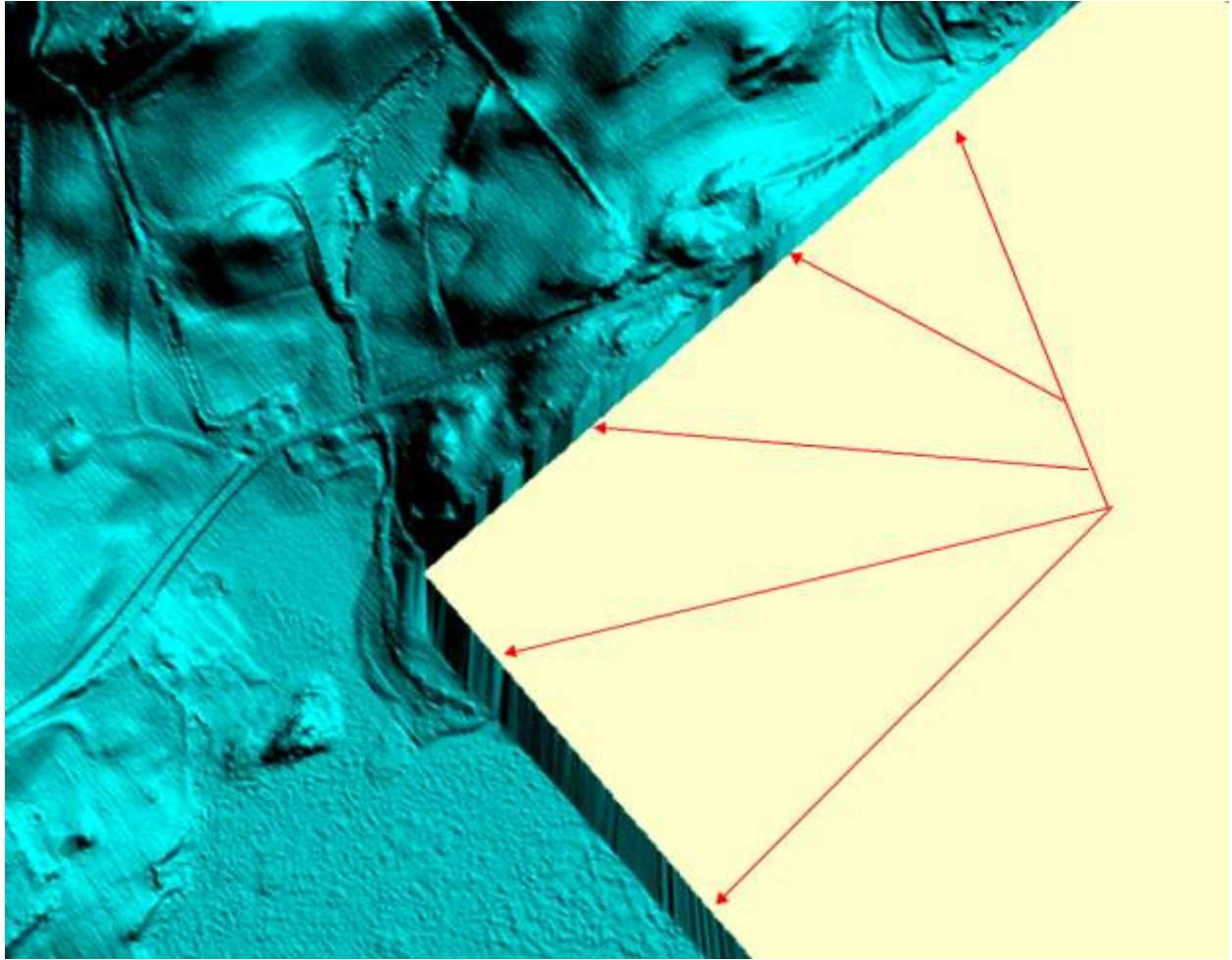Based on this review, the USGS <u>accepts</u> the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

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

☐ Image?

culverts have been removed throughout project. It is not required to remove culverts in hydro-flattened projects.
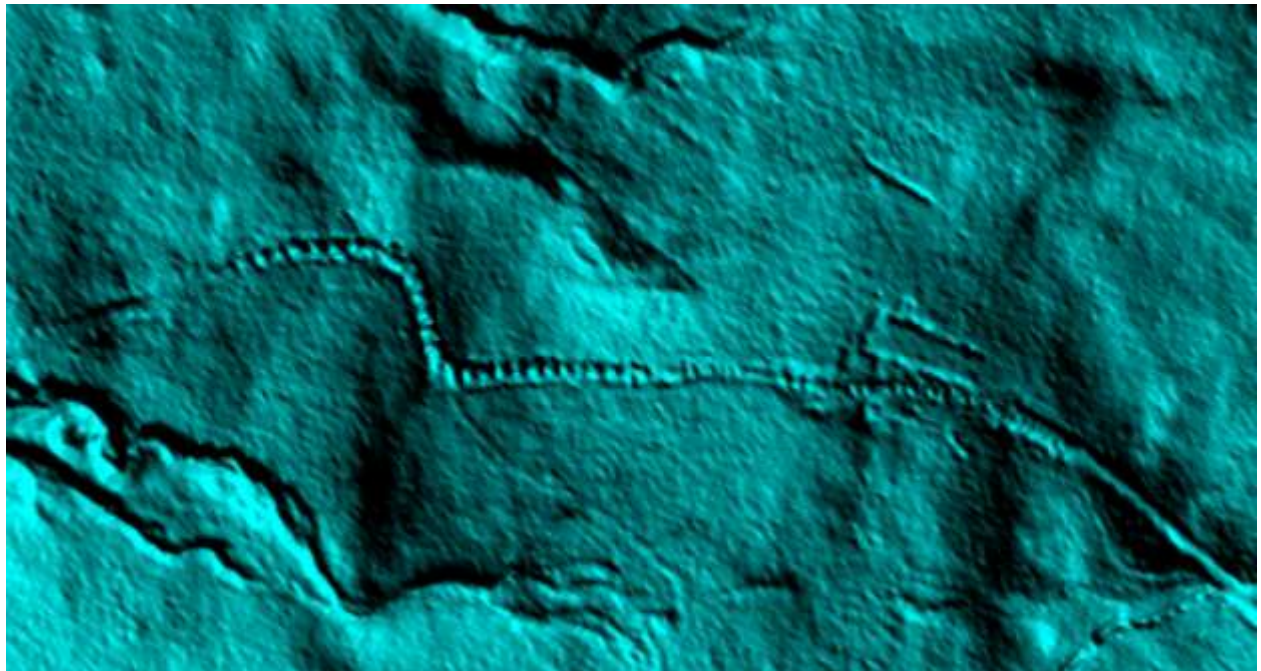
☑ Image?

bad or missing data on exterior tile edges
edges have been corrected by vendor
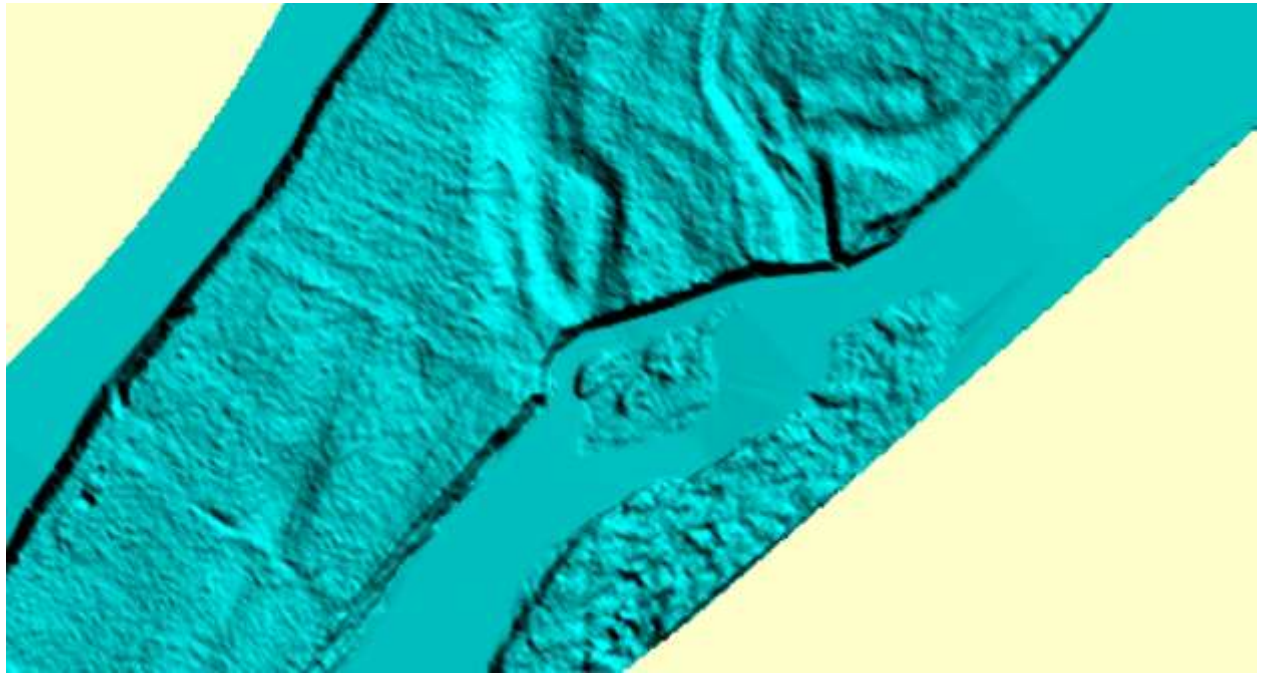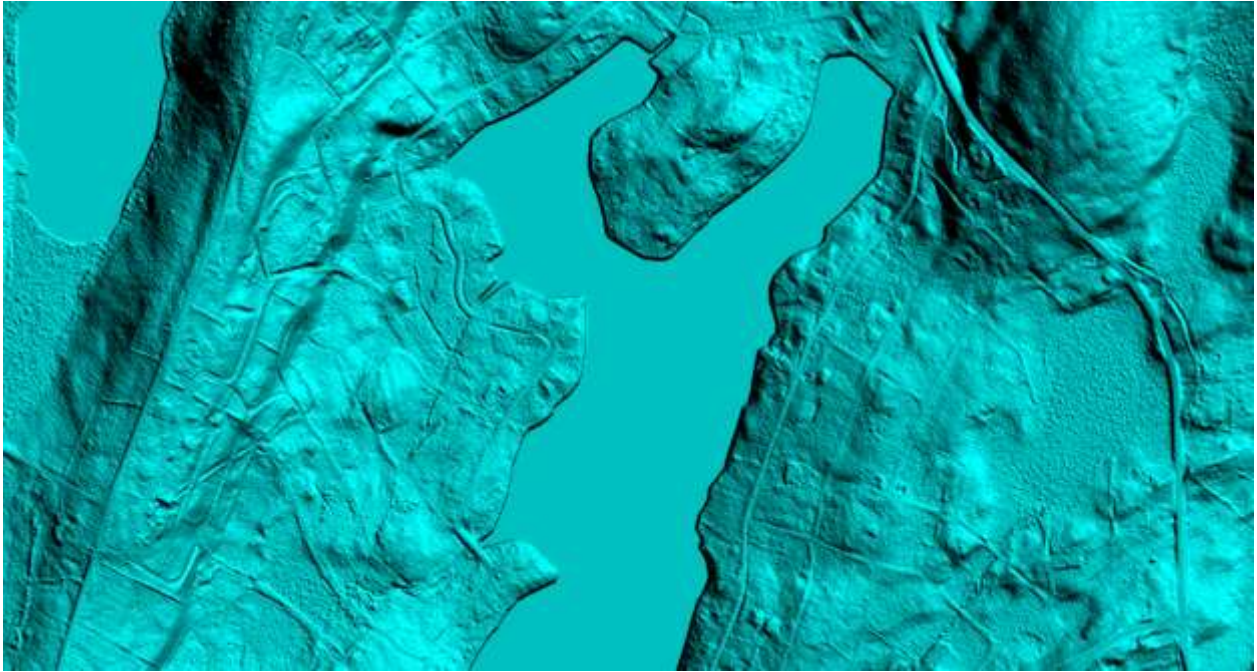
☑ Image?

floating island
corrected by vendor

☑ Image?

questionable pits in surface
has not been addressed by vendor

☑ Image?
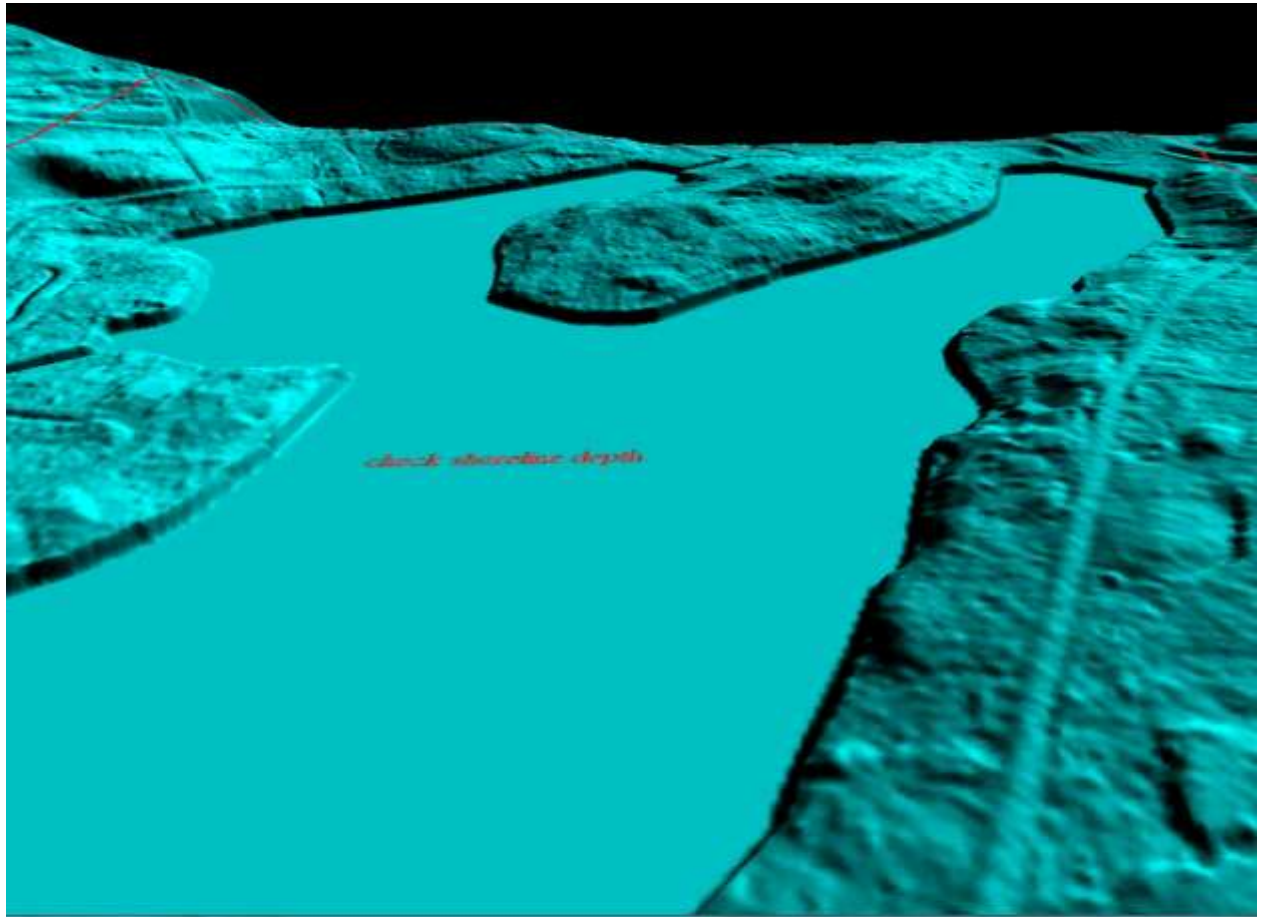
steep/cookie cutter affect shoreline
corrected by vendor

☑ Image?

shoreline 3-D

This is the end of the report.