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c. Client Contact Information

Client Contact Information	
Name of Contact	Tara Lanzrath, CFM
Organization	Kansas Department of Agriculture
Position	Floodplain Mapping Coordinator
Telephone	785-296-2513
E-Mail Address	Tara.Lanzrath@ks.gov
Mailing Address	6531 SE Forbes Ave., Suite B
City	Topeka
State or Province	Kansas
Postal Code	66619

Table 1: Aerial LiDAR Client Contact Information

d. Contract Deliverables

Item	Specification/Format
Metadata	FGDC compliant, xml format
Project Report	.pdf format
Raw Point Cloud	Swaths, LAS 1.4
Classified Point Cloud	LAS 1.4
Bare Earth DEM	ERDAS .IMG format, Hydroflattened
First Return DSM	ERDAS .IMG format
Hydro Polygon Breaklines	.gdb format
Intensity Imagery	ERDAS .IMG format

Table 2: Aerial LiDAR Contract Deliverables

SECTION II: FIELD OPERATIONS

1. Aerial LiDAR Project – Aerial Acquisition

a. Aircraft & Sensor Information

Atlantic operated a Cessna (N732JE) outfitted with a Leica ALS70-HP LiDAR system during the collection of the project area. The specifications of this system are presented in the following table:

Parameter	Specification
Model	ALS70-HP
Manufacturer	Leica
Platform	Fixed-Wing
Scan Pattern	Sine, Triangle, Raster
Maximum Scan Rate (Hz)	Sine: 200 Triangle: 158 Raster: 120
Field of View (°)	0 – 75 (Full Angle, User Adjustable)
Maximum Pulse Rate (kHz)	500
Maximum Flying Height (m AGL)	3500
Number of Returns	Unlimited
Number of Intensity Measurements	3 (First, Second, Third)
Roll Stabilization (Automatic Adaptive, °)	75 - Active FOV
Storage Media	Removable 500 GB SSD
Storage Capacity (Hours @ Max Pulse Rate)	6
Size (cm)	Scanner: 37 W x 68 L x 26 H Control Electronics: 45 W x 47 D x 36 H
Weight (kg)	Scanner: 43 Control Electronics: 45
Operation Temperature (°C)	0 – 40
Flight Management	FCMS
Power Consumption	927 @ 22.0 – 30.3 VDC

Table 3: System Specifications – ALS70-HP

b. Sensor Acquisition Information

The following table illustrates project specific system parameters for LiDAR acquisition on this project:

Parameter	Specification
System	Leica ALS70-HP
Nominal Pulse Spacing (m)	0.71
Nominal Pulse Density (pls/m²)	2.2
Nominal Flight Height (AGL meters)	2000
Nominal Flight Speed (kts)	130
Pass Heading (°)	0
Sensor Scan Angle (°)	45
Scan Frequency (Hz)	33.9
Pulse Rate of Scanner (kHz)	256,400
Line Spacing (m)	1,171

Parameter	Specification
Pulse Duration of Scanner (ns)	4
Pulse Width of Scanner (m)	.35
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	2
Beam Divergence (mrad)	.15
Nominal Swath Width (m)	1,740
Nominal Swath Overlap (%)	20
Scan Pattern	TRIANGLE

Table 4: Aerial LiDAR Sensor Acquisition Parameters

c. Flight Plan Execution

Atlantic acquired 98 passes of the AOI as a series of perpendicular and/or adjacent flight-lines executed in 10 flight missions conducted between February 27, 2018 and March 13, 2018. Onboard differential Global Navigation Satellite System (GNSS) unit(s) recorded sample aircraft positions at 2 hertz (Hz) or more frequency. LiDAR data was only acquired when a minimum of six (6) satellites were in view.

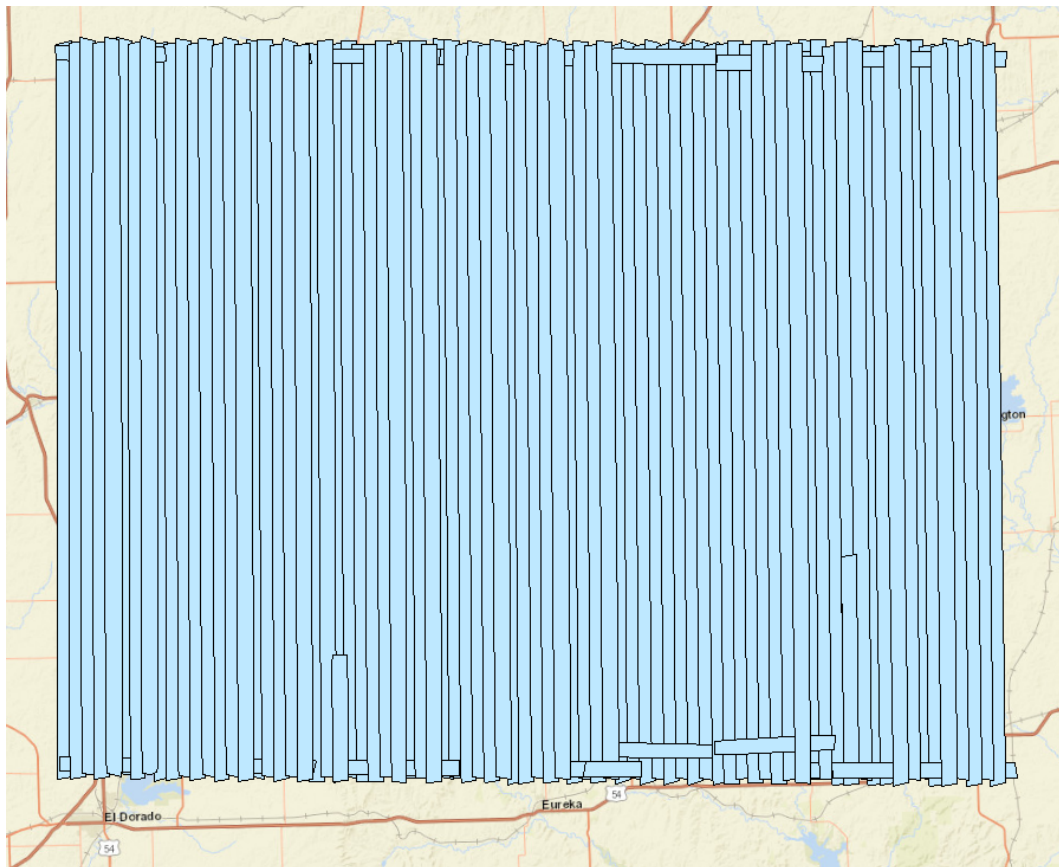


Figure 2: Orientation of Executed Flight-lines and LiDAR DPA

d. GNSS Reference Stations

Five (5) Continuously Operating Reference Stations (CORS) were used to control the LiDAR acquisition for the defined project area. The coordinates provided in below are in NAD83 (2011), Geographic Coordinate System, Ellipsoid, Meters.

Designation	Type	PID	Latitude (N)	Longitude (W)	Elevation
ICT3	CORS	ICT3	37°45'09.33297"	97°12'58.42230"	401.242
ICT5	CORS	ICT5	37°47'12.04062"	97°37'32.73360"	411.107
KSEU	CORS	KSEU	37°51'6.27229"	96°17'23.73009"	345.3789
KSU1	CORS	KSU1	39°06'02.70006"	96°36'34.13595"	325.564
MOSB	CORS	MOSB	38°49'48.71034"	94°32'04.48758"	301.135

Table 5: GNSS Reference Stations

2. Aerial LiDAR Project – Ground Acquisition

a. Ground Control Survey

A total of 122 ground survey points were collected in support of this project, including 36 LiDAR Control Points (LCP), 49 Non-vegetated Vertical Accuracy (NVA) and 37 Vegetated Vertical Accuracy (VVA).

Point cloud data accuracy was 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 five (5) times the Nominal Pulse Spacing (NPS) exists with less than 1/3 of the RMSEZ deviation from a low-slope plane. Slopes that exceed ten (10) percent were avoided.

Each land cover type representing ten (10) percent or more of the total project area were tested and reported with a VVA. In land cover categories other than dense urban areas, the tested points did not have obstructions forty-five (45) degrees above the horizon to ensure a satisfactory TIN surface. The VVA value is provided as a target. It is understood that in areas of dense vegetation, swamps, or extremely difficult terrain, this value may be exceeded.

The NVA value is a requirement that must be met, regardless of any allowed “busts” in the VVA(s) for individual land cover types within the project. Checkpoints for each assessment (NVA & VVA) are required to be well-distributed throughout the land cover type, for the entire project area.

The following tables and figures outline the coordinate values and distribution of LCP, NVA and VVA points collected in support of this project:

ID	Easting	Northing	Elevation
LCP134	787186.1	4252650	331.771
LCP135	775523.7	4268448	339.615
LCP142	777129.3	4198762	359.818
LCP29	774520.9	4250892	338.847
LCP30	770314	4234066	348.671
LCP31	773821.9	4222706	346.748
LCP32	765378	4213114	355.72
LCP331	756646.5	4212807	337.518
LCP332	746611.3	4208180	345.219
LCP333	738229.5	4206763	394.232
LCP334	704163.7	4205075	432.136
LCP335	734762.1	4239704	414.94
LCP336	716393.1	4220690	423.776
LCP337	732096.8	4219197	504.99
LCP338	744396.6	4222245	379.566
LCP339	743056.4	4218932	372.131
LCP340	704274	4224371	450.189
LCP341	708339.4	4236524	401.067
LCP342	704913.4	4235690	425.073

ID	Easting	Northing	Elevation
LCP343	716779.2	4243419	373.969
LCP344	753294.8	4259521	363.481
LCP345	752920.2	4266307	383.346
LCP348	742628.6	4268924	359.832
LCP349	736280.6	4259110	374.223
LCP350	719600.1	4257037	378.017
LCP351	713438.9	4253658	375.351
LCP352	688864.8	4249506	460.683
LCP36	783498.8	4263931	347.671
LCP38	784423.3	4268118	324.471
LCP39	764263.1	4267888	336.798
LCP529	691214.4	4206284	441.638
LCP536	746565.7	4243249	361.019
LCP537	751000.6	4225120	328.606
LCP538	729924.7	4197665	347.188
LCP539	740946	4241445	377.38
LCP545	686986.4	4258789	429.504

Table 6: LiDAR Control Point Coordinates

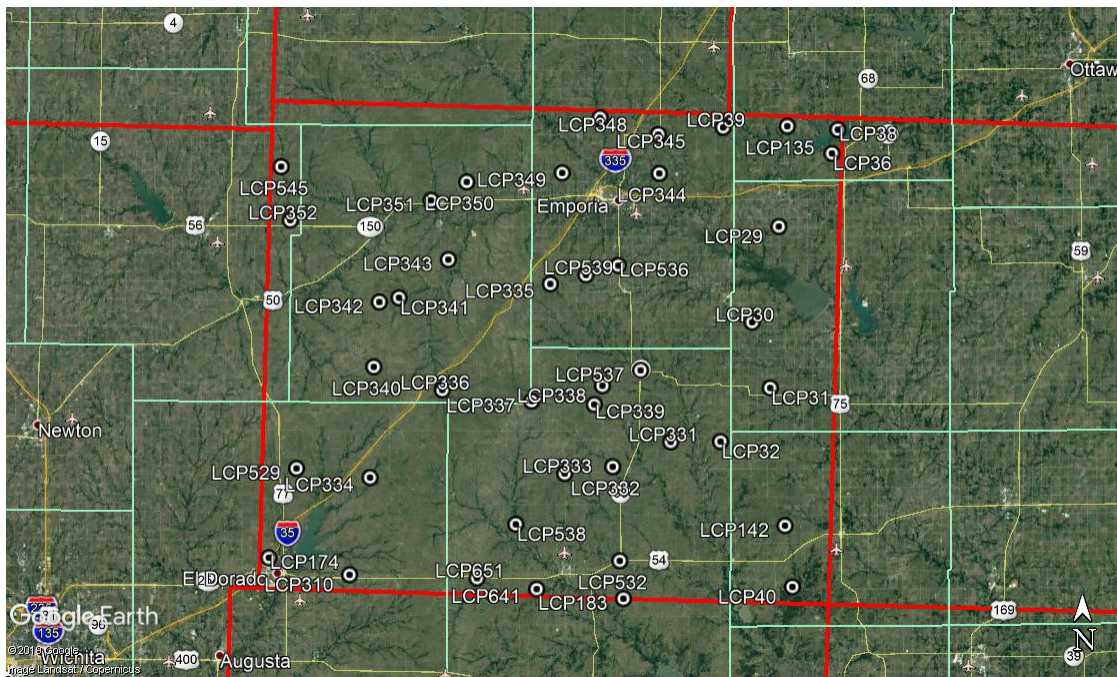


Figure 3: LiDAR Control Point Distribution

ID	Easting	Northing	Elevation
NVA03	784420.1	4268134	324.408
NVA04	774508.5	4250887	338.709
NVA06	773809.9	4222707	346.716
NVA08	765387.7	4213113	355.83
NVA126	775407.9	4201976	347.507
NVA153	775525.3	4268493	340.578
NVA154	785365.3	4239937	344.304
NVA156	785906.6	4221548	309.498
NVA199	787393.2	4197583	344.638
NVA232	769875.2	4221220	348.452
NVA400	713432.8	4253651	375.161
NVA401	736278.2	4259109	374.222
NVA402	753274.1	4259509	363.365
NVA403	688875.5	4249506	460.793
NVA404	734761.1	4239713	414.879
NVA406	708333.6	4236528	401.071
NVA407	756653.1	4212809	337.482
NVA408	732096.9	4219191	505.063
NVA410	738229	4206776	394.271
NVA470	686895.9	4265365	439.639
NVA598	748622.7	4235186	380.714
NVA599	725369.9	4267560	389.673
NVA600	733832.7	4268661	353.802
NVA601	740949.2	4241453	377.274
NVA602	743976.9	4247989	353.932
NVA603	708223.1	4248634	410.963
NVA604	706784.9	4242235	451.166
NVA605	697397.8	4216263	458.423
NVA606	743071	4218943	371.975
NVA607	691194.5	4206313	441.86
NVA608	725368.7	4213807	474.211
NVA76	764672.1	4197066	287.621
NVA80	768007.1	4229202	354.131
NVA800	715010.1	4253033	375.907
NVA801	742706.5	4256145	363.34
NVA802	746554.7	4243246	361.256

ID	Easting	Northing	Elevation
NVA803	697923.2	4242010	374.442
NVA804	712972.4	4232270	386.301
NVA805	751001.2	4225133	328.504
NVA806	707612.2	4213182	447.749
NVA809	689027.2	4199628	415.809
NVA81	787180.4	4252668	331.201
NVA810	748152.1	4198152	325.862
NVA83	779554.4	4244308	345.85
NVA864	751988.2	4248291	350.178
NVA865	735426.5	4209181	429.713
NVA866	736633.1	4230292	358.621
NVA868	685801.9	4253817	426.206
NVA962	719226.561	4195357.024	416.382

Table 7: Non-Vegetated Vertical Accuracy (NVA) Point Coordinates

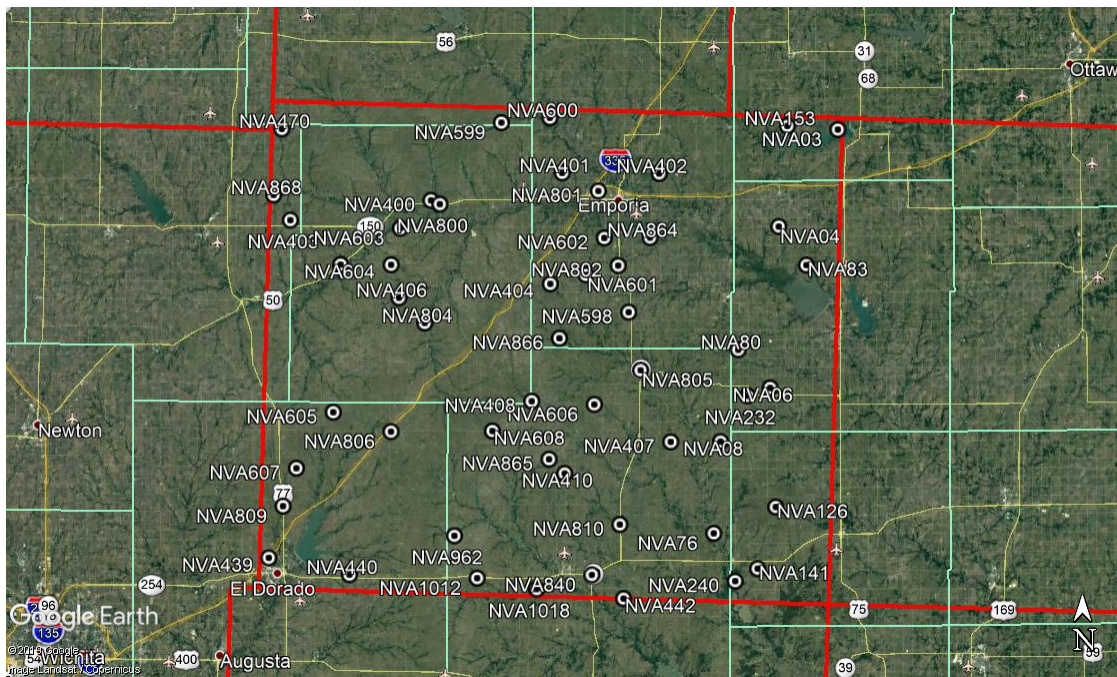


Figure 4: Non-Vegetated Vertical Accuracy (NVA) Point Distribution

ID	Easting	Northing	Elevation
VVA02	783479.6	4263942	346.291
VVA04	770307.8	4234110	348.784
VVA096	783010.2	4212864	317.141
VVA097	766555.1	4242412	337.247
VVA099	764253.8	4267901	337.14
VVA151	785901	4221574	306.768
VVA279	704268.2	4224345	450.099

ID	Easting	Northing	Elevation
VVA280	742633.5	4268916	359.819
VVA281	719594.9	4257040	378.271
VVA282	716768.9	4243426	373.586
VVA283	704935.5	4235704	422.983
VVA284	716396.1	4220676	423.366
VVA285	744401.9	4222245	379.628
VVA286	746582.2	4208169	346.256
VVA287	704171.6	4205057	431.478
VVA412	752934.7	4266309	382.839
VVA413	733895.5	4264896	362.743
VVA414	713352.4	4260851	385.138
VVA415	686975.6	4258781	428.501
VVA416	753942.6	4239460	360.522
VVA417	722758.5	4222126	456.761
VVA418	701858.6	4229202	444.919
VVA419	735441.5	4209197	429.379
VVA420	702303.6	4213058	444.709
VVA48	769850.1	4221236	348.5
VVA51	779361.9	4250678	361.828
VVA552	685806.7	4253826	426.063
VVA553	752002.5	4248304	350.053
VVA555	736615.6	4230300	358.441
VVA556	709242.9	4198442	447.392
VVA557	729937.3	4197642	346.777
VVA597	748602.7	4235178	380.125
VVA598	707635.5	4213137	447.855
VVA599	744025.3	4247979	355.362
VVA602	686907.6	4265377	439.42
VVA640	689043.9	4199647	414.041
VVA76	777114.5	4198780	359.423

Table 8: Vegetated Vertical Accuracy (VVA) Point Coordinates

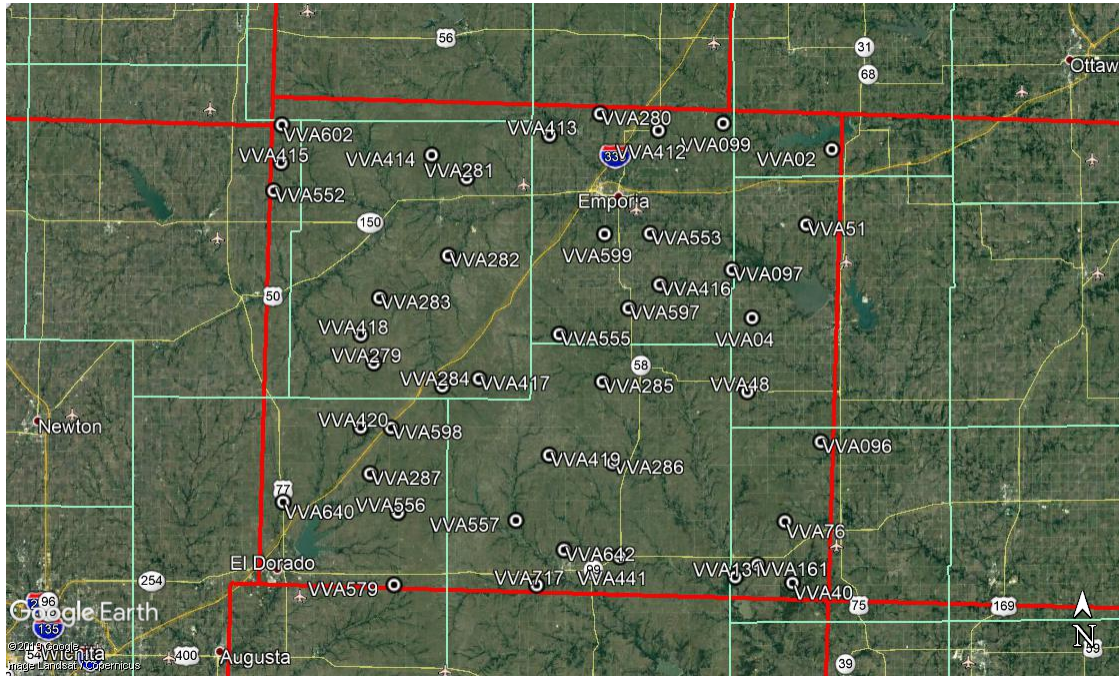


Figure 5: Vegetated Vertical Accuracy (VVA) Point Distribution

SECTION III: DATA PRODUCTION

3. Aerial LiDAR Project – Calibration/Classification

a. LiDAR Point Cloud Generation

Atlantic used Leica software products to download the IPAS ABGNSS/IMU data and raw laser scan files from the airborne system. Waypoint Inertial Explorer is used to extract the raw IPAS ABGNSS/IMU data, which is further processed in combination with controlled base stations to provide the final Smoothed Best Estimate Trajectory (SBET) for each mission. The SBETs are combined with the raw laser scan files to export the LiDAR ASCII Standard (*.las) formatted swath point clouds.

b. Coordinate Reference System

Horizontal Datum: NAD83(HARN)
Coordinate System: UTM, 14N/UTM, 15N
Vertical Datum: NAVD88
Geoid Model: 12B
Units of Reference: Meter

c. LiDAR Point Cloud Statistics

Category	Value
Total Points	55,233,050,657
Nominal Pulse Spacing (m)	0.5887
Nominal Pulse Density (pls/m²)	2.8852
Aggregate Total Points	55,456,554,436
Aggregate Nominal Pulse Spacing (m)	0.5988
Aggregate Nominal Pulse Density (pls/m²)	2.7888

Table 9: LiDAR Point Cloud Statistics

d. Smooth Surface Repeatability (Interswath)

Departures from planarity of first returns within single swaths in non-vegetated areas were assessed at multiple locations with hard surface areas (parking lots or large rooftops) inside the project area. Each area was evaluated using signed difference rasters (maximum elevation – minimum elevation) at a cell size equal to 2 x ANPS, rounded to the next integer.

e. LiDAR Calibration

Using a combination of GeoCue, TerraScan and TerraMatch; overlapping swath point clouds are corrected for any orientation or linear deviations to obtain the best fit swath-to-swath calibration. Relative calibration was evaluated using advanced plane-matching analysis and parameter corrections derived. This process was repeated interactively until residual errors between overlapping swaths, across all project missions, was reduced to ≤2cm. A final analysis of the calibrated lidar is preformed using a TerraMatch tie line report for an overall statistical model of the project area. Individual control point assessments for this project can be found in Section VI of this report.

Upon completion of the data calibration, a complete set of elevation difference intensity rasters (dZ Orthos) are produced. A user-defined color ramp is applied depicting the offsets between overlapping swaths based on project specifications. The dZ orthos provide an opportunity to review the data calibration in a qualitative

manner. Atlantic assigns green to all offset values that fall below the required RMSDz requirement of the project. A yellow color is assigned for offsets that fall between the RMSDz value and 1.5x of that value. Finally, red values are assigned to all values that fall beyond 1.5x of the RMSDz requirements of the project.

f. LiDAR Classification

Multiple automated filtering routines are applied to the calibrated LiDAR point cloud identifying and extracting bare-earth and above ground features. GeoCue, TerraScan, and TerraModeler software was used for the initial batch processing, visual inspection and any manual editing of the LiDAR point clouds. Atlantic utilized collected breakline data to preform classification for classes 9 (Water) and 10 (Ignored Ground).

Code	Description
1	Unclassified
2	Ground
7	Low point (noise)
9	Water
10	Ignored ground (breakline proximity)
17	Bridge
18	High point (noise)

Table 10: LiDAR Point Classification Codes and Descriptions

g. LiDAR Intensity Imagery

LiDAR intensity imagery was created from the final calibrated and classified lidar point cloud. Intensity images were produced from all classified points and posted to a 0.5-meter cell size. Intensity images were cut to match the tile index and its corresponding tile names and delivered in .img format.

h. Hydro-line Collection/Conflation

Hydro breaklines were compiled using LiDAR intensity data and surface terrain models of the entire project area. After the collection, all delineated hydro features were validated for monotonicity and vertical variance. This procedure ensures that no points were floating above ground. Hydro-lines were then encoded into the LiDAR surface and used to hydro-enforce/flatten all significant water bodies. These final hydro-lines were then used in the production of bare Earth digital models to hydro flatten significant water bodies. This product was delivered as an ESRI geodatabase for the entire project area.

i. Bare-Earth Surface – Digital Elevation Model (DEM)

Bare earth Digital Elevation Models (DEMs) were derived using the hydro-lines and bare earth (ground) LiDAR points. All DEMs were created with a grid spacing of 1 meter. DEMs for this project were cut to match the tile index and its corresponding tile names and delivered in 32-bit floating point .img format.

j. Surface-Digital Elevation Model (DSM)

Surface digital elevation models (DSMs) were derived using all first return LiDAR points, excluding LiDAR points classified as high or low noise. All DSMs were created with a grid spacing of 1 meter. DSMs for this project were cut to match the tile index and its corresponding tile names and delivered in 32-bit floating point .img format.

SECTION IV: ACCURACY ASSESSMENT

1. Aerial LiDAR Project – Vertical Accuracy Assessment

a. Requirements

Per the table below, the Vertical Accuracy Assessment utilized the required parameters for Vertical Data Accuracy Class IV.

Vertical Data Accuracy Class	RMSEz in Non-Vegetated Terrain (cm)	Non-Vegetated Vertical Accuracy (NVA) at 95% Confidence Level (cm)	Vegetated Vertical Accuracy (VVA) at 95 th Percentile (cm)
I	1.0	2.0	2.9
II	2.5	4.9	7.4
III	5.0	9.8	14.7
IV	10.0	19.6	29.4
V	12.5	24.5	36.8
VI	20.0	39.2	58.8
VII	33.3	65.3	98.0
VIII	66.7	130.7	196.0
IX	100.0	196.0	294.0
X	333.3	653.3	980.0

Table 11: Vertical Accuracy Standards, Source: ASPRS Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014)

*The terms NVA and VVA are from the American Society for Photogrammetry and Remote Sensing (ASPRS) Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014). The term NVA refers to assessments in clear, open areas (which typically produce only single LiDAR returns); the term VVA refers to assessments in vegetated areas (typically characterized by multiple return LiDAR).

b. Results

An overall statistical assessment of the check points can be found in the following two tables (values provided in meters):

Broad Land Cover Type	Points (#)	RMSEz	Confidence Level (95%)	Percentile (95th)
NVA (Point Cloud)	49	0.0952	0.1866	0.1028
NVA (DEM)	49	0.0907	0.1777	0.1438
VVA (Point Cloud)	37	0.0843	0.1652	0.1520
VVA (DEM)	37	0.0767	0.1503	0.1056

Table 12: NVA/VVA Accuracies

SECTION V: CERTIFICATION STATEMENTS

1. Aerial LiDAR Project

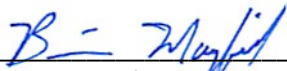
This accuracy assessment confirms that the data may be used for the intended applications stated in Section I of this document. This dataset may also be used as a topographic input for other applications, but the user should be aware that this LiDAR dataset was designed with a specific purpose and was not intended to meet specifications and/or requirements of users outside of the United States Geological Survey.

It should also be noted that LiDAR points do not represent a continuous surface model. LiDAR points are discrete measurements of the surface and any values derived within a triangle of three LiDAR points are interpolated. As such, the user should not use the resultant LiDAR dataset for vertical placement of a planimetric feature such as a headwall, building footprint or any other planimetric feature unless there is an associated LiDAR point that can be reasonably located on this structure.

Consideration should be given by the end user of this dataset to the fact that this LiDAR dataset was developed differently and separately than previous LiDAR datasets that may be available for this geographic location. It is likely that the data in this project was created using different geodetic control, a different Geoid, newer LiDAR technology and more up-to-date processing techniques. As such, any direct comparative analysis performed between this dataset and previous datasets could result in misleading or inaccurate results. Users are encouraged to proceed with caution while performing this type of comparative analysis and to completely understand the variables that make each of these datasets unique and not corollary.

It is encouraged that the user refers to the full FGDC Metadata and project reports for a complete understanding on the content of this dataset.

I, hereby, certify to the extent of my knowledge that the statements and statistics represented in this document are true and factual.



Brian J. Mayfield, ASPRS Certified Photogrammetrist #R1276



SECTION VI: CONTROL POINT ASSESSMENTS

1. Aerial LiDAR Project

a. Point Cloud Check Point Assessment

Point ID	Easting	Northing	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
NVA03	784420.1080	4268134.2240	324.4080	324.4560	0.0480	NVA
NVA04	774508.5300	4250887.0880	338.7090	338.5770	-0.1320	NVA
NVA06	773809.8910	4222707.1660	346.7160	346.7400	0.0240	NVA
NVA08	765387.7020	4213112.7570	355.8300	355.8960	0.0660	NVA
NVA126	775407.9390	4201975.6590	347.5070	347.3180	-0.1890	NVA
NVA153	775525.2670	4268493.1650	340.5780	340.4700	-0.1080	NVA
NVA154	785365.2560	4239936.7020	344.3040	344.3550	0.0510	NVA
NVA156	785906.6210	4221547.9910	309.4980	309.5870	0.0890	NVA
NVA199	787393.2340	4197582.5840	344.6380	344.5510	-0.0870	NVA
NVA232	769875.1720	4221219.5700	348.4520	348.3970	-0.0550	NVA
NVA400	713432.7770	4253651.2550	375.1610	374.9820	-0.1790	NVA
NVA401	736278.2100	4259108.5180	374.2220	374.0850	-0.1370	NVA
NVA402	753274.1170	4259508.8020	363.3650	363.3180	-0.0470	NVA
NVA403	688875.5090	4249505.5740	460.7930	460.7170	-0.0760	NVA
NVA404	734761.0900	4239713.3780	414.8790	414.7540	-0.1250	NVA
NVA406	708333.5890	4236528.4160	401.0710	400.9680	-0.1030	NVA
NVA407	756653.0560	4212809.1320	337.4820	337.3970	-0.0850	NVA
NVA408	732096.8640	4219191.4240	505.0630	504.9080	-0.1550	NVA
NVA410	738229.0200	4206775.5830	394.2710	394.0720	-0.1990	NVA
NVA470	686895.8640	4265364.8480	439.6390	439.7050	0.0660	NVA
NVA598	748622.7080	4235185.9680	380.7140	380.8320	0.1180	NVA
NVA599	725369.9110	4267559.5830	389.6730	389.6480	-0.0250	NVA
NVA600	733832.7260	4268660.8540	353.8020	353.6910	-0.1110	NVA
NVA601	740949.2430	4241453.0390	377.2740	377.1760	-0.0980	NVA
NVA602	743976.8920	4247988.9320	353.9320	354.0200	0.0880	NVA
NVA603	708223.0710	4248634.4320	410.9630	411.0780	0.1150	NVA
NVA604	706784.8940	4242234.5760	451.1660	451.1530	-0.0130	NVA
NVA605	697397.7500	4216263.1590	458.4230	458.3920	-0.0310	NVA
NVA606	743071.0350	4218942.6230	371.9750	372.0280	0.0530	NVA
NVA607	691194.4510	4206312.8490	441.8600	441.7520	-0.1080	NVA
NVA608	725368.7190	4213807.4550	474.2110	474.1520	-0.0590	NVA
NVA76	764672.0730	4197065.7880	287.6210	287.6030	-0.0180	NVA
NVA80	768007.0700	4229201.5060	354.1310	354.0670	-0.0640	NVA
NVA800	715010.1350	4253033.3750	375.9070	375.8510	-0.0560	NVA

NVA801	742706.5430	4256144.9810	363.3400	363.3380	-0.0020	NVA
NVA802	746554.7340	4243245.8810	361.2560	361.2390	-0.0170	NVA
NVA803	697923.1840	4242010.2210	374.4420	374.4390	-0.0030	NVA
NVA804	712972.4300	4232269.7960	386.3010	386.2600	-0.0410	NVA
NVA805	751001.1530	4225133.3380	328.5040	328.4560	-0.0480	NVA
NVA806	707612.1720	4213182.2220	447.7490	447.6700	-0.0790	NVA
NVA809	689027.2190	4199627.9830	415.8090	415.7410	-0.0680	NVA
NVA81	787180.3720	4252668.3870	331.2010	331.3130	0.1120	NVA
NVA810	748152.0850	4198151.7800	325.8620	325.8060	-0.0560	NVA
NVA83	779554.4290	4244308.3410	345.8500	345.8970	0.0470	NVA
NVA864	751988.2260	4248291.3490	350.1780	350.1810	0.0030	NVA
NVA865	735426.5150	4209180.5290	429.7130	429.6100	-0.1030	NVA
NVA866	736633.1470	4230292.1720	358.6210	358.4580	-0.1630	NVA
NVA868	685801.8960	4253816.5200	426.2060	426.1050	-0.1010	NVA
NVA962	719226.5610	4195357.0240	416.3820	416.2200	-0.1620	NVA
VVA02	783479.5970	4263942.4500	346.2910	346.3790	0.0880	VVA
VVA04	770307.8070	4234110.3290	348.7840	348.7930	0.0090	VVA
VVA096	783010.2140	4212863.8240	317.1410	317.3160	0.1750	VVA
VVA097	766555.1070	4242412.2900	337.2470	337.1970	-0.0500	VVA
VVA099	764253.7590	4267900.5360	337.1400	337.0970	-0.0430	VVA
VVA151	785900.9820	4221573.7680	306.7680	306.8670	0.0990	VVA
VVA279	704268.2320	4224345.2760	450.0990	450.2400	0.1410	VVA
VVA280	742633.4740	4268916.1750	359.8190	359.8640	0.0450	VVA
VVA281	719594.9330	4257039.9420	378.2710	378.1420	-0.1290	VVA
VVA282	716768.8670	4243425.7430	373.5860	373.5780	-0.0080	VVA
VVA283	704935.4780	4235703.8860	422.9830	423.0150	0.0320	VVA
VVA284	716396.0960	4220675.5840	423.3660	423.3530	-0.0130	VVA
VVA285	744401.8790	4222244.9670	379.6280	379.7530	0.1250	VVA
VVA286	746582.1750	4208168.8410	346.2560	346.2940	0.0380	VVA
VVA287	704171.5640	4205057.0100	431.4780	431.4800	0.0020	VVA
VVA412	752934.7320	4266309.4630	382.8390	382.7910	-0.0480	VVA
VVA413	733895.5450	4264896.4040	362.7430	362.7250	-0.0180	VVA
VVA414	713352.4300	4260851.3340	385.1380	385.0400	-0.0980	VVA
VVA415	686975.5810	4258780.7970	428.5010	428.5800	0.0790	VVA
VVA416	753942.5500	4239460.4000	360.5220	360.6410	0.1190	VVA
VVA417	722758.5230	4222126.3770	456.7610	456.6570	-0.1040	VVA
VVA418	701858.6350	4229202.4820	444.9190	444.9690	0.0500	VVA
VVA419	735441.4790	4209196.8600	429.3790	429.3930	0.0140	VVA
VVA420	702303.6050	4213058.3740	444.7090	444.8000	0.0910	VVA
VVA48	769850.0780	4221235.9410	348.5000	348.4960	-0.0040	VVA

VVA51	779361.9070	4250678.1010	361.8280	361.8600	0.0320	VVA
VVA552	685806.6790	4253825.8730	426.0630	426.0450	-0.0180	VVA
VVA553	752002.5080	4248303.7470	350.0530	350.1560	0.1030	VVA
VVA555	736615.5860	4230300.0760	358.4410	358.4500	0.0090	VVA
VVA556	709242.8640	4198441.7020	447.3920	447.4600	0.0680	VVA
VVA557	729937.2610	4197642.4380	346.7770	346.6180	-0.1590	VVA
VVA597	748602.6930	4235177.9490	380.1250	380.1790	0.0540	VVA
VVA598	707635.4530	4213136.7320	447.8550	447.9050	0.0500	VVA
VVA599	744025.2590	4247978.6200	355.3620	355.5090	0.1470	VVA
VVA602	686907.5700	4265377.4470	439.4200	439.5920	0.1720	VVA
VVA640	689043.9130	4199646.8560	414.0410	414.0450	0.0040	VVA
VVA76	777114.4860	4198780.1950	359.4230	359.4430	0.0200	VVA

Table 13: Point Cloud Check Point Assessment

b. Digital Elevation Model (DEM) Check Point Assessment

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
NVA03	784420.1080	4268134.2240	324.4080	324.4530	-0.0450	NVA
NVA04	774508.5300	4250887.0880	338.7090	338.5700	0.1390	NVA
NVA06	773809.8910	4222707.1660	346.7160	346.7280	-0.0120	NVA
NVA08	765387.7020	4213112.7570	355.8300	355.8260	0.0040	NVA
NVA126	775407.9390	4201975.6590	347.5070	347.3310	0.1760	NVA
NVA153	775525.2670	4268493.1650	340.5780	340.4980	0.0800	NVA
NVA154	785365.2560	4239936.7020	344.3040	344.3330	-0.0290	NVA
NVA156	785906.6210	4221547.9910	309.4980	309.5920	-0.0940	NVA
NVA199	787393.2340	4197582.5840	344.6380	344.5850	0.0530	NVA
NVA232	769875.1720	4221219.5700	348.4520	348.4280	0.0240	NVA
NVA400	713432.7770	4253651.2550	375.1610	374.9720	0.1890	NVA
NVA401	736278.2100	4259108.5180	374.2220	374.0750	0.1470	NVA
NVA402	753274.1170	4259508.8020	363.3650	363.2290	0.1360	NVA
NVA403	688875.5090	4249505.5740	460.7930	460.7320	0.0610	NVA
NVA404	734761.0900	4239713.3780	414.8790	414.7530	0.1260	NVA
NVA406	708333.5890	4236528.4160	401.0710	401.0170	0.0540	NVA
NVA407	756653.0560	4212809.1320	337.4820	337.3620	0.1200	NVA
NVA408	732096.8640	4219191.4240	505.0630	504.9500	0.1130	NVA
NVA410	738229.0200	4206775.5830	394.2710	394.1500	0.1210	NVA
NVA470	686895.8640	4265364.8480	439.6390	439.6690	-0.0300	NVA
NVA598	748622.7080	4235185.9680	380.7140	380.7840	-0.0700	NVA
NVA599	725369.9110	4267559.5830	389.6730	389.6930	-0.0200	NVA
NVA600	733832.7260	4268660.8540	353.8020	353.6710	0.1310	NVA
NVA601	740949.2430	4241453.0390	377.2740	377.1450	0.1290	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
NVA602	743976.8920	4247988.9320	353.9320	354.0300	-0.0980	NVA
NVA603	708223.0710	4248634.4320	410.9630	411.1030	-0.1400	NVA
NVA604	706784.8940	4242234.5760	451.1660	451.1850	-0.0190	NVA
NVA605	697397.7500	4216263.1590	458.4230	458.3880	0.0350	NVA
NVA606	743071.0350	4218942.6230	371.9750	372.0630	-0.0880	NVA
NVA607	691194.4510	4206312.8490	441.8600	441.7630	0.0970	NVA
NVA608	725368.7190	4213807.4550	474.2110	474.1180	0.0930	NVA
NVA76	764672.0730	4197065.7880	287.6210	287.5560	0.0650	NVA
NVA80	768007.0700	4229201.5060	354.1310	354.0410	0.0900	NVA
NVA800	715010.1350	4253033.3750	375.9070	375.8780	0.0290	NVA
NVA801	742706.5430	4256144.9810	363.3400	363.3220	0.0180	NVA
NVA802	746554.7340	4243245.8810	361.2560	361.2390	0.0170	NVA
NVA803	697923.1840	4242010.2210	374.4420	374.4070	0.0350	NVA
NVA804	712972.4300	4232269.7960	386.3010	386.2350	0.0660	NVA
NVA805	751001.1530	4225133.3380	328.5040	328.4750	0.0290	NVA
NVA806	707612.1720	4213182.2220	447.7490	447.7060	0.0430	NVA
NVA809	689027.2190	4199627.9830	415.8090	415.7220	0.0870	NVA
NVA81	787180.3720	4252668.3870	331.2010	331.2710	-0.0700	NVA
NVA810	748152.0850	4198151.7800	325.8620	325.8150	0.0470	NVA
NVA83	779554.4290	4244308.3410	345.8500	345.8780	-0.0280	NVA
NVA864	751988.2260	4248291.3490	350.1780	350.2660	-0.0880	NVA
NVA865	735426.5150	4209180.5290	429.7130	429.6480	0.0650	NVA
NVA866	736633.1470	4230292.1720	358.6210	358.4880	0.1330	NVA
NVA868	685801.8960	4253816.5200	426.2060	426.1070	0.0990	NVA
NVA962	719226.5610	4195357.0240	416.3820	416.2510	0.1310	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
VVA02	783479.5970	4263942.4500	346.2910	346.3760	-0.0850	VVA
VVA04	770307.8070	4234110.3290	348.7840	348.7260	0.0580	VVA
VVA096	783010.2140	4212863.8240	317.1410	317.2810	-0.1400	VVA
VVA097	766555.1070	4242412.2900	337.2470	337.1600	0.0870	VVA
VVA099	764253.7590	4267900.5360	337.1400	337.1320	0.0080	VVA
VVA151	785900.9820	4221573.7680	306.7680	306.8060	-0.0380	VVA
VVA279	704268.2320	4224345.2760	450.0990	450.1870	-0.0880	VVA
VVA280	742633.4740	4268916.1750	359.8190	359.9000	-0.0810	VVA
VVA281	719594.9330	4257039.9420	378.2710	378.2150	0.0560	VVA
VVA282	716768.8670	4243425.7430	373.5860	373.6650	-0.0790	VVA
VVA283	704935.4780	4235703.8860	422.9830	423.0480	-0.0650	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
VVA284	716396.0960	4220675.5840	423.3660	423.3670	-0.0010	VVA
VVA285	744401.8790	4222244.9670	379.6280	379.7750	-0.1470	VVA
VVA286	746582.1750	4208168.8410	346.2560	346.3840	-0.1280	VVA
VVA287	704171.5640	4205057.0100	431.4780	431.5490	-0.0710	VVA
VVA412	752934.7320	4266309.4630	382.8390	382.7480	0.0910	VVA
VVA413	733895.5450	4264896.4040	362.7430	362.6970	0.0460	VVA
VVA414	713352.4300	4260851.3340	385.1380	385.0100	0.1280	VVA
VVA415	686975.5810	4258780.7970	428.5010	428.5190	-0.0180	VVA
VVA416	753942.5500	4239460.4000	360.5220	360.6000	-0.0780	VVA
VVA417	722758.5230	4222126.3770	456.7610	456.6610	0.1000	VVA
VVA418	701858.6350	4229202.4820	444.9190	444.9340	-0.0150	VVA
VVA419	735441.4790	4209196.8600	429.3790	429.3800	-0.0010	VVA
VVA420	702303.6050	4213058.3740	444.7090	444.7890	-0.0800	VVA
VVA48	769850.0780	4221235.9410	348.5000	348.4780	0.0220	VVA
VVA51	779361.9070	4250678.1010	361.8280	361.8120	0.0160	VVA
VVA552	685806.6790	4253825.8730	426.0630	426.0880	-0.0250	VVA
VVA553	752002.5080	4248303.7470	350.0530	350.1120	-0.0590	VVA
VVA555	736615.5860	4230300.0760	358.4410	358.4090	0.0320	VVA
VVA556	709242.8640	4198441.7020	447.3920	447.4270	-0.0350	VVA
VVA557	729937.2610	4197642.4380	346.7770	346.6340	0.1430	VVA
VVA597	748602.6930	4235177.9490	380.1250	380.1400	-0.0150	VVA
VVA598	707635.4530	4213136.7320	447.8550	447.8600	-0.0050	VVA
VVA599	744025.2590	4247978.6200	355.3620	355.5090	-0.1470	VVA
VVA602	686907.5700	4265377.4470	439.4200	439.5060	-0.0860	VVA
VVA640	689043.9130	4199646.8560	414.0410	414.0140	0.0270	VVA
VVA76	777114.4860	4198780.1950	359.4230	359.4320	-0.0090	VVA

Table 14: DEM Check Point Assessment