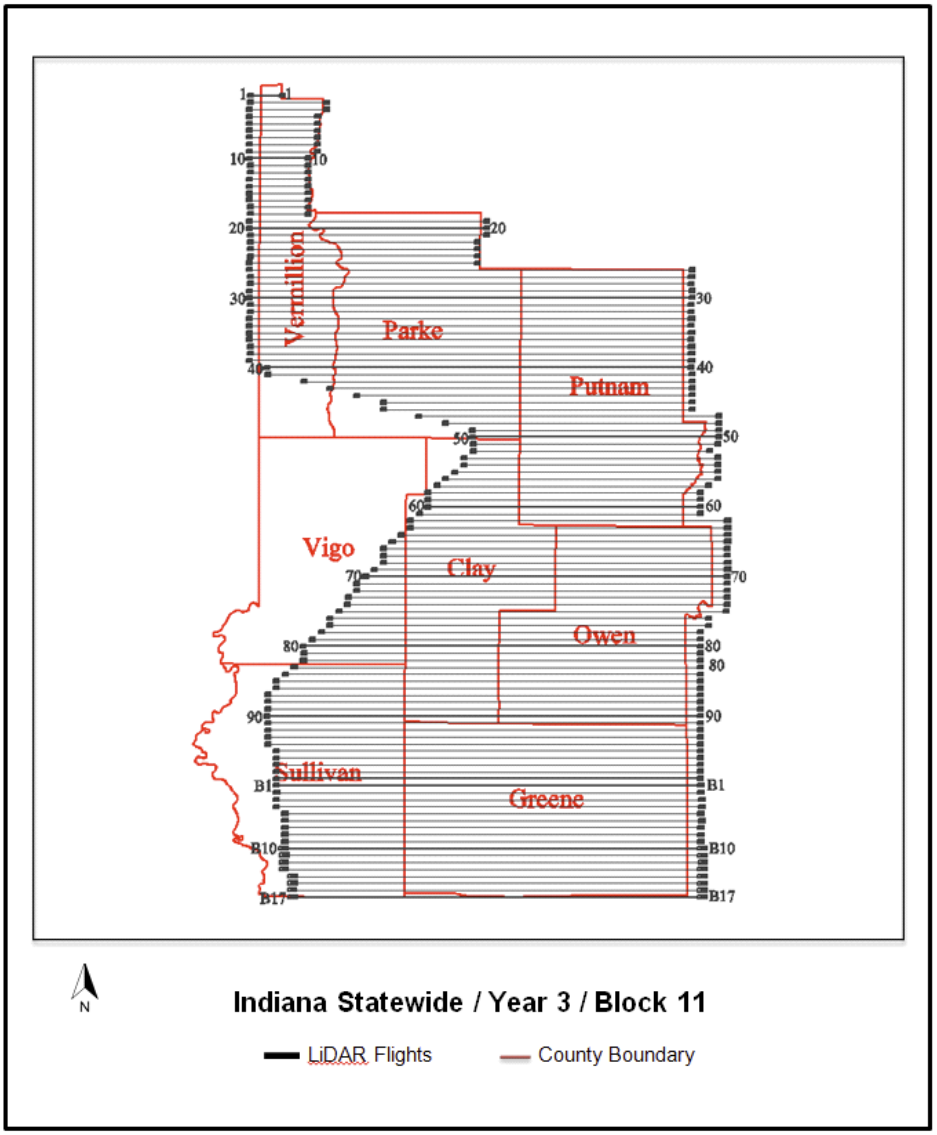
LiDAR Quality Assessment Report

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. 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.

IN_WesternTier-Block11_2013

NGTOC



Project Information

Project: IN_WesternTier-Block11_2013

Contractor: Woolpert, Inc.

Project Type:
Partnership

Applicable Specification:
NGP LiDAR Base Specification Draft V12

Project Points of Contact:

Name:	*Type:*	*Email:*
	Select or type...	

REPORT QUALIFICATION SUMMARY:

Task Order Overall:
Does Not Meet Requirements

Metadata:
0 of 1 Reviews Accepted
1 Reviews Not Accepted

Vertical Accuracy:
0 of 1 Reviews Accepted
0 Reviews Not Accepted

Swath/Raw LAS:
1 of 1 Reviews Accepted
0 Reviews Not Accepted

Tiled/Classified LAS:
0 of 1 Reviews Accepted
1 Reviews Not Accepted

Breakline:
0 of 1 Reviews Accepted
1 Reviews Not Accepted

DEM(s):
0 of 1 Reviews Accepted
1 Reviews Not Accepted

NED Review:
0 of 1 DEM tile reviews recommended for NED 1/3rd
0 of 1 DEM tile reviews recommended for NED 1/9th

Project Delivery Lots: Select...

Dates Collected Range:
Collection Start: 3/14/2013
Collection End: 4/14/2013

Project Aliases:

Licensing:
Public Domain

Project Description:
This project is part of the statewide airborne LiDAR data acquisition of Indiana for the Indiana Office of Information Technology. The project has been divided into three project areas. Area 1 will be the center tier and performed in 2011. Area 2 will be the eastern tier and performed in 2012. Area 3 will be the western tier and performed in 2013. The project area will contain both existing LiDAR data and new LiDAR data to be collected by Woolpert beginning in 2011. The boundary limits for the new LiDAR data will be the same as the orthoimagery and cover ±29,218 square miles. However, unlike the orthoimagery, full tiles will not be delivered. The new LiDAR data will only be delivered to the 1,000-foot buffer or to the opposite river bank whichever is greater. Block 11 covers full and/or partial counties for Clay, Greene, Owen, Parke, Putnam, Sullivan, Vermillion and Vigo.

Review Information

Reviewer:	Select or type...	*Date Delivered:*	
3rd Party QA Performed:	☐	*Date Assigned:*	8/11/2014

Action To Contractor Date:	*Issue Description:*	*Return Date:*
12/12/2014	See report	

Review Complete:

Dates Project Worked:

Start:	8/11/2014
End:	12/11/2014

Project Materials Received

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 Section supervisor and informed of the problem. Processing will resume after the COTR has coordinated the deposition of remaining deliverables.

METADATA

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Collection Report:	☐		☐	*PDF*	1	
Survey Report:	☐		☐	*PDF*	1	
Processing Report:	☐		☐	*PDF*	1	
QA/QC Report:	☐		☐	*Select...*	0	
Project Level XML Metadata:	☐		☐	*XML*	0	
Project Extent:	☐	☐	☐	*Select...*	0	
Tile Scheme:	☐	☐	☐	*Select...*	0	
Control (Calibration) Points:	☐	☐	☐	*.shp*	1	Statewide block 11 lidar GCP

Check (Validation) Points:	☐	☐	☐	.shp	1	Statewide block 11 lidar QC
Additional Comments:						

LIDAR DATA

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
Swath Data:	☐	☐	☐	.las	1,100	Block10_11_12
Classified/ Tiled Data:	☐	☐	☐	.las	4,173	8 counties
Additional Comments:	Swath was delivered in two files: One for Block 9 and one for Blocks 10, 11, 12. The 1100 files listed above are for all three blocks.					

DERIVED DELIVERABLES

Deliverables	*Delivered*	*XML Metadata*	*Required*	*Format*	*Quantity*	*Additional Details*
DEM Tiles:	☐	☐	☐	IMG	4,173	8 counties
Breaklines:	☐	☐	☐	.shp	16	Polyline & Polygon for each county
Additional Comments:						

OTHER

Additional Comments:	

Geographic Information

Area Extent: 3484.6 *Sq. Miles*

Tile Size: 1000x1000 *Feet*

DEM/DTM Grid Spacing: 5 *U.S. Feet*

Coordinate Reference System:

Indiana State Plane West (1302), NAD83 Survey Feet, NAVD 1988 feet, GEOID09

Projection: Transverse Mercator

Horizontal Datum: NAD83 ☐ Meters ☐ U.S. Feet ☐ Int'l Feet

Vertical Datum: NAVD88 ☐ Meters ☐ U.S. Feet ☐ Int'l Feet

THIS PROJECTION COORDINATE REFERENCE SYSTEM IS CONSISTENT ACROSS THE FOLLOWING DELIVERABLES

- ☐ *Project Tile Scheme*
- ☐ *Control Points*
- ☐ *Checkpoints*
- ☐ *Tiled/Classified XML Metadata*
- ☐ *Tiled/Classified LiDAR*
- ☐ *Swath/Raw LiDAR XML Metadata*

no swath metadata provided

- ☐ *Swath/Raw LiDAR*
- ☐ *DEM(s)*
- ☐ *DEM XML Metadata*
- ☐ *Breakline(s)*
- ☐ *Breakline XML Metadata*

Additional Comments:

Collection Information

Configured Project Nominal Pulse Spacing:

1.5 Meters

Sensor Information:

Sensor Type:
Aerial
Sensor Used:
Leica ALS70
Configured Scan Angle ± from nadir:
75 *Degrees*

Sensor Type:
Aerial
Sensor Used:
Optech Gemini LiDAR
Configured Scan Angle ± from nadir:
50 *Degrees*

Additional Comments:

Project report for the Western Tier states that both sensors were used to collect Tier 3 data.

Metadata Review Not Accepted

Vendor 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.
Parser can be found @ http://geo-nsdi.er.usgs.gov/validation/

The Swath XML Metadata parsed select...errors.

Check if 'Best Use' metadata for NED: ☐

The Classified XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The DEM XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

The Breakline XML Metadata parsed without errors.

Check if 'Best Use' metadata for NED: ☐

Additional Comments:

all metadata appear to be the same metadata. xml metadata or reports do not specify collection and processing version. It is assumed to be v12

metadata does not specify the actual fva accuracy - see snippet below.
<vertaccv>30 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 15 cm in the open terrain land cover category (Note USGS V1.2 Specification).</vertaccv> <vertacce>The data collected shall meet the National Standard for Spatial Database Accuracy (NSSDA) accuracy standards.</vertacce

version should be v12 not "v1.2" concerning vertical accuracy.

Class 6 is not defined in any reports or LAS metadata or reports. Please define class 6 or reclassify.

Please provide or clarify the above information

Based on this review, the USGS does not accept the xml metadata provided.

End of Metadata Review

Vertical Accuracy 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.

Required Vertical Accuracy

☐ *Yes* ☐ *No*

REQUIRED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH FILES

Confidence Interval Required: 95 th % CI

Required Unit: Centimeters

Required # of checkpoints:

Required RMSEz: 15

*Required Vertical Accuracy (RMSEz * .% CI)* 30

REQUIRED FUNDAMENTAL VERTICAL ACCURACY FOR DEM FILES

Confidence Interval Required: 95 th % CI

Required Unit: U.S. Feet

Required # of checkpoints: 20

Required RMSEz: 15

*Required Vertical Accuracy (RMSEz * .% CI)* 30

Additional Required Vertical Accuracy Information:

Please supply checkpoints shapefile for vertical accuracy specifying land cover class in attribute table.
Of QC and GCP shapefiles provided it is unclear what land cover class points fall in.

Reported Vertical Accuracy

☐ *Yes* ☐ *No*

REPORTED FUNDAMENTAL VERTICAL ACCURACY FOR SWATH LIDAR FILES

Confidence Interval Reported: 95 th % CI

Reported Unit: U.S. Feet

Reported # of checkpoints:

Reported RMSEz:

*Reported Vertical Accuracy (RMSEz * .% CI)*

REPORTED FUNDAMENTAL VERTICAL ACCURACY FOR DEM FILES

Confidence Interval Reported: 95 th % CI

Reported Unit: U.S. Feet

Reported # of checkpoints:

Reported RMSEz: 0.193

*Reported Vertical Accuracy (RMSEz * .% CI)* 0.378

Additional Reported Vertical Accuracy Information: swath FVA was not reported, not required for v12 specification

Reviewed Vertical Accuracy

☐ *Yes* ☐ *No*

Vertical Accuracy information was not or could not be reviewed.

Based on this review, the USGS Select... the vertical accuracy.

End of Vertical Accuracy Review

Raw-Swath LiDAR Review Accepted

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 (*see Vertical Accuracy Review Section*).

Review Required: ☐ *Yes* ☐ *No*

RAW-SWATH LIDAR FILE CHARACTERISTICS

☐ *Separate folder for swath/raw LiDAR files*

LAS Version: 1.2

Point Record Format: 1

☐ *Each swath file ≤ 2 GB and properly segmented*

☐ *Correct and properly formatted georeference information is included in all LAS file headers*

☐ *Adjusted GPS time used with the global encoder id set to 1*

☐ *Scan Angles conform to USGS base-spec recommendations*

☐ *All points set to class '0' (not classified)*

Additional comments:

Based on this review, the USGS accepts the swath/raw LiDAR data.

End of Swath/Raw LiDAR Review

Tiled/Classified LiDAR Review Not Accepted

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. Classified LAS Tiles are comprised as follows, "all project swaths, returns, and collected points, fully calibrated, adjusted to ground, and classified and cut, by tiles, excluding calibration swaths, cross-ties, and other swaths not used, or intended to be used, in product generation".

Review Required: ☐ *Yes* ☐ *No*

CLASSIFIED LIDAR TILE CHARACTERISTICS

☐ *Separate folder for classified/tiled LiDAR files*

LAS Version: 1.2

Point Record Format: 1

☐ *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*

☐ *Correct and properly formatted georeference information is included in all LAS file headers*

☐ *Adjusted GPS time used with the global encoder id set to 1*

☐ *Classified LAS tile files have no points classified as '12' (Overlap)*

All classified LAS tile files have points classified as '12' (Overlap). Please correct.

☐ *Point classifications are limited to the standard values listed below:*

Code	Description	Used
1	Processed, but unclassified	☐
2	Bare-earth/Ground	☐
7	Noise(low or high, manually identified, if needed)	☐
8	Model key points	☐
9	Water	☐
10	Ignored ground (breakline proximity)	☐
11	Withheld (if the "Withheld Bit" is not implemented in the processing software	☐

Additional Classes:

Class	Description
6	NOT DEFINED
12	Overlap
13	Bridges

Additional comments:

Clay, Parke, Sullivan, and Vermillion counties contain class 6 which is not defined in the metadata or reports, please define class 6 or reclassify LAS

Class 12 overlap should not be present in LAS, please correct

Based on this review, the USGS does not accept classified/tiled LiDAR data.

End of Tiled/Classified LiDAR Review

Breakline Review Not Accepted

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

Review Required: ☐ *Yes* ☐ *No*

BREAKLINE FILE CHARACTERISTICS:

☐ Separate folder for breakline files.

☐ Breaklines contain elevation values.

Elevation values stored in Geometery (ZEnabled) .

Units: U.S. Feet

☐ Waterbody Breaklines.

Polyline ☐ Polygon ☐
☐ Single elevation value per waterbody feature.
☐ Required.
Waterbody Elevations were created via Unknown waterbody level techniques.

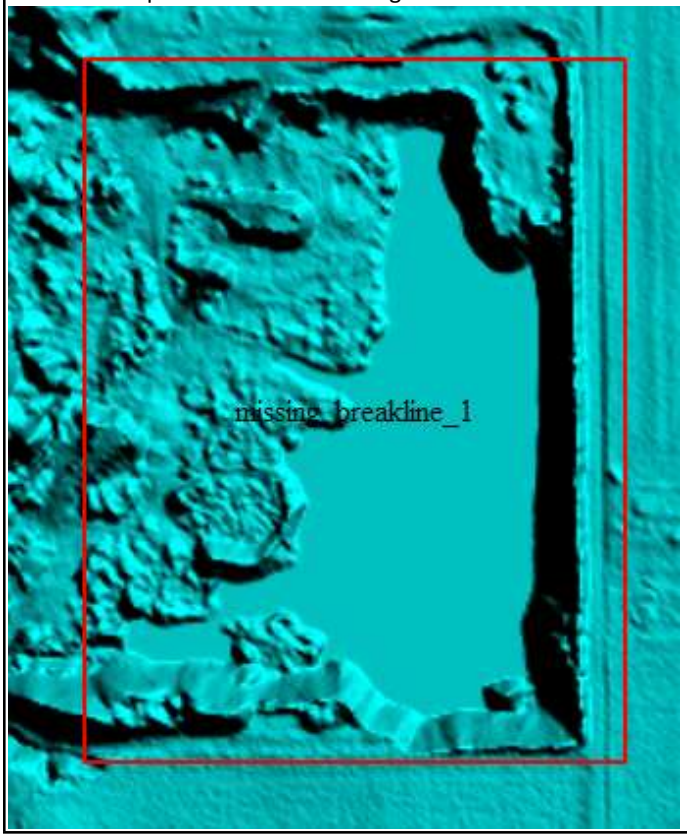
☐ Double Line Stream Breaklines (Streams Approximately > 100 ft).

Polyline ☐ Polygon ☐
Downstream DLS Flow is Stairstepped .
☐ Required.

☐ Single Line Breaklines.
☐ No missing or misplaced breaklines.

ADDITIONAL COMMENTS, ERRORS, ANOMALIES, OR OTHER ISSUES:

See error shapefile to correct missing breakline issues.



Based on this review, the USGS does not accept the breakline files.

End of Breakline Review

DEM Review Not Accepted

The derived bare-earth file(s) receive a review of the vertical accuracies provided by the data supplier, vertical accuracies calculated by the USGS using supplied and independent checkpoints (*see the prior Vertical Accuracy Review Section*), and a thorough visual review for any anomalies or inconsistencies in assessing the quality of the DEM(s).

BARE-EARTH DEM TILE CHARACTERISTICS:

☐ Separate folder for bare-earth DEM files

Raster File Type: IMG

Raster Cell Size: 5 U.S. Feet

Tile bit depth/pixel Type: 32_BIT_FLOAT

Interpolation or Resampling Technique: Unknown

☐ DEM tiles do not overlap

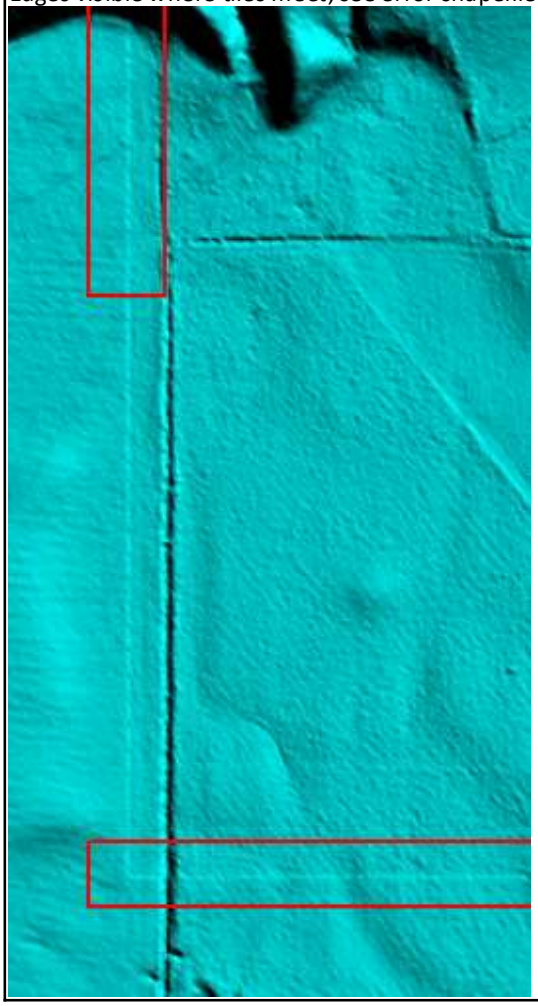
☐ DEM tiles conform to Project Tiling Scheme

☐ Quantity of DEM files conforms to Project Tiling Scheme

☐ DEM tiles are uniform in size

☐ DEM tiles properly edge match and free of edge artifacts

Edges visible where tiles meet, see error shapefile



☐ Tiles are free from Spikes and Pits

☐ Tiles are free from Data Holidays (*voids due to processing or collection errors*)

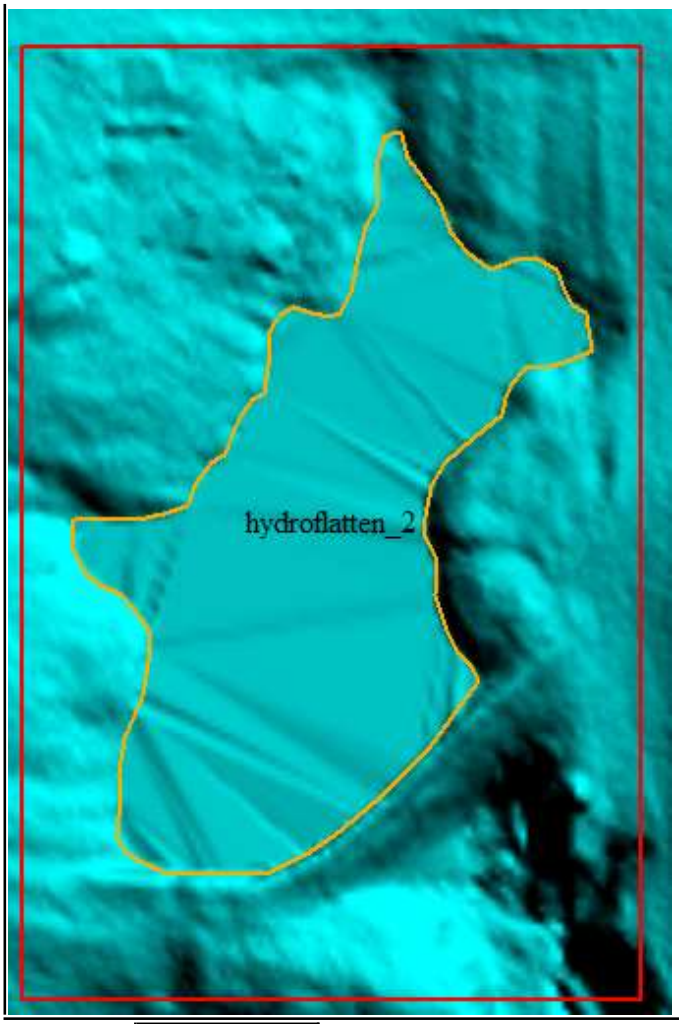
☐ Tiles do not exhibit systematic sensor error or cornrowing

Pattern changes seem to be due to sensor error

DEM tiles are properly Hydro Flattened ☐ Yes ☐ No

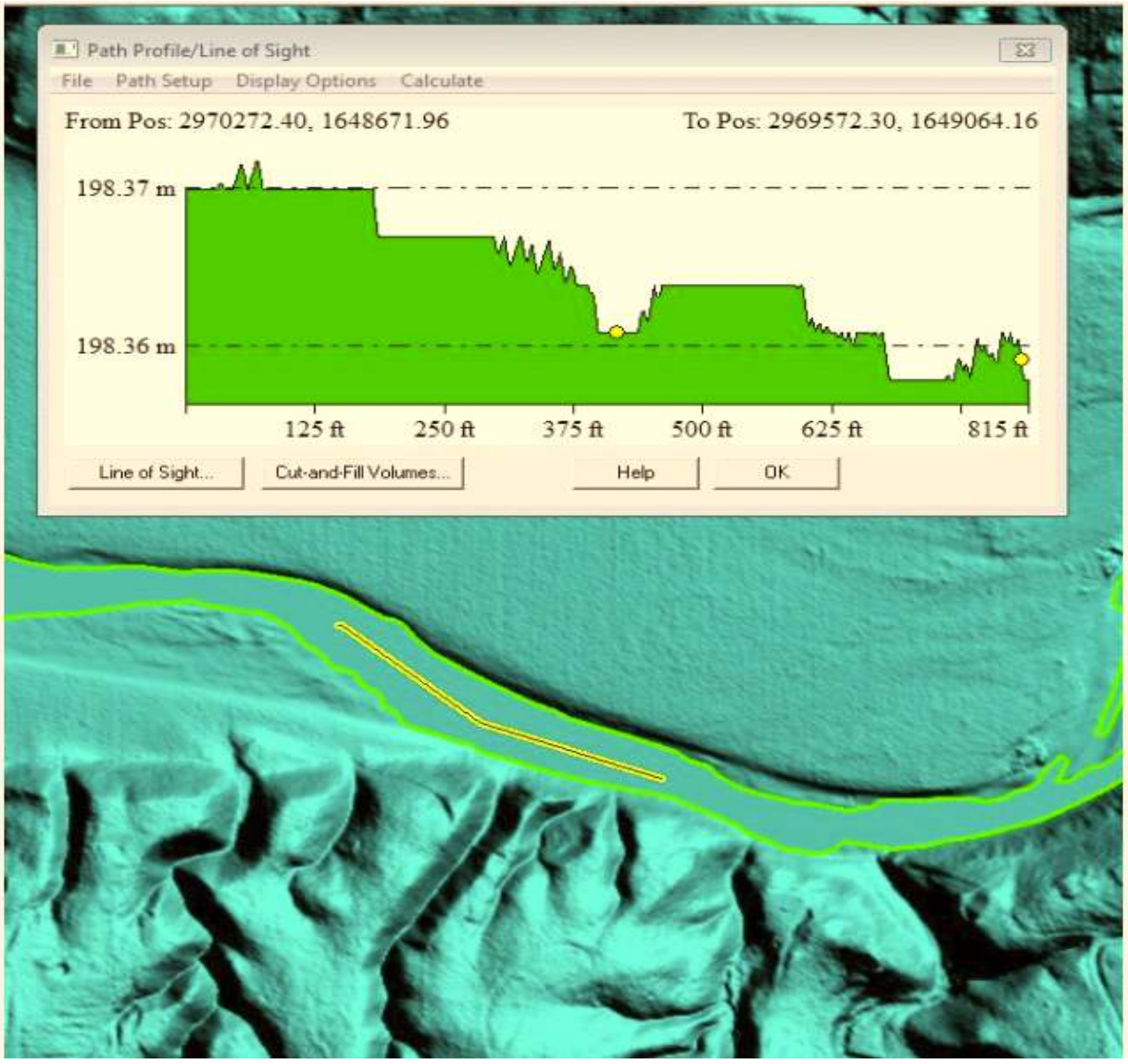
☐ Waterbodies 2 Acres or greater are flattened

Water bodies greater than 2 acres should be hydroflattened

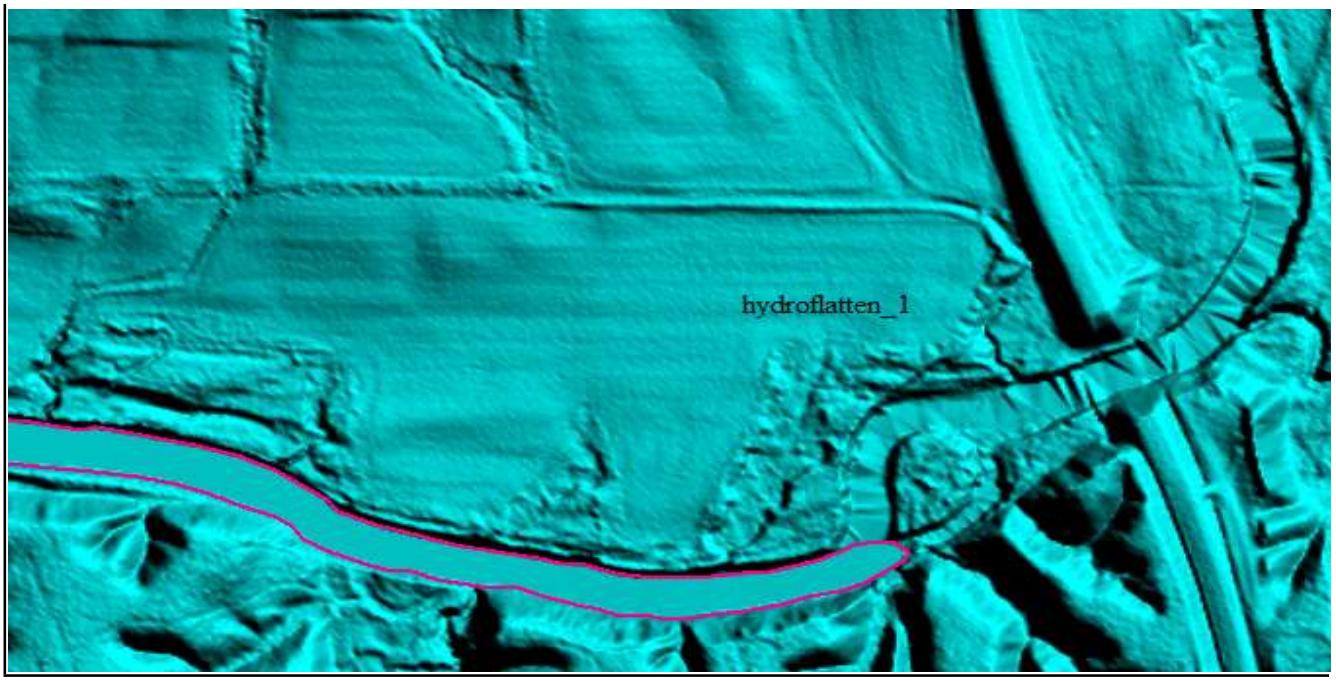


☐ Streams 100 ft. or greater are flattened in a downstream manner

Streams need to be flattened in consistent downhill flow, fix hydroflattening errors that contain peaks and valleys



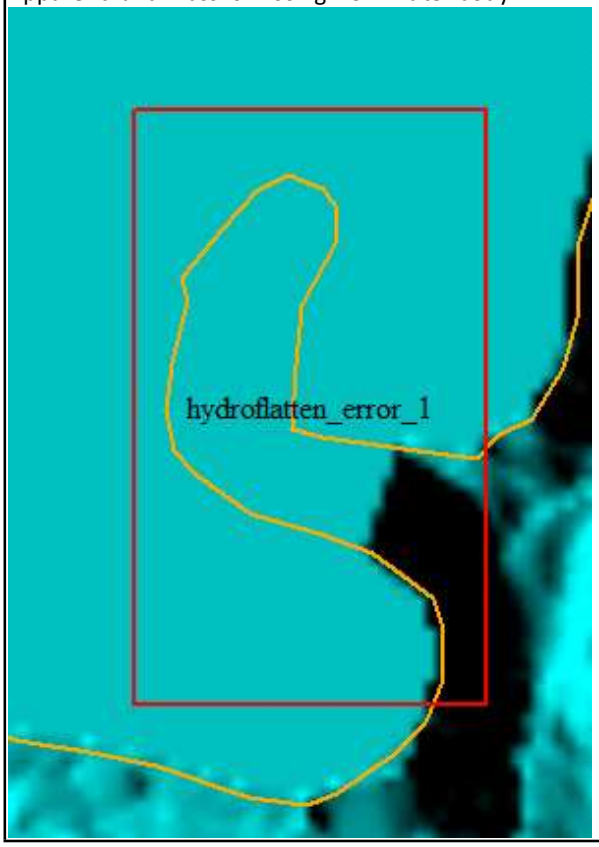
Hydroflattening of this stream/river is inconsistent. it is unclear why the hydroflattening process was completed up to this point then stopped



☐ Tidal Boundaries/Shorelines are flattened

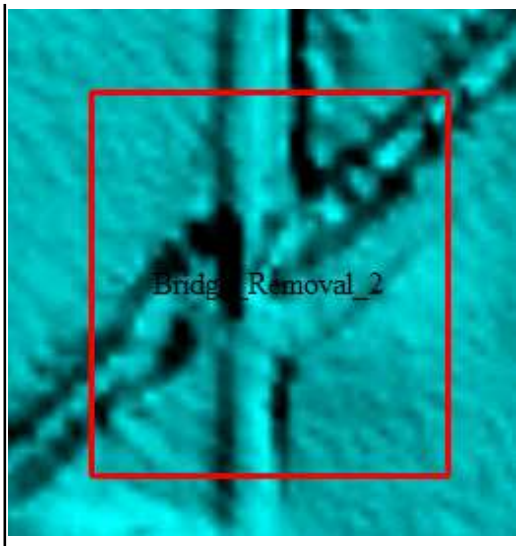
☐ No missing islands 1 Acre or larger

Apparent land mass is missing from water body

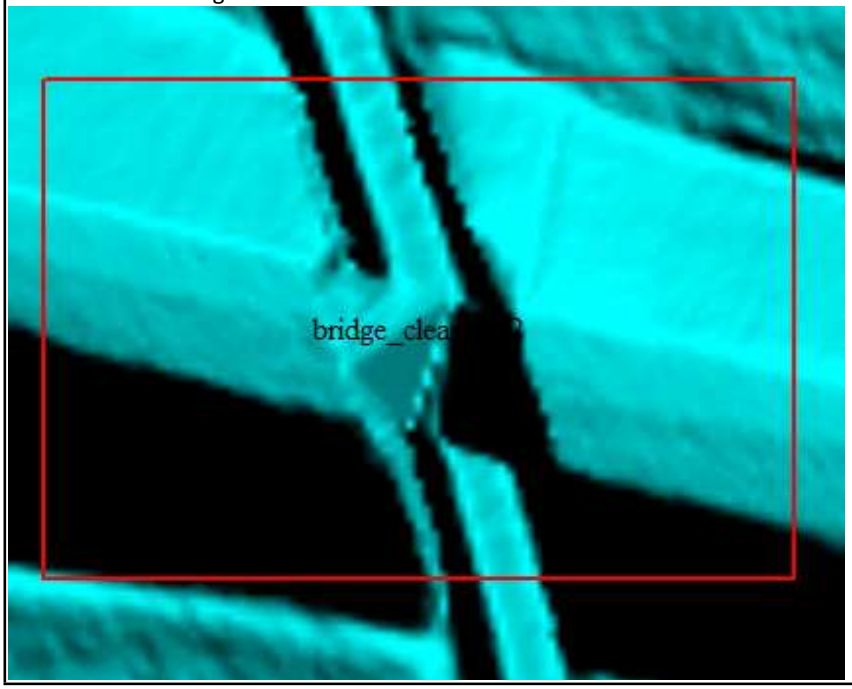


☐ Bridges/Overpasses are properly removed

Some bridges not completely removed

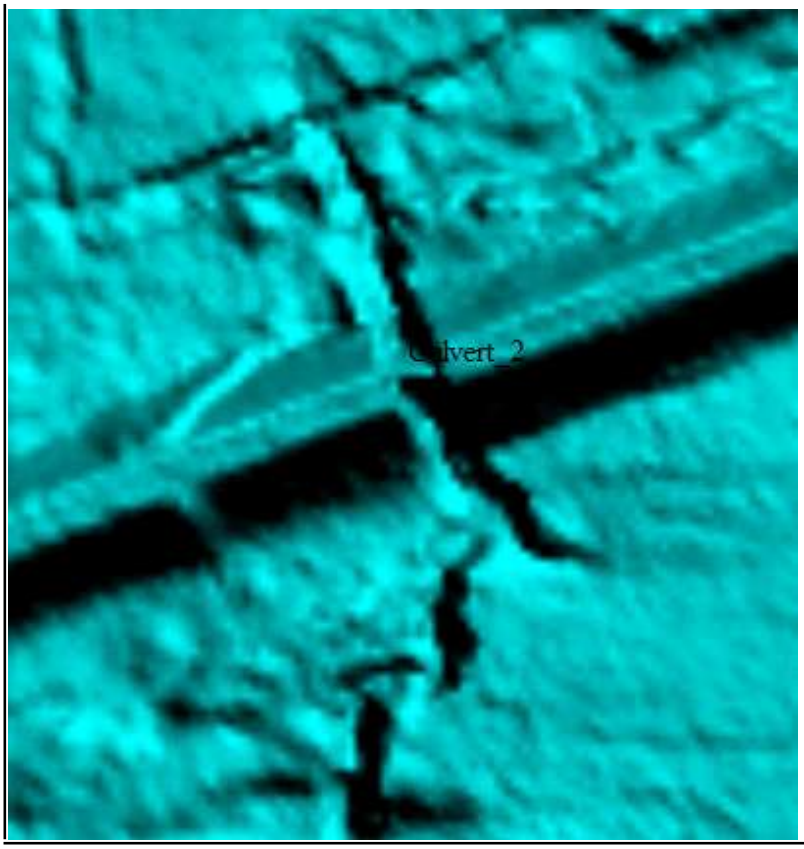


Please remove bridge remnants



☐ Culverts are maintained (Not Hydro Enforced)

Some culvert have been removed, please replace culverts

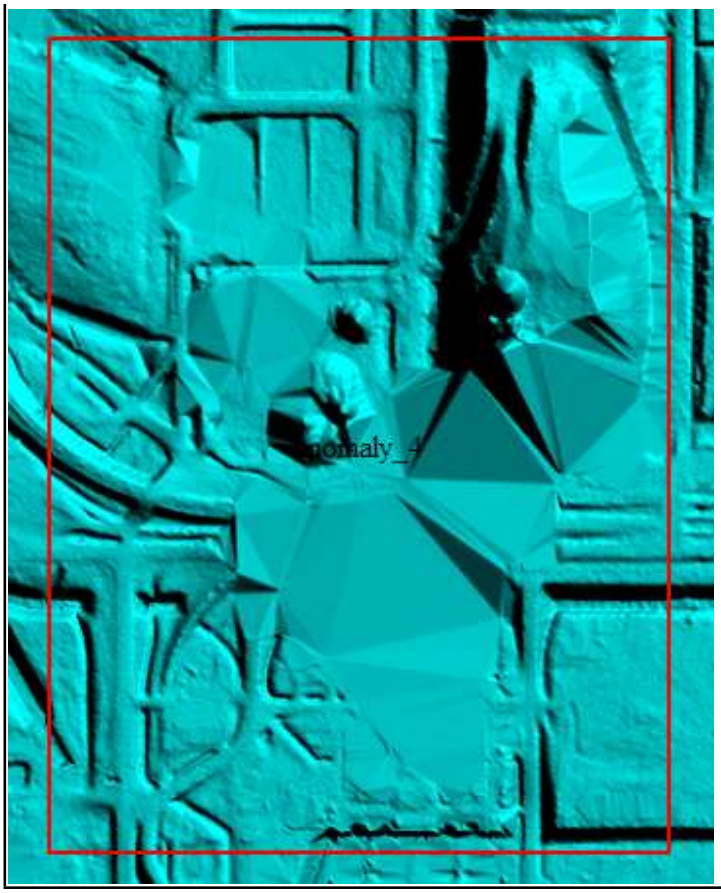


☐ Depressions, Sinks, are not filled in (Not Hydro Conditioned)

☐ Vegetation properly removed

☐ Manmade structures properly removed

Unknown removal causing excessive tinning of area, please correct or explain



Tiles recommended for NED 1/3rd: ☐ Yes. ☐ No.
Tiles recommended for NED 1/9th: ☐ Yes. ☐ No.

Based on this review, the USGS does not accept the DEM tiles.

End of DEM Review

Based on this review, the provided delivery Does Not Meet the Contract and/or Task Order requirements.
Additional Comments:

INTERNAL COMMENTS

END OF REPORT (v2.1.1)