Maine 2016
QL2 LiDAR Project Report

USGS Contract # G16PC00016
Requisition # 0040267114
Task Order # G16PD00396

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1. Summary / Scope

1.1. Summary

This report contains a summary of the Maine 2016 QL2 LiDAR acquisition task order, issued by USGS National Geospatial Technical Operations Center (NGTOC) under their Geospatial Product and Services Contract v.3 (GPSC3) on April 10, 2016. The task order yielded a project area covering 5,034 square miles over Maine. The intent of this document is only to provide specific validation information for the data acquisition/collection work completed as specified in the task order.

1.2. Scope

Aerial topographic LiDAR was acquired using state of the art technology along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

Table 1. Originally Planned LiDAR Specifications

Average Point Density	Flight Altitude (AGL)	Field of View	Minimum Side Overlap	RMSEz
≥ 2 pts / m^2	2,100 m	40°	30%	≤ 10 cm

1.3. Coverage

The project boundary covers approximately 5,034 total square miles and partially covers the following counties: Franklin, Piscataquis, Oxford, and Somerset.

A buffer of 100-meters was created to meet task order specifications. LiDAR extents are shown in Figure 1 on the following page.

1.4. Duration

LiDAR data was acquired from April 5, 2016 to May 21, 2016 in 42 total lifts. See “Section: 2.5. Time Period” for more details.

1.5. Issues

There were no issues to report with this project.

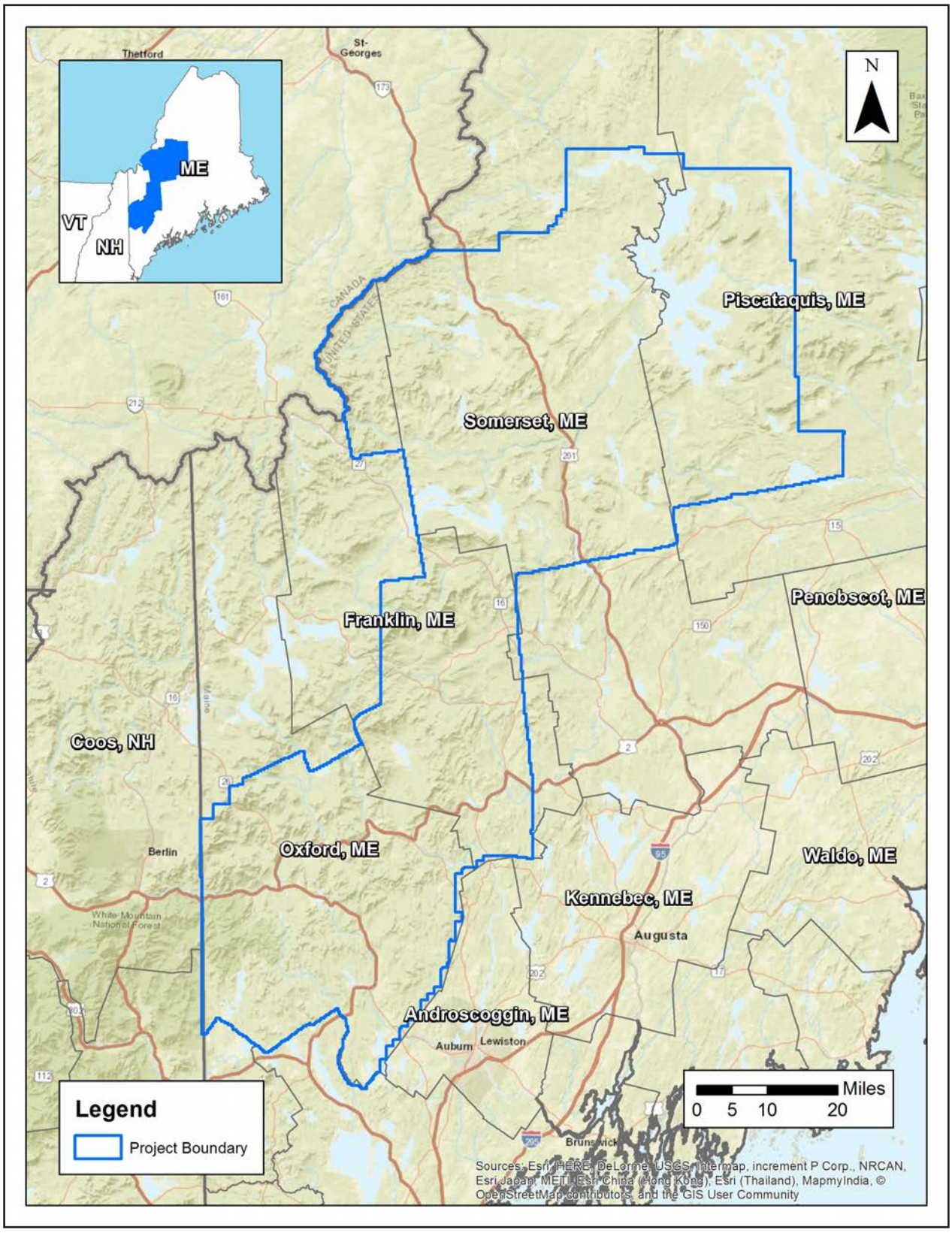
1.6. Deliverables

The following products were produced and delivered:

- Raw LiDAR point cloud data swaths in LAS 1.4 format
- Classified LiDAR point cloud data, tiled, in LAS 1.4 format
- Continuous hydro-flattened breaklines in Esri file geodatabase format
- 1-meter hydro-flattened bare-earth raster DEMs, tiled, in ERDAS .IMG format
- 1-meter intensity images, tiled, in GeoTIFF format
- 1-foot continuous contours in Esri file geodatabase format
- Processing boundary in Esri shapefile format
- Tile index in Esri shapefile format
- Calibration and QC checkpoints in Esri shapefile format
- Accuracy Assessment in .XLS format
- Project-, deliverable-, and lift-level metadata in .XML format

All geospatial deliverables were produced in NAD83 (2011) UTM Zone 19, meters; NAVD88 (Geoid 12B), meters. All tiled deliverables have a tile size of 1,500 meters x 1,500 meters. Tile names are derived from US National Grid naming conventions.

Figure 1. LiDAR Project Boundary



2. Planning / Equipment

2.1. Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount / type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity. Please note that certain values in the table below are listed as "Variable" due to the various flight plans used, as described in "Section: 1.5. Issues" of this document.

Detailed project flight planning calculations were performed for the project using Leica Mission Pro planning software.

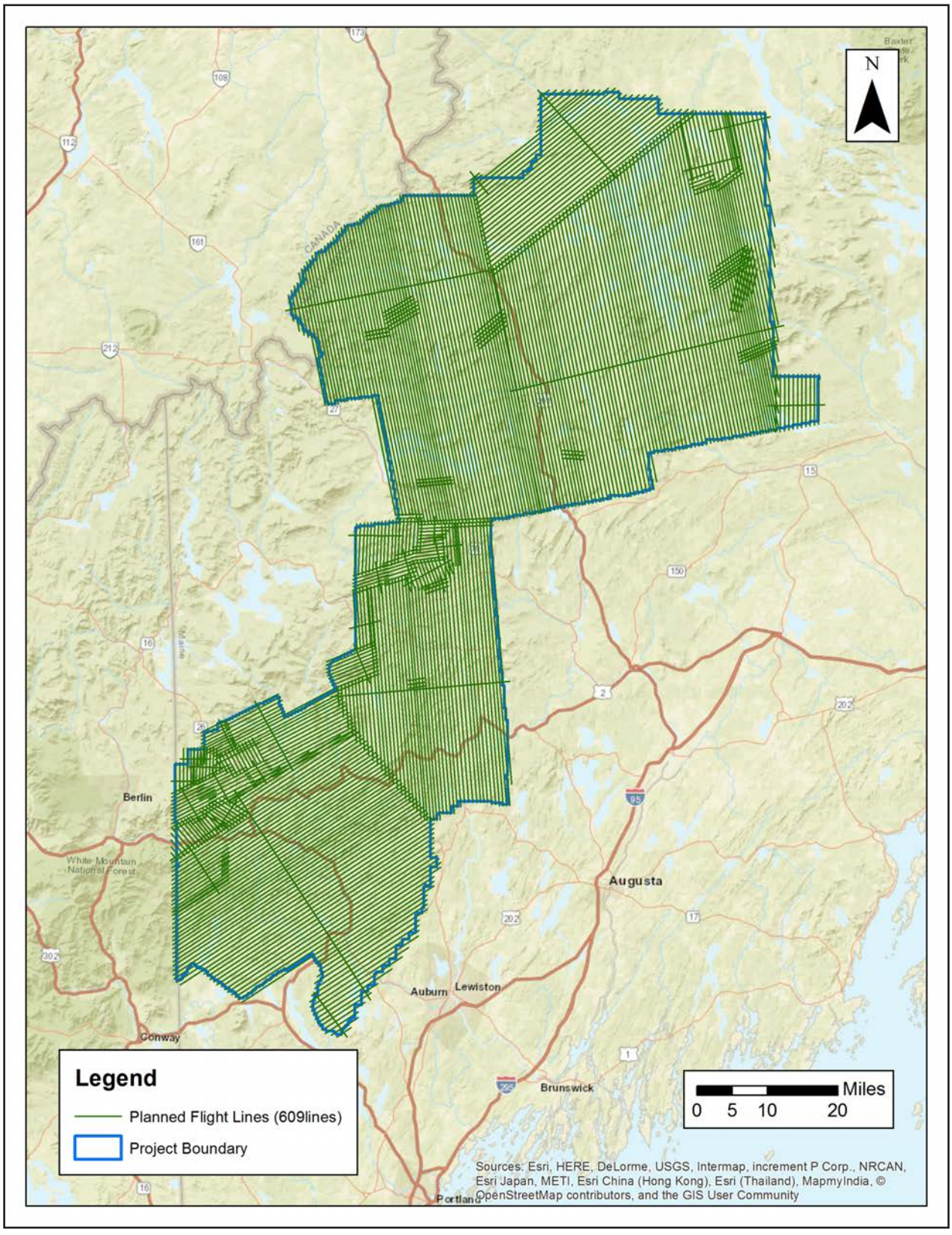
The entire target area was comprised of 609 planned flight lines measuring approximately total 11,448.09 flight line miles (Figure 2).

2.2. LiDAR Sensor

Quantum Spatial utilized two Leica LiDAR sensors (Figure 3), serial numbers 7161 and 7178, during the project. These systems are capable of collecting data at a maximum frequency of 500 kHz, which affords elevation data collection of up to 500,000 points per second. These systems utilize a Multi-Pulse in the Air option (MPIA). The sensors are also equipped with the ability to measure up to 4 returns per outgoing pulse from the laser and these come in the form of 1st, 2nd, 3rd and last returns. The intensity of the returns is also captured during aerial acquisition.

A brief summary of the aerial acquisition parameters for the project are shown in the LiDAR System Specifications in Table 2.

Figure 2. Planned LiDAR Flight Lines



		7161	7178
Terrain and Aircraft Scanner	Flying Height	2100 m	2,100 m
	Recommended Ground Speed	150 kts	150 kts
Scanner	Field of View	40.0°	40.0°
	Scan Rate Setting Used	53.4 Hz	53.4 Hz
Laser	Laser Pulse Rate Used	260.4 kHz	260.4 kHz
	Multi Pulse in Air Mode	Enabled	Enabled
Coverage	Full Swath Width	1,528.67 m	1,528.67 m
	Line Spacing	1,365.52 m	1,365.52 m
Point Spacing and Density	Maximum Point Spacing Across Track	1.36 m	1.36 m
	Maximum Point Spacing Along Track (in phase)	1.44 m	1.44 m
	Maximum Point Spacing Along Track (out of phase)	0.72 m	0.72 m
	Average Point Density	2.21 pts / m^2	2.21 pts / m^2

Figure 3. Leica ALS 70 LiDAR Sensor

2.3. Aircraft

All flights for the project were accomplished through the use of customized Piper Navajo (twin-piston), tail numbers: N73TM and N812TB. These aircraft provided an ideal, stable aerial base for LiDAR and orthoimagery acquisition. These aerial platforms have relatively fast cruise speeds which are beneficial for project mobilization / demobilization while maintaining relatively slow stall speeds which prove ideal for collection of high-density, consistent data posting using a state-of-the-art Leica LiDAR systems. Some of Quantum Spatial's operating aircraft can be seen in Figure 4 below.

Figure 4. Some of Quantum Spatial's Planes

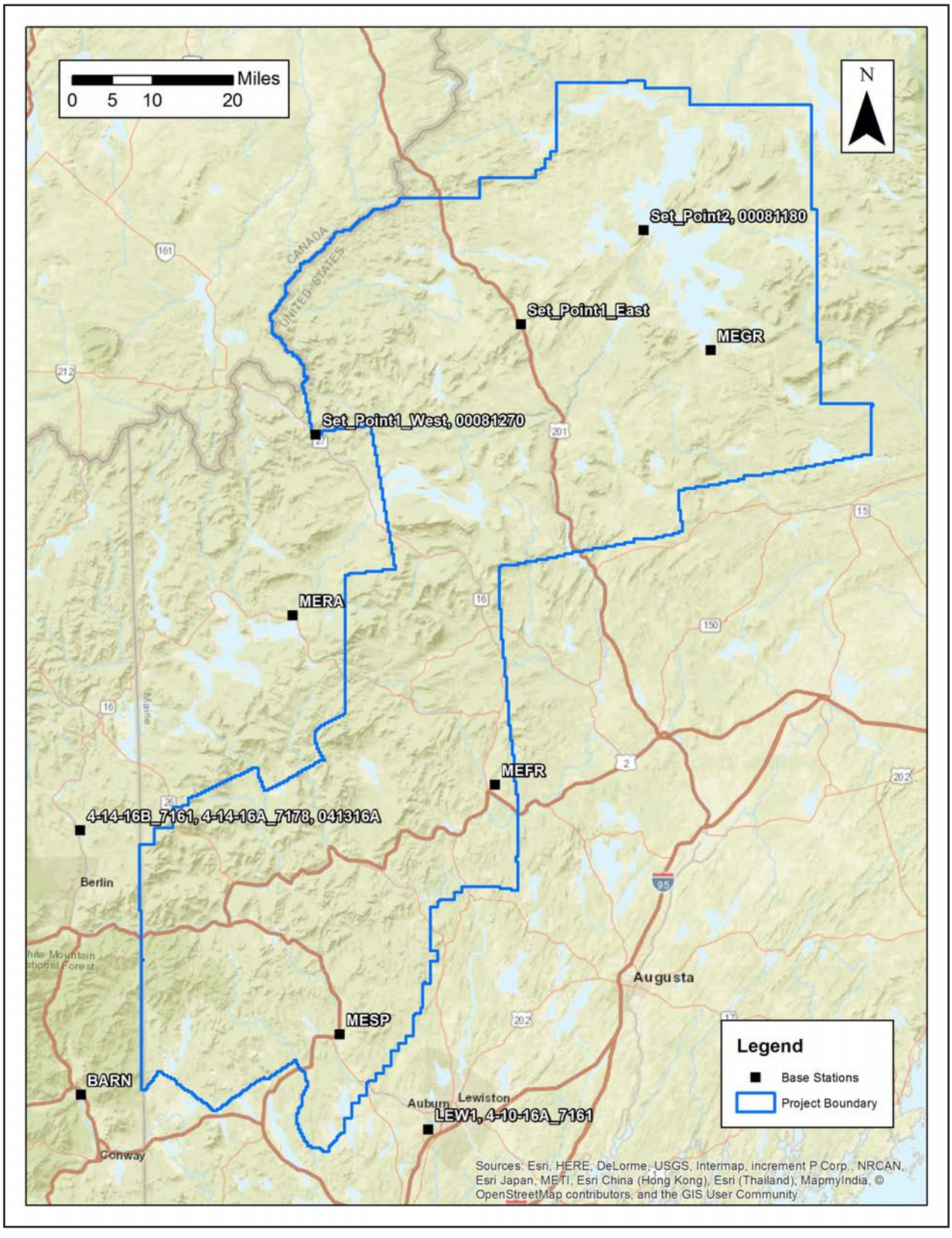
2.4. Base Station Information

GPS base stations were utilized during all phases of flight (Table 3). The base station locations were verified using NGS OPUS service and subsequent surveys. Base station locations are depicted in Figure 5. Data sheets, graphical depiction of base station locations or log sheets used during station occupation are available in Appendix A.

Table 3. Base Station Locations

Base Station	Longitude	Latitude	Ellipsoid Height (m)
4-14-16B_7161, 4-14-16A_7178, 041316A	71° 10′ 43.67149″	44° 34′ 37.37822″	318.188
BARN	71° 9′ 34.39925″	44° 5′ 56.68362″	140.793
LEW1, 4-10-16A_7161	70° 17′ 12.20047″	44° 2′ 56.74648″	51.351
MEFR	70° 7′ 54.54215″	44° 40′ 28.9745″	131.643
MEGR	69° 35′ 36.89811″	45° 27′ 49.23447″	293.886
MERA	70° 39′ 10.58376″	44° 58′ 25.33352″	489.568
MESP	70° 30′ 47.1074″	44° 13′ 6.19617″	105.463
Set_Point1_East	70° 4′ 53.68744″	45° 30′ 23.79424″	471.643
Set_Point1_West, 00081270	70° 36′ 12.34092″	45° 18′ 4.00868″	351.264
Set_Point2, 00081180	69° 46′ 8.20112″	45° 40′ 46.36938″	295.651

Figure 5. Base Station Locations



2.5. Time Period

Project specific flights were conducted over two months. Forty-two sorties, or aircraft lifts were completed. Accomplished sorties are listed below.

- Apr 5, 2016-A (N812TB, SN7161)
- Apr 5, 2016-B (N812TB, SN7161)
- Apr 6, 2016-A (N812TB, SN7161)
- Apr 6, 2016-B (N812TB, SN7161)
- Apr 10, 2016-A (N812TB, SN7161)
- Apr 10, 2016-B (N812TB, SN7161)
- Apr 13, 2016-A (N73TM, SN7178)
- Apr 13, 2016-A (N812TB, SN7161)
- Apr 14, 2016-A (N73TM, SN7178)
- Apr 14, 2016-A (N812TB, SN7161)
- Apr 14, 2016-B (N73TM, SN7178)
- Apr 15, 2016-A (N73TM, SN7178)
- Apr 15, 2016-A (N812TB, SN7161)
- Apr 15, 2016-B (N73TM, SN7178)
- Apr 15, 2016-B (N812TB, SN7161)
- Apr 16, 2016-A (N73TM, SN7178)
- Apr 16, 2016-A (N812TB, SN7161)
- Apr 17, 2016-A (N73TM, SN7178)
- Apr 17, 2016-A (N812TB, SN7161)
- Apr 17, 2016-B (N73TM, SN7178)
- Apr 21, 2016-A (N73TM, SN7178)
- Apr 21, 2016-A (N812TB, SN7161)
- Apr 21, 2016-B (N73TM, SN7178)
- Apr 24, 2016-A (N73TM, SN7178)
- Apr 24, 2016-A (N812TB, SN7161)
- Apr 24, 2016-B (N73TM, SN7178)
- Apr 24, 2016-B (N812TB, SN7161)
- Apr 25, 2016-A (N73TM, SN7178)
- Apr 25, 2016-A (N812TB, SN7161)
- Apr 27, 2016-A (N812TB, SN7161)
- Apr 29, 2016-A (N73TM, SN7178)
- Apr 29, 2016-A (N812TB, SN7161)
- Apr 30, 2016-A (N73TM, SN7178)
- Apr 30, 2016-A (N812TB, SN7161)
- May 1, 2016-A (N73TM, SN7178)
- May 6, 2016-A (N73TM, SN7178)
- May 6, 2016-B (N73TM, SN7178)
- May 10, 2016-B (N73TM, SN7178)
- May 11, 2016-A (N73TM, SN7178)
- May 12, 2016-A (N73TM, SN7178)
- May 12, 2016-B (N73TM, SN7178)
- May 21, 2016-A (N73TM, SN7178)

3. Processing Summary

3.1. Flight Logs

Flight logs were completed by LIDAR sensor technicians for each mission during acquisition. These logs depict a variety of information, including:

- Job / Project #
- Flight Date / Lift Number
- FOV (Field of View)
- Scan Rate (HZ)
- Pulse Rate Frequency (Hz)
- Ground Speed
- Altitude
- Base Station
- PDOP avoidance times
- Flight Line #
- Flight Line Start and Stop Times
- Flight Line Altitude (AMSL)
- Heading
- Speed
- Returns
- Crab

Notes: (Visibility, winds, ride, weather, temperature, dew point, pressure, etc). Project specific flight logs for each sortie are available in Appendix A.

3.2. LiDAR Processing

Inertial Explorer software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the LiDAR sensor during all flights. Inertial Explorer combines aircraft raw trajectory data with stationary GPS base station data yielding a "Smoothed Best Estimate Trajectory (SBET) necessary for additional post processing software to develop the resulting geo-referenced point cloud from the LiDAR missions.

During the sensor trajectory processing (combining GPS & IMU datasets) certain statistical graphs and tables are generated within the Inertial Explorer processing environment which are commonly used as indicators of processing stability and accuracy. This data for analysis include: Max horizontal / vertical GPS variance, separation plot, altitude plot, PDOP plot, base station baseline length, processing mode, number of satellite vehicles, and mission trajectory. All relevant graphs produced in the Inertial Explorer processing environment for each sortie during the project mobilization are available in Appendix A.

The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. Laser point data are imported into TerraScan and a manual calibration is performed to assess the system offsets for pitch, roll, heading and scale. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above-ground features are removed from the data set. Point clouds were created using the Leica CloudPro software. GeoCue distributive processing software was used in the creation of some files needed in downstream processing, as well as in the tiling of the dataset into more manageable file sizes. TerraScan and TerraModeler software packages were then used for the automated data classification, manual cleanup, and bare earth generation. Project specific macros were developed to classify the ground and remove side overlap between parallel flight lines.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper was used as a final check of the bare earth dataset. GeoCue was used to create the deliverable industry-standard LAS files for both the All Point Cloud Data and the Bare Earth. In-house software was then used to perform final statistical analysis of the classes in the LAS files.

3.3. LAS Classification Scheme

The classification classes are determined by the USGS Version 1.2 specifications and are an industry standard for the classification of LIDAR point clouds. All data starts the process as Class 1 (Unclassified), and then through automated classification routines, the classifications are determined using TerraScan macro processing.

The classes used in the dataset are as follows and have the following descriptions:

- Class 1 – Processed, but Unclassified – These points would be the catch all for points that do not fit any of the other deliverable classes. This would cover features such as vegetation, cars, etc.
- Class 2 – Bare-Earth Ground – This is the bare earth surface
- Class 7 – Low Noise – Low points, manually identified below the surface that could be noise points in point cloud.
- Class 9 – In-land Water – Points found inside of inland lake/ponds
- Class 10 – Ignored Ground – Points found to be close to breakline features. Points are moved to this class from the Class 2 dataset. This class is ignored during the DEM creation process in order to provide smooth transition between the ground surface and hydro flattened surface.
- Class 17 – Bridge Decks – Points falling on bridge decks.
- Class 18 – High Noise – High points, manually identified above the surface that could be noise points in point cloud.

3.4. Classified LAS Processing

The bare earth surface is then manually reviewed to ensure correct classification on the Class 2 (Ground) points. After the bare- earth surface is finalized; it is then used to generate all hydro-breaklines through heads-up digitization.

All ground (ASPRS Class 2) LiDAR data inside of the Lake Pond and Double Line Drain hydro flattening breaklines were then classified to water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 3 feet was also used around each hydro flattened feature to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 10). All Lake Pond Island and Double Line Drain Island features were checked to ensure that the ground (ASPRS Class 2) points were reclassified to the correct classification after the automated classification was completed. All bridge decks were classified to Class 17.

All overlap data was processed through automated functionality provided by TerraScan to classify the overlapping flight line data to approved classes by USGS. The overlap data was identified using the Overlap Flag, per LAS 1.4 specifications.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper is used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable industry-standard LAS files for all point cloud data. Quantum Spatial proprietary software was used to perform final statistical analysis of the classes in the LAS files, on a per tile level to verify final classification metrics and

full LAS header information.

3.5. Hydro-Flattened Breakline Creation

Class 2 LiDAR was used to create a bare earth surface model. The surface model was then used to heads-up digitize 2D breaklines of inland streams and rivers with a 30 meter nominal width and Inland Ponds and Lakes of 2 acres or greater surface area.

Elevation values were assigned to all Inland Ponds and Lakes, Inland Pond and Lake Islands, Inland Stream and River Islands, using TerraModeler functionality.

Elevation values were assigned to all Inland streams and rivers using Quantum Spatial proprietary software.

All ground (ASPRS Class 2) LiDAR data inside of the collected inland breaklines were then classified to water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 1-meter was also used around each hydro flattened feature. These points were moved from ground (ASPRS Class 2) to Ignored Ground (ASPRS Class 10).

The continuous breakline files were then translated to Esri file geodatabase format using Esri conversion tools.

3.6. Hydro-Flattened Raster DEM Creation

Class 2 LiDAR in conjunction with the hydro breaklines were used to create a 1-meter raster DEM. Using automated scripting routines within ArcMap, an ERDAS .IMG file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.7. Contour Creation

Using automated scripting routines within ArcMap, a terrain surface was created using the ground (ASPRS Class 2) LiDAR data as well as the hydro breaklines. This surface was then used to generate the final continuous 1-foot contour dataset in Esri file geodatabase format.

4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 6 and Figure 7.

Figure 6. Flightline Swath LAS File Coverage - Norther Half

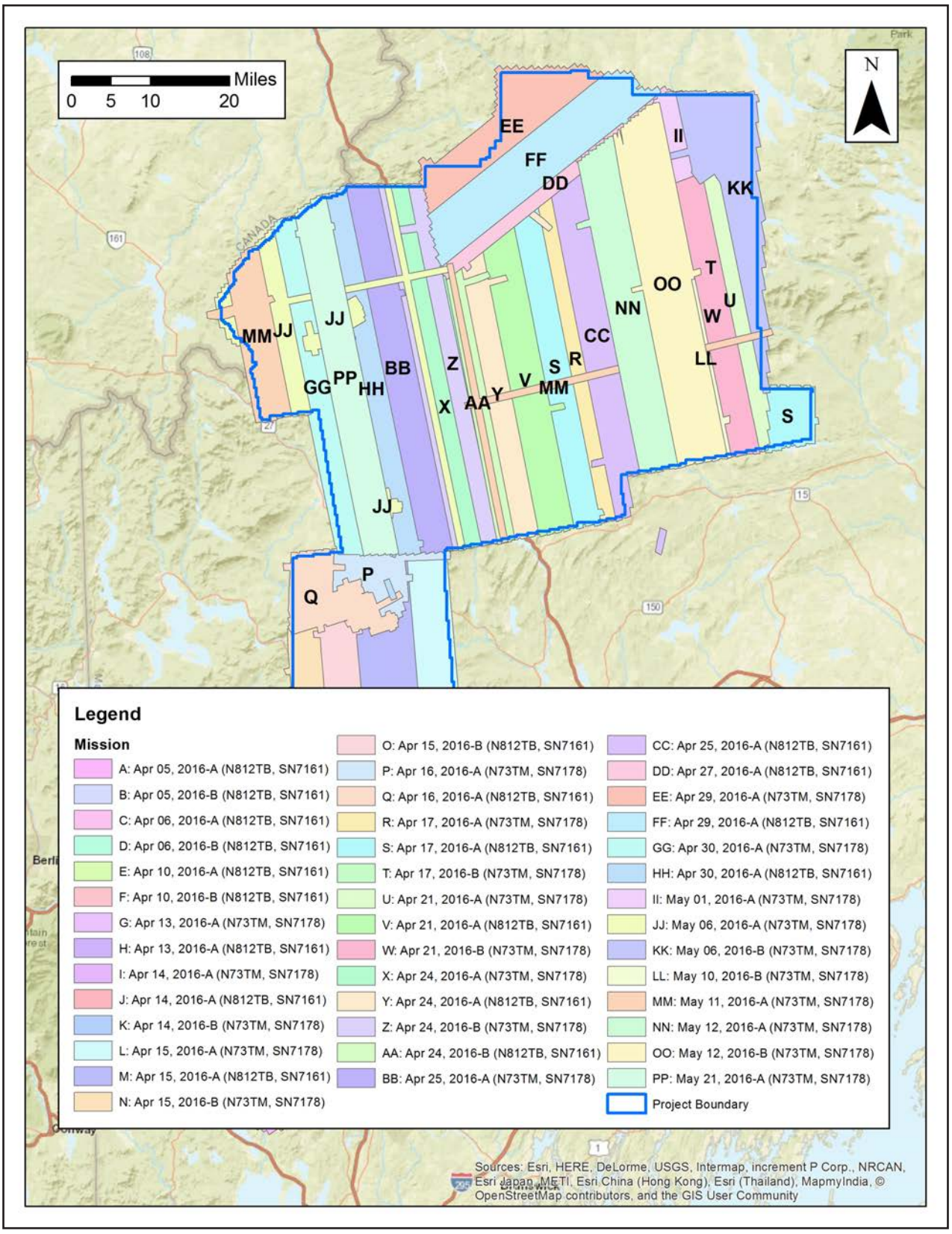
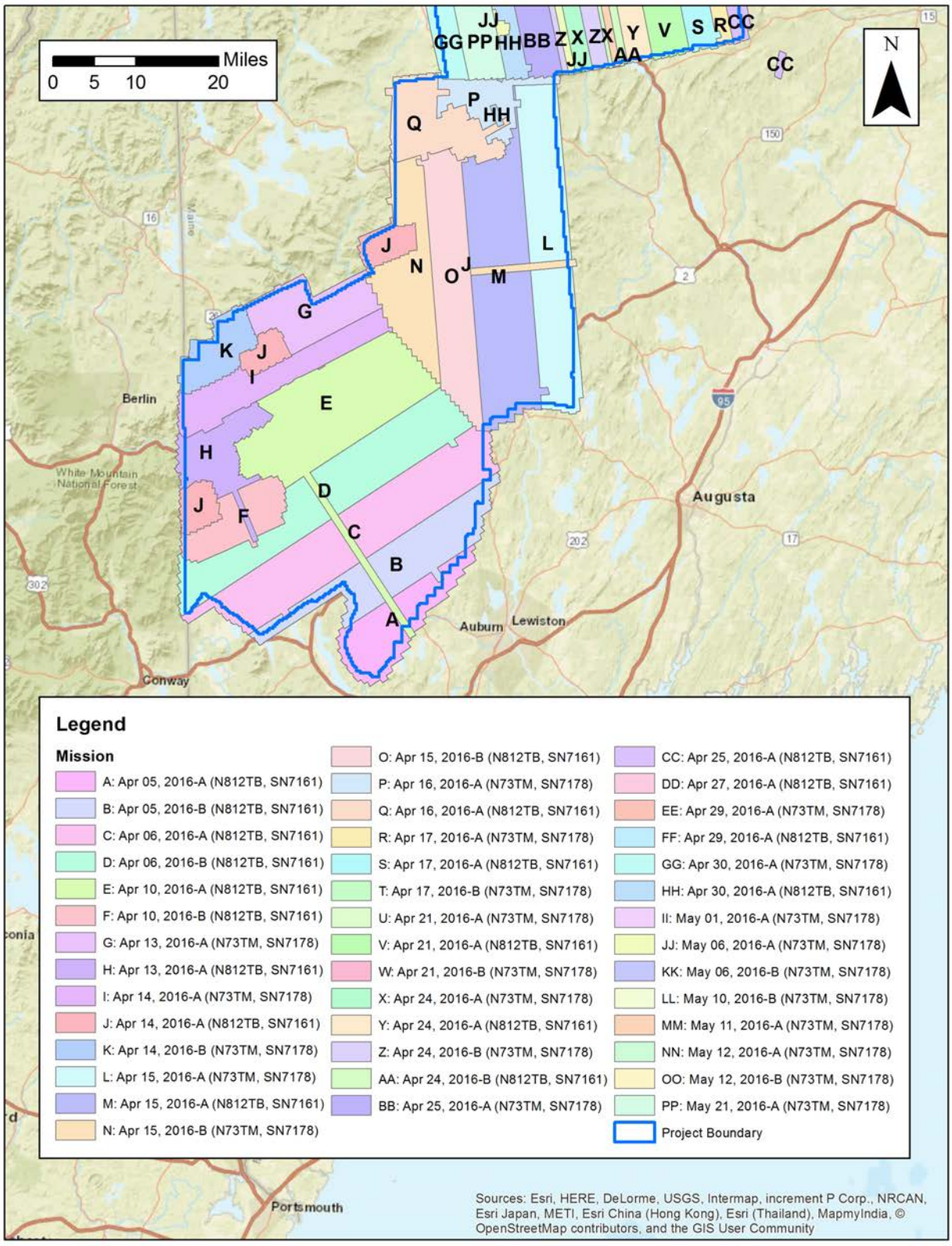


Figure 7. Flightline Swath LAS File Coverage - Southern Half



5. Ground Control and Check Point Collection

Quantum Spatial worked with the James W. Sewall Company to complete a field survey of 101 ground control (calibration) points along with 205 blind QA points in Vegetated and Non-Vegetated land cover classifications (total of 306 points) as an independent test of the accuracy of this project. For more information, see the Survey Report in Appendix B.

The required accuracy testing was performed on the LiDAR dataset (both the LiDAR point cloud and derived DEM's) according to the USGS LiDAR Base Specification Version 1.2 (2014). In this document, horizontal coordinates for ground control and QA points for all LiDAR classes are reported in NAD83 (2011) UTM Zone 19, meters; NAVD88 (Geoid 12B), meters.

5.1. Calibration Control Point Testing

Figure 8 shows the location of each bare earth calibration point for the project area. Table 4 depicts the Control Report for the LiDAR bare earth calibration points, as computed in TerraScan as a quality assurance check. Note that these results of the surface calibration are not an independent assessment of the accuracy of these project deliverables, but the statistical results do provide additional feedback as to the overall quality of the elevation surface.

5.2. Point Cloud Testing

The project specifications require that only Non-Vegetated Vertical Accuracy (NVA) be computed for raw lidar point cloud swath files. The required accuracy (ACCz) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes; two points were removed due to vehicles obstructing the point location. The NVA was tested with 116 of the 118 collected checkpoints located in bare earth and urban (non-vegetated) areas. These check points were not used in the calibration or post processing of the lidar point cloud data. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See survey report for additional survey methodologies.

Elevations from the unclassified lidar surface were measured for the x,y location of each check point. Elevations interpolated from the lidar surface were then compared to the elevation values of the surveyed control points. AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASRPS Guidelines. See Figure 9 and Table 5.

5.3. Digital Elevation Model (DEM) Testing

The project specifications require the accuracy (ACCz) of the derived DEM be calculated and reported in two ways:

1. The required NVA is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. This is a required accuracy. The NVA was tested with 118 checkpoints located in bare earth and urban (non-vegetated) areas. See Figure 10 and Table 6.

2. Vegetated Vertical Accuracy (VVA): VVA shall be reported for "brushlands/low trees" and "tall weeds/crops" land cover classes. The target VVA is: 29.4 cm at the 95th percentile, derived according to ASPRS Guidelines, Vertical Accuracy Reporting for Lidar Data, i.e., based on the 95th percentile error in all vegetated land cover classes combined. This is a target accuracy. The VVA was tested with 87 checkpoints located in tall weeds/ crops and brushlands/low trees (vegetated) areas. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See Figure 11 and Table 7.

See survey report for additional survey methodologies. AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASRPS Guidelines.

Figure 8. Calibration Control Point Locations

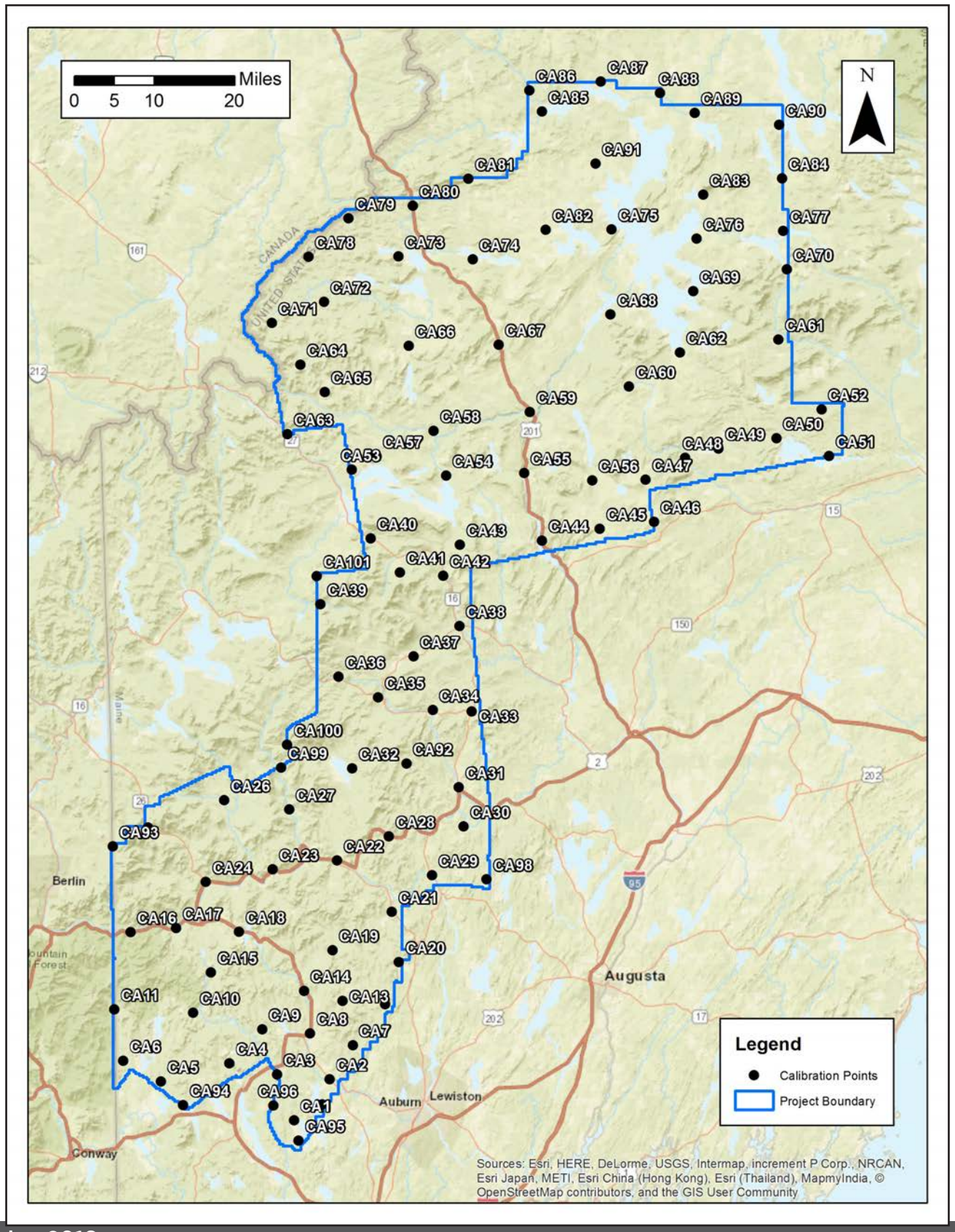


Table 4. Calibration Control Point Report

Units = Meters

Number	Easting	Northing	Known Z	Laser Z	Dz
CA1	375599.522	4879641.450	148.87	148.91	0.04
CA10	355353.361	4901242.723	183.00	182.99	-0.01
CA100	374251.966	4955178.617	427.00	427.01	0.01
CA101	380160.760	4989043.442	869.45	869.45	0.00
CA11	339473.095	4901954.496	167.83	167.78	-0.05
CA12	393887.910	4902971.339	108.69	108.73	0.04
CA13	385392.781	4903667.191	273.35	273.29	-0.06
CA14	377633.919	4905691.834	137.63	137.68	0.05
CA15	358925.003	4909409.987	196.79	196.75	-0.04
CA16	342749.828	4917474.812	218.47	218.45	-0.02
CA17	351931.313	4918303.163	206.82	206.90	0.08
CA18	364557.617	4917555.638	220.92	220.89	-0.03
CA19	383342.861	4913818.918	191.23	191.12	-0.11
CA2	382773.971	4887913.727	97.11	97.13	0.02
CA20	396701.663	4911422.535	133.48	133.60	0.12
CA21	395286.360	4921529.945	123.62	123.57	-0.05
CA22	384270.480	4931936.718	128.26	128.42	0.16
CA23	371286.613	4930139.047	189.03	189.13	0.10
CA24	357869.079	4927623.438	194.80	194.82	0.02
CA25	346266.918	4938500.294	455.90	456.03	0.13
CA26	361547.617	4943995.686	199.54	199.52	-0.01
CA27	374659.948	4942166.247	174.42	174.43	0.01
CA28	394674.271	4936697.268	168.97	168.91	-0.06
CA29	403330.427	4928941.602	123.95	123.95	0.00
CA3	372231.033	4888860.147	123.68	123.67	-0.01
CA30	409704.708	4938741.001	113.25	113.25	0.00
CA31	408742.795	4946586.158	107.37	107.33	-0.04
CA32	387329.960	4950399.079	226.92	227.12	0.20
CA33	411324.390	4961845.919	184.78	184.78	0.00
CA34	403496.280	4962129.690	153.65	153.70	0.05
CA35	392518.399	4964694.298	232.82	232.82	0.00

Number	Easting	Northing	Known Z	Laser Z	Dz
CA36	384567.643	4968876.375	258.78	258.83	0.05
CA37	399617.962	4972933.831	263.26	263.25	-0.01
CA38	408859.078	4979030.515	175.70	175.68	-0.02
CA39	380930.111	4983380.619	468.40	468.50	0.10
CA4	362648.731	4891080.062	130.69	130.64	-0.05
CA40	390991.435	4996635.293	365.94	366.01	0.07
CA41	396873.118	4989801.580	532.12	532.16	0.04
CA42	405618.919	4989131.431	231.94	231.98	0.04
CA43	408957.406	4995375.457	379.41	379.45	0.04
CA44	425453.273	4996234.316	158.70	158.62	-0.08
CA45	437042.791	4998586.426	311.23	311.34	0.11
CA46	447936.193	5000013.396	483.89	483.92	0.03
CA47	446264.909	5008507.181	401.26	401.27	0.01
CA48	454224.657	5012827.810	177.85	177.83	-0.02
CA49	460910.505	5014690.775	260.75	260.76	0.01
CA5	348843.897	4887420.710	127.21	127.18	-0.02
CA50	472551.452	5016768.596	110.38	110.45	0.07
CA51	483154.983	5013219.679	128.18	128.19	0.01
CA52	481622.409	5022605.835	215.70	215.77	0.07
CA53	387218.962	5010453.862	425.02	425.06	0.04
CA54	406150.437	5009275.893	317.37	317.32	-0.05
CA55	421839.585	5009823.334	158.10	158.18	0.08
CA56	435519.158	5008310.007	303.23	303.32	0.09
CA57	392202.051	5013128.222	424.18	424.12	-0.06
CA58	403683.268	5018310.765	335.74	335.72	-0.02
CA59	423006.349	5022093.155	187.08	187.14	0.06
CA6	341276.033	4891587.870	131.46	131.45	-0.01
CA60	442935.703	5027204.375	381.82	381.87	0.05
CA61	472946.773	5036630.035	422.13	422.15	0.02
CA62	453146.653	5034070.487	322.83	322.86	0.03
CA63	374282.589	5017644.118	377.46	377.54	0.08
CA64	376880.422	5031573.027	680.94	680.97	0.03
CA65	381766.479	5026089.670	725.65	725.63	-0.02
CA66	398669.241	5035416.476	338.77	338.77	0.00

Number	Easting	Northing	Known Z	Laser Z	Dz
CA67	416724.89	5035574.46	516.35	516.35	0.00
CA68	439198.91	5041699.71	325.87	325.89	0.02
CA69	455836.29	5046375.89	313.99	314.01	0.02
CA7	387417.59	4894754.88	170.87	170.92	0.05
CA70	474640.25	5050748.85	396.23	396.16	-0.07
CA71	371168.86	5039988.29	513.26	513.29	0.03
CA72	381623.04	5044260.64	450.78	450.76	-0.02
CA73	396554.51	5053393.23	381.14	381.05	-0.09
CA74	411530.57	5052799.39	361.64	361.70	0.06
CA75	439445.29	5058807.27	317.15	317.21	0.06
CA76	456515.39	5056918.95	364.35	364.37	0.02
CA77	473922.02	5058495.59	408.36	408.24	-0.12
CA78	378517.87	5053265.56	443.05	443.10	0.05
CA79	386574.06	5060992.97	539.75	539.74	-0.01
CA8	378843.28	4897111.17	118.84	119.01	0.17
CA80	399473.65	5063520.91	428.69	428.61	-0.08
CA81	410650.16	5068984.81	455.58	455.58	0.00
CA82	426194.55	5058727.04	340.18	340.18	0.00
CA83	457829.47	5065785.54	344.10	344.15	0.05
CA84	473645.40	5069092.22	370.38	370.28	-0.10
CA85	425427.21	5082534.52	335.18	335.12	-0.06
CA86	422890.48	5086730.41	348.95	348.91	-0.04
CA87	437264.21	5088542.34	335.54	335.51	-0.03
CA88	449174.40	5086242.13	315.41	315.35	-0.06
CA89	456129.42	5082195.25	295.13	295.12	-0.01
CA9	369259.60	4897924.87	166.75	166.73	-0.02
CA90	473060.54	5079827.80	308.39	308.33	-0.06
CA91	436212.19	5072063.97	318.73	318.79	0.06
CA92	398191.16	4951394.37	331.26	331.21	-0.05
CA93	339198.78	4934744.13	486.19	486.16	-0.03
CA94	353336.11	4882716.00	241.20	241.19	-0.01
CA95	376550.77	4875527.17	166.90	166.93	0.03
CA96	371494.90	4882630.01	101.77	101.81	0.04
CA97	381310.62	4882830.23	130.37	130.31	-0.06

Number	Easting	Northing	Known Z	Laser Z	Dz
CA98	414314.17	4928088.31	175.53	175.53	0.00
CA99	373059.43	4950584.27	228.00	227.97	-0.03
	Average Dz	0.01 m			
	Minimum Dz	-0.116 m			
	Maximum Dz	0.198 m			
	Root Mean Square	0.060 m			
	Std. Deviation	0.059 m			

Figure 9. QC Checkpoint Locations - Raw NVA

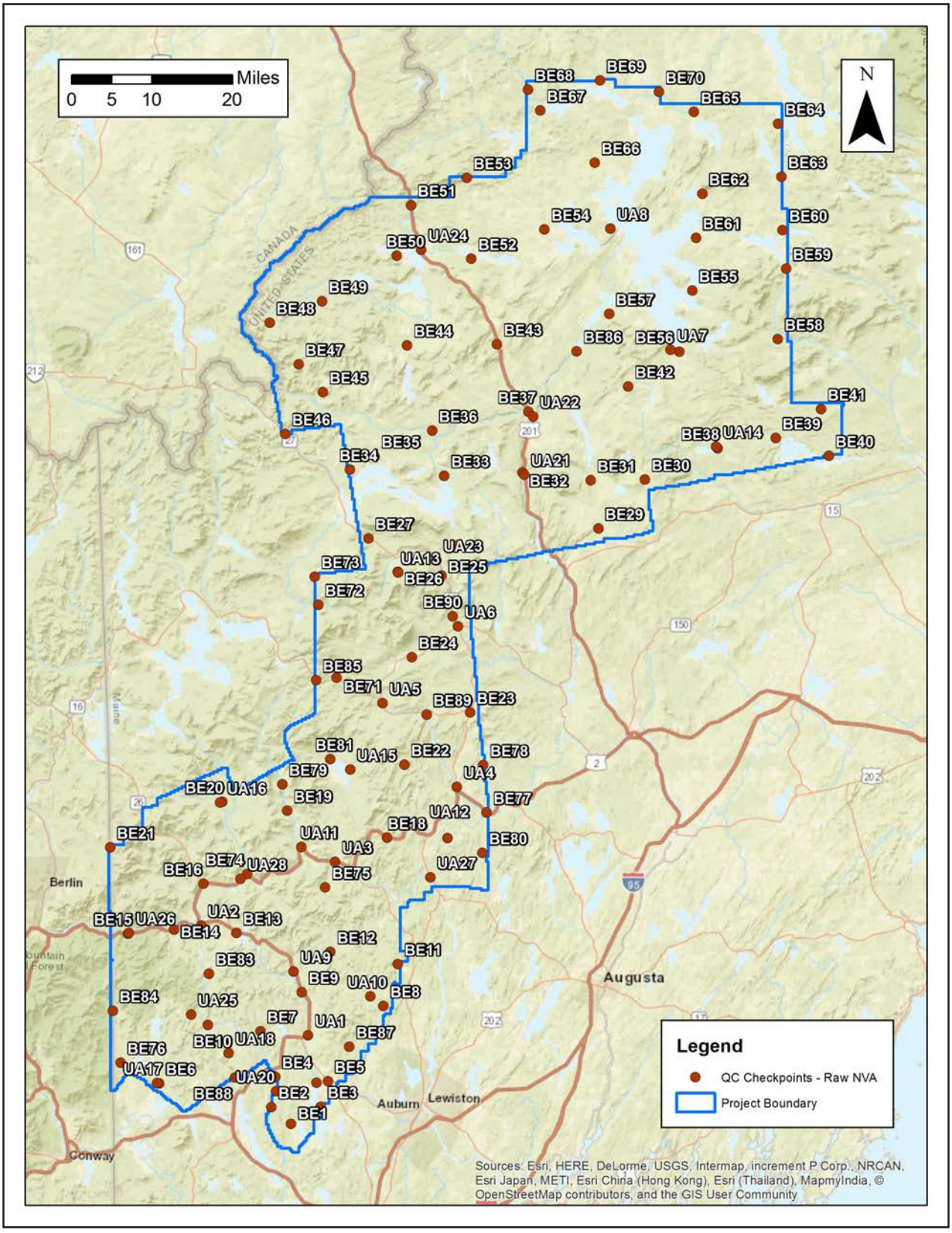


Table 5. QC Checkpoint Report - Raw NVA

Units = Meters

Number	Easting	Northing	Known Z	Laser Z	Dz
BE1	375393.873	4879323.200	148.15	148.20	0.05
BE10	358729.970	4899177.343	189.82	189.78	-0.04
BE11	396829.843	4911419.180	127.20	127.19	-0.01
BE12	383304.289	4913836.846	187.08	187.04	-0.04
BE13	364458.033	4917599.271	221.06	221.12	0.06
BE14	351987.639	4918308.118	206.61	206.56	-0.05
BE15	342763.587	4917455.703	218.68	218.66	-0.02
BE16	357861.946	4927546.114	194.30	194.28	-0.02
BE17	406782.416	4936644.339	192.76	192.80	0.04
BE18	394646.493	4936719.971	169.09	169.07	-0.02
BE19	374648.752	4942147.069	174.37	174.43	0.06
BE2	371477.578	4882670.916	104.03	104.08	0.05
BE20	361625.318	4943972.281	199.58	199.62	0.04
BE21	339200.663	4934781.619	487.99	487.91	-0.08
BE22	398154.782	4951395.502	331.80	331.78	-0.02
BE23	411306.171	4961824.170	185.05	185.02	-0.03
BE24	399623.334	4972969.311	263.03	*	*
BE25	405591.452	4989199.630	232.50	232.49	-0.01
BE26	396818.274	4989991.624	512.42	*	*
BE27	390927.049	4996656.546	366.67	366.73	0.06
BE28	409017.368	4995379.360	384.24	384.20	-0.04
BE29	437031.081	4998660.179	312.58	312.64	0.06
BE3	381360.244	4882790.707	132.17	132.08	-0.08
BE30	446302.757	5008502.120	402.04	402.11	0.07
BE31	435485.979	5008341.258	303.09	303.12	0.03
BE32	421818.691	5009852.975	157.93	157.97	0.04
BE33	406137.760	5009245.426	317.06	317.06	0.00
BE34	387255.358	5010472.477	424.43	424.44	0.01
BE35	392156.313	5013131.616	422.07	422.02	-0.05
BE36	403709.469	5018298.694	334.85	334.81	-0.04
BE37	423005.747	5022074.669	186.89	186.93	0.04
BE38	460897.960	5014682.088	261.13	261.12	-0.01

Number	Easting	Northing	Known Z	Laser Z	Dz
BE39	472544.149	5016774.528	110.59	110.62	0.04
BE4	372256.083	4888806.222	123.43	123.48	0.06
BE40	483171.804	5013212.262	127.67	127.71	0.04
BE41	481632.432	5022590.427	215.52	215.59	0.07
BE42	443010.633	5027166.001	385.95	386.00	0.05
BE43	416693.394	5035570.163	517.36	517.36	0.00
BE44	398689.164	5035393.958	338.32	338.32	0.00
BE45	381760.918	5026048.909	722.21	722.18	-0.03
BE46	374273.250	5017612.282	377.28	377.37	0.09
BE47	376934.634	5031574.326	679.75	679.80	0.05
BE48	371182.315	5039928.475	515.41	515.44	0.03
BE49	381627.768	5044250.532	450.68	450.69	0.01
BE5	382811.585	4887909.660	97.07	97.28	0.21
BE50	396556.274	5053407.231	381.81	381.74	-0.07
BE51	399473.247	5063516.075	428.35	428.35	0.00
BE52	411557.983	5052810.448	361.02	361.02	0.00
BE53	410640.792	5068979.540	456.09	456.09	0.00
BE54	426204.006	5058654.879	340.62	340.62	0.00
BE55	455835.515	5046401.115	314.06	314.04	-0.02
BE56	453206.278	5034141.893	322.41	322.42	0.01
BE57	439153.135	5041678.373	325.32	325.29	-0.02
BE58	472975.005	5036676.190	420.88	420.87	-0.01
BE59	474611.847	5050757.117	396.25	396.19	-0.06
BE6	348994.113	4887481.590	127.40	127.37	-0.03
BE60	473917.932	5058502.590	408.23	408.10	-0.13
BE61	456561.612	5056933.125	366.34	366.34	0.00
BE62	457848.540	5065822.150	347.14	347.19	0.05
BE63	473658.458	5069181.858	371.72	371.63	-0.09
BE64	473040.221	5079846.744	307.12	307.04	-0.08
BE65	456165.919	5082219.379	295.02	294.93	-0.09
BE66	436278.808	5072044.862	317.75	317.79	0.04
BE67	425357.281	5082549.037	336.06	336.02	-0.04
BE68	422926.301	5086682.604	345.88	345.87	0.00
BE69	437298.297	5088545.605	333.91	333.87	-0.04
BE7	369273.359	4897902.161	166.64	166.53	-0.11

Number	Easting	Northing	Known Z	Laser Z	Dz
BE70	449119.045	5086207.767	313.20	313.18	-0.02
BE71	384581.242	4968870.853	258.41	258.45	0.04
BE72	380874.064	4983360.373	468.26	468.43	0.17
BE73	380137.356	4989029.856	867.58	867.60	0.02
BE74	366615.735	4929455.351	191.81	191.74	-0.06
BE75	382266.231	4926785.588	153.87	153.83	-0.04
BE76	341250.895	4891624.365	132.56	132.56	0.00
BE77	414600.096	4941801.174	105.04	105.12	0.08
BE78	413933.970	4951288.901	176.46	176.52	0.06
BE79	373710.249	4947459.549	219.40	219.39	-0.01
BE8	393908.715	4902967.739	108.52	108.57	0.05
BE80	413761.110	4933656.263	116.82	116.82	0.00
BE81	383270.889	4952495.600	207.90	207.82	-0.08
BE82	392436.993	4898008.018	105.33	105.35	0.02
BE83	358945.231	4909420.278	196.33	196.33	0.00
BE84	339692.433	4901992.647	165.64	165.61	-0.03
BE85	380439.328	4968325.820	325.58	325.58	0.00
BE86	432675.422	5034223.560	296.55	296.54	-0.01
BE87	387098.285	4894782.005	165.96	165.93	-0.03
BE88	364165.229	4888663.601	118.38	118.44	0.06
BE89	402604.689	4961444.180	149.25	149.32	0.07
BE9	377594.097	4905728.783	138.08	138.06	-0.02
BE90	407823.35	4981022.88	184.80	184.72	-0.08
UA1	378813.44	4897127.42	119.17	119.31	0.14
UA10	391287.98	4904906.83	109.80	109.83	0.03
UA11	377474.43	4934841.24	132.56	132.61	0.05
UA12	401827.03	4939118.42	188.30	188.30	0.00
UA13	396877.44	4989822.79	531.30	531.36	0.06
UA14	460593.90	5015094.81	266.35	266.33	-0.02
UA15	387287.00	4950377.93	225.83	226.02	0.19
UA16	361216.07	4943778.07	213.07	213.06	-0.01
UA17	348579.74	4887516.30	126.92	126.85	-0.07
UA18	362888.21	4893528.23	154.08	154.00	-0.08
UA19	380538.43	4887593.00	99.83	99.95	0.13
UA2	357378.61	4919093.86	201.39	201.42	0.03

Number	Easting	Northing	Known Z	Laser Z	Dz
UA20	372409.13	4885909.48	115.18	115.17	-0.01
UA21	422158.46	5009428.18	170.47	170.50	0.03
UA22	423926.09	5021121.95	177.93	177.95	0.02
UA23	404582.38	4992230.48	255.78	255.78	0.00
UA24	401529.69	5054528.50	357.70	357.68	-0.02
UA25	355399.80	4901236.37	182.70	182.72	0.03
UA26	342932.94	4917593.83	218.38	218.34	-0.04
UA27	403358.60	4928782.36	121.68	121.71	0.03
UA28	365314.32	4928459.10	194.23	194.27	0.04
UA3	384260.59	4931919.03	127.92	127.88	-0.04
UA4	408632.47	4946914.49	111.84	111.91	0.07
UA5	393794.41	4963685.89	172.11	172.17	0.06
UA6	408866.43	4979036.24	175.62	175.57	-0.05
UA7	451420.89	5034504.83	314.85	314.91	0.06
UA8	439421.61	5058798.43	317.77	317.80	0.03
UA9	375960.63	4909872.96	144.69	144.64	-0.05

Average Dz	0.01 m
Minimum Dz	-0.130 m
Maximum Dz	0.211 m
Root Mean Square	0.058 m
95% Confidence Level	0.114 m

***Points BE24 and BE26 were removed from the final calculations due to #.**

Figure 10. QC Checkpoint Locations - NVA

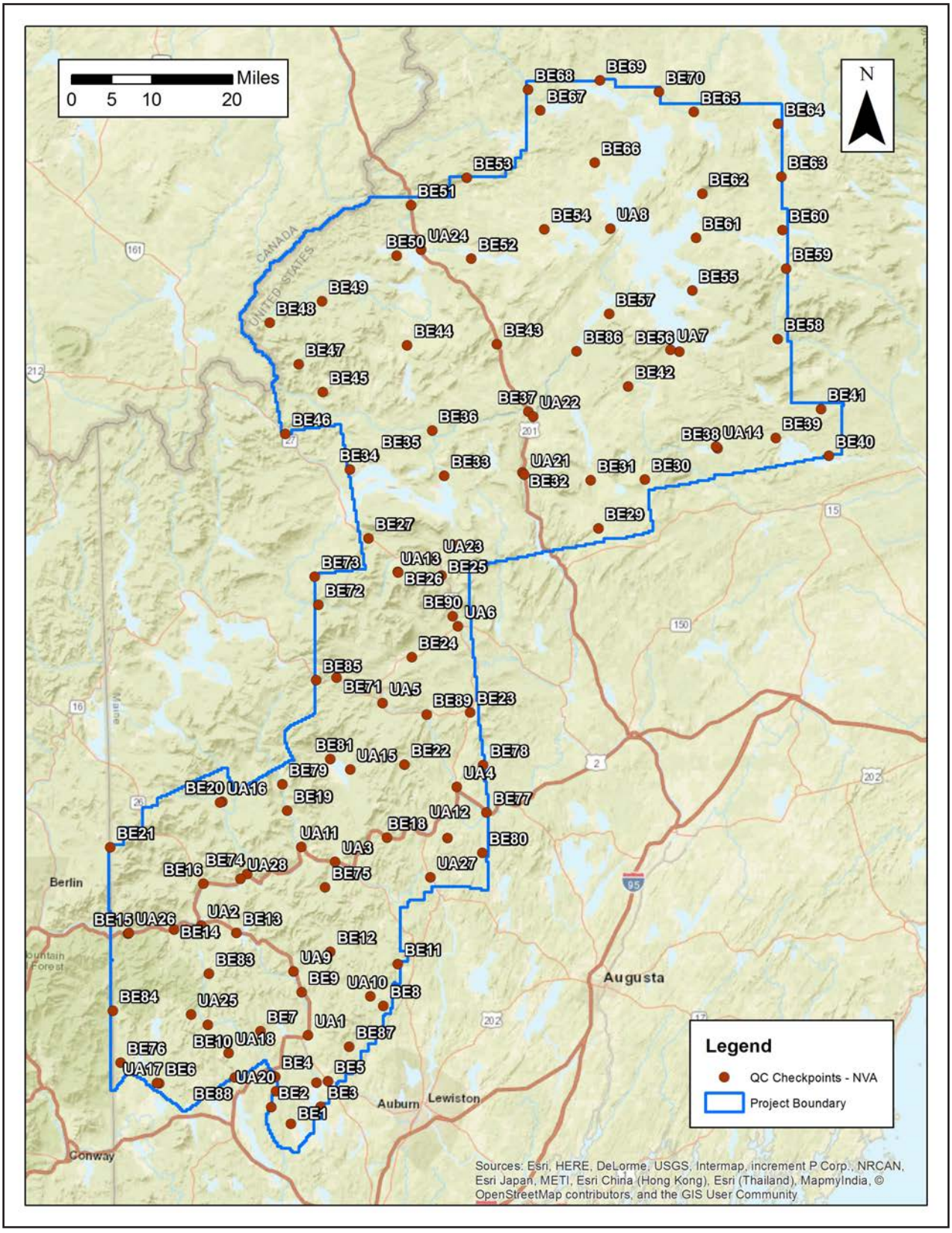


Table 6. QC Checkpoint Report - NVA

Units = Meters

Number	Easting	Northing	Known Z	Laser Z	Dz
BE1	375393.87	4879323.20	148.15	148.21	0.06
BE10	358729.97	4899177.34	189.82	189.78	-0.03
BE11	396829.84	4911419.18	127.20	127.20	0.00
BE12	383304.29	4913836.85	187.08	187.01	-0.06
BE13	364458.03	4917599.27	221.06	221.05	0.00
BE14	351987.64	4918308.12	206.61	206.57	-0.04
BE15	342763.59	4917455.70	218.68	218.72	0.04
BE16	357861.95	4927546.11	194.30	194.28	-0.01
BE17	406782.42	4936644.34	192.76	192.80	0.04
BE18	394646.49	4936719.97	169.09	169.02	-0.07
BE19	374648.75	4942147.07	174.37	174.42	0.05
BE2	371477.58	4882670.92	104.03	104.11	0.08
BE20	361625.32	4943972.28	199.58	199.60	0.03
BE21	339200.66	4934781.62	487.99	487.91	-0.09
BE22	398154.78	4951395.50	331.80	331.76	-0.04
BE23	411306.17	4961824.17	185.05	185.03	-0.02
BE24	399623.33	4972969.31	263.02	263.09	0.06
BE25	405591.45	4989199.63	232.50	232.51	0.02
BE26	396818.27	4989991.62	512.41	512.52	0.11
BE27	390927.05	4996656.55	366.67	366.74	0.07
BE28	409017.37	4995379.36	384.24	384.20	-0.04
BE29	437031.08	4998660.18	312.58	312.65	0.07
BE3	381360.24	4882790.71	132.16	132.10	-0.07
BE30	446302.76	5008502.12	402.04	402.10	0.06
BE31	435485.98	5008341.26	303.09	303.13	0.05
BE32	421818.69	5009852.98	157.93	157.98	0.05
BE33	406137.76	5009245.43	317.06	317.01	-0.04
BE34	387255.36	5010472.48	424.43	424.43	0.00
BE35	392156.31	5013131.62	422.07	422.01	-0.06
BE36	403709.47	5018298.69	334.85	334.81	-0.04
BE37	423005.75	5022074.67	186.89	186.91	0.02
BE38	460897.96	5014682.09	261.13	261.12	-0.01

Number	Easting	Northing	Known Z	Laser Z	Dz
BE39	472544.15	5016774.53	110.58	110.61	0.03
BE4	372256.08	4888806.22	123.43	123.49	0.06
BE40	483171.80	5013212.26	127.67	127.70	0.03
BE41	481632.43	5022590.43	215.52	215.67	0.15
BE42	443010.63	5027166.00	385.95	385.92	-0.04
BE43	416693.39	5035570.16	517.38	517.35	-0.03
BE44	398689.16	5035393.96	338.38	338.33	-0.05
BE45	381760.92	5026048.91	722.21	722.17	-0.03
BE46	374273.25	5017612.28	377.28	377.37	0.09
BE47	376934.63	5031574.33	679.75	679.79	0.04
BE48	371182.32	5039928.48	515.41	515.42	0.01
BE49	381627.77	5044250.53	450.68	450.70	0.02
BE5	382811.59	4887909.66	97.07	97.12	0.05
BE50	396556.27	5053407.23	381.81	381.73	-0.08
BE51	399473.25	5063516.08	428.38	428.38	0.00
BE52	411557.98	5052810.45	360.95	361.01	0.06
BE53	410640.79	5068979.54	456.09	456.09	0.00
BE54	426204.01	5058654.88	340.58	340.62	0.04
BE55	455835.52	5046401.12	314.06	314.03	-0.02
BE56	453206.28	5034141.89	322.41	322.42	0.01
BE57	439153.14	5041678.37	325.32	325.31	0.00
BE58	472975.01	5036676.19	420.88	420.90	0.02
BE59	474611.85	5050757.12	396.25	396.19	-0.07
BE6	348994.11	4887481.59	127.40	127.37	-0.03
BE60	473917.93	5058502.59	408.23	408.10	-0.13
BE61	456561.61	5056933.13	366.34	366.36	0.02
BE62	457848.54	5065822.15	347.14	347.18	0.04
BE63	473658.46	5069181.86	371.72	371.62	-0.11
BE64	473040.22	5079846.74	307.12	307.04	-0.08
BE65	456165.92	5082219.38	295.02	294.98	-0.04
BE66	436278.81	5072044.86	317.75	317.80	0.05
BE67	425357.28	5082549.04	336.06	336.01	-0.05
BE68	422926.30	5086682.60	345.88	345.86	-0.02
BE69	437298.30	5088545.61	333.91	333.87	-0.03
BE7	369273.36	4897902.16	166.64	166.52	-0.12

Number	Easting	Northing	Known Z	Laser Z	Dz
BE70	449119.05	5086207.77	313.20	313.18	-0.02
BE71	384581.24	4968870.85	258.41	258.44	0.03
BE72	380874.06	4983360.37	468.26	468.44	0.17
BE73	380137.36	4989029.86	867.58	867.59	0.01
BE74	366615.74	4929455.35	191.80	191.75	-0.06
BE75	382266.23	4926785.59	153.87	153.91	0.04
BE76	341250.90	4891624.37	132.56	132.55	-0.02
BE77	414600.10	4941801.17	105.04	105.11	0.07
BE78	413933.97	4951288.90	176.46	176.52	0.06
BE79	373710.25	4947459.55	219.40	219.40	0.00
BE8	393908.72	4902967.74	108.51	108.61	0.09
BE80	413761.11	4933656.26	116.82	116.80	-0.02
BE81	383270.89	4952495.60	207.90	207.82	-0.07
BE82	392436.99	4898008.02	105.33	105.30	-0.03
BE83	358945.23	4909420.28	196.33	196.31	-0.02
BE84	339692.43	4901992.65	165.64	165.60	-0.04
BE85	380439.33	4968325.82	325.58	325.60	0.02
BE86	432675.42	5034223.56	296.55	296.54	-0.01
BE87	387098.29	4894782.01	165.96	165.93	-0.02
BE88	364165.23	4888663.60	118.38	118.42	0.03
BE89	402604.69	4961444.18	149.25	149.29	0.04
BE9	377594.10	4905728.78	138.08	138.05	-0.03
BE90	407823.35	4981022.88	184.80	184.73	-0.08
UA1	378813.44	4897127.42	119.17	119.30	0.14
UA10	391287.98	4904906.83	109.80	109.91	0.11
UA11	377474.43	4934841.24	132.56	132.58	0.02
UA12	401827.03	4939118.42	188.30	188.30	0.00
UA13	396877.44	4989822.79	531.30	531.33	0.03
UA14	460593.90	5015094.81	266.35	266.32	-0.03
UA15	387287.00	4950377.93	225.83	226.02	0.19
UA16	361216.07	4943778.07	213.07	213.10	0.02
UA17	348579.74	4887516.30	126.92	126.88	-0.04
UA18	362888.21	4893528.23	154.08	154.02	-0.06
UA19	380538.43	4887593.00	99.82	99.94	0.12
UA2	357378.61	4919093.86	201.39	201.38	0.00

Number	Easting	Northing	Known Z	Laser Z	Dz
UA20	372409.13	4885909.48	115.18	115.19	0.00
UA21	422158.46	5009428.18	170.47	170.49	0.01
UA22	423926.09	5021121.95	177.93	177.96	0.03
UA23	404582.38	4992230.48	255.78	255.78	-0.01
UA24	401529.69	5054528.50	357.70	357.68	-0.01
UA25	355399.80	4901236.37	182.70	182.72	0.02
UA26	342932.94	4917593.83	218.38	218.42	0.04
UA27	403358.60	4928782.36	121.68	121.69	0.01
UA28	365314.32	4928459.10	194.23	194.26	0.04
UA3	384260.59	4931919.03	127.92	127.94	0.01
UA4	408632.47	4946914.49	111.84	111.91	0.07
UA5	393794.41	4963685.89	172.11	172.14	0.03
UA6	408866.43	4979036.24	175.62	175.57	-0.05
UA7	451420.89	5034504.83	314.85	314.92	0.06
UA8	439421.61	5058798.43	317.77	317.80	0.03
UA9	375960.63	4909872.96	144.69	144.63	-0.06

Average Dz	0.01 m
Minimum Dz	-0.133 m
Maximum Dz	0.187 m
Root Mean Square	0.058 m
95% Confidence Level	0.113 m

Figure 11. QC Checkpoint Locations - VVA

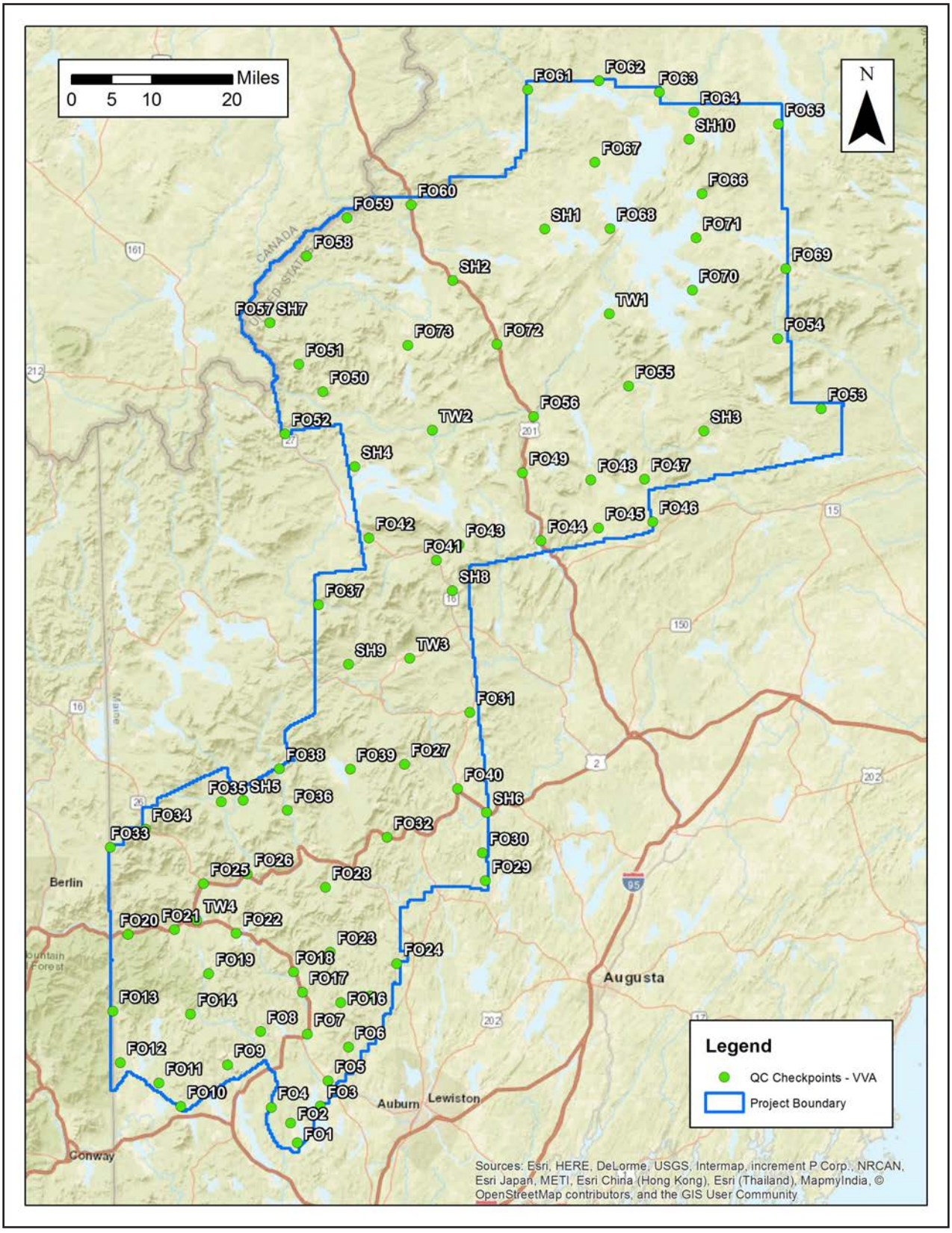


Table 7. QC Checkpoint Report - VVA

Units = Meters

Number	Easting	Northing	Known Z	Laser Z	Dz
FO1	376640.46	4875578.70	162.40	162.32	-0.07
FO10	353302.36	4882810.09	239.90	239.93	0.03
FO11	348953.34	4887517.34	126.89	126.87	-0.02
FO12	341211.81	4891597.54	131.23	131.32	0.09
FO13	339689.12	4901951.97	165.00	165.06	0.06
FO14	355291.84	4901318.19	192.16	192.25	0.09
FO15	391287.72	4904978.60	102.67	102.72	0.05
FO16	385384.46	4903620.15	275.25	275.30	0.05
FO17	377701.51	4905714.40	135.33	135.41	0.07
FO18	375905.27	4909816.99	140.81	140.83	0.02
FO19	358928.02	4909441.87	195.56	195.90	0.34
FO2	375328.29	4879481.52	144.85	144.82	-0.04
FO20	342789.44	4917338.73	221.76	221.86	0.10
FO21	352032.24	4918313.34	205.90	205.94	0.04
FO22	364427.90	4917581.62	220.84	220.98	0.14
FO23	383313.27	4913793.93	185.66	185.62	-0.04
FO24	396627.02	4911420.85	140.47	140.63	0.16
FO25	357897.04	4927505.29	192.25	192.31	0.06
FO26	366653.27	4929430.18	191.24	191.34	0.10
FO27	398130.26	4951423.80	330.87	331.07	0.20
FO28	382325.07	4926779.91	152.12	152.12	-0.01
FO29	414349.38	4928117.33	175.95	176.01	0.05
FO3	381287.80	4882892.81	126.93	127.07	0.13
FO30	413786.76	4933667.21	119.87	119.90	0.03
FO31	411251.77	4961829.46	185.31	185.33	0.01
FO32	394652.09	4936773.94	177.26	177.07	-0.19
FO33	339185.04	4934798.85	487.42	487.40	-0.01
FO34	346257.79	4938467.43	458.08	458.30	0.21
FO35	361441.72	4943907.34	199.53	199.63	0.10
FO36	374676.71	4942196.76	173.96	173.84	-0.12
FO37	380868.67	4983341.10	467.55	467.70	0.15
FO38	373110.93	4950557.65	227.45	227.51	0.06

Number	Easting	Northing	Known Z	Laser Z	Dz
FO39	387292.41	4950448.36	226.61	226.83	0.21
FO4	371445.75	4882620.78	102.20	102.38	0.18
FO40	408774.27	4946513.96	104.22	104.36	0.14
FO41	404510.83	4992249.40	260.61	260.76	0.15
FO42	390996.59	4996696.56	365.92	366.00	0.07
FO43	409043.63	4995407.33	386.62	386.67	0.05
FO44	425497.17	4996198.11	167.23	167.29	0.06
FO45	437051.26	4998722.99	317.57	317.60	0.04
FO46	447857.35	4999992.37	481.78	481.80	0.03
FO47	446266.77	5008535.11	403.06	402.91	-0.15
FO48	435501.20	5008375.89	301.64	301.76	0.12
FO49	421820.86	5009783.49	158.48	158.70	0.22
FO5	382859.62	4887936.58	96.33	96.39	0.06
FO50	381798.21	5026082.08	723.16	723.27	0.11
FO51	376945.98	5031587.28	677.86	678.12	0.26
FO52	374218.25	5017608.31	389.21	389.34	0.14
FO53	481601.11	5022657.59	214.23	214.48	0.25
FO54	472964.52	5036742.89	418.52	418.52	0.00
FO55	443046.05	5027188.01	383.67	383.70	0.03
FO56	423991.81	5021099.48	177.04	177.49	0.45
FO57	371165.48	5039905.10	516.11	516.20	0.10
FO58	378549.92	5053261.38	442.15	442.25	0.10
FO59	386612.62	5060948.47	544.04	544.13	0.09
FO6	386912.78	4894733.62	163.43	163.44	0.01
FO60	399484.95	5063550.64	430.13	430.18	0.05
FO61	422817.55	5086668.80	347.51	347.56	0.05
FO62	437116.61	5088437.29	344.89	344.98	0.09
FO63	449217.04	5086170.33	312.75	312.85	0.10
FO64	456101.08	5082170.90	295.34	295.48	0.14
FO65	473050.08	5079768.30	309.48	309.48	0.00
FO66	457764.28	5065783.06	341.29	341.37	0.09
FO67	436311.95	5072112.61	320.97	321.14	0.17
FO68	439370.03	5058799.33	318.95	319.00	0.05
FO69	474581.81	5050776.93	396.35	396.26	-0.09
FO7	378688.89	4897348.27	126.89	126.92	0.03

Number	Easting	Northing	Known Z	Laser Z	Dz
FO70	455868.68	5046449.19	315.99	315.93	-0.06
FO71	456604.81	5056937.46	368.10	368.12	0.02
FO72	416690.79	5035588.54	519.14	519.13	-0.01
FO73	398786.81	5035390.69	343.52	343.58	0.06
FO8	369291.75	4897879.61	165.86	165.83	-0.03
FO9	362714.18	4891135.53	132.11	131.97	-0.14
SH1	426234.63	5058708.69	337.53	337.56	0.03
SH10	455158.38	5076729.66	327.81	327.92	0.11
SH2	407815.75	5048412.34	606.63	606.64	0.01
SH3	458158.04	5018183.96	336.80	336.84	0.04
SH4	388176.84	5011062.48	422.94	423.21	0.27
SH5	365837.18	4944265.42	231.88	232.03	0.15
SH6	414593.37	4941824.03	104.54	104.88	0.34
SH7	371195.08	5039922.60	515.56	515.77	0.21
SH8	407735.94	4986165.30	227.84	227.93	0.09
SH9	386930.93	4971551.55	297.99	298.11	0.12
TW1	439173.11	5041730.49	324.51	324.65	0.15
TW2	403708.54	5018326.81	335.64	335.76	0.12
TW3	399210.38	4972724.34	263.81	263.92	0.11
TW4	356541.25	4920154.11	197.24	197.30	0.06

Average Dz	0.08 m
Minimum Dz	-0.189 m
Maximum Dz	0.453 m
Root Mean Square	0.131 m
95th Percentile	0.253 m