McDonough 3rd Delivery QAQC

Summary LiDAR QA/QC Report

Report generated on 12/13/2013

This document reports on compliance with the USGS National Geospatial Program LiDAR Base Specification Version 1.0. The complete specification, which also contains a list of abbreviations, acronyms, and a glossary of related terms, can be found here.

0.0 Report on LAS Statistics (By Tile)

The purpose of this section is to show basic quantifiable information about the LAS files tested.

Classified Files - E:\McDonough 3rd Delivery\LAS

Horizontal Units: US Survey Feet Vertical Units: US Survey Feet
Number of boresighted LAS files: 610
Number of classified LAS files: 4399

All LAS statistic information can be reviewed in a geographic manner by accessing the shapefile located at E:\McDonough 3rd Delivery\QAQC\0_0\Tile_Index.shp

Average Point Density: 0.14 / 1.51 pp Square US Survey Foot / pp Square Meter
Average GSD: 2.67 US Survey Feet

Note: These statistics are for tiled LAS files. Not all LAS files fill tiles completely, especially along project boundaries. This may skew the results by including area, count, and density values for partially filled tiles.

0.0 Report on LAS Statistics (By Tile) - Class Totals

The purpose of this section is to list the number of points in each classification present in the tested data so that the user can determine if any points were filtered to unintended classes.

Classified Files - E:\McDonough 3rd Delivery\LAS

Class(es) Expected: N/A
Class(es) Present: 1,2,7,9,10

Class	Total
1	1,344,327,507
2	1,521,572,110
7	45,834
9	3,181,008
10	488,555

1.1 Report on Multiple Discrete Returns (Tiled Data)

The USGS LiDAR Base Specification Version 1.0 requires: "Data collection must be capable of at least three returns per pulse. Full waveform collection is acceptable and welcomed; however, waveform data are regarded as supplemental information. Deriving and delivering multiple discrete returns is required in all cases."

The purpose of this section is to report on the presence and quantities of LiDAR returns in the LAS tiled data. Empty return columns can indicate a collection or processing problem dealing with LiDAR return attribute information.

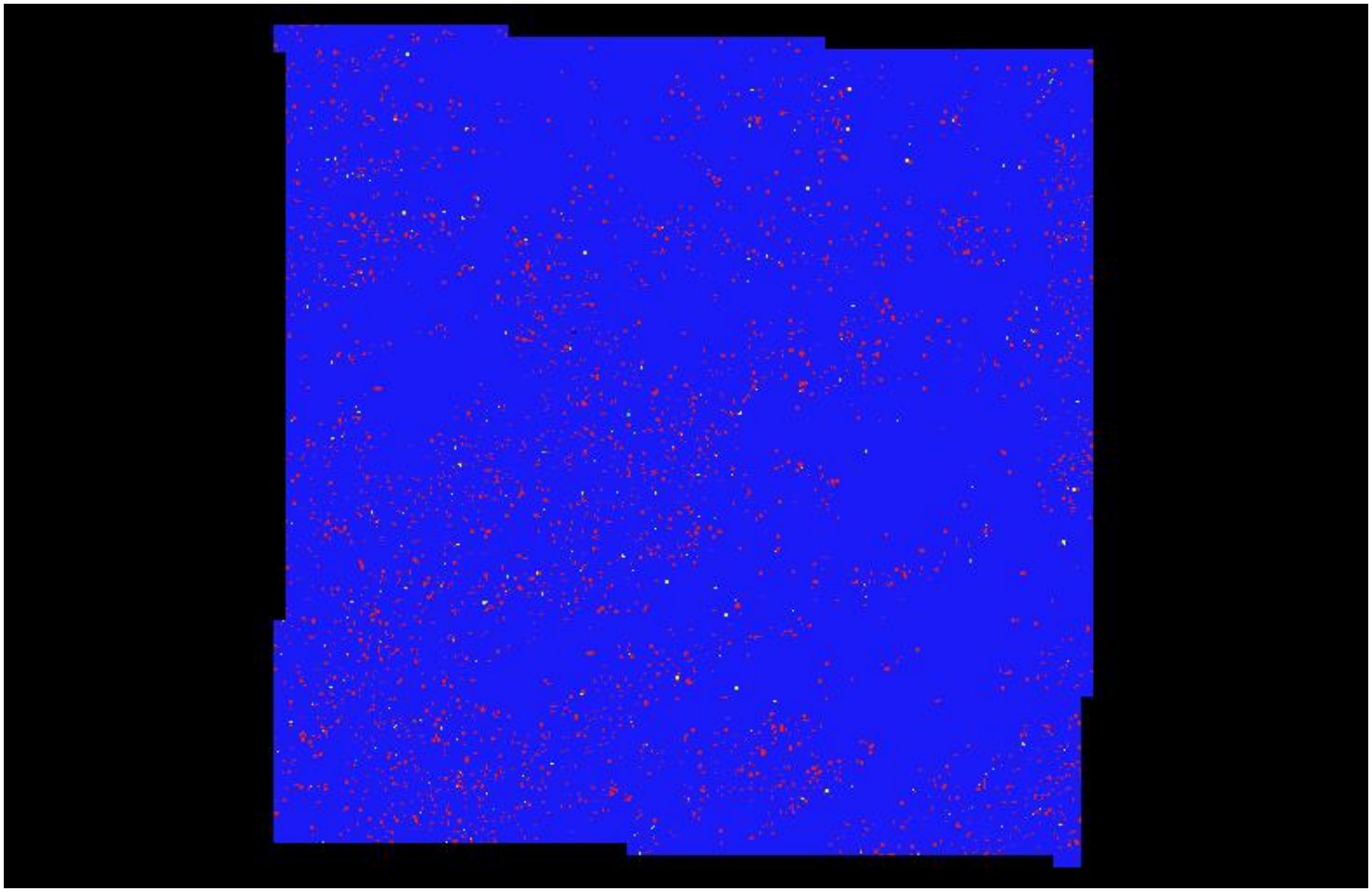
Classified Files - E:\McDonough 3rd Delivery\LAS

File	First return	Second return	Third return	Other return	Total points
Total	2,518,862,930	259,390,242	80,488,491	10,873,351	2,869,615,014

1.1 Report on Multiple Discrete Returns (Tiled Data) - All Returns

The purpose of this section is to show a graphic of LiDAR tiled data points colored by all returns. Blank tiles can indicate a collection or processing problem dealing with LiDAR return attribute information.

Data Source - E:\McDonough 3rd Delivery\LAS
Result Path - E:\McDonough 3rd Delivery\QAQC\1_1\ColorByReturns_Classified.jpg



1.2 Report on Intensity Values (Tiled Data)

The USGS LiDAR Base Specification Version 1.0 requires: "Intensity values are required for each return. The values are to be recorded in the .las files in their native radiometric resolution."

The purpose of this section is to report on the presence and quantities of LiDAR intensity in the LAS tiled data. It is important to understand that 8-bit intensity LiDAR systems have a valid intensity range from 0-255, and 12-bit intensity LiDAR systems have a valid intensity range from 0-4095.

Classified Files - E:\McDonough 3rd Delivery\LAS

File	Minimum	Maximum	Mean	Median	Mode
Average	01	5,100	36	39	40

1.2 Report on Intensity Values (Tiled Data)

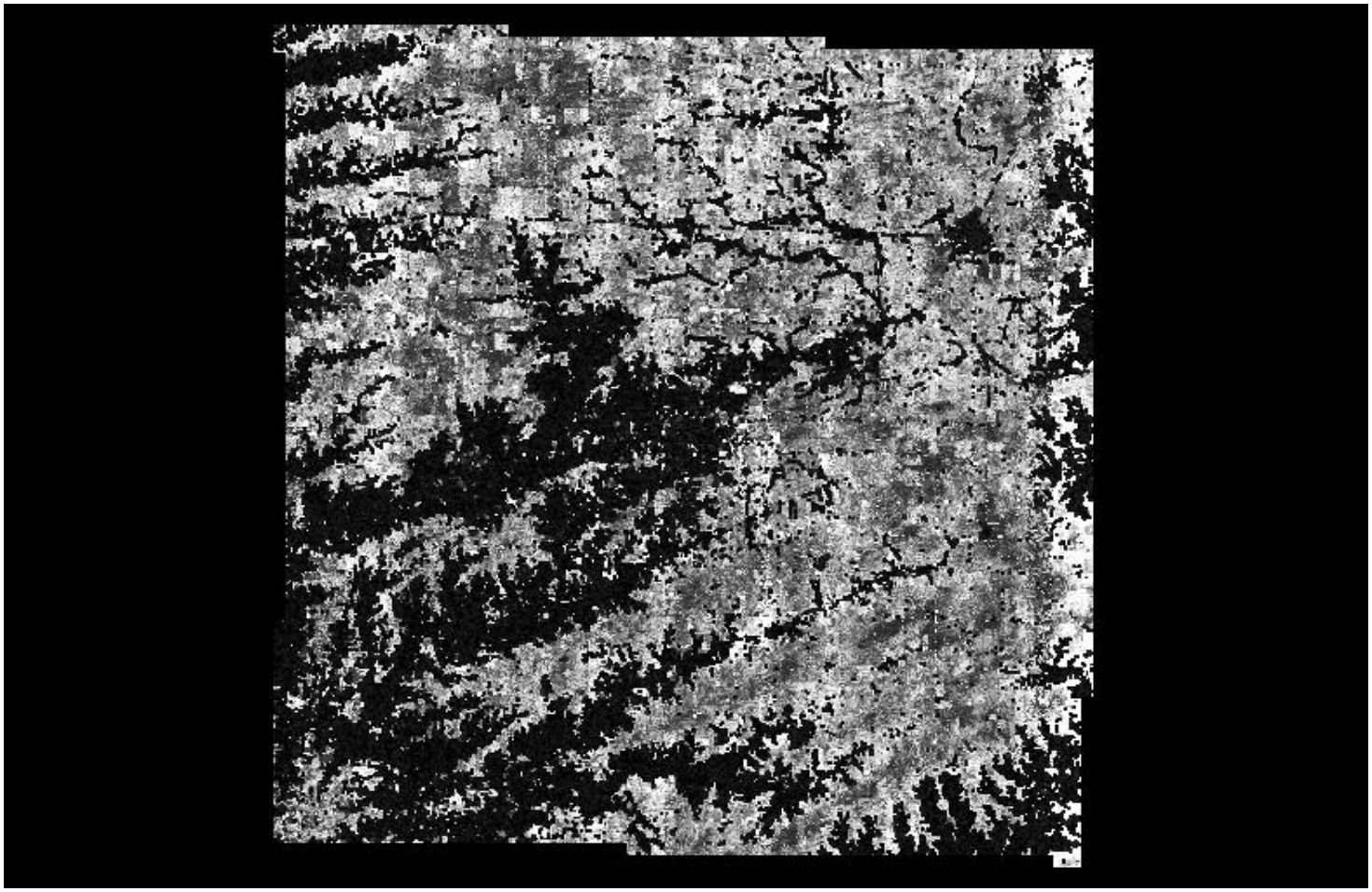
The purpose of this section is to show a frequency distribution chart of intensities throughout all of the LiDAR tiled files. It is important to understand that 8-bit intensity LiDAR systems have a valid intensity range from 0-255, and 12-bit intensity LiDAR systems have a valid intensity range from 0-4095.

Data Source - E:\McDonough 3rd Delivery\LAS

1.2 Report on Intensity Values (Tiled Data)

The purpose of this section is to show a graphic of LiDAR tiled data points colored by intensity. Blank tiles can indicate a processing problem dealing with LiDAR intensity attribute information.

Data Source - E:\McDonough 3rd Delivery\LAS
Result Path - E:\McDonough 3rd Delivery\QAQC\1_2\ColorByIntensity_Classified.jpg



1.3 Report on Point Density and Nominal Pulse Spacing (NPS) (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "An NPS of 2 meters or less is required. Dependent on the local terrain and land cover conditions in the project area, a greater point density may be required on specific projects. Assessment of the NPS will be made against single swath, first-return only data, located within the geometrically usable center portion (typically 90 percent) of each swath, acceptable data voids excluded. NPS will be calculated as the square root of the average area per point. Average along-track and cross-track point spacing should be comparable (within 10 percent)."

The purpose of this section is to report on the LiDAR point density and nominal point spacing by swath file. Averages by swath files (not including overlap), project boundary polygons (including swath overlap), and aggregate project boundary polygons (including swath overlap) are reported.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

Units: US Survey Feet

File	Number of First Returns	Area of Swath	Point Density	NPS
Average			0.07/0.75 pp Square US Survey Feet/ pp Square Meter	3.90/1.19 US Survey Feet/ Meter
Aggregate	2,511,661,093	17,595,999,979	0.14/1.51 pp Square US Survey Feet/ pp Square Meter	2.65/0.81 US Survey Feet/ Meter

1.4 Report on Point Density and Nominal Pulse Spacing (NPS) (Tiled Data)

The USGS LiDAR Base Specification Version 1.0 states: "In general, the target NPS for a project should not be achieved through swath overlap or multiple passes. Such collection techniques may be permitted with prior approval."

The purpose of this section is to report on the LiDAR point density and nominal point spacing by tiled file. Point densities and NPS by tile are calculated by including any overlapping swath data within each tile. These statistics are for tiled LAS files. Not all LAS files fill tiles completely, especially along project boundaries. This may skew the calculated density and NPS values for partially filled tiles.

Classified Files - E:\McDonough 3rd Delivery\LAS

Units: US Survey Feet

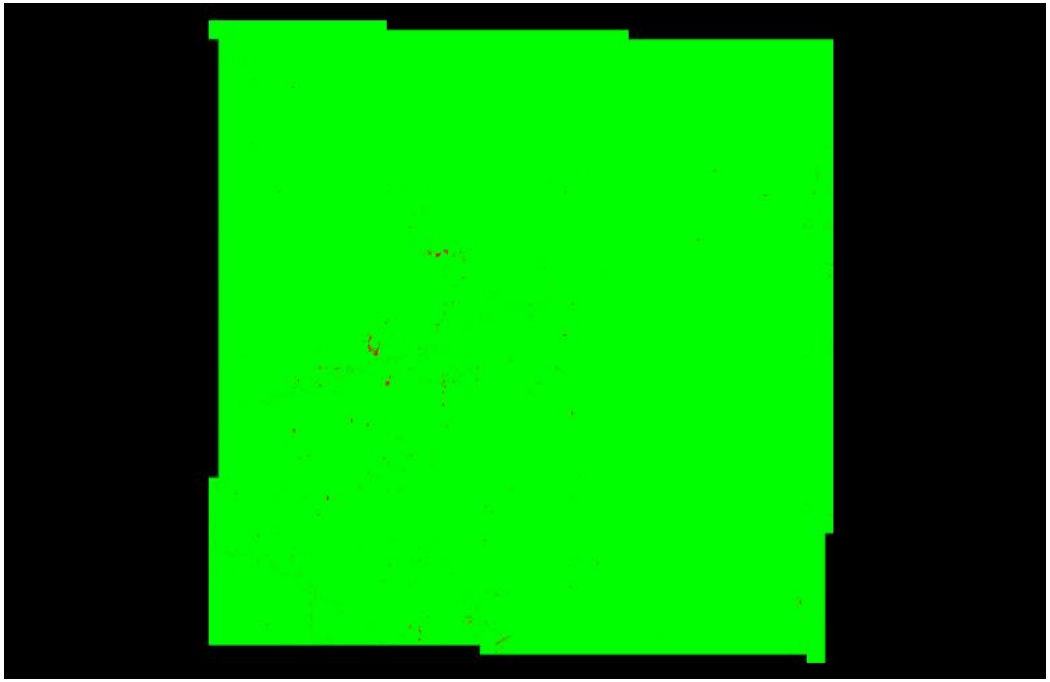
File	Point Density	Nominal Pulse Spacing (NPS)
Average	0.14/1.51	2.67/0.81
	pp Square US Survey Feet/ pp Square Meter	US Survey Feet/ Meter

1.5 Report on Data Voids (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states that: "Data voids within a single swath are not acceptable, except in the following circumstances: (1) where caused by water bodies. (2) where caused by areas of low near infra-red (NIR) reflectivity such as asphalt or composition roofing and (3) where appropriately filled-in by another swath."

The purpose of this section is to show graphically where possible LiDAR data voids are located. Data voids can be caused by a lack of coverage at the time of collection, water bodies not reflecting the laser beam back to the receiver, LiDAR occlusions caused by objects above ground like tall buildings, etc. Not all data voids are problematic. The intention of this test is to isolate the first example of LiDAR data voids - a lack of coverage at the time of collection. A close inspection must be done on the results to determine if the LiDAR coverage was collected and processed to meet the intended specifications.

Data Source - E:\McDonough 3rd Delivery\Boresight
E:\McDonough 3rd Delivery\QAQC\1_5\Boresighted_DataVoids_SingleFile.jp2



Cell size: 14 US Survey Feet

Green: No data void (number of cells = 89,688,153)
Red: Data void (number of cells = 83,908)
Background Color: Null data
See JPG2000 file for full resolution results

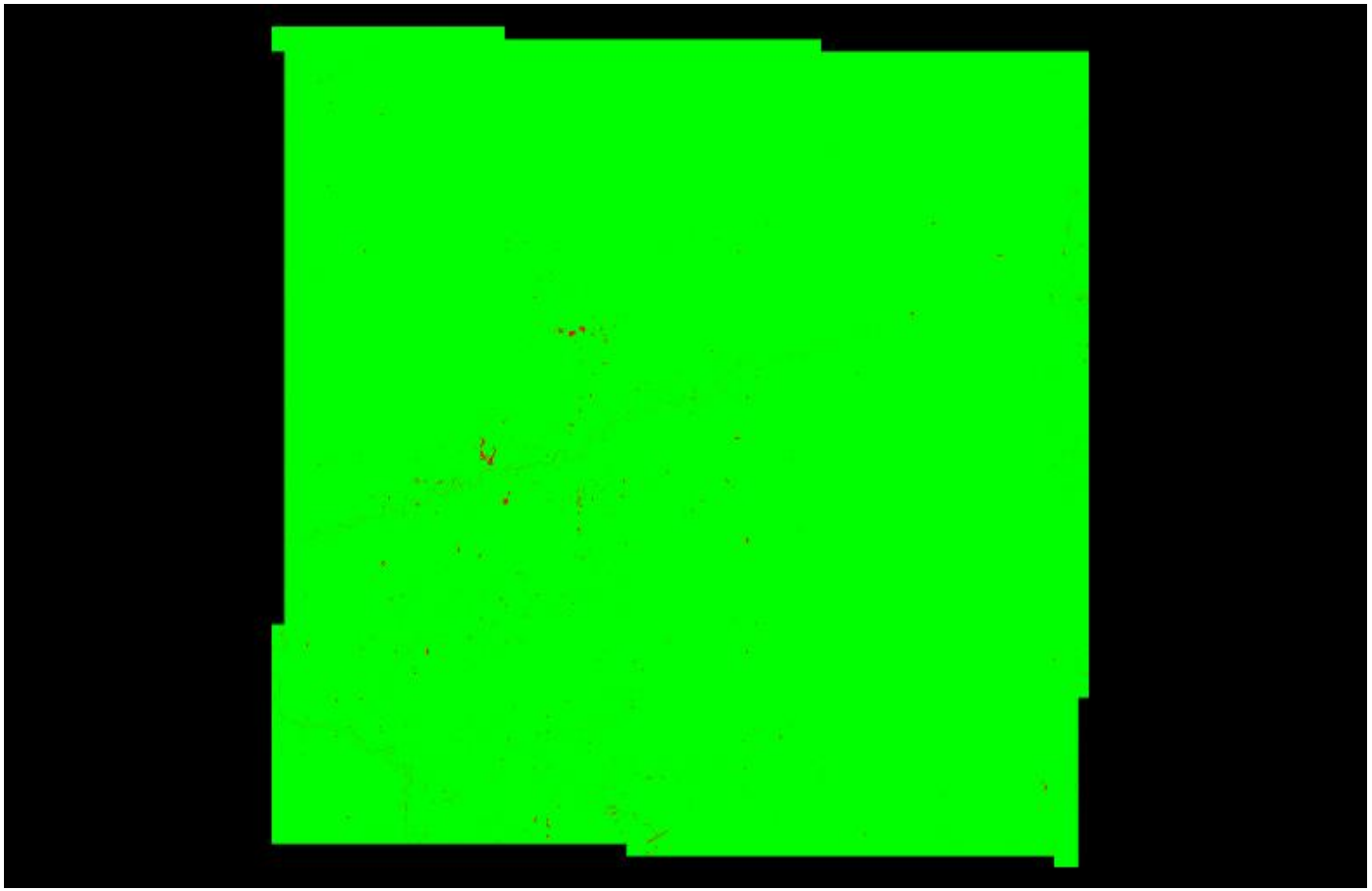
1.6 Report on Spatial Distribution Verification

The USGS LiDAR Base Specification Version 1.0 states that: "The spatial distribution of geometrically usable points is expected to be uniform. Although it is understood that lidar instruments do not produce regularly gridded points, collections should be planned and executed to produce a first-return point cloud that approaches a regular lattice of points, rather than a collection of widely spaced high density profiles of the terrain. The uniformity of the point density throughout the dataset is important and will be assessed using the following steps:
(1) Generating a density grid from the data with cell sizes equal to the design NPS times 2, using a radius equal to the design NPS
(2) Ensuring at least 90 percent of the cells in the grid contain at least one lidar point.
(3) The assessment is to be made against individual (single) swaths, using only the first-return points located within the geometrically usable center portion (typically 90 percent) of each swath.
Excluding acceptable data voids previously identified in this specification.
Note: This requirement may be relaxed in areas of substantial relief where it is impractical to maintain a consistent and uniform distribution.
Note: The process described in this section relates only to the uniformity of the point distribution. It in no way relates to, nor can it be used for the assessment of point density or NPS."

The purpose of this section is to show graphically where unacceptable LiDAR spatial distributions are located. LiDAR spatial distribution can be affected by problems in flight planning (e.g., incorrect scan frequency / pulse rate pairing) or flight execution (e.g., strong headwinds or tailwinds), a lack of coverage at the time of collection, water bodies not reflecting the laser beam back to the receiver, LiDAR occlusions caused by objects above ground like tall buildings, etc. Not all LiDAR spatial distribution violations are truly problematic. The intention of this test is to isolate the first example of LiDAR spatial distribution violations - problems in flight planning or flight execution. A close inspection must be done on the results to determine if the LiDAR spatial distribution was collected and processed to meet the intended specifications.

Data Source - E:\McDonough 3rd Delivery\Boresight
E:\McDonough 3rd Delivery\QAQC\1_6\Boresighted_SpatialDistribution_SingleFile.jp2

1.6 Report on Spatial Distribution Verification - continued



Cell size: 7 US Survey Feet

Green: Cells containing at least 1 first return LiDAR point(s) (number of cells = 358,570,897)
Red: Cells not containing at least 1 first return LiDAR point(s) (number of cells = 541,632)
Background Color: Null data
Percentage of cells in the grid that contain at least 1 first return LiDAR point(s) = 99.85% (Requirement is typically 90%)
See JPG2000 file for full resolution results

1.8 Report on Vertical Accuracy (Tiled Data)

The USGS LiDAR Base Specification Version 1.0 states that: "Vertical Accuracy of the LiDAR data will be assessed and reported in accordance with the guidelines developed by the NDEP and subsequently adopted by the ASPRS.

(1) The minimum vertical accuracy requirement for the unclassified lidar point cloud, using the NDEP/ASPRS methodology, is listed below:. See: http://www.ndep.gov/NDEP_Elevation_Guidelines_Ver1_10May2004.pdf

(2) Fundamental Vertical Accuracy (FVA)<= 24.5 centimeters (cm) Accuracyz (ACCz), 95 percent (12.5 cm Root Mean Square Error (RMSE)z).

(3) Accuracy for the LiDAR point cloud data is to be reported independently from accuracies of derivative products (i.e., DEMs). Point cloud data accuracy is to be tested against a TIN constructed from bare-earth LiDAR points.

Point cloud data accuracy is to be tested against a Triangulated Irregular Network (TIN) constructed from lidar points in clear and open areas. A clear and open area can be characterized with respect to topographic and ground cover variation such that a minimum of 5 times the NPS exists with less than 1/3 of the RMSEz deviation from a low-slope plane. Slopes that exceed 10 percent should be avoided. Ground that has been plowed or otherwise disturbed is not acceptable. All tested locations should be photographed showing the position of the tripod and the surrounding area ground condition."

The purpose of this section is to report on the fundamental vertical accuracy of the LiDAR data measured against surveyed ground check points.

This reports only the Fundamental Vertical Accuracy (FVA)

E:\McDonough 3rd Delivery\QAQC\1_8\Report_VerticalAccuracy.csv

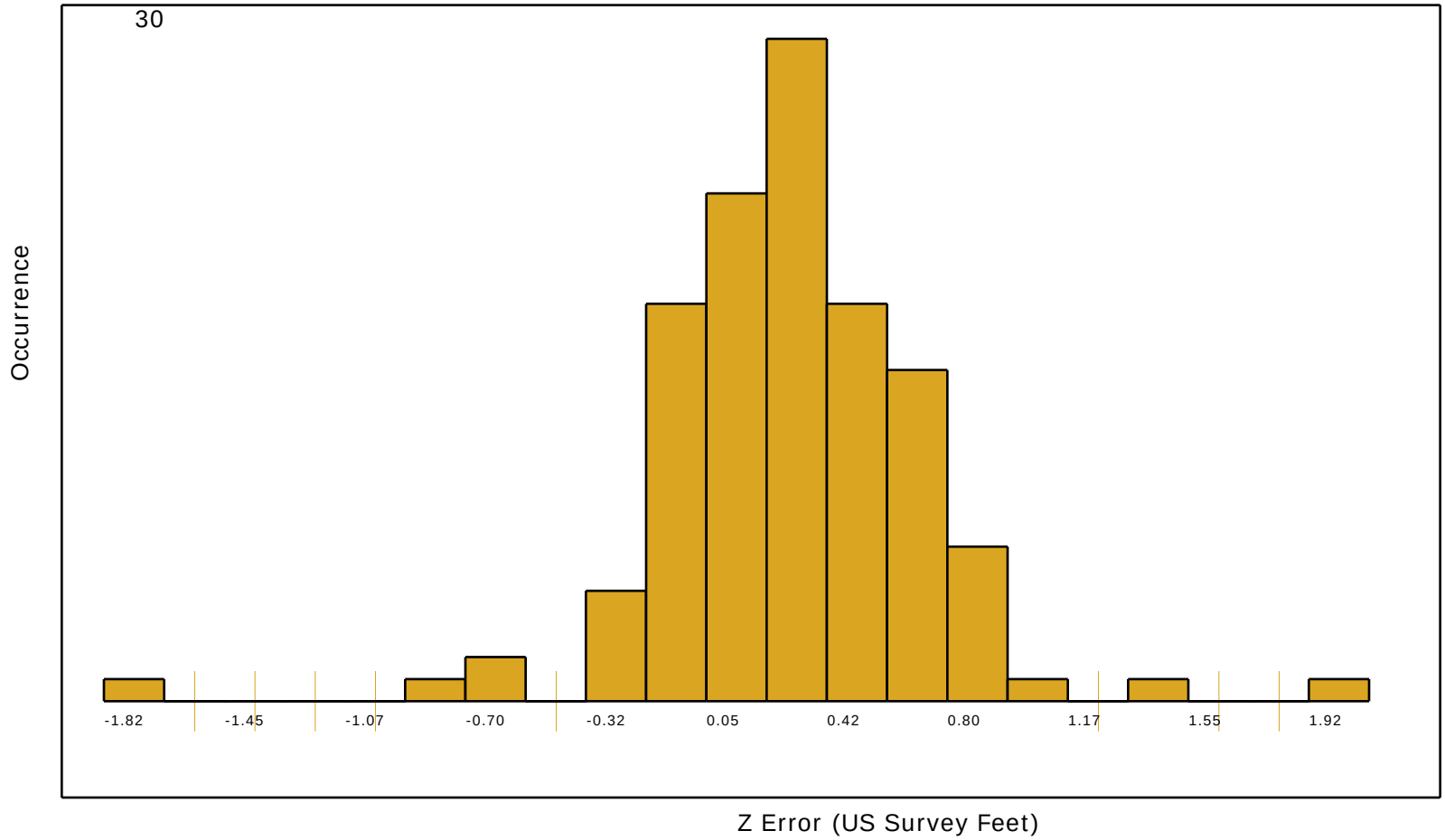
Units: US Survey Feet

		Classified Data
Control Points		123
Points with Coverage		123
Points With Required Accuracy		114
Percent of Points With Required Accuracy		92.68%
Average Z Error		0.21
Maximum Z Error		1.92
Median Z Error		0.20
Minimum Z Error		-1.82
NSSDA Vertical Accuracy	at the 95 confidence level	0.91
Standard Deviation (sigma) of Z for Sample		0.42
RMSE of Z for Sample		0.46 PASS
FGDC/NSSDA/FEMA Contour Interval		2.00
ASPRS Contour Interval		2.00
NMAS Contour Interval		2.00

1.8 Report on Vertical Accuracy (Tiled Data)

The purpose of this section is to show a frequency distribution chart of the the fundamental vertical accuracy of the LiDAR data measured against surveyed ground check points.

Data Source - E:\McDonough 3rd Delivery\LAS



1.9.1 Report on Flight Line Separation (Relative Accuracy) per Project

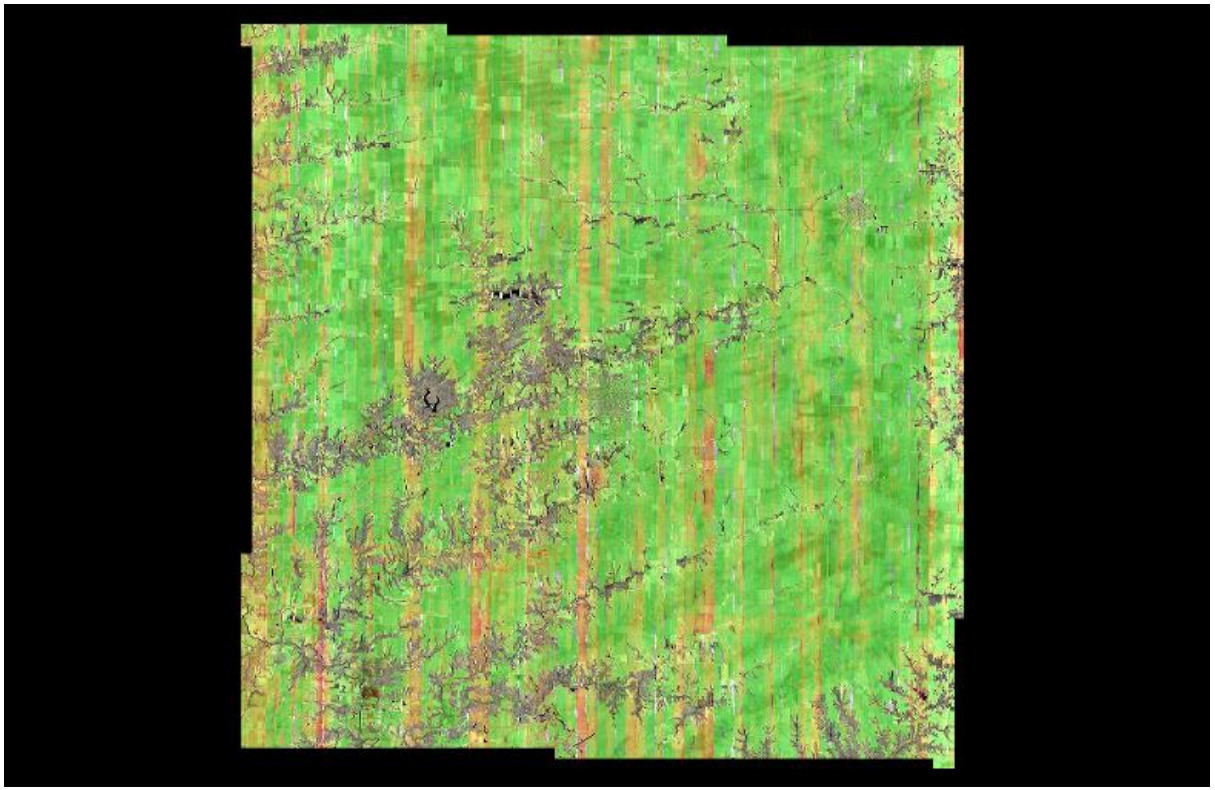
The USGS LiDAR Base Specification Version 1.0 states that: "Relative accuracy within overlap between adjacent swaths: <=10 cm RMSEz"

The purpose of this section is to show a graphic of the flight line separation raster for all of the data processed. This grid/image shows the vertical separation of flight lines by thematically coloring the separation magnitude on a color ramp based on absolute distance. This color thematic rendering is modulated by intensity to show land cover features. If there is no flight line overlap, the raster is displayed as grayscale intensity alone. The relative accuracy RMSEz is reported in the bottom left of this page.

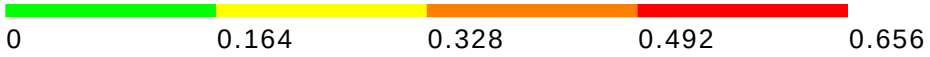
Data Source - E:\McDonough 3rd Delivery\Boresight

Vertical Units: US Survey Feet

E:\McDonough 3rd Delivery\QAQC\1_9\Boresighted_FlightlineSeparation_SingleFile.jp2



RMSEz = 0.26 (7.9248 cm)
See JPG2000 file for full resolution results



1.9.2 Report on Separation of Scan Direction (Relative Accuracy) per Flight Line

The USGS LiDAR Base Specification Version 1.0 states that: "Relative accuracy within individual swaths:<= 7 cm RMSEz."

The purpose of this section is to show a graphic of the relative vertical accuracy within a representative sample flight line. This automatically selected flight line will have the lowest multiple return to single return ratio. This vertical accuracy analysis is done by comparing the inbound and outbound scan lines to each other as two separate surfaces and then generating a vertical separation raster from their TIN deltas. This is displayed by thematically coloring the separation magnitude on a color ramp based on absolute distance. Good LiDAR data should have a consistent green coloration across the flight line (perpendicular to flight), ignoring warmer colorations due to above ground surface features. Small color variations are to be expected. The purpose of this test is to find problematic data indicated by warming color variation trends away from the center of the scan line. Flight lines that have inconsistent colorations from the center towards the edges of the flight line would highlight the possibility of a sensor or internal calibration problem, usually an incorrect encoder latency value. The relative accuracy RMSEz is reported in the bottom left of this page.

Data Source - E:\McDonough 3rd Delivery\Boresight\2811_F.las

Vertical Units: US Survey Feet

E:\McDonough 3rd Delivery\QAQC\1_9\2811_F.jp2

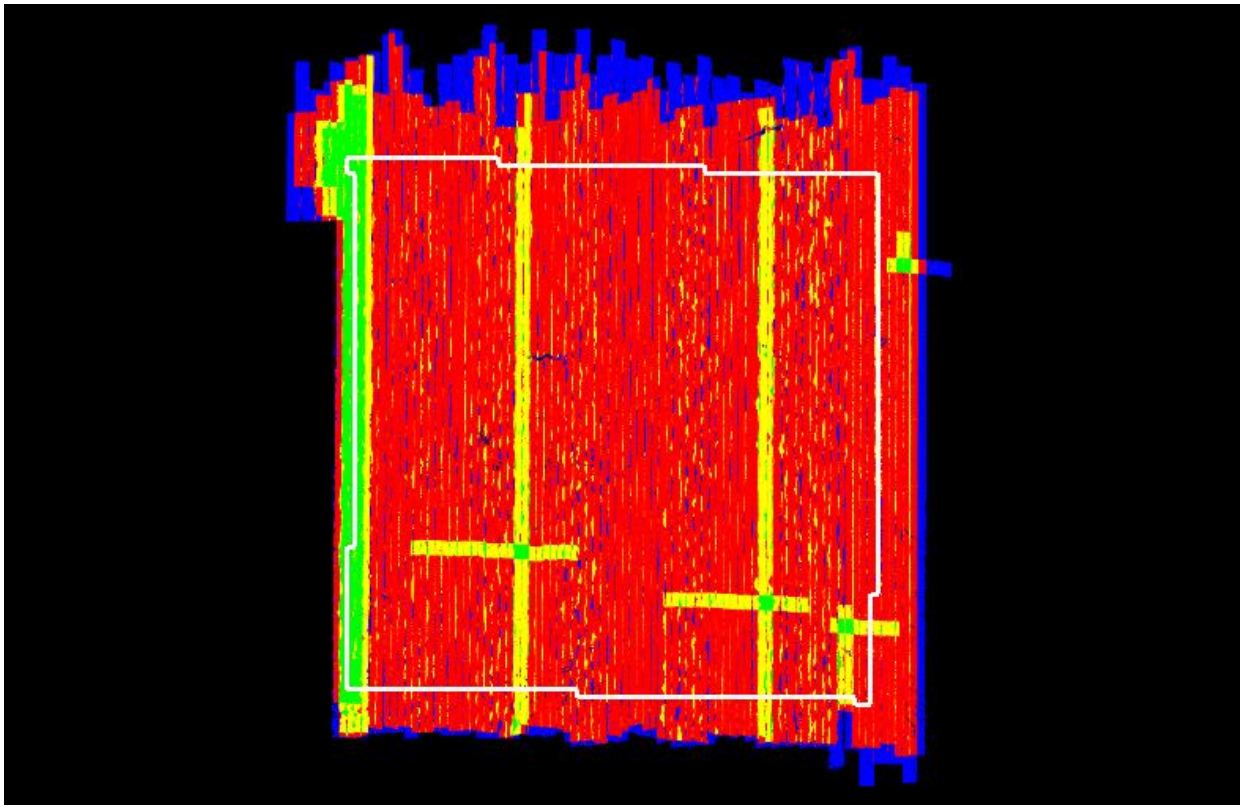
RMSEz = NaN (NaN cm)
See JPG2000 file for full resolution results

1.10 Report on Flight Line Overlap (Swath Data)

The USGS LiDAR Base Specification Version 1.0 requires: "Flightline overlap of 10 percent or greater is required to ensure there are no data gaps between the usable portions of the swaths. Collections in high relief terrain are expected to require greater overlap. Any data with gaps between the geometrically usable portions of the swaths will be rejected."

The purpose of this section is to show flight line overlap. Lack of flight line overlap would be displayed as black polygons or slivers between flight lines.

Data Source - E:\McDonough 3rd Delivery\Boresight
Result Path - E:\McDonough 3rd Delivery\QAQC\1_10\Flightline_Coverage_Overlap.jp2



White polygon is project boundary

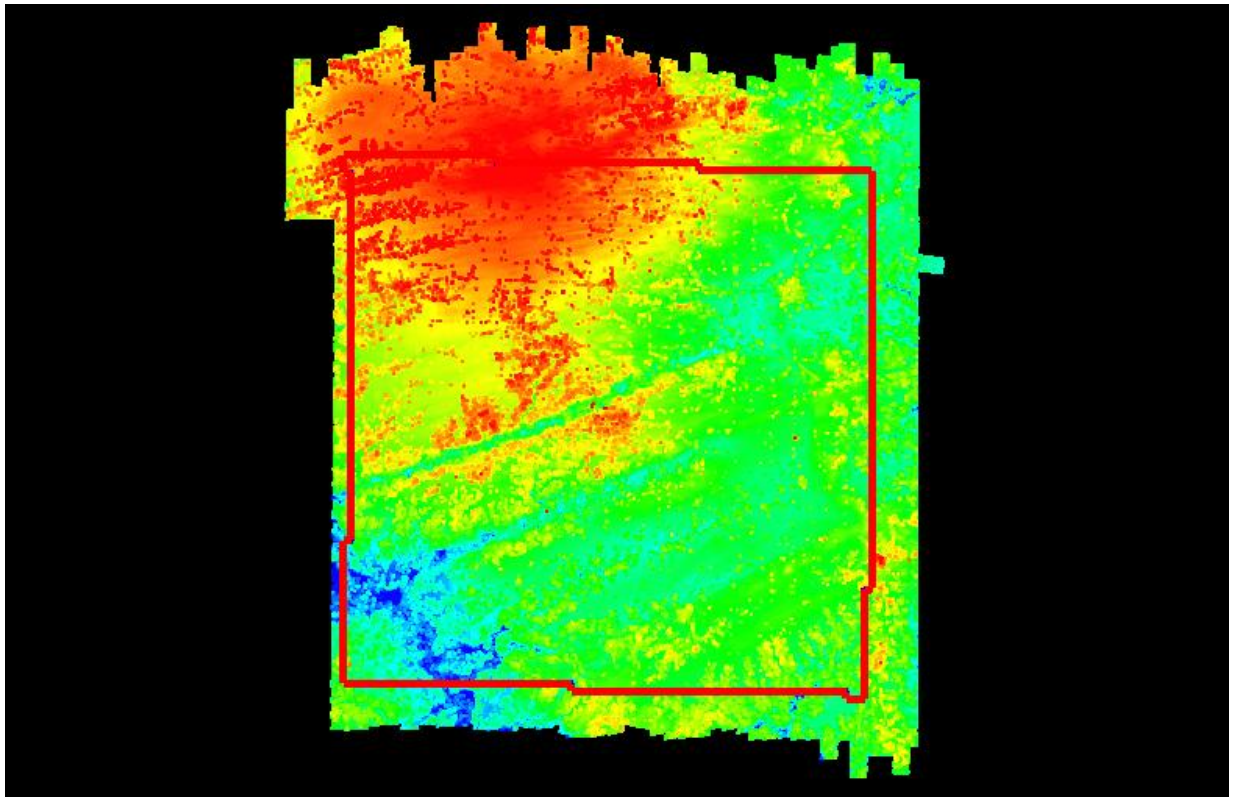
Single Double Triple Quadruple coverage or more

1.11 Report on Collection Area Buffered by 330 US Survey Feet (Swath Data)

The USGS LiDAR Base Specification Version 1.0 requires: "Data collection for the Defined Project Area, buffered by a minimum of 100 meters, is required. The buffered boundary is the Buffered Project Area. In order that all products are consistent to the edge of the Defined Project Area, all products must be generated to the limit of the Buffered Project Area. Since these areas are being generated, they shall also be delivered."

The purpose of this section is to show LiDAR coverage to the extent of a 100 meter buffer of the project boundary.

Data Source - E:\McDonough 3rd Delivery\Boresight
Result Path - E:\McDonough 3rd Delivery\QAQC\1_11\CollectionArea.jpg



Blue polygon is project boundary
Red polygon is project boundary buffered by 330 US Survey Feet

2.1 Report on ASPRS LAS File Format (Swath Data)

The USGS LiDAR Base Specification Version 1.0 requires: "All processing should be carried out with the understanding that all point deliverables are required to be in fully compliant LAS format, either v1.2 or v1.3. The version selected must be used for all LAS deliverables in the project. Data producers are encouraged to review the LAS specification in detail (ASPRS, 2011)."

The purpose of this section is to show the LAS format for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

All LAS swath files are formatted as LAS 1.2.

2.1 Report on ASPRS LAS File Format (Tiled Data)

The purpose of this section is to show the LAS format for the LiDAR tiled data.

Classified Files - E:\McDonough 3rd Delivery\LAS

All LAS tiled files are formatted as LAS 1.2.

2.2 Report on Full Waveform Data (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "If full waveform data are collected, delivery of the waveform packets is required. LAS v1.3 deliverables with waveform data are to use external auxiliary files with the extension .wdp for the storage of waveform packet data. See the LAS v1.3 Specification for additional information (ASPRS, 2011)."

The purpose of this section is to show the presence of waveform data for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

All LAS swath files have no waveform data present.

2.2 Report on Full Waveform Data (Tiled Data)

The purpose of this section is to show the presence of waveform data for the LiDAR tiled data.

Classified Files - E:\McDonough 3rd Delivery\LAS

All LAS tiled files have no waveform data present.

2.3 Report on Global Positioning System (GPS) Times Type (Swath Data)

The USGS LiDAR Base Specification Version 1.0 requires: "GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each pulse. Adjusted GPS Time is defined to be Standard (or satellite) GPS time minus 1*109. See the LAS v1.3 Specification for more detail (ASPRS, 2011)."

The purpose of this section is to show the GPS time type within the LAS files for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

All LAS swath files are formatted as Adjusted GPS Time.

2.3 Report on Global Positioning System (GPS) Times Type (Tiled Data)

The purpose of this section is to show the GPS time type within the LAS files for the LiDAR tiled data.

Classified Files - E:\McDonough 3rd Delivery\LAS

All LAS tiled files are formatted as Adjusted GPS Time.

2.4 Report on Datums (Swath Data)

The USGS LiDAR Base Specification Version 1.0 requires: "All data collected must be tied to the datums listed below:
(1) Horizontal datum reference to the North American Datum of 1983/HARN adjustment (NAD83 HARN) is required.
(2) Vertical datum reference to the North American Vertical Datum of 1988 (NAVD 88) is required.
(3) The most recent National Geodetic Survey (NGS)-approved geoid model is required to perform conversions from ellipsoidal heights to orthometric heights."

The purpose of this section is to show the datums of the LAS files for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

All LAS swath files are defined as:

EPSG Code = None
Vertical Datum = NAVD88 - Geoid09 (Feet)

2.4 Report on Datums (Tiled Data)

The purpose of this section is to show the datums of the LAS files for the LiDAR tiled data.

Classified Files - E:\McDonough 3rd Delivery\LAS

All LAS tiled files are defined as:

EPSG Code = None
Vertical Datum = NAVD88 - Geoid09 (Feet)

2.5 Report on Coordinate Reference System (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "The USGS preferred Coordinate Reference System for the Conterminous United States (CONUS) is Universal Transverse Mercator UTM, NAD83 HARN, Meters; NAVD88, Meters. Each discrete project is to be processed using the single predominant UTM zone for the overall collection area. The USGS will also accept data in other Coordinate Reference Systems that meet the conditions below:
(1) State Plane and State Coordinate Reference Systems that have been accepted by the European Petroleum Survey Group (EPSG) may be used.
(2) Coordinate Reference Systems for collections in Alaska, Hawaii, and other areas Outside the Conterminous United States (OCONUS) must be approved by the USGS before collection."

The purpose of this section is to show the projections of the LAS files for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

All LAS swath files are defined as:

EPSG Code = 3444
Projection = NAD_1983_HARN_StatePlane_Illinois_West_FIPS_1202_Feet

2.5 Report on Coordinate Reference System (Tiled Data)

The purpose of this section is to show the projections of the LAS files for the LiDAR tiled data.

Classified Files - E:\McDonough 3rd Delivery\LAS

All LAS tiled files are defined as:

EPSG Code = 3444
Projection = NAD_1983_HARN_StatePlane_Illinois_West_FIPS_1202_Feet

2.6 Report on Units of Reference (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "All references to the unit of measure "Feet" and "Foot" must specify "International", "Intl", "U.S. Survey", or "US"."

The purpose of this section is to show the horizontal and vertical units of the LAS files for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

All LAS swath files are defined as:

Horizontal Unit = US Survey Feet
Vertical Unit = US Survey Feet

2.6 Report on Units of Reference (Tiled Data)

The purpose of this section is to show the horizontal and vertical units of the LAS files for the LiDAR tiled data.

Classified Files - E:\McDonough 3rd Delivery\LAS

All LAS tiles files are defined as:

Horizontal Unit = US Survey Feet
Vertical Unit = US Survey Feet

2.7 Report on Swath Size and Segmentation (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "Swath files will be 2 gigabytes (GB) in size or less. Long swaths (those which result in a LAS file larger than 2 GB) will be split into segments no greater than 2 GB each.
(1) Each sub-swath will retain the original File Source ID of the original complete swath.
(2) Points within each sub-swath will retain the Point Source ID of the original complete swath.
(3) Each sub-swath file will be named identically to the original complete swath, with the addition of an ordered alphabetic suffix to the name ("-a", "-b" … "-n"). The order of the named sub-swaths shall be consistent with the collection order of the points ("-a" will be the chronological beginning of the swath; "-n" will be the chronological end of the swath).
(4) Point families shall be maintained intact within each sub-swath.
(5) Sub-swaths should be broken at the edge of the scan line.
(6) Other swath segmentation approaches may be acceptable, with prior approval."

The purpose of this section is to show the files sizes of the LAS files for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

There are 0 swath files over 2 GB in size.

2.8 Report on File Source ID (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "Each swath will be assigned a unique File Source ID. It is required that the Point Source ID field for each point within each LAS swath file be set equal to the File Source ID before any processing of the data. See the LAS v1.3 Specification (ASPRS, 2011)."

The purpose of this section is to report on the File Source ID and Point Source ID values for the LiDAR swath data. Note that sub-swaths of original swaths (see Test 2.7) may violate the unique values specification described in this test.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

There are 103 unique Point Source IDs.
There are 103 unique File Source IDs.
602 files are in violation with duplicated File Source ID or Point Source ID values.

This is in violation of the USGS LiDAR Base Specification Version 1.0 which states that each swath shall be assigned a unique File Source ID. The Point Source ID field for each point within each LAS swath file shall be set equal to the File Source ID prior to any processing of the data. Again, note that this requirement may be violated when sub-swaths of original swaths (to comply with Test 2.7) are present in the folder being tested.

2.9 Report on Point Families (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "Point families (multiple return "children" of a single "parent" pulse) shall be maintained intact through all processing before tiling. Multiple returns from a given pulse will be stored in sequential (collected) order."

The purpose of this section is to report on the presence and integrity of point families for the LiDAR swath data.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

All LAS swath files have point families present.

2.9 Report on Point Families (Tiled Data)

The purpose of this section is to report on the presence and integrity of point families for tiled data.

Classified Files - E:\McDonough 3rd Delivery\LAS

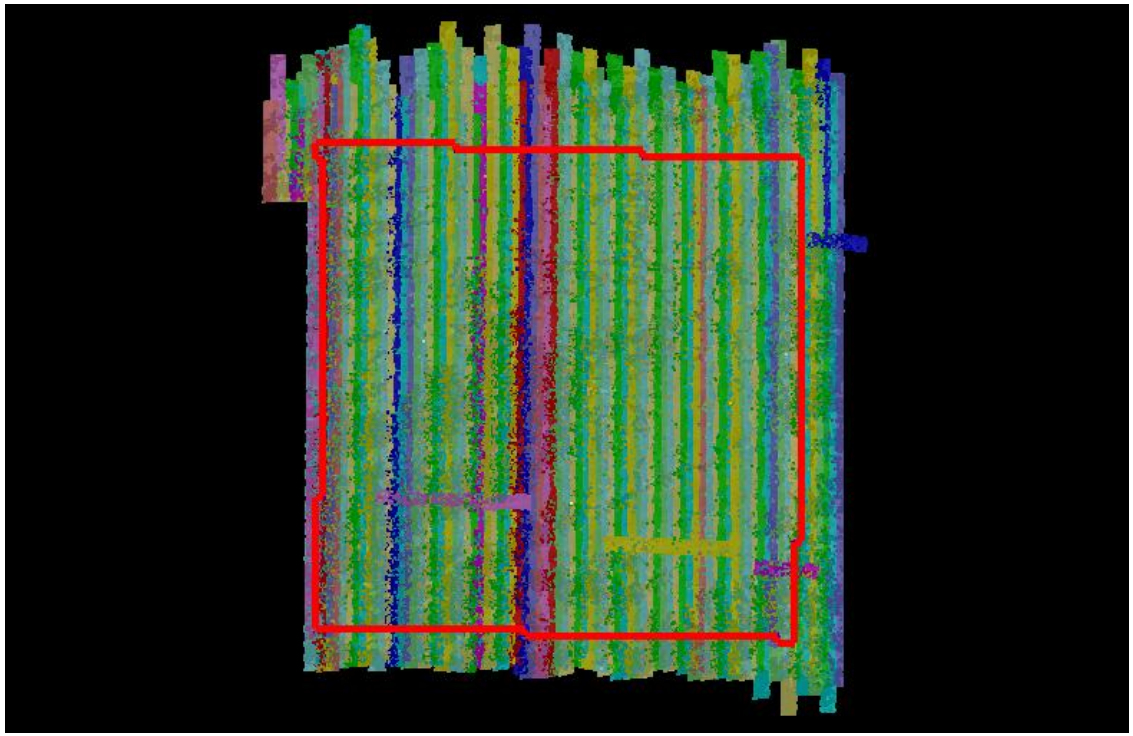
All LAS tiled files have point families present.

2.10 Report on Scope of Collection / Swath Coverage

The USGS LiDAR Base Specification Version 1.0 states: "All collected swaths are to be delivered as part of the Raw Data Deliverable. This includes calibration swaths and crossties. This in no way requires or implies that calibration swath data are to be included in product generation. All collected points are to be delivered. No points are to be deleted from the swath LAS files. Excepted from this are extraneous data outside of the buffered project area (aircraft turns, transit between the collection area and airport, transit between fill-in areas, and the like). These points may be permanently removed. Busted swaths that are being completely discarded by the vendor and re-flown do not need to be delivered."

The purpose of this section is to show the presence and extent of all LiDAR swath data files.

Data Source - E:\McDonough 3rd Delivery\Boresight
Result Path - E:\McDonough 3rd Delivery\QAQC\2_10\CollectionArea.jpg



Blue polygon is project boundary
Red polygon is project boundary buffered by 330 US Survey Feet

2.11 Report on Noise Classes and Withheld Points (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states: "Outliers, blunders, noise points, geometrically unreliable points near the extreme edge of the swath, and other points the vendor deems unusable are to be identified using the Withheld flag, as defined in the LAS specification. This applies primarily to points that are identified during pre-processing or through automated post-processing routines. If processing software is not capable of populating the Withheld bit, these points may be identified using Class=11. Noise points subsequently identified during manual Classification and Quality Assurance/Quality Control (QA/QC) may be assigned the standard LAS classification value for Noise (Class=7), regardless of whether the noise is "low" or "high" relative to the ground surface."

The purpose of this section is to list the presence and quantities of noise and withheld points for all LiDAR swath data files.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

Class 7	0
Class 11	0
Withheld	0

2.11 Report on Noise Classes and Withheld Points (Tiled Data)

The purpose of this section is to list the presence and quantities of noise and withheld points for all LiDAR tiled data files.

Classified Files - E:\McDonough 3rd Delivery\LAS

Class 7	45834
Class 11	0
Withheld	0

2.12 Report on Overlap Points (Swath Data)

The USGS LiDAR Base Specification Version 1.0 states:
(1) ALL points not identified as Withheld are to be classified.
(2) No points in the Classified LAS deliverable will be assigned Class=0.
(3) Use of the ASPRS/LAS Overlap classification (Class=12) is prohibited.
If overlap points are required to be differentiated by the data producer or cooperating partner, they must be identified using a method that does not interfere with their classification:
(1) Overlap points are tagged using Bit:0 of the User Data byte, as defined in the LAS specification. (SET=Overlap).
(2) Overlap points are classified using the Standard Class values + 16.
(3) Other techniques as agreed upon in advance.
The technique used to identify overlap must be clearly described in the project metadata files.
Note: A standard bit flag for identification of overlap points has been included in LAS v1.4, released on November 14, 2011.

The purpose of this section is to list the presence and quantities of overlap and unclassified points for all LiDAR swath data files.

Boresighted Files - E:\McDonough 3rd Delivery\Boresight

Class 12	0

2.12 Report on Overlap Points (Tiled Data)

The purpose of this section is to list the presence and quantities of overlap and unclassified points for all LiDAR tiled data files.

Classified Files - E:\McDonough 3rd Delivery\LAS

Class 12	0

2.13.1 Report on Positional Accuracy Validation

The USGS LiDAR Base Specification Version 1.0 states that: "Before classification of and development of derivative products from the point cloud, verification of the vertical accuracy of the point cloud, absolute and relative, is required. The Fundamental Vertical Accuracy (absolute) is to be assessed in clear, open areas as described in the section called Vertical Accuracy above. Swath-to-swath and within swath accuracies (relative) are to be documented. A detailed report of this validation process is a required deliverable."

The purpose of this section is to compare the fundamental vertical accuracy of the LiDAR swath data and the tiled data measured against surveyed ground check points. The reason for this comparison is to ensure that inappropriate steps were not taken after the filtering process to "warp" the LiDAR data to control/check points. The control check statistics of each dataset should look very similar, with only constant offsets as differences or variations due to the filtering process.

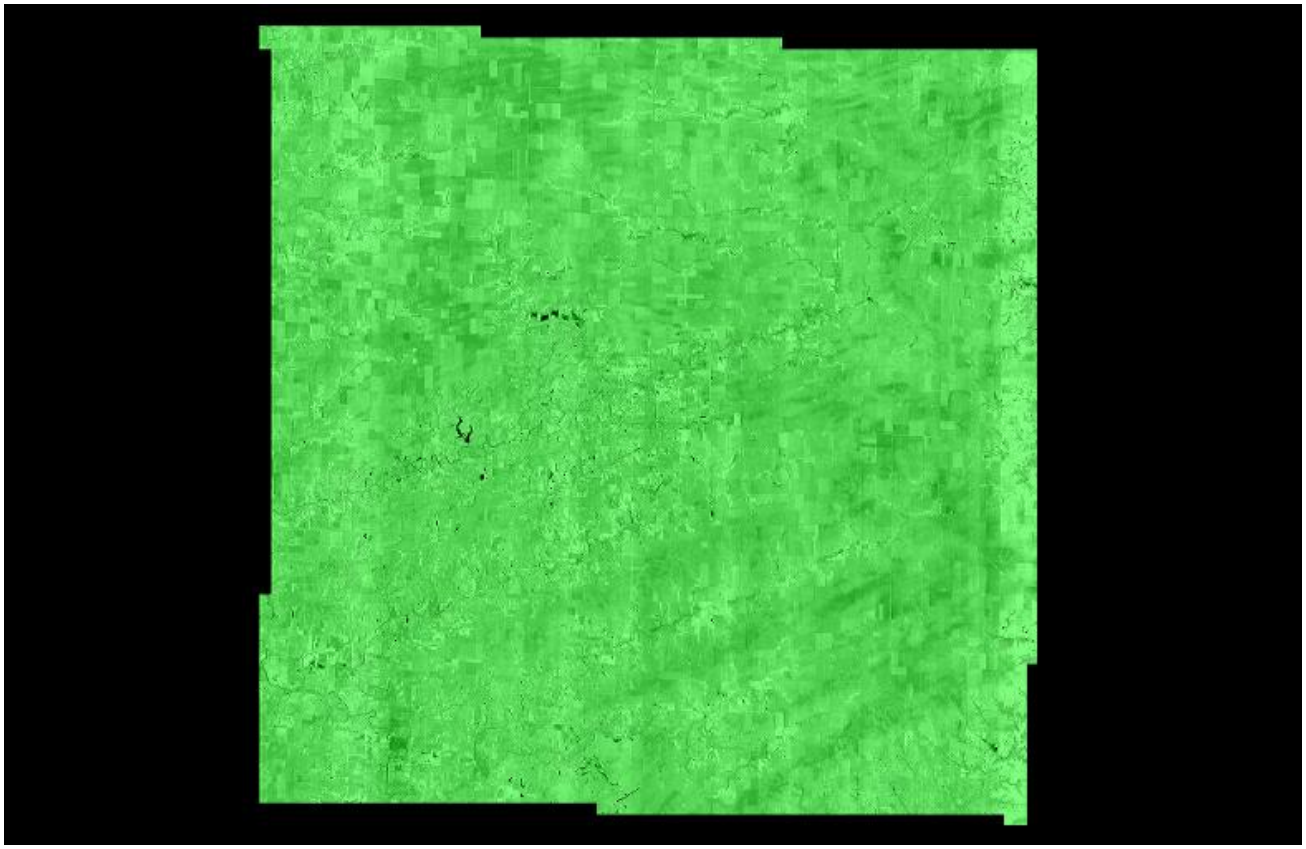
This reports only the Fundamental Vertical Accuracy (FVA)
E:\McDonough 3rd Delivery\QAQC\2_13\Report_PositionalAccuracy.csv
Vertical Units: US Survey Feet

		Boresighted Data	Classified Data
Control Points		123	123
Points with Coverage		123	123
Points With Required Accuracy		94	114
Percent of Points With Required Accuracy		76.42%	92.68%
Average Z Error		2.68	0.21
Maximum Z Error		40.39	1.92
Median Z Error		0.24	0.20
Minimum Z Error		-1.77	-1.82
NSSDA Vertical Accuracy	at the 95 confidence level	15.19	0.91
Standard Deviation (sigma) of Z for Sample		7.30	0.42
RMSE of Z for Sample		7.75	0.46
FGDC/NSSDA/FEMA Contour Interval		26.00	2.00
ASPRS Contour Interval		24.00	2.00
NMAS Contour Interval		26.00	2.00

2.13.2 Overview of Separation between Boresighted and Classified

The purpose of this section is to graphically show the vertical separation deltas (after removing any constant vertical distance offset – i.e., shift) between the swath data and the tiled data. The graphic should look entirely green. If there is a checkerboard pattern of colors, it is highly likely that the tiled data was warped to fit the control check points. This unauthorized practice is also known as custom error geoid adjustment.

This reports only the Fundamental Vertical Accuracy (FVA)
E:\McDonough 3rd Delivery\QAQC\2_13\Separation_Boresighted_With_Classified.jp2
Vertical Units: US Survey Feet



See JPG2000 file for full resolution results

2.16 Report on Tiles

The USGS LiDAR Base Specification Version 1.0 states that:
Tiles:
Note: This section assumes a projected coordinate reference system.
A single non-overlapped tiling scheme (the Project Tiling Scheme) will be established and agreed upon by the data producer and the USGS before collection. This scheme will be used for ALL tiled deliverables.
(1) Tile size is required to be an integer multiple of the cell size of raster deliverables.
(2) Tiles are required to be sized using the same units as the coordinate system of the data.
(3) Tiles are required to be indexed in X and Y to an integer multiple of the tile's X-Y dimensions.
(4) All tiled deliverables will conform to the Project Tiling Scheme, without added overlap.
(5) Tiled deliverables will edge-match seamlessly and without gaps.

The purpose of this section is to report on the unallowed presence of skew and overlap in the project tile scheme.

Tile File: E:\McDonough 3rd Delivery\Tile Index\Tile_Index.shp
Units: US Survey Feet

The following lists tiles that are either skewed or overlapped.

Tile	Non-Skewed Tile	Width	Height	Overlap

NONE

The following lists tile widths/heights in the project.

2000.00/2000.00

Skipped Tests

1.7 Overview of Scan Angles Exceeding Limitations
1.12 Report on Collection Conditions
2.14 Overview of Classification Accuracy
2.15 Overview of Classification Consistency

USGS QC Module Input Requirements Matrix

Test number	Boresighted LAS (Swath Data)	Classified LAS (Tiled Data)	Shapefile Tile Scheme	Shapefile Boundary	Shapefile SBET(s)	NPS	LiDAR Check Points	Project Name	Description	Logo	Output Folder	PDF Name
0.0		X	X					X	O	O	X	X
1.1	X	X						X	O	O	X	X
1.2	X	X						X	O	O	X	X
1.3	X			O				X	O	O	X	X
1.4		X	X					X	O	O	X	X
1.5	X			O		X		X	O	O	X	X
1.6	X			O		X		X	O	O	X	X
1.7	X			O	X	X		X	O	O	X	X
1.8	X	X					X	X	O	O	X	X
1.9	X			O				X	O	O	X	X
1.10	X			O		X		X	O	O	X	X
1.11	X			X				X	O	O	X	X
1.12	X	X						X	O	O	X	X
2.1	X	X						X	O	O	X	X
2.2	X	X						X	O	O	X	X
2.3	X	X						X	O	O	X	X
2.4	X	X						X	O	O	X	X
2.5	X	X						X	O	O	X	X
2.6	X	X						X	O	O	X	X
2.7	X							X	O	O	X	X
2.8	X							X	O	O	X	X
2.9	X	X						X	O	O	X	X
2.10	X			X				X	O	O	X	X
2.11	X	X						X	O	O	X	X
2.12	X	X						X	O	O	X	X
2.13	X	X		X		X	X	X	O	O	X	X
2.14		X				X		X	O	O	X	X
2.15		X						X	O	O	X	X
2.16			X					X	O	O	X	X

X = Required

X = Will use Classified LAS if available, else Boresighted (Swath) LAS

X = requires one or the other (or both)

O = Optional

O = Optional for single-area density reporting, but required for multi-area (multiple boundary) reporting of individual and aggregate areas