



Project Report

TASK ORDER NAME: GA_Central_2019_B19

TASK ORDER NUMBER: 140G0219F0277

CONTRACT NUMBER: G16PC00042

ATLANTIC PROJECT NUMBER: 19064

BLOCK NUMBER: Block 5

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SECTION 1: PROJECT OVERVIEW AND PURPOSE

1.1 Aerial LiDAR Project

1.1.1 Project Overview

USGS task order 140G0219F0277 required Winter 2019/Spring 2020 LiDAR surveys to be collected over 20,320 square miles covering part or all of 60 counties in Georgia and 6 counties in Alabama in support of the USGS 3DEP Program. Aerial LiDAR data for this task order was planned, acquired, processed, and produced at an aggregate nominal pulse spacing (ANPS) of ≤ 0.71 meters and in compliance with USGS National Geospatial Program LiDAR Base Specification version 1.3. The Block 05 area encompasses approximately 3,057 square miles.

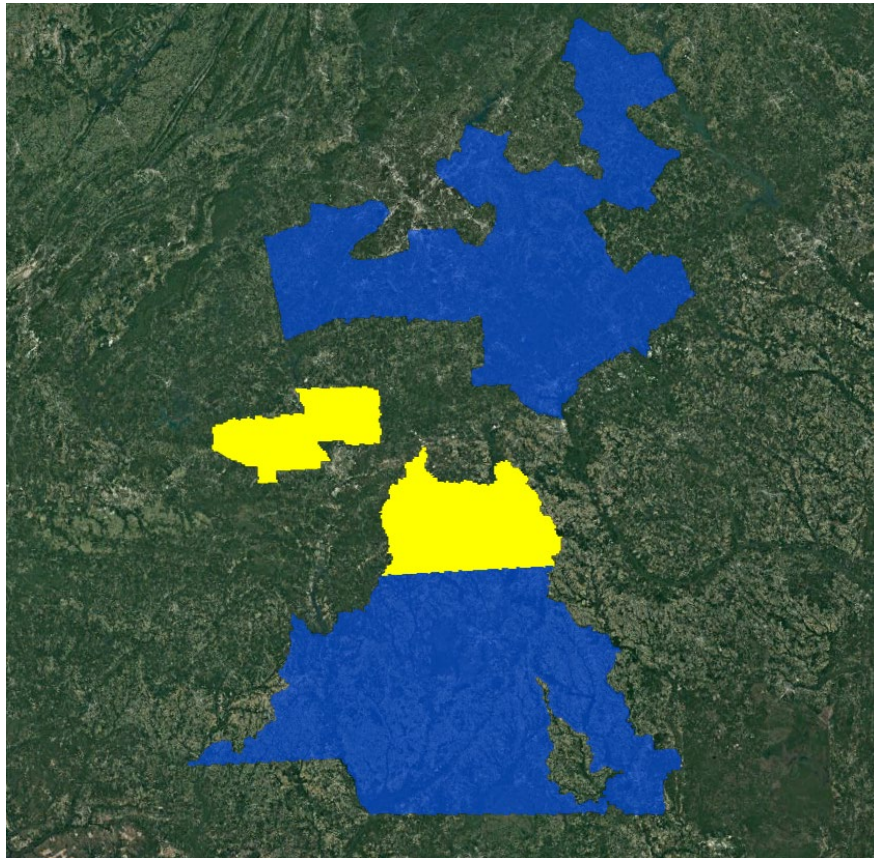


Figure 1: Aerial LiDAR Project Overview – Defined Project Area (DPA) in Yellow and Associated Areas of Interest (AOIs) in Blue

1.1.2 Project Purpose

Aerial lidar was collected to support the mapping efforts of individual counties in the State of Georgia and Alabama and the USGS 3DEP program.

1.1.3 Contract Deliverables

Item	Specification/Format
Classified Point Cloud	LAS v1.4, tiled delivery
Bare Earth Surface	Raster DEM, 1m cell size, hydro flattened, GeoTIFF format
Breaklines	Hydro breaklines to BPA limit, .gdb format
Intensity Imagery	1m cell size, 8-bit, 256 gray scale, GeoTIFF format
Delivery Diagram	.gdb format
Metadata	Per product, FGDC compliant, .xml format
Project Report	Field work procedures, QC procedures and results, overall accuracy, .pdf format

Table 1: Aerial LiDAR Contract Deliverables

SECTION 2: FIELD OPERATIONS

2.1 Aerial LiDAR Project – Aerial Acquisition

2.1.1 Aircraft and Sensor Information

Atlantic operated a PAC 750 outfitted with an Optech Galaxy Prime LiDAR system during the collection of the project area. The specifications of this system are presented in the following table:

Parameter	Specification
Model	Galaxy Prime
Manufacturer	Optech
Performance Envelope	150 – 4700 m AGL, nominal
Absolute Horizontal Accuracy	1/10,000 x altitude
Absolute Elevation Accuracy	< 0.03 – 0.20 m RMSE from 150 – 4700 m AGL
Topographic Laser	1064-nm near-infrared
Laser Classification	Class IV
Pulse Repetition Frequency (Effective)	Programmable, 50 – 1000 kHz
Beam Divergence	0.25 mrad (1/e)
Laser Range Precision	< 0.008 m
Minimum Target Separation Distance	< 0.7 m (discrete)
Range Capture	Up to 8 range measurements, including last
Intensity Capture	Up to 8 intensity measurements, including last (12-bit)
Scan Angle (Fov)	10 – 60°
Swath Width	10 – 115% of altitude AGL
Scan Frequency	0 – 120 Hz advertised (0 – 240 scan lines/sec)
Scan Product	2000 maximum
Roll Compensation	±5° minimum
Data Storage	Internal solid-state drive (SSD)
Power Requirements	28 V; 300 W
Dimensions and Weight	Sensor: 0.34 x 0.34 x 0.25 m, 27 kg PDU: 0.42 x 0.33 x 0.10 m, 6.5 kg
Operation Temperature	0 to +35°C

Table 2: System Specifications – Galaxy Prime

2.1.2 Sensor Acquisition Information

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

Parameter	Specification
System	Optech Galaxy Prime
Nominal Pulse Spacing (m)	.70
Nominal Pulse Density (pls/m²)	2
Nominal Flight Height (AGL meters)	2000
Nominal Flight Speed (kts)	150
Pass Heading (°)	91-271
Sensor Scan Angle (°)	45
Scan Frequency (Hz)	60
Pulse Rate of Scanner (kHz)	350
Line Spacing (m)	1300
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	6
Beam Divergence (mrad)	.25
Nominal Swath Width (m)	1657
Nominal Swath Overlap (%)	20
Scan Pattern	TRIANGLE

Table 3: Aerial LiDAR Sensor Acquisition Parameters

2.1.3 Flight Plan Execution

Atlantic acquired 128 passes of the AOI as a series of perpendicular and/or adjacent flight-lines executed in 10 flight missions conducted between January 25, 2020 and February 23, 2020. 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.

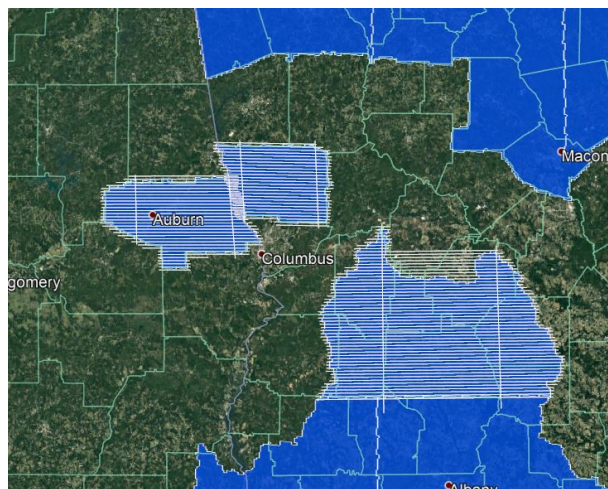


Figure 2: Orientation of Executed Flight-lines and LiDAR DPA

2.1.4 GNSS Reference Stations

Twenty-nine (29) 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
AL60	CORS	AL60	N32°24'40.94502"	W86°16'13.97623"	44.676
AL62	CORS	AL62	N32°08'53.36427"	W85°41'12.37923"	140.811
AL76	CORS	AL76	N31°52'29.95916"	W85°13'32.48368"	100.108
ALA1	CORS	ALA1	N32°35'55.88602"	W85°30'14.13662"	184.083
ALAS	CORS	ALAS	N33°40'01.20714"	W85°49'50.49202"	203.112
ALB2	CORS	ALB2	N32°36'23.67663"	W85°29'43.69118"	191.602
ALCL	CORS	ALCL	N32°50'23.79917"	W86°37'47.41442"	167.636
ALCN	CORS	ALCN	N34°09'46.97942"	W85°39'31.04967"	164.904
ALHC	CORS	ALHC	N33°31'25.44554"	W85°38'05.50168"	256.548
ALHL	CORS	ALHL	N33°53'15.29815"	W86°23'52.62571"	330.735
ALLA	CORS	ALLA	N32°55'02.66210"	W85°24'01.80638"	237.158
ALTU	CORS	ALTU	N31°48'00.73673"	W85°57'15.53866"	141.125
FL75	CORS	FL75	N30°36'45.11303"	W83°08'48.07670"	23.03
GAAE	CORS	GAAE	N33°25'38.07517"	W82°04'04.06813"	124.356
GAAY	CORS	GAAY	N31°39'40.91991"	W84°16'29.65337"	55.889
GABY	CORS	GABY	N31°22'39.31821"	W84°56'06.69095"	63.548
GACC	CORS	GACC	N33°32'44.73033"	W82°08'01.72589"	98.476
GACR	CORS	GACR	N32°22'51.45820"	W83°20'46.43161"	97.765
GACU	CORS	GACU	N32°27'51.70105"	W84°59'11.19593"	53.137
GALG	CORS	GALG	N33°01'14.63304"	W84°59'51.19813"	217.572
GAMN	CORS	GAMN	N32°50'39.13862"	W84°37'23.96481"	307.93
GANW	CORS	GANW	N33°18'20.82416"	W84°46'02.51034"	260.003
GARA	CORS	GARA	N32°12'58.40828"	W83°51'11.16996"	91.464
GAWE	CORS	GAWE	N32°00'31.56777"	W84°33'33.38034"	128.755
P805	CORS	P805	N32°57'47.65078"	W84°13'32.99334"	215.735
P806	CORS	P806	N32°57'47.92284"	W84°13'33.05704"	215.865
TALH	CORS	TALH	N30°23'47.50413"	W84°21'21.06140"	-7.292
ZJX1	CORS	ZJX1	N30°41'55.89381"	W81°54'29.46897"	1.722
ZTL4	CORS	ZTL4	N33°22'46.87805"	W84°17'48.21669"	260.682

Table 4: GNSS Reference Stations

2.2 Aerial LiDAR Project – Ground Acquisition

2.2.1 Ground Control Survey

A total of 160 ground survey points were collected in support of this project, including 47 LiDAR Control Points (LCP), 65 Non-vegetated Vertical Accuracy (NVA) and 48 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 and 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
LCP86	970317.339	1118209.342	179.412
LCP87	975307.887	1107344.495	158.944
LCP88	988809.165	1118097.379	234.25
LCP89	988216.233	1104302.034	171.134
LCP90	1009467.532	1104533.299	104.398
LCP91	1003435.998	1127454.278	202.642
LCP92	1015340.813	1143789.582	222.649
LCP93	1035790.014	1147034.281	269.004
LCP94	1047621.651	1130443.632	230.236
LCP95	1039396.709	1121295.658	221.639
LCP96	1022787.014	1127182.5	167.796
LCP97	1024965.602	1142981.62	252.927
LCP701	1076662.155	1112355.516	196.758
LCP702	1075215.872	1106465.61	194.259
LCP703	1069268.138	1103094.723	219.487
LCP704	1068334.875	1095231.942	196.876
LCP705	1081025.401	1098817.595	137.689
LCP706	1065276.503	1090341.697	185.336

ID	Easting	Northing	Elevation
LCP707	1083959.898	1091189.856	156.384
LCP708	1101062.226	1097529.151	133.95
LCP709	1119988.765	1096692.673	104.088
LCP710	1108033.654	1090276.823	116.473
LCP711	1088135.95	1083337.63	169.964
LCP712	1066587.363	1074707.068	174.506
LCP713	1062534.56	1072027.308	172.388
LCP714	1072514.875	1061627.657	145.083
LCP716	1080301.496	1069903.2	167.962
LCP717	1092708.383	1066286.007	148.8
LCP718	1110358.547	1082321.553	113.017
LCP719	1120356.655	1073903.627	121.706
LCP720	1070093.443	1051725.237	146.31
LCP721	1075823.325	1047765.117	144.109
LCP722	1099116.106	1064914.673	140.44
LCP723	1134958.231	1060734.698	76.151
LCP724	1113479.427	1067421.088	124.453
LCP725	1102465.558	1068730.49	108.783
LCP726	1120525.203	1108540.388	138.253
LCP727	1125951.648	1108279.651	132.818
LCP728	1131984.373	1104289.738	115.852
LCP729	1128282.514	1090112.178	112.82
LCP730	1125534.908	1084708.678	100.308
LCP731	1132445.469	1086565.7	93.629
LCP732	1143081.364	1091056.237	115.311
LCP733	1137417.125	1073310.615	99.676
LCP734	1131168.238	1069726.667	90.018
LCP735	1153444.978	1071004.744	111.261
LCP736	1144766.44	1056997.533	88

Table 5: LiDAR Control Point Coordinates

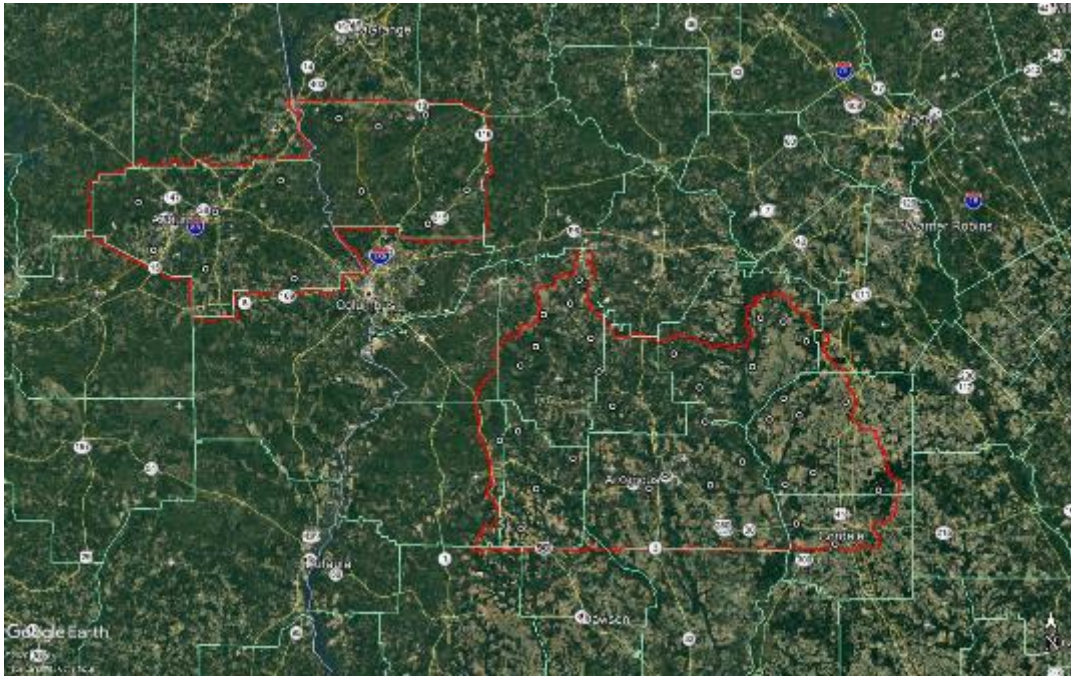


Figure 3: LiDAR Control Point Distribution

ID	Easting	Northing	Elevation
BE50	1011162.476	1142608.355	191.325
BE51	1031103.526	1144642.351	263.941
BE52	1047715.413	1125825.075	208.342
BE53	1018943.571	1122550.176	162.485
BE54	965066.915	1121859.34	235.012
BE55	986664.825	1110350.93	183.047
BE56	1014663.611	1107792.317	134.124
BE57	1076667.964	1112351.74	197.208
BE58	1069264.079	1103096.555	219.618
BE59	1065272.442	1090341.64	185.402
BE60	1083964.521	1091191.202	156.401
BE61	1108029.922	1090278.199	116.391
BE62	1128282.054	1090120.131	112.502
BE63	1120528.999	1108541.109	138.243
BE64	1131984.255	1104285.108	115.906
BE65	1143084.103	1091054.363	115.281
BE66	1062532.47	1072029.858	172.454
BE67	1102469.544	1068723.971	108.741

ID	Easting	Northing	Elevation
BE68	1120357.366	1073899.323	121.582
BE69	1137417.146	1073314.544	99.791
BE70	1153442.133	1071008.368	111.187
BE701	1085728.913	1081974.647	167.201
BE702	1138663.865	1081866.851	112.535
BE71	1070089.957	1051729.359	146.318
OT110	1095353.115	1056263.515	115.801
OT117	1069008.23	1068018.87	138.607
OT118	1109908.301	1076280.619	138.878
OT119	1060816.889	1082623.549	185.542
OT50	1019411.326	1141431.255	221.119
OT51	1042131.659	1143170.793	234.59
OT52	1020573.333	1134370.588	212.683
OT53	1037242.368	1125797.754	211.512
OT54	985889.349	1123826.093	214.652
OT55	988933.105	1097527.857	164.715
OT56	1005903.515	1119063.986	198.48
OT57	1078001.763	1100532.054	135.339
OT58	1068435.65	1081130.331	155.989
OT59	1097580.49	1082626.187	145.176
OT60	1125532.873	1084705.616	100.273
OT61	1124314.967	1099928.522	122.64
OT62	1138668.954	1081866.722	112.576
OT63	1080759.623	1062597.577	138.046
OT64	1106525.616	1068355.06	124.057
OT65	1128716.42	1062380.742	88.131
OT66	1146354.244	1063442.949	86.982
OT701	1105206.695	1068087.201	124.922
UR50	1040108.604	1134530.795	198.545
UR51	974077.518	1112456.023	204.716
UR52	997329.633	1123287.932	225.858
UR53	1001494.632	1108176.783	158.276
UR54	1009727.797	1126974.818	161.203
UR55	1027397.043	1127334.202	190.688
UR56	1045891.15	1136042.079	241.951
UR57	1072928.524	1091918.982	202.19
UR58	1082792.062	1076288.078	183.27
UR59	1094444.915	1092299.281	145.299

ID	Easting	Northing	Elevation
UR60	1115109.88	1089593.489	101.161
UR61	1134506.567	1092548.39	120.844
UR62	1129216.271	1077933.43	93.185
UR63	1144861.63	1077735.419	108.079
UR64	1105127.501	1069606.846	136.046
UR65	1068292.814	1059975.178	150.491
UR66	1083602.61	1053510.406	126.574
UR67	1118078.718	1056899.52	105.565
UR68	1136862.195	1057549.128	83.313

Table 6: Non-Vegetated Vertical Accuracy (NVA) Point Coordinates

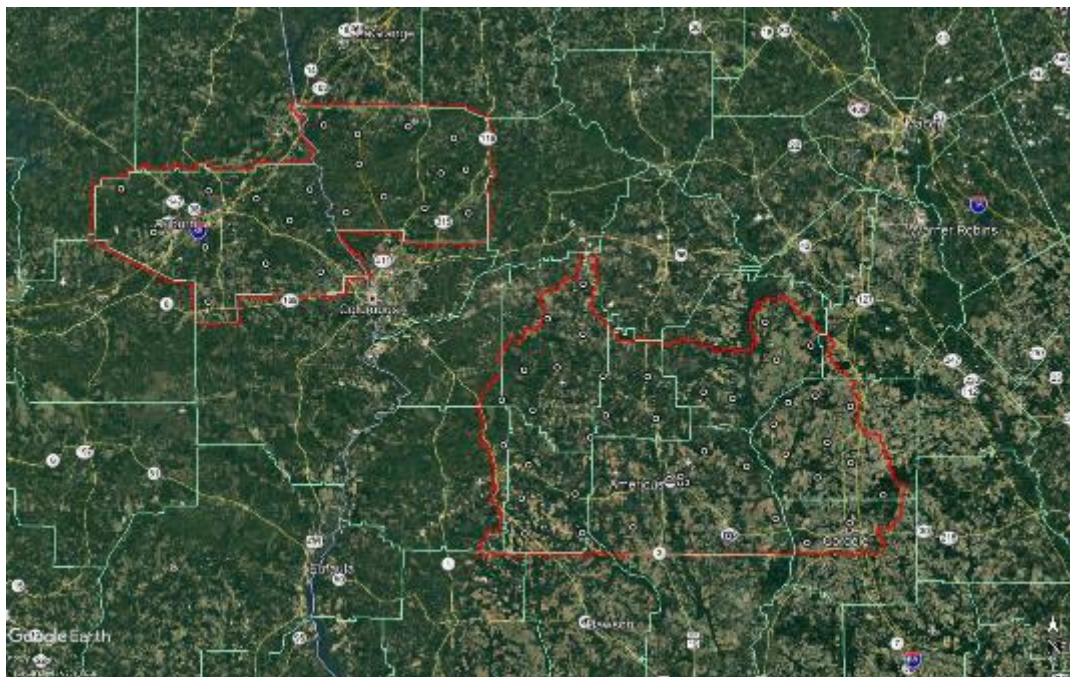


Figure 4: Non-Vegetated Vertical Accuracy (NVA) Point Distribution

ID	Easting	Northing	Elevation
BR35	975006.289	1122263.367	214.515
BR36	982395.171	1105690.806	158.229
BR37	1009648.325	1114599.66	198.746
BR38	1037749.904	1141444.624	258.896

ID	Easting	Northing	Elevation
BR39	1024774.039	1120809.472	163.338
BR40	1077766.85	1083717.706	161.071
BR41	1117803.242	1082165.394	99.851
BR42	1075825.886	1056857.746	150.602
BR43	1120249.488	1063988.65	94.669
BR44	1138634.673	1064854.441	94.835
BR47	1103421.352	1055310.077	107.316
BR701	1063582.009	1076897.072	176.403
HG35	981440.778	1117173.509	196.796
HG36	994342.458	1106214.967	206.165
HG37	1014519.349	1119187.541	157.436
HG38	1014052.333	1130016.321	200.343
HG39	1032926.066	1130936.815	198.177
HG40	1068690.117	1084911.185	159.379
HG41	1101663.926	1089130.878	149.529
HG42	1111984.036	1095149.591	118.28
HG43	1138734.069	1087672.599	123.897
HG44	1100716.132	1079024.121	147.3
HG45	1074501.254	1074914.487	149.281
HG48	1128573.446	1056557.207	86.521
TR35	1013924.095	1136659.509	214.131
TR36	1028370.476	1135067.982	238.64
TR37	1042963.396	1130746.033	219.914
TR38	966608.9	1112426.028	172.175
TR39	995958.773	1116580.56	243.296
TR40	1075219.865	1106463.83	194.249
TR41	1068305.916	1095230.99	198.241
TR42	1081033.099	1098819.322	137.797
TR43	1101058.183	1097527.747	133.924
TR44	1119993.477	1096697.53	104.112
TR45	1125955.309	1108278.256	132.857
TR46	1132446.351	1086578.632	94.117
TR47	1110342.589	1082332.851	114.55
TR48	1088131.986	1083332.657	169.94
TR49	1066593.347	1074708.244	174.428
TR50	1080303.539	1069914.515	167.641
TR51	1092717.78	1066294.22	148.495
TR52	1113483.309	1067418.356	124.54

ID	Easting	Northing	Elevation
TR53	1131152.915	1069730.254	89.554
TR54	1144759.961	1056994.117	88.205
TR56	1099117.311	1064930.108	139.985
TR58	1075815.839	1047764.186	144.372
TR701	1134950.761	1060725.121	76.724
TR702	1138737.978	1087666.736	124.177

Table 7: Vegetated Vertical Accuracy (VVA) Point Coordinates

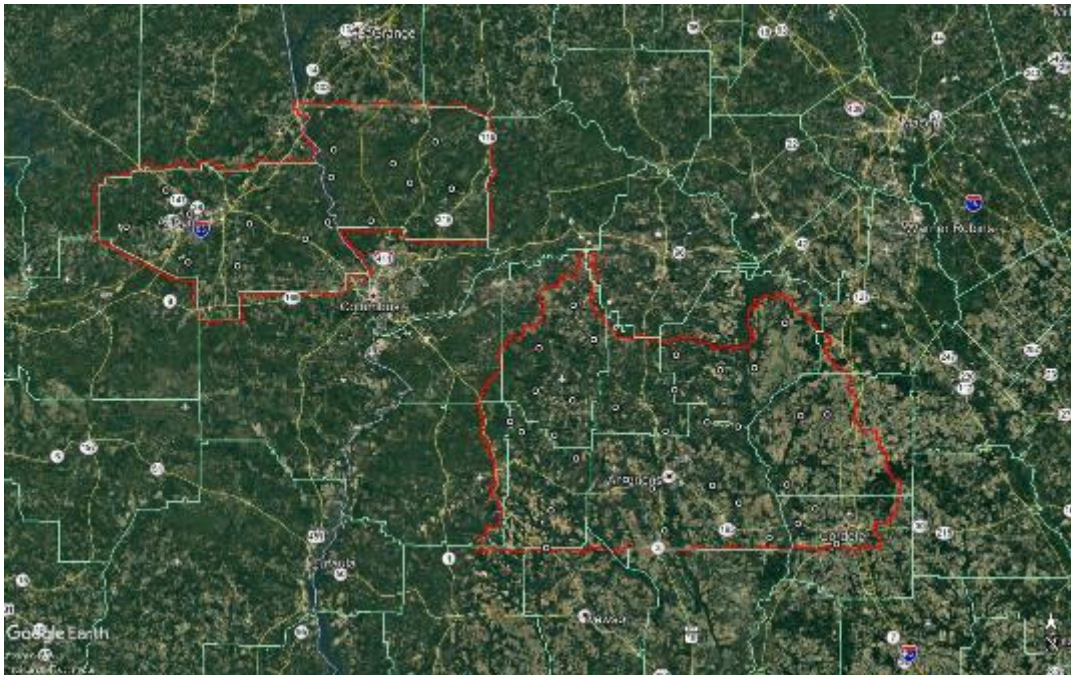


Figure 5: Vegetated Vertical Accuracy (VVA) Point Distribution

SECTION 3: DATA PRODUCTION

3.1 Aerial LiDAR Project – Calibration/Classification

3.1.1 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.

3.1.2 Coordinate Reference System

Parameter	Specification
Horizontal Datum	Albers Equal Area
Coordinate System	NAD83 2011
Vertical Datum	NAVD88
Geoid Model	12B
EPSG Code	6350
Units of Reference	Meter

Table 1: Coordinate Reference System

3.1.3 LiDAR Point Cloud Statistics

Category	Value
Total Points (Nominal)	25,815,441,129
Nominal Pulse Spacing (M)	0.4253
Nominal Pulse Density (PLS/M²)	5.5287
Total Points (Aggregate)	25,817,581,617
Aggregate Pulse Spacing (M)	0.5749
Aggregate Pulse Density (PLS/M²)	3.0260

Table 9: LiDAR Point Cloud Statistics

3.1.4 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.

3.1.5 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.

3.1.6 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 class 9 (Water).

Code	Description
1	Processed but unclassified
2	Bare-earth ground
3	Low Vegetation (0.5-5 feet)
4	Medium Vegetation (5-20 feet)
5	High Vegetation (>20 feet)
6	Buildings
7	Low Noise
9	Water
17	Bridge Decks
18	High Noise
20	Ignored Ground (breakline proximity)

Table 2: LiDAR Point Classification Codes and Descriptions

3.1.7 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 GeoTIFF format.

3.1.8 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 format for the entire project area.

3.1.9 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 .tif format.

SECTION 4: ACCURACY ASSESSMENT

4.1 Aerial LiDAR Project – Vertical Accuracy Assessment

4.1.1 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 95th 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 3: 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).

4.1.2 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)	64	0.0640	0.1255	0.1271
NVA (DEM)	64	0.0633	0.1241	0.0672
VVA (Point Cloud)	45	0.0876	0.1717	0.1834
VVA (DEM)	45	0.0884	0.1733	0.0312

Table 4: NVA/VVA Accuracies

SECTION 5: CERTIFICATION STATEMENTS

5.1 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 6: CONTROL POINT ASSESSMENTS

6.1 Aerial LiDAR Project

6.1.1 Point Cloud Check Point Assessment

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
BE50	1011162.4760	1142608.3550	191.3250	191.3040	-0.0210	NVA
BE51	1031103.5260	1144642.3510	263.9410	263.9300	-0.0110	NVA
BE52	1047715.4130	1125825.0750	208.3420	208.3170	-0.0250	NVA
BE53	1018943.5710	1122550.1760	162.4850	162.4610	-0.0240	NVA
BE54	965066.9150	1121859.3400	235.0120	234.9950	-0.0170	NVA
BE55	986664.8250	1110350.9300	183.0470	183.0700	0.0230	NVA
BE56	1014663.6110	1107792.3170	134.1240	134.0880	-0.0360	NVA
BE57	1076667.4970	1112352.3810	197.2080	197.2160	0.0080	NVA
BE58	1069263.6100	1103097.1930	219.6180	219.6830	0.0650	NVA
BE59	1065271.9730	1090342.2750	185.4020	185.4300	0.0280	NVA
BE60	1083964.0550	1091191.8370	156.4010	156.4690	0.0680	NVA
BE61	1108029.4610	1090278.8340	116.3910	116.3980	0.0070	NVA
BE62	1128281.5980	1090120.7660	112.5020	112.4190	-0.0830	NVA
BE63	1120528.5410	1108541.7490	138.2430	138.1990	-0.0440	NVA
BE64	1131983.8000	1104285.7460	115.9060	115.8610	-0.0450	NVA
BE65	1143083.6500	1091054.9980	115.2810	115.2370	-0.0440	NVA
BE66	1062531.9990	1072030.4890	172.4540	172.4140	-0.0400	NVA
BE67	1102469.0820	1068724.6020	108.7410	108.7390	-0.0020	NVA
BE68	1120356.9080	1073899.9540	121.5820	121.6960	0.1140	NVA
BE69	1137416.6910	1073315.1750	99.7910	99.8770	0.0860	NVA
BE70	1153441.6820	1071008.9990	111.1870	111.2740	0.0870	NVA
BE701	1085728.4480	1081975.2800	167.2010	167.1960	-0.0050	NVA
BE702	1138663.4110	1081867.4840	112.5350	112.4750	-0.0600	NVA
BE71	1070089.4890	1051729.9860	146.3180	146.4630	0.1450	NVA
BR35	975006.2890	1122263.3670	214.5150	214.6070	0.0920	VVA
BR36	982395.1710	1105690.8060	158.2290	158.2510	0.0220	VVA
BR37	1009648.3250	1114599.6600	198.7460	198.7670	0.0210	VVA
BR38	1037749.9040	1141444.6240	258.8960	258.9200	0.0240	VVA
BR39	1024774.0390	1120809.4720	163.3380	163.3300	-0.0080	VVA
BR40	1077766.3830	1083718.3400	161.0710	161.1540	0.0830	VVA
BR41	1117802.7830	1082166.0270	99.8510	99.8840	0.0330	VVA
BR42	1075825.4190	1056858.3730	150.6020	150.7750	0.1730	VVA
BR43	1120249.0300	1063989.2790	94.6690	94.8550	0.1860	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
BR44	1138634.2190	1064855.0700	94.8350	94.9650	0.1300	VVA
BR47	1103420.8910	1055310.7040	107.3160	107.5500	0.2340	VVA
BR701	1063581.5390	1076897.7040	176.4030	176.4240	0.0210	VVA
HG35	981440.7780	1117173.5090	196.7960	196.8800	0.0840	VVA
HG36	994342.4580	1106214.9670	206.1650	206.1380	-0.0270	VVA
HG37	1014519.3490	1119187.5410	157.4360	157.4920	0.0560	VVA
HG38	1014052.3330	1130016.3210	200.3430	200.3470	0.0040	VVA
HG39	1032926.0660	1130936.8150	198.1770	198.1880	0.0110	VVA
HG40	1068689.6480	1084911.8190	159.3790	159.4350	0.0560	VVA
HG41	1101663.4640	1089131.5130	149.5290	149.6580	0.1290	VVA
HG42	1111983.5760	1095150.2280	118.2800	118.3250	0.0450	VVA
HG43	1138733.6150	1087673.2330	123.8970	123.9430	0.0460	VVA
HG44	1100715.6700	1079024.7540	147.3000	147.4550	0.1550	VVA
HG45	1074500.7860	1074915.1190	149.2810	149.3420	0.0610	VVA
HG48	1128572.9890	1056557.8340	86.5210	86.6560	0.1350	VVA
OT110	1095352.6510	1056264.1420	115.8010	116.0280	0.2270	NVA
OT117	1069007.7610	1068019.5000	138.6070	138.5840	-0.0230	NVA
OT118	1109907.8410	1076281.2510	138.8780	138.8220	-0.0560	NVA
OT119	1060816.4180	1082624.1820	185.5420	185.5880	0.0460	NVA
OT50	1019411.3260	1141431.2550	221.1190	221.1090	-0.0100	NVA
OT52	1020573.3330	1134370.5880	212.6830	212.6670	-0.0160	NVA
OT53	1037242.3680	1125797.7540	211.5120	211.5130	0.0010	NVA
OT54	985889.3490	1123826.0930	214.6520	214.6300	-0.0220	NVA
OT55	988933.1050	1097527.8570	164.7150	164.7060	-0.0090	NVA
OT56	1005903.5150	1119063.9860	198.4800	198.4540	-0.0260	NVA
OT57	1078001.2960	1100532.6910	135.3390	135.3430	0.0040	NVA
OT58	1068435.1810	1081130.9640	155.9890	155.9850	-0.0040	NVA
OT59	1097580.0270	1082626.8200	145.1760	145.2280	0.0520	NVA
OT60	1125532.4160	1084706.2500	100.2730	100.2390	-0.0340	NVA
OT61	1124314.5090	1099929.1600	122.6400	122.6350	-0.0050	NVA
OT62	1138668.4990	1081867.3550	112.5760	112.5580	-0.0180	NVA
OT63	1080759.1570	1062598.2060	138.0460	138.1010	0.0550	NVA
OT64	1106525.1550	1068355.6900	124.0570	124.0860	0.0290	NVA
OT65	1128715.9640	1062381.3710	88.1310	88.2590	0.1280	NVA
OT66	1146353.7920	1063443.5780	86.9820	87.1380	0.1560	NVA
OT701	1105206.2340	1068087.8310	124.9220	124.9950	0.0730	NVA
TR37	1042963.3960	1130746.0330	219.9140	219.8910	-0.0230	VVA
TR38	966608.9000	1112426.0280	172.1750	172.1770	0.0020	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
TR40	1075219.3970	1106464.4690	194.2490	194.2310	-0.0180	VVA
TR41	1068305.4470	1095231.6260	198.2410	198.2460	0.0050	VVA
TR42	1081032.6330	1098819.9590	137.7970	137.8120	0.0150	VVA
TR43	1101057.7210	1097528.3840	133.9240	133.9430	0.0190	VVA
TR44	1119993.0190	1096698.1670	104.1120	104.0980	-0.0140	VVA
TR45	1125954.8520	1108278.8950	132.8570	132.7830	-0.0740	VVA
TR46	1132445.8960	1086579.2660	94.1170	94.1010	-0.0160	VVA
TR47	11110342.1290	1082333.4840	114.5500	114.5700	0.0200	VVA
TR48	1088131.5210	1083333.2910	169.9400	169.9260	-0.0140	VVA
TR49	1066592.8780	1074708.8760	174.4280	174.5200	0.0920	VVA
TR50	1080303.0720	1069915.1460	167.6410	167.6950	0.0540	VVA
TR51	1092717.3160	1066294.8500	148.4950	148.5650	0.0700	VVA
TR52	1113482.8490	1067418.9860	124.5400	124.5380	-0.0020	VVA
TR53	1131152.4590	1069730.8840	89.5540	89.6370	0.0830	VVA
TR54	1144759.5080	1056994.7440	88.2050	88.3930	0.1880	VVA
TR56	1099116.8480	1064930.7370	139.9850	140.0070	0.0220	VVA
TR58	1075815.3710	1047764.8120	144.3720	144.5150	0.1430	VVA
TR701	1134950.3060	1060725.7490	76.7240	76.8720	0.1480	VVA
TR702	1138737.5240	1087667.3710	124.1770	124.1540	-0.0230	VVA
UR50	1040108.6040	1134530.7950	198.5450	198.5010	-0.0440	NVA
UR51	974077.5180	1112456.0230	204.7160	204.7390	0.0230	NVA
UR52	997329.6330	1123287.9320	225.8580	225.8610	0.0030	NVA
UR53	1001494.6320	1108176.7830	158.2760	158.2570	-0.0190	NVA
UR54	1009727.7970	1126974.8180	161.2030	161.1720	-0.0310	NVA
UR55	1027397.0430	1127334.2020	190.6880	190.6830	-0.0050	NVA
UR56	1045891.1500	1136042.0790	241.9510	241.8730	-0.0780	NVA
UR57	1072928.0560	1091919.6170	202.1900	202.1640	-0.0260	NVA
UR58	1082791.5960	1076288.7100	183.2700	183.2470	-0.0230	NVA
UR59	1094444.4520	1092299.9170	145.2990	145.2870	-0.0120	NVA
UR60	1115109.4200	1089594.1240	101.1610	101.2000	0.0390	NVA
UR61	1134506.1120	1092549.0250	120.8440	120.8200	-0.0240	NVA
UR62	1129215.8140	1077934.0620	93.1850	93.2520	0.0670	NVA
UR63	1144861.1780	1077736.0510	108.0790	107.9920	-0.0870	NVA
UR64	1105127.0390	1069607.4770	136.0460	136.0980	0.0520	NVA
UR65	1068292.3450	1059975.8060	150.4910	150.5430	0.0520	NVA
UR66	1083602.1440	1053511.0330	126.5740	126.6920	0.1180	NVA
UR67	1118078.2590	1056900.1470	105.5650	105.6870	0.1220	NVA
UR68	1136861.7400	1057549.7560	83.3130	83.4090	0.0960	NVA

Table 13: Point Cloud Check Point Assessment

6.1.2 Digital Elevation Model (DEM) Check Point Assessment

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BE50	1011162.4760	1142608.3550	191.3250	191.3040	0.0210	NVA
BE51	1031103.5260	1144642.3510	263.9410	263.9270	0.0140	NVA
BE52	1047715.4130	1125825.0750	208.3420	208.3140	0.0280	NVA
BE53	1018943.5710	1122550.1760	162.4850	162.4640	0.0210	NVA
BE54	965066.9150	1121859.3400	235.0120	235.0000	0.0120	NVA
BE55	986664.8250	1110350.9300	183.0470	183.0780	-0.0310	NVA
BE56	1014663.6110	1107792.3170	134.1240	134.0900	0.0340	NVA
BE57	1076667.4970	1112352.3810	197.2080	197.2160	-0.0080	NVA
BE58	1069263.6100	1103097.1930	219.6180	219.6830	-0.0650	NVA
BE59	1065271.9730	1090342.2750	185.4020	185.4200	-0.0180	NVA
BE60	1083964.0550	1091191.8370	156.4010	156.4670	-0.0660	NVA
BE61	1108029.4610	1090278.8340	116.3910	116.4040	-0.0130	NVA
BE62	1128281.5980	1090120.7660	112.5020	112.4250	0.0770	NVA
BE63	1120528.5410	1108541.7490	138.2430	138.1970	0.0460	NVA
BE64	1131983.8000	1104285.7460	115.9060	115.8520	0.0540	NVA
BE65	1143083.6500	1091054.9980	115.2810	115.2350	0.0460	NVA
BE66	1062531.9990	1072030.4890	172.4540	172.4070	0.0470	NVA
BE67	1102469.0820	1068724.6020	108.7410	108.7390	0.0020	NVA
BE68	1120356.9080	1073899.9540	121.5820	121.6910	-0.1090	NVA
BE69	1137416.6910	1073315.1750	99.7910	99.8750	-0.0840	NVA
BE70	1153441.6820	1071008.9990	111.1870	111.2790	-0.0920	NVA
BE701	1085728.4480	1081975.2800	167.2010	167.1930	0.0080	NVA
BE702	1138663.4110	1081867.4840	112.5350	112.4720	0.0630	NVA
BE71	1070089.4890	1051729.9860	146.3180	146.4580	-0.1400	NVA
OT110	1095352.6510	1056264.1420	115.8010	116.0280	-0.2270	NVA
OT117	1069007.7610	1068019.5000	138.6070	138.5860	0.0210	NVA
OT118	1109907.8410	1076281.2510	138.8780	138.8190	0.0590	NVA
OT119	1060816.4180	1082624.1820	185.5420	185.5980	-0.0560	NVA
OT50	1019411.3260	1141431.2550	221.1190	221.1130	0.0060	NVA
OT52	1020573.3330	1134370.5880	212.6830	212.6700	0.0130	NVA
OT53	1037242.3680	1125797.7540	211.5120	211.5090	0.0030	NVA
OT54	985889.3490	1123826.0930	214.6520	214.6580	-0.0060	NVA
OT55	988933.1050	1097527.8570	164.7150	164.7130	0.0020	NVA
OT56	1005903.5150	1119063.9860	198.4800	198.4540	0.0260	NVA
OT57	1078001.2960	1100532.6910	135.3390	135.3420	-0.0030	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
OT58	1068435.1810	1081130.9640	155.9890	155.9640	0.0250	NVA
OT59	1097580.0270	1082626.8200	145.1760	145.2330	-0.0570	NVA
OT60	1125532.4160	1084706.2500	100.2730	100.2390	0.0340	NVA
OT61	1124314.5090	1099929.1600	122.6400	122.6340	0.0060	NVA
OT62	1138668.4990	1081867.3550	112.5760	112.5080	0.0680	NVA
OT63	1080759.1570	1062598.2060	138.0460	138.0890	-0.0430	NVA
OT64	1106525.1550	1068355.6900	124.0570	124.0960	-0.0390	NVA
OT65	1128715.9640	1062381.3710	88.1310	88.2530	-0.1220	NVA
OT66	1146353.7920	1063443.5780	86.9820	87.1360	-0.1540	NVA
OT701	1105206.2340	1068087.8310	124.9220	125.0030	-0.0810	NVA
UR50	1040108.6040	1134530.7950	198.5450	198.4850	0.0600	NVA
UR51	974077.5180	1112456.0230	204.7160	204.7320	-0.0160	NVA
UR52	997329.6330	1123287.9320	225.8580	225.8560	0.0020	NVA
UR53	1001494.6320	1108176.7830	158.2760	158.2640	0.0120	NVA
UR54	1009727.7970	1126974.8180	161.2030	161.1700	0.0330	NVA
UR55	1027397.0430	1127334.2020	190.6880	190.6870	0.0010	NVA
UR56	1045891.1500	1136042.0790	241.9510	241.8760	0.0750	NVA
UR57	1072928.0560	1091919.6170	202.1900	202.1600	0.0300	NVA
UR58	1082791.5960	1076288.7100	183.2700	183.2520	0.0180	NVA
UR59	1094444.4520	1092299.9170	145.2990	145.2850	0.0140	NVA
UR60	1115109.4200	1089594.1240	101.1610	101.1890	-0.0280	NVA
UR61	1134506.1120	1092549.0250	120.8440	120.8160	0.0280	NVA
UR62	1129215.8140	1077934.0620	93.1850	93.2280	-0.0430	NVA
UR63	1144861.1780	1077736.0510	108.0790	107.9950	0.0840	NVA
UR64	1105127.0390	1069607.4770	136.0460	136.1010	-0.0550	NVA
UR65	1068292.3450	1059975.8060	150.4910	150.5540	-0.0630	NVA
UR66	1083602.1440	1053511.0330	126.5740	126.6730	-0.0990	NVA
UR67	1118078.2590	1056900.1470	105.5650	105.6840	-0.1190	NVA
UR68	1136861.7400	1057549.7560	83.3130	83.3890	-0.0760	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BR35	975006.2890	1122263.3670	214.5150	214.5980	-0.0830	VVA
BR36	982395.1710	1105690.8060	158.2290	158.2590	-0.0300	VVA
BR37	1009648.3250	1114599.6600	198.7460	198.7790	-0.0330	VVA
BR38	1037749.9040	1141444.6240	258.8960	258.9170	-0.0210	VVA
BR39	1024774.0390	1120809.4720	163.3380	163.3400	-0.0020	VVA
BR40	1077766.3830	1083718.3400	161.0710	161.1210	-0.0500	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BR41	1117802.7830	1082166.0270	99.8510	99.8590	-0.0080	VVA
BR42	1075825.4190	1056858.3730	150.6020	150.7810	-0.1790	VVA
BR43	1120249.0300	1063989.2790	94.6690	94.8750	-0.2060	VVA
BR44	1138634.2190	1064855.0700	94.8350	94.9780	-0.1430	VVA
BR47	1103420.8910	1055310.7040	107.3160	107.5440	-0.2280	VVA
BR701	1063581.5390	1076897.7040	176.4030	176.4330	-0.0300	VVA
HG35	981440.7780	1117173.5090	196.7960	196.8970	-0.1010	VVA
HG36	994342.4580	1106214.9670	206.1650	206.1420	0.0230	VVA
HG37	1014519.3490	1119187.5410	157.4360	157.5040	-0.0680	VVA
HG38	1014052.3330	1130016.3210	200.3430	200.3590	-0.0160	VVA
HG39	1032926.0660	1130936.8150	198.1770	198.1680	0.0090	VVA
HG40	1068689.6480	1084911.8190	159.3790	159.4370	-0.0580	VVA
HG41	1101663.4640	1089131.5130	149.5290	149.6650	-0.1360	VVA
HG42	1111983.5760	1095150.2280	118.2800	118.3160	-0.0360	VVA
HG43	1138733.6150	1087673.2330	123.8970	123.9500	-0.0530	VVA
HG44	1100715.6700	1079024.7540	147.3000	147.3740	-0.0740	VVA
HG45	1074500.7860	1074915.1190	149.2810	149.3450	-0.0640	VVA
HG48	1128572.9890	1056557.8340	86.5210	86.6830	-0.1620	VVA
TR37	1042963.3960	1130746.0330	219.9140	219.8630	0.0510	VVA
TR38	966608.9000	1112426.0280	172.1750	172.1800	-0.0050	VVA
TR40	1075219.3970	1106464.4690	194.2490	194.2360	0.0130	VVA
TR41	1068305.4470	1095231.6260	198.2410	198.2450	-0.0040	VVA
TR42	1081032.6330	1098819.9590	137.7970	137.8110	-0.0140	VVA
TR43	1101057.7210	1097528.3840	133.9240	133.9430	-0.0190	VVA
TR44	1119993.0190	1096698.1670	104.1120	104.0790	0.0330	VVA
TR45	1125954.8520	1108278.8950	132.8570	132.7530	0.1040	VVA
TR46	1132445.8960	1086579.2660	94.1170	94.1260	-0.0090	VVA
TR47	1110342.1290	1082333.4840	114.5500	114.5790	-0.0290	VVA
TR48	1088131.5210	1083333.2910	169.9400	169.9240	0.0160	VVA
TR49	1066592.8780	1074708.8760	174.4280	174.5260	-0.0980	VVA
TR50	1080303.0720	1069915.1460	167.6410	167.7160	-0.0750	VVA
TR51	1092717.3160	1066294.8500	148.4950	148.5570	-0.0620	VVA
TR52	1113482.8490	1067418.9860	124.5400	124.5360	0.0040	VVA
TR53	1131152.4590	1069730.8840	89.5540	89.6410	-0.0870	VVA
TR54	1144759.5080	1056994.7440	88.2050	88.3850	-0.1800	VVA
TR56	1099116.8480	1064930.7370	139.9850	140.0020	-0.0170	VVA
TR58	1075815.3710	1047764.8120	144.3720	144.5040	-0.1320	VVA
TR701	1134950.3060	1060725.7490	76.7240	76.8690	-0.1450	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
TR702	1138737.5240	1087667.3710	124.1770	124.1530	0.0240	VVA

Table 145: DEM Check Point Assessment