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:
2/15/2013

Project ID:
MO_DunklinCo_2012

Project Alias(es):

Project Type: Donated Data

Project Description:

This project is a continuation from previous SEMA task order. This task is for breakline collection and hydro flattening of lakes/ponds > 1 acre.

The USDA- Natural Resources Conservation Service in Missouri (NRCS-MO) requires hydro breakline collection across the Upper Grand Watershed in Northern Missouri. This area includes all or portions of the Missouri Counties of Nodaway, Worth, Harrison, Gentry, Davies, De Kalb, and Caldwell. In addition, Dunklin County in the Bootheel is also included. A 30% hydro collection was performed in Dunklin County. A 15% hydro collection was performed over the remaining Counties listed above. This task order requires Dunklin County to be hydro flattened per USGS Specifications V13, with one modification noted below.

These data will be used to supplement or enhance the digital elevation models (DEMs) produced during the initial task order, for conservation planning activities and environmental assessments. The specifications outlined in this document will follow the USGS National Geospatial Program LiDAR Guidance and Base Specification, v13. NRCS has requested changing the minimum size of lakes-

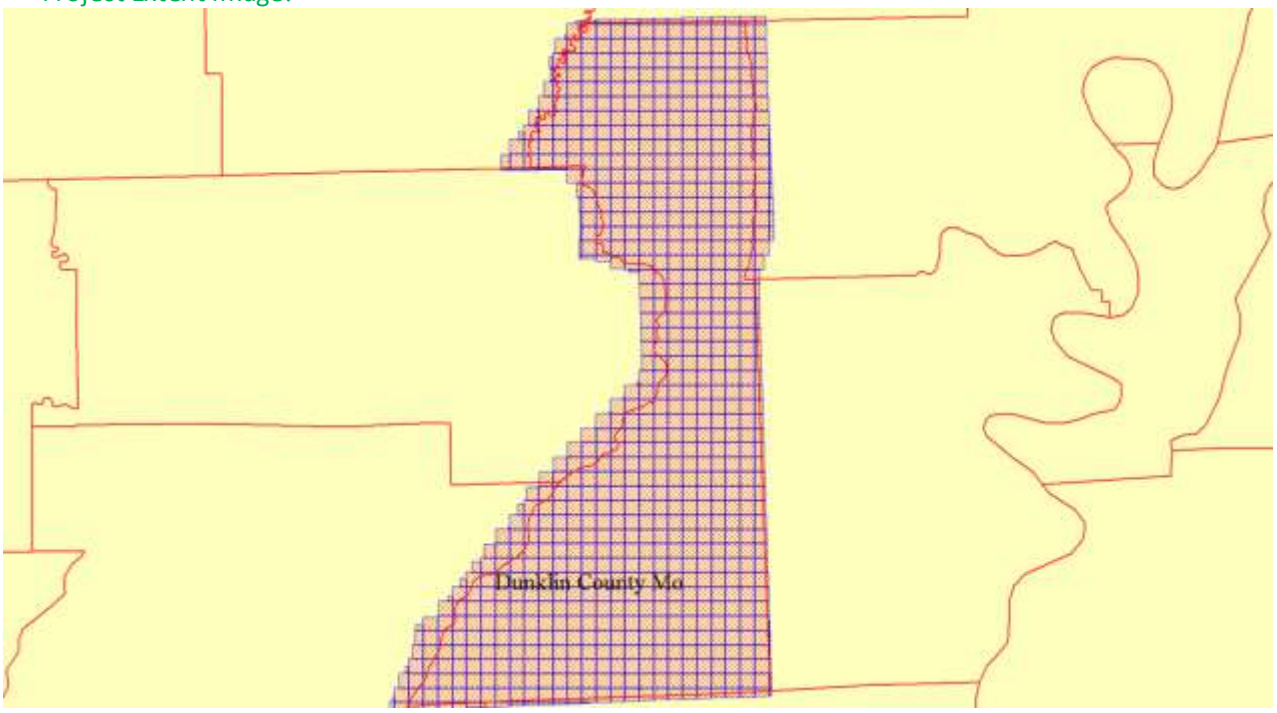
ponds collected to 1 acre instead of 2 acres (per USGS specifications). This is in addition to inland streams and rivers as pointed out in the USGS version 13 specifications. Hydro-flattening pertains only to the creation of derived DEMs.

Year of Collection: 2012

Lot Select/type... of Select/type... lots.

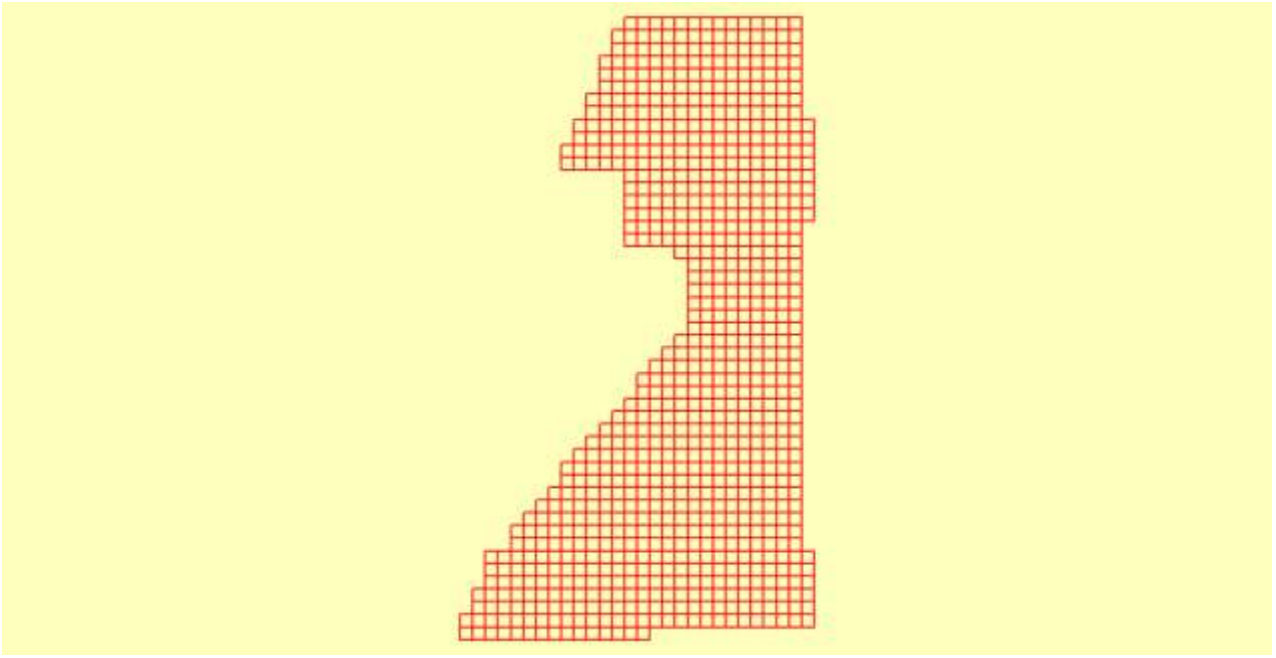
Project Extent:

☑ Project Extent image?



Project Tiling Scheme:

☑ Project Tiling Scheme image?



Contractor:

Photo Science, Inc.

Applicable Specification:

V13

Licensing Restrictions:

☐ Third Party Performed QA?

Project Points of Contact:

POC Name	Type	Primary Phone	E-Mail
Ray Fox	NSDI Liaison	573-308-3744	rfox@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?	81
☐ Intensity Image Files ☐ Required?	
☑ Tiled LAS Files ☑ Required? ☑ XML Metadata?	817
☑ Breakline Files ☑ Required? ☑ XML Metadata?	1
☑ Bare-Earth DEM Files ☑ Required? ☑ XML Metadata?	817

Additional Deliverables

	Item
☑	Bare Earth LAS

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

Project Geographic Information

Areal Extent:

630

Sq Mi
Grid Size:
1
meters
Tile Size:
1500x1500
meters
Nominal Pulse Spacing: 1 meters
Vertical Datum: NAVD88 meters
Horizontal Datum: NAD83 meters

Project Projection/Coordinate Reference System: UTM Zone 15 North meters.

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

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

Project Shapefile/Geodatabase CRS

NOT DELIVERED WITH PROJECT

Check Point Shapefile/Geodatabase CRS

NOT DELIVERED WITH PROJECT

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:
2/15/2013

Action to Contractor Date	Issue Description	Return Date
2/22/2013	Corrections for this project will not be delivered to NGTOC. The DEM appears to be good. Project status is As Is. It is the sole discretion of EROS to accept or reject this data. 3rd delivery review started 6/7/2013 This task order is in addition to the previous SEMA task order for Dunklin Co MO and is for the collection of additional breaklines and lake/ponds > 1 acre to be hydro flattened. This SOW/task order requires 5 deliverables, Classified LAS, Bare Earth DEMs, Breaklines, Bare Earth LAS, and Project Tile Index. Metadata was not delivered for these 5 deliverables. Metadata for individual deliverables was not addressed in the SOW. One project metadata.xml was delivered. 3rd delivery Missing V13 required deliverables unless otherwise stated: 1. Project Boundary 2. Calibration/processing report 3. Collection report 4. Survey report 5. QAQC report 6. Calibration control and checkpoints Please provide above deliverables. ***It is not clear if the Control provided in the 3rd delivery is blind or has been used in calibration and	

processing.*** Please verify and provide calibration points and checkpoints.

Issues with the points provided in the 3rd delivery.

What are they? Blind or Calibration? If blind points there are not 20 (preferably 30) points per land cover class.

Points provided are all clustered in 5 locations county wide. This is not a good distribution of points.

Vertical Accuracy:

It is not clear if the points provided in the 3rd delivery are blind check points or calibration, therefore vertical accuracy checks were not calculated at NGTOC.

Due to conflicting information, lack of information in metadata, and missing control and documentation, vertical accuracies for Swath FVA, or FVA, SVAs and CVA on the DEM were not calculated @ NGTOC. Vendor provided accuracies were not put forth in this report.

Metadata issues:

The RMSEz was reported in the metadata and the SOW. The metadata and SOW should report the NSSDA. It is indicated in the SOW, RMSE = .285 overall (CVA) for the DEM surface. FVA SVAs and CVA need to be reported for the DEM.

SOW page 1:

From the previous task order, the contractor has provided an RMSE report comparing the ground truth

survey check points to the generated bare earth surface. The reports indicate an overall RMSE of 0.285 feet.

Breakline.xml failed the parser

FVA for swath was not reported in swath metadata. RMSE was calculated on the classified LAS tiles

<vertaccv>0.267</vertaccv>
<vertacce>RMSE in feet, as calculated from Classified LAS files</vertacce>

Vertical accuracy was not reported for the DEM in DEM.xml.

SVAs CVA or FVA was not reported in any metadata. Please correct all metadata.

Swath & Classified LAS errors:

Missing point data within the project boundary @
-90 18 55, 35 59 33

LP360 stats extractor verifies swath as having classes 1-4.

Swath overlap insufficient in many areas along the southern border of Dunklin Co. Swath overlap measures as little as 2-4' in some areas past the project boundary which also affects the classified LAS.

Not Accepted at this time:

Swath
LAS
Metadata
Control

Accepted at this time:
breaklines
DEM (pending future vertical accuracy testing)

Review Complete: 6/12/2013

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 with errors.

Parse failed.
mismatched tag
at line 97
column 6
Trying another XML parser to check well-formedness:

XML error on line 97: Mismatched tag

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

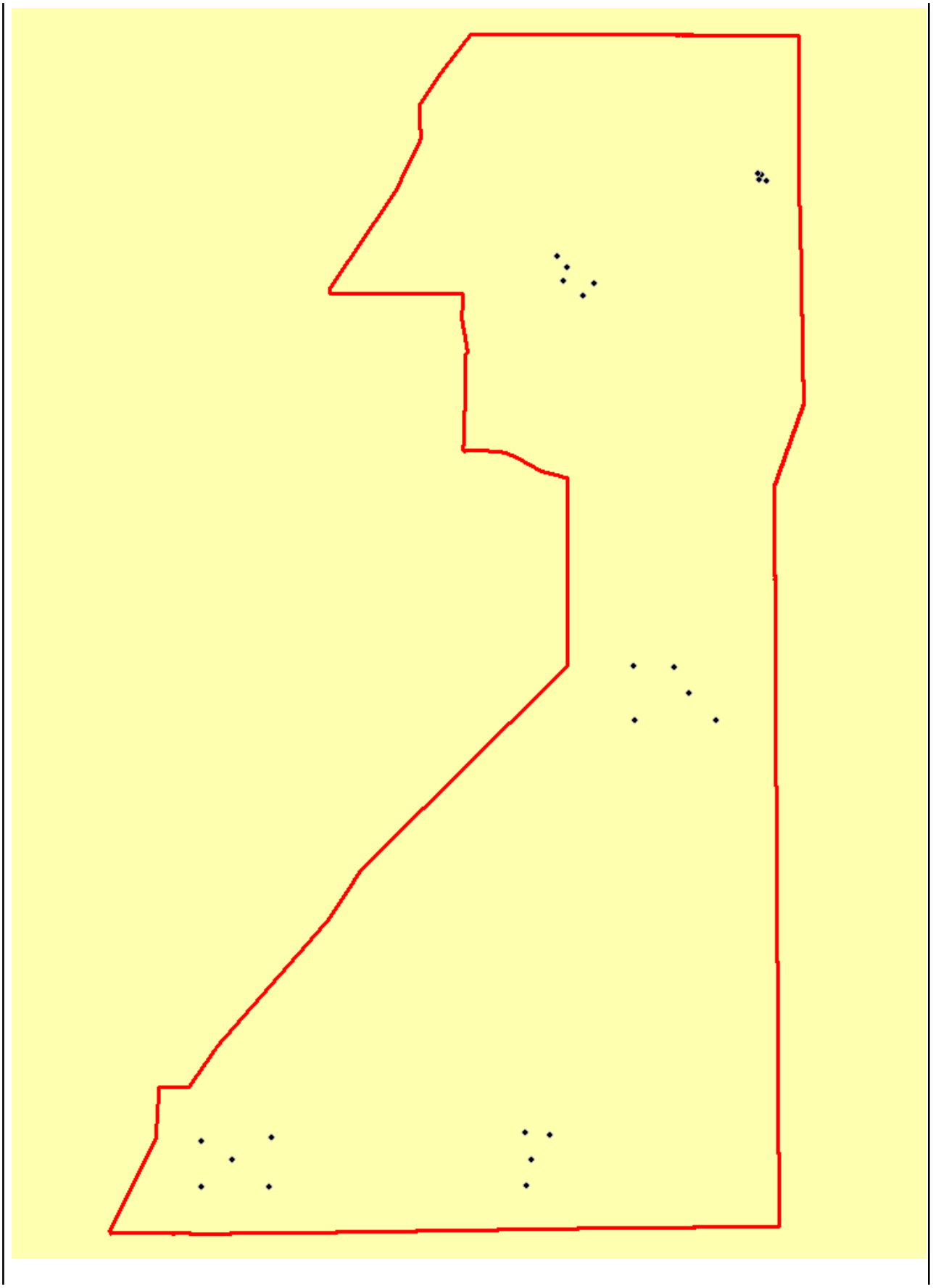
☐ Urban Areas with Dense Man-Made Structures

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 does not acccept at this timethe quality of the checkpoint data for these LiDAR datasets.

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

☑ Image?



Are these calibration or blind? There is no documentation. Points provided are clustered into 5 areas in the county. This is not good distribution and there are not 20 (preferably 30) per land cover class.

☐ Image?

Only the RMSEz was reported in the SOW and project metadata. FVA SVAs and CVA were not reported.

overall RMSE is indicated as .285 in the SOW and .267 in all metadata. Which is it?

It is indicated in the SOW, RMSE = .285 overall (CVA) for the DEM surface. FVA SVAs and CVA need to be reported for the DEM.

Project metadata indicates RMSE = .267 over (CVA) for the DEM surface. FVA SVAs and CVA need to be reported for the DEM in all metadata.

Due to conflicting information, lack of information in metadata, and missing control and documentation, Vertical Accuracies for Swath FVA, or FVA, SVAs or CVA on the DEM were not calculated @NGTOC. Vendors accuracies were not put forth in this report.

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

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

The reported FVA of the Bare-Earth DEM data is 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		N/A

Brush Lands and Low Trees			N/A
Forested Areas Fully Covered by Trees			N/A
Urban Areas with Dense Man-Made Structu...			N/A

The reported CVA of this data set is: 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

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

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

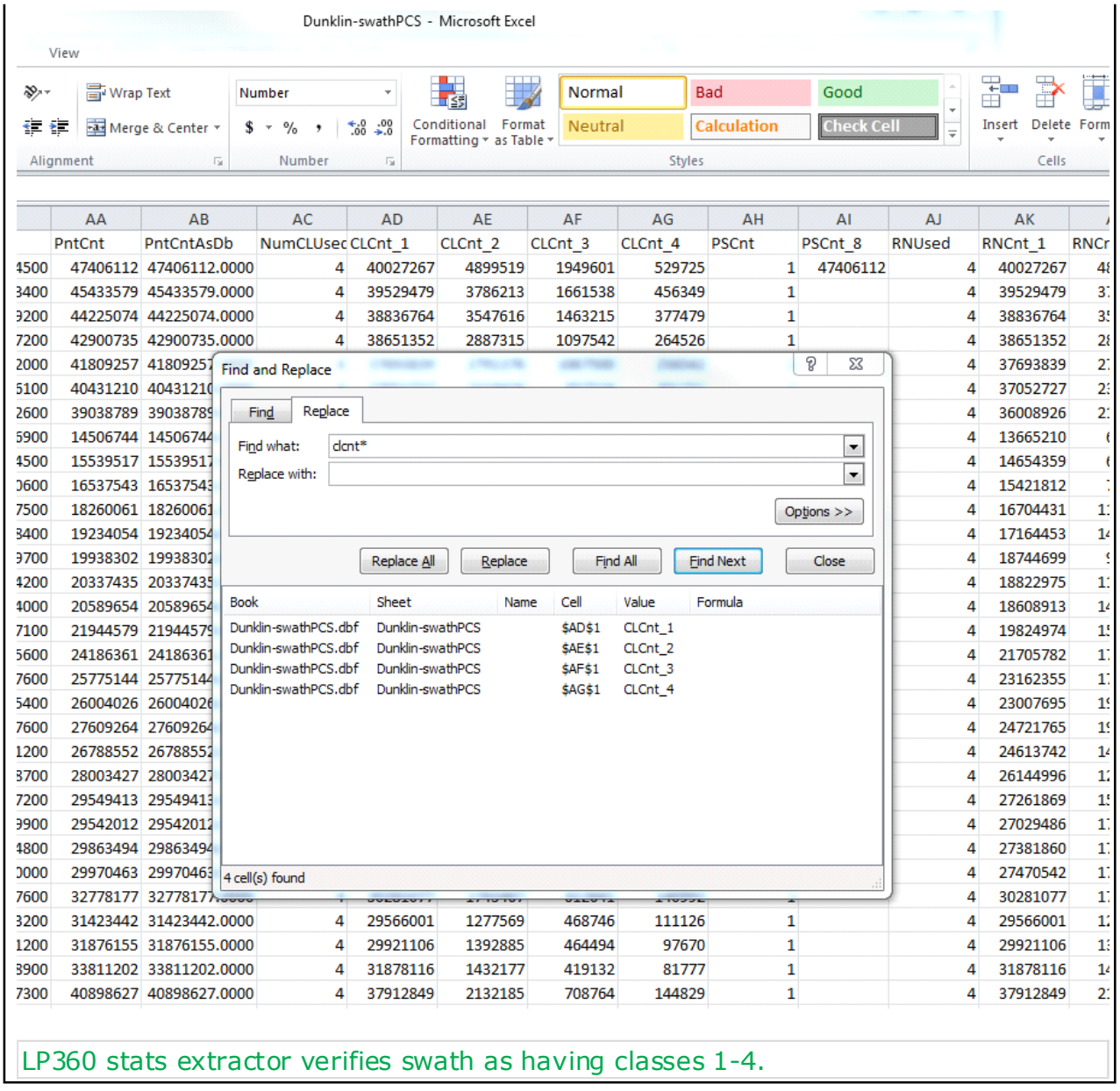
Based on this review, the USGS does not accept at this time the LAS swath file data.

Errors, Anomalies, Other Issues to document? (•) Yes ( ) No

- [ ] Image?

FVA for swath was not reported in the swath.xml

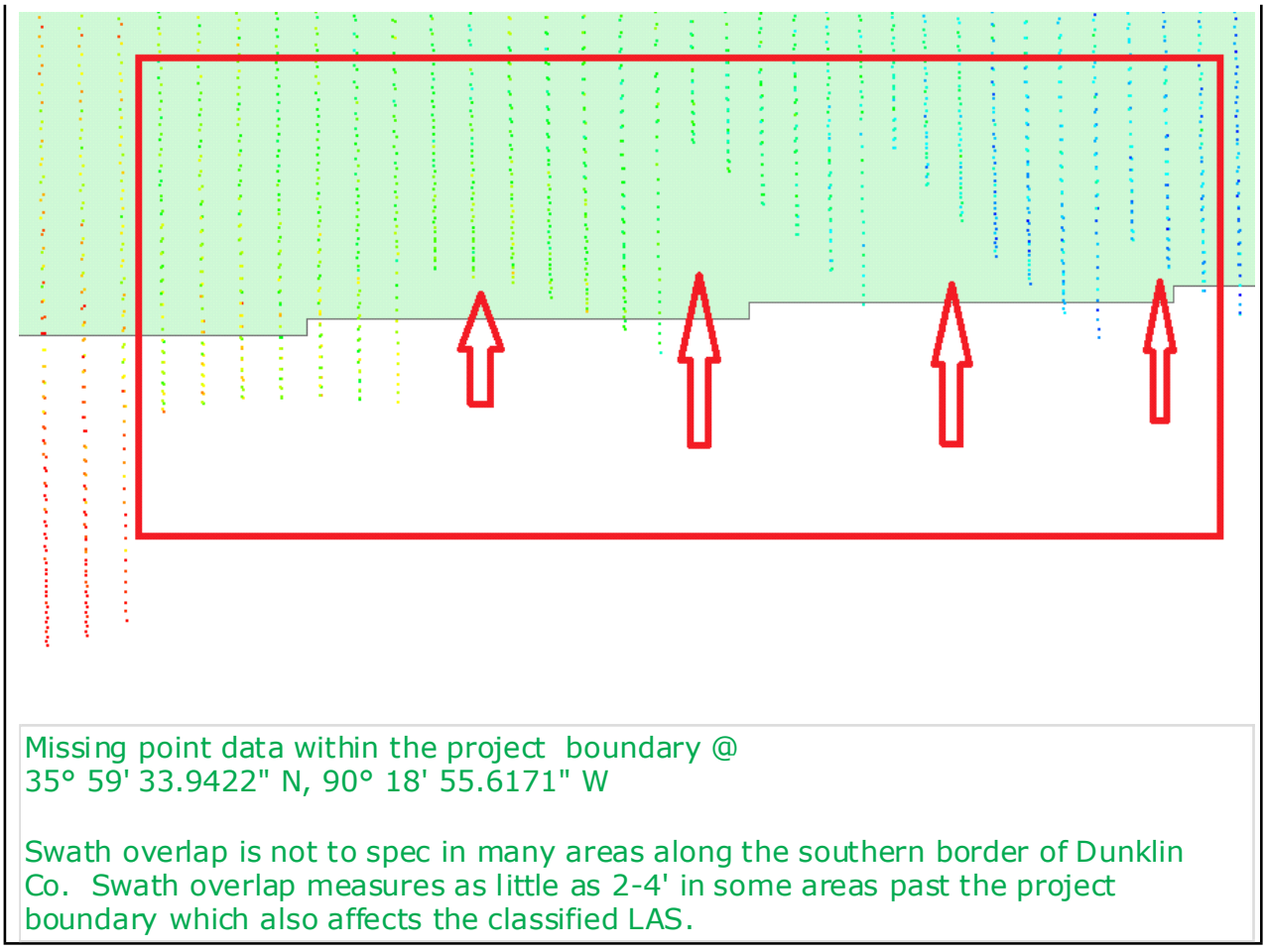
- [x] Image?



	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	
	PntCnt	PntCntAsDb	NumCLUsec	CLCnt_1	CLCnt_2	CLCnt_3	CLCnt_4	PSCnt	PSCnt_8	RNUsed	RNCnt_1	RNCr
4500	47406112	47406112.0000	4	40027267	4899519	1949601	529725	1	47406112	4	40027267	48
3400	45433579	45433579.0000	4	39529479	3786213	1661538	456349	1		4	39529479	37
9200	44225074	44225074.0000	4	38836764	3547616	1463215	377479	1		4	38836764	35
7200	42900735	42900735.0000	4	38651352	2887315	1097542	264526	1		4	38651352	28
2000	41809257	41809257								4	37693839	27
5100	40431210	40431210								4	37052727	23
2600	39038789	39038789								4	36008926	21
5900	14506744	14506744								4	13665210	6
4500	15539517	15539517								4	14654359	6
0600	16537543	16537543								4	15421812	7
7500	18260061	18260061								4	16704431	11
3400	19234054	19234054								4	17164453	14
9700	19938302	19938302								4	18744699	9
4200	20337435	20337435								4	18822975	11
4000	20589654	20589654								4	18608913	14
7100	21944579	21944579								4	19824974	15
5600	24186361	24186361								4	21705782	17
7600	25775144	25775144								4	23162355	17
5400	26004026	26004026								4	23007695	19
7600	27609264	27609264								4	24721765	19
1200	26788552	26788552								4	24613742	14
3700	28003427	28003427								4	26144996	12
7200	29549413	29549413								4	27261869	15
9900	29542012	29542012								4	27029486	17
4800	29863494	29863494								4	27381860	17
0000	29970463	29970463								4	27470542	17
7600	32778177	32778177								4	30281077	17
3200	31423442	31423442.0000	4	29566001	1277569	468746	111126	1		4	29566001	12
1200	31876155	31876155.0000	4	29921106	1392885	464494	97670	1		4	29921106	13
3900	33811202	33811202.0000	4	31878116	1432177	419132	81777	1		4	31878116	14
7300	40898627	40898627.0000	4	37912849	2132185	708764	144829	1		4	37912849	21

LP360 stats extractor verifies swath as having classes 1-4.

☑ Image?



Missing point data within the project boundary @
35° 59' 33.9422" N, 90° 18' 55.6171" W

Swath overlap is not to spec in many areas along the southern border of Dunklin Co. Swath overlap measures as little as 2-4' in some areas past the project boundary which also affects the classified LAS.

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?

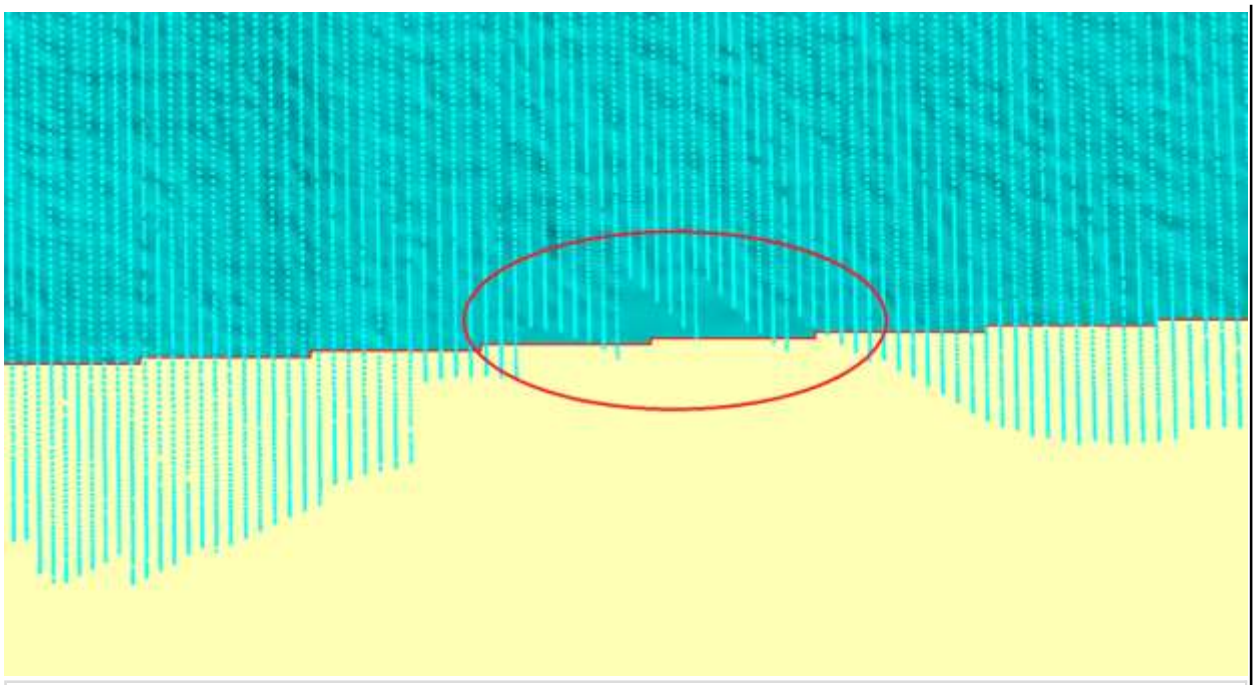
Based on this review, the USGS does not accept at this time the classified LAS tile file data.

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

☐ Image?

LAS has not been accepted due to missing metadata.

☑ Image?



missing ground points @35° 59' 33.9422" N, 90° 18' 55.6171" W
LAS tile # 07413985
This does not affect the elevation surface in the DEM.

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
- [ ] 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 = or less.	Supplemental Vertical Accuracy @95th Percentile Error Target SVA = or less.	Consolidated Vertical Accuracy @95th Percentile Error Required CVA = or less.
Open Terrain	20			
Tall Weeds and Crops				
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 accepts the bare-earth DEM files.

Bare-Earth DEM Anomalies, Errors, Other Issues

Errors, Anomalies, Other Issues to document? (•) Yes ( ) No

☐ Image?

Due to conflicting information, lack of information in metadata, and missing control and documentation, Vertical Accuracies for Swath FVA, or FVA, SVAs or CVA on the DEM were not calculated @NGTOC. Nor was the vendors accuracies put forth in this report.

This is the end of the report.