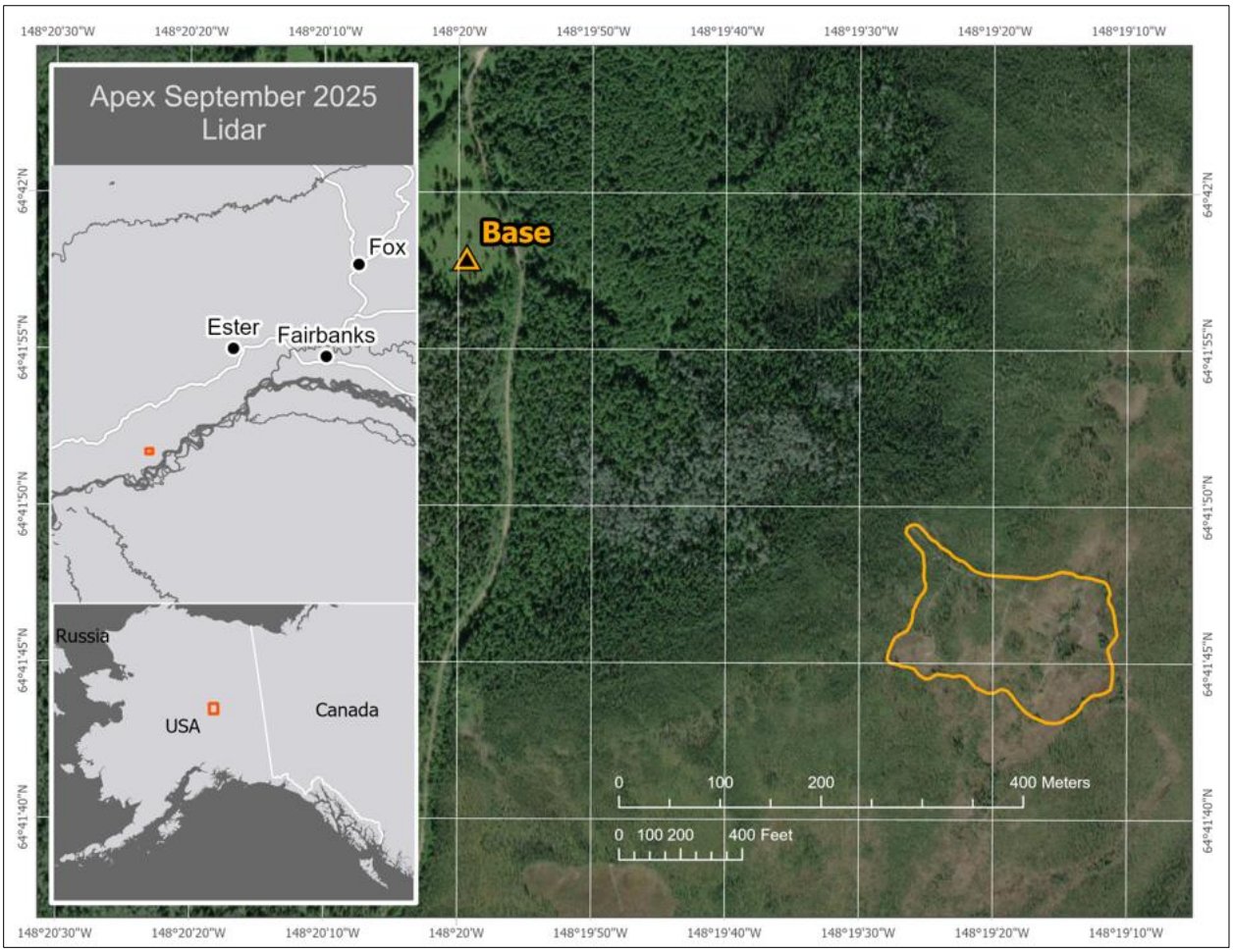
Lidar-derived elevation data for the Alaska Peatland Experiment (APEX) plot, Bonanza Creek Experimental Forest, Interior Alaska, collected September 20, 2025

Jenna M. Zechmann, J. Barrett Salisbury, and Katreen M. Wikstrom Jones

Raw Data File 2026-17



Location map of the survey area.

Publications in the DGGS RDF series provide elevation data, field observations, or analytical results. The data have been reviewed for clarity and consistency but have not undergone technical peer review.

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Lidar-derived elevation data for the Alaska Peatland Experiment (APEX) plot, Bonanza Creek Experimental Forest, Interior Alaska, collected September 20, 2025

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used mobile ground-based lidar to produce a classified point cloud, a digital surface model (DSM), a digital terrain model (DTM), and an intensity model of the Alaska Peatlands Experiment (APEX) plot in the Bonanza Creek Experimental Forest in Interior Alaska during leaf-on conditions (see cover figure). The Bonanza Creek Long Term Ecological Research Program is part of the Long Term Ecological Research (LTER) Network, which is supported by the United States National Science Foundation and comprises 26 research sites spanning multiple biomes worldwide. This survey provides snow-free surface elevations for monitoring permafrost evolution. Lidar data and ground control data were collected on September 20, 2025, and subsequently merged and processed using a suite of geospatial processing software. These data and accompanying documentation are released as a DGGS Raw Data File and are available from the DGGS website at https://doi.org/10.14509/32122.

DATA PRODUCTS

- Classified Points
- DSM and DTM
- Intensity Image
- Metadata

MISSION PLAN

Ground Lidar Survey Details

DGGS used a Riegl VUX1-LR[22] laser scanner with a global navigation satellite system (GNSS) and a Northrop Grumman LN-200C inertial measurement unit (IMU) integrated by Phoenix LiDAR Systems. The sensor can collect up to 1,500,000 points per second at a range of 230 m, or a minimum of 50,000 points per second at 1,000 m (ranges assume ≥ 20 percent natural reflectance). The scanner operated with a pulse refresh rate of 1,500,000 pulses per second at a scan rate of 200 revolutions per second. We walked the existing boardwalks at the site (fig. 1), using a backpack-mounted system to survey from approximately 2 meters above ground level, at a ground speed of approximately 0.8 m/s, and with a scan angle set to 10 to 350 degrees. The total survey area covers approximately 0.025 km^2 (see cover figure).

Weather Conditions and Collection Times

The survey area was accessed by car from Fairbanks. Data was collected from 1:10 pm to 2:10 pm (AKDT). The weather throughout the survey was clear with no wind.

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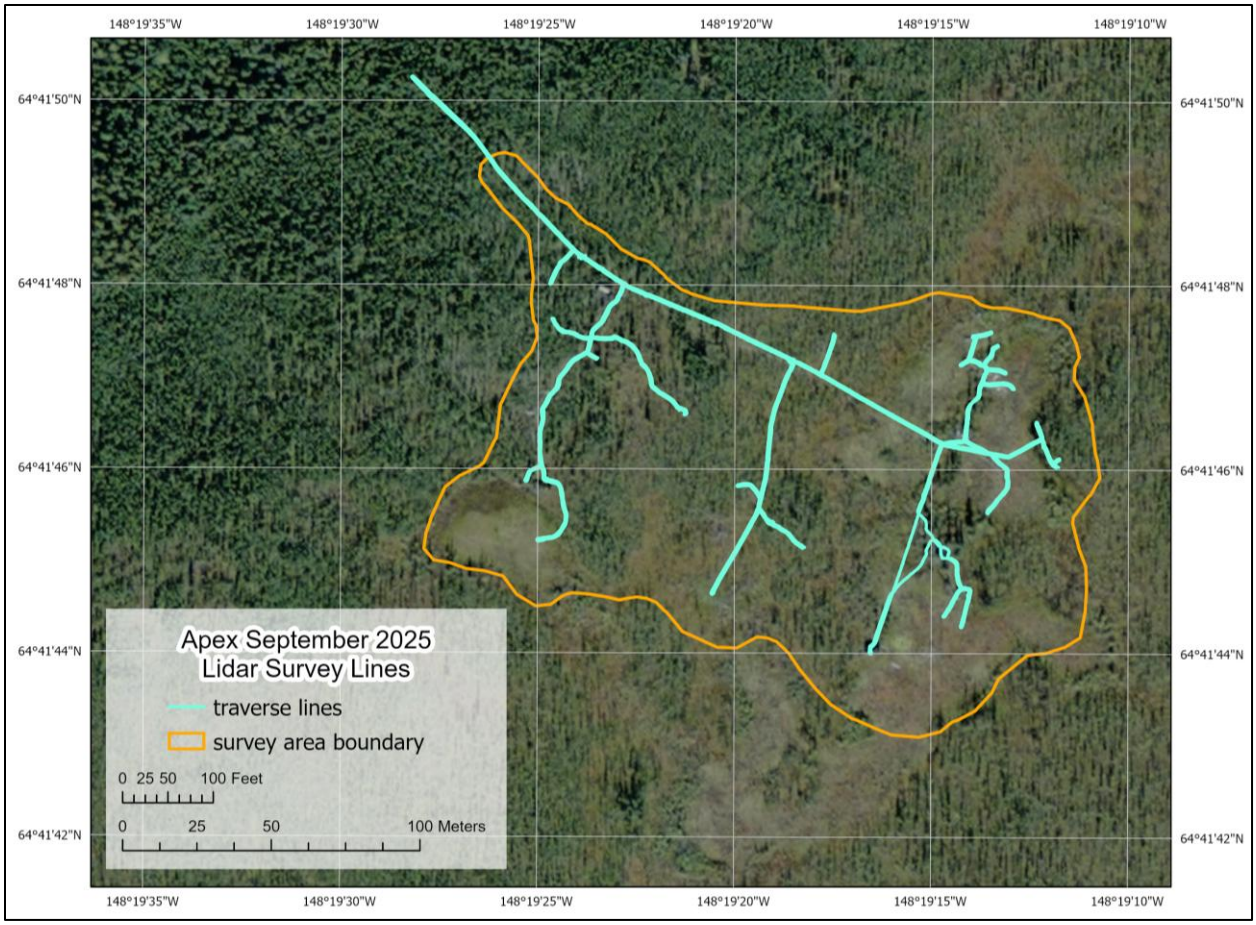

Figure 1. Lidar data collection traverse.

PROCESSING REPORT

Lidar Dataset Processing

We processed point data in Spatial Explorer for initial filtering and multiple-time-around (MTA) disambiguation. MTA errors, corrected in this process, result from ambiguous interpretations of received pulse time intervals and occur more frequently with higher pulse refresh rates. IMU and GNSS data were processed in Inertial Explorer, and traverse line information was integrated with the point cloud in Spatial Explorer. We calibrated the point data at an incrementally precise scale of sensor movement and behavior, incorporating sensor velocity, roll, pitch, and yaw fluctuations throughout the survey. For the lidar data collection, the average pulse density is 116,860.5 pulses/m^2, and the average pulse spacing is 0.29 cm.

We created a macro (an ordered list of point classification commands tailored to this dataset) in Terrasolid software and classified points according to the American Society for Photogrammetry & Remote Sensing (ASPRS) 2025 guidelines. Once classified, we applied a geometric transformation and converted the points from ellipsoidal heights to GEOID12B (Alaska) orthometric heights.

Raster products were derived from the point cloud in ArcGIS Pro. A 5-cm DSM was interpolated from ground and vegetation classes using a binning method and maximum values.

A 5-cm DTM was interpolated from all ground-class returns using a binning method and minimum values. We also produced a 5-cm intensity image using average binning in ArcGIS Pro, with no normalization or corrections applied.

Classified Point Cloud

Classified point cloud data are provided in LAZ format. Data are classified following ASPRS 2025 guidelines (table 1) and contain return and intensity information. For classified ground points, the average point density (fig. 2) is 308.1 pts/m^2, and the average spacing is 5.7 cm.

Table 1. Point cloud class code definitions

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, ≥0.0m, <0.1m
4	Medium Vegetation, ≥0.1m, <0.3m
5	High Vegetation, ≥0.3m, ≤7m
7	Low Noise
17	Bridge Deck
18	High Noise
30	Noise (manually classified)

Digital Surface Model

The DSM represents surface elevations, including vegetation heights. The DSM is a single-band, 32-bit GeoTIFF file of 5-cm resolution. No Data value is set to -3.40282306074e+38 (32-bit, floating-point minimum).

Digital Terrain Model

The DTM represents bare-earth or snow-surface elevations, excluding vegetation. The DTM is a single-band, 32-bit GeoTIFF file of 5-cm resolution. No Data value is set to -3.40282306074e+38.

Lidar Intensity Image

The lidar intensity image describes the relative amplitude of reflected signals that contribute to the point cloud. Lidar intensity is (1) primarily a function of scanned object reflectance in relation to the signal frequency, (2) dependent on ambient conditions, and (3) not necessarily consistent between separate scans. The intensity image is a single-band, 32-bit GeoTIFF file of 5-cm resolution. No Data value is set to -3.40282306074e+38.

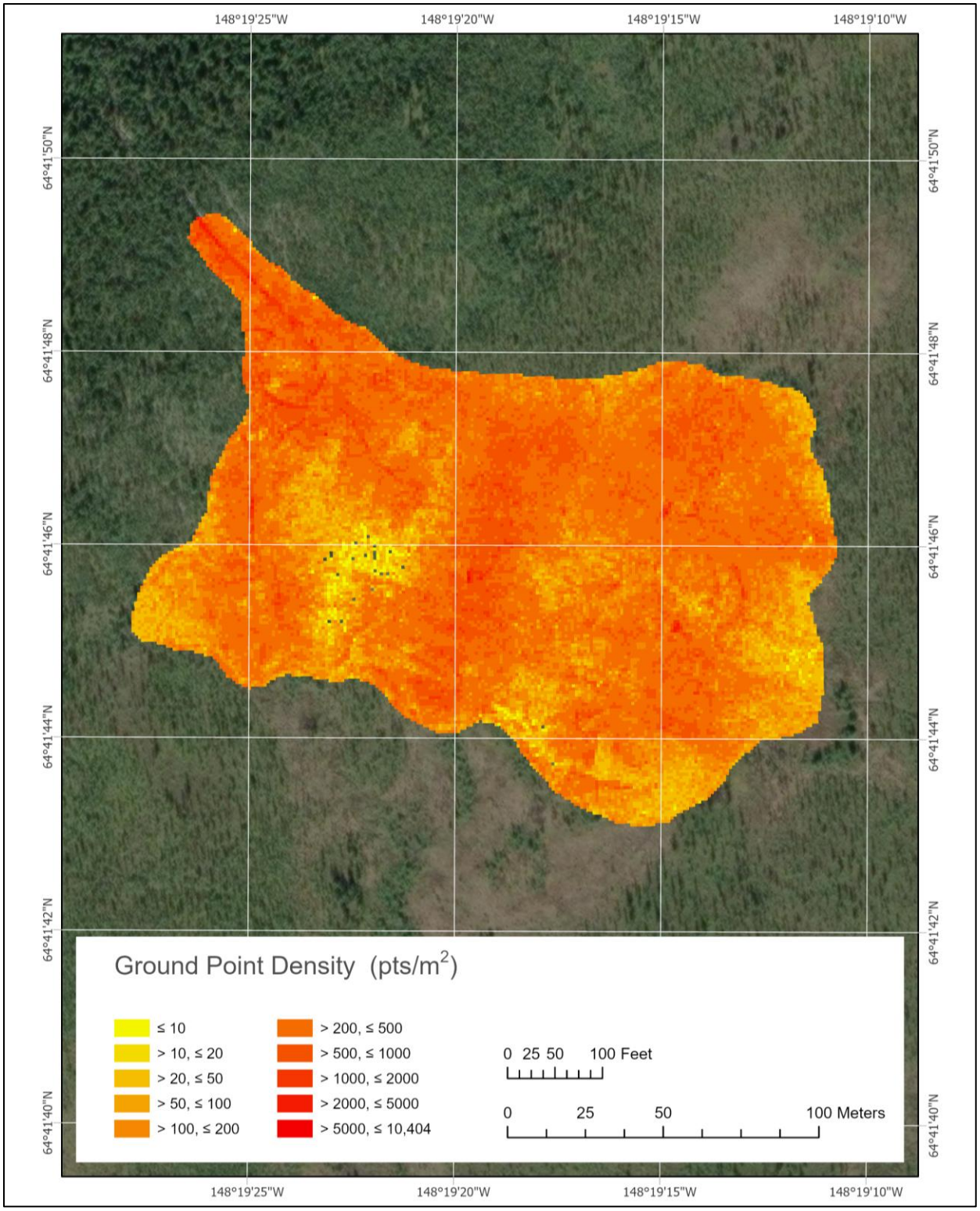

Figure 2. Ground point density for the survey displayed as a raster.

SURVEY REPORT

Ground Survey Details

Ground control points were collected on September 20, 2025. We deployed a Trimble R12i GNSS base receiver and surveyed points using a rover Trimble R12i GNSS receiver/Mesa3 controller within the survey area. We collected 110 ground control points and checkpoints on boardwalk surfaces and corners, bog surfaces, tussock areas, forested areas, and tundra vegetation areas.

For a GNSS base station occupation to later correct lidar survey lines, we set up a Trimble R12i in a field ~0.6 km northwest of the survey area (see cover figure).

Coordinate System and Datum

We processed and delivered all data in NAD83 (2011), UTM6N, and the vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

The offset between the point cloud (visualized as a 2 cm resolution shaded relief using only ground and bridge deck point classes) and 27 horizontal ground control points was -10.1 cm easting and +13.0 cm northing (tables A1-1 and A1-2). This was changed to -0.2 cm and -5.6 cm, respectively, by applying a seven-parameter affine transformation (tables A2-1 and A2-2). To determine the horizontal accuracy of the corrected point cloud, we used 14 checkpoints and measured the offset between checkpoints and their respective locations in the corrected point cloud. The project's horizontal accuracy has a root-mean-square error (RMSE) of 10.2 cm in the east-west direction and 12.9 cm in the north-south direction (tables A2-1 and A2-2).

Vertical Accuracy

We measured a mean elevation offset of +12.5 cm between 15 control points and the point cloud (tables A3-1 and A3-2). This offset was reduced to 1.0 cm in nonvegetated areas (tables A4-1, A4-2) and 15.1 cm in vegetated areas (tables A5-1 and A5-2) by applying a constant vertical correction to the lidar point data. We used 15 nonvegetated and 39 vegetated checkpoints to determine the vertical accuracy of the point cloud ground class using a Triangulated Irregular Network (TIN) approach. The project's nonvegetated vertical accuracy has a root mean square error (RMSE) of 3.8 cm (tables A4-1 and A4-2), and the vegetated vertical accuracy is 17.2 cm RMSE. We evaluated the relative accuracy for this dataset as the interswath overlap consistency, yielding an RMSE of 4.6 cm.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect. Data quality is best nearest the traverse lines, which were limited to boardwalks. Areas far from boardwalks have relatively low point density due to line-of-sight shadows in the point cloud data.

ACKNOWLEDGMENTS

This survey area lies within the ancestral homelands of the Dene peoples of the lower Tanana River. This work was funded by the U.S. Geological Survey National Land Imaging Program. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

REFERENCES

The American Society for Photogrammetry & Remote Sensing (ASPRS), 2025, LAS Specification 1.4 - R16. https://publicdocuments.asprs.org/las-v14-r16-2025

APPENDIX: SURVEY CONTROL POINTS

Table A1-1. Horizontal ground control points

GCP Name	Easting (m)	Northing (m)	Point Cloud Easting (m)	Point Cloud Northing (m)	Easting Offset (Point Cloud X – GCP X) (m)	Northing Offset (Point Cloud Y – GCP Y) (m)
009	436894.371	7175317.535	436894.804	7175317.992	0.433	0.457
014	436897.040	7175291.753	436897.211	7175292.272	0.171	0.519
016	436896.543	7175291.741	436896.772	7175292.244	0.229	0.503
017	436896.594	7175290.539	436896.809	7175291.029	0.215	0.490
024	436883.974	7175223.339	436883.788	7175223.782	-0.186	0.443
031	436914.798	7175281.810	436915.041	7175282.261	0.243	0.451
033	436915.721	7175281.231	436915.944	7175281.660	0.223	0.429
034	436914.783	7175281.244	436914.852	7175281.680	0.069	0.436
046	436956.757	7175226.928	436956.517	7175227.170	-0.240	0.242
047	436956.463	7175226.579	436956.223	7175226.904	-0.240	0.325
048	436954.615	7175227.970	436954.344	7175228.259	-0.271	0.289
049	436955.115	7175228.252	436954.781	7175228.542	-0.334	0.290
050	436954.014	7175230.115	436953.688	7175230.297	-0.326	0.182
054	436952.666	7175232.977	436952.380	7175233.201	-0.286	0.224
055	436952.132	7175231.128	436951.806	7175231.326	-0.326	0.198
056	436953.224	7175229.858	436953.071	7175230.019	-0.153	0.161
060	436937.662	7175207.872	436937.359	7175208.213	-0.303	0.341
061	436937.267	7175207.373	436937.037	7175207.685	-0.230	0.312
076	437023.897	7175254.637	437023.784	7175254.370	-0.113	-0.267
077	437024.170	7175255.808	437024.049	7175255.536	-0.121	-0.272
078	437022.991	7175256.089	437022.788	7175255.893	-0.203	-0.196
079	437022.720	7175254.912	437022.562	7175254.835	-0.158	-0.077
093	437036.179	7175247.235	437035.959	7175246.871	-0.220	-0.364
094	437036.834	7175247.809	437036.787	7175247.517	-0.047	-0.292
095	437036.646	7175247.821	437036.596	7175247.505	-0.050	-0.316
101	437036.297	7175239.261	437036.089	7175238.747	-0.208	-0.514

GCP Name	Easting (m)	Northing (m)	Point Cloud Easting (m)	Point Cloud Northing (m)	Easting Offset (Point Cloud X – GCP X) (m)	Northing Offset (Point Cloud Y – GCP Y) (m)
102	437036.790	7175239.192	437036.500	7175238.705	-0.290	-0.487

Table A1-2. Horizontal ground control point summary

Horizontal Ground Control Point Summary	Easting Offset (Point Cloud X – GCP X) (m)	Northing Offset (Point Cloud Y – GCP Y) (m)
Average Offset (m)	-0.101	0.130
Minimum Offset (m)	-0.334	-0.514
Maximum Offset (m)	0.433	0.519
Average Magnitude Error (m)	0.218	0.336
Root Mean Square Error (m)	0.236	0.357
Standard Deviation (m)	0.213	0.333

Table A2-1: Horizontal checkpoints

Check Point Name	Easting (m)	Northing (m)	Corrected Point Cloud Easting (m)	Corrected Point Cloud Northing (m)	Easting Offset (Corrected Point Cloud X – GCP X) (m)	Northing Offset (Corrected Point Cloud Y – GCP Y) (m)
007	436892.518	7175317.596	436892.548	7175317.474	0.030	-0.122
008	436893.171	7175318.442	436893.190	7175318.316	0.019	-0.126
010	436893.720	7175316.701	436893.764	7175316.561	0.044	-0.140
015	436897.072	7175290.550	436897.093	7175290.569	0.021	0.019
022	436877.861	7175222.777	436877.989	7175222.572	0.128	-0.205
023	436877.976	7175222.188	436878.068	7175221.888	0.092	-0.300
025	436883.874	7175223.917	436883.878	7175223.849	0.004	-0.068
032	436915.736	7175281.776	436915.832	7175281.833	0.095	0.057
051	436954.147	7175230.206	436954.009	7175230.175	-0.138	-0.031
052	436953.431	7175231.712	436953.279	7175231.675	-0.152	-0.037
053	436953.292	7175231.920	436953.108	7175231.902	-0.184	-0.018
092	437037.118	7175247.078	437037.239	7175247.002	0.121	-0.076
099	437035.797	7175236.886	437035.821	7175237.011	0.024	0.125
100	437036.330	7175236.817	437036.199	7175236.958	-0.131	0.141

Table A2-2. Horizontal checkpoint summary

Horizontal Checkpoint Summary Statistic	Easting Offset (Corrected Point Cloud X – GCP X) (m)	Northing Offset (Corrected Point Cloud Y – GCP Y) (m)
Average Offset (m)	-0.002	-0.056
Minimum Offset (m)	-0.184	-0.300
Maximum Offset (m)	0.128	0.141
Average Magnitude Error (m)	0.084	0.105
Root Mean Square Error (m)	0.102	0.129
Standard Deviation (m)	0.102	0.117

Table A3-1. Vertical ground control points

GCP Name	Easting (m)	Northing (m)	GCP Z (m)	Point Cloud Z (m)	Elevation Difference (Point Cloud Z – GCP Z) (m)
001	436867.137	7175346.862	123.040	123.088	0.048
005	436888.688	7175316.913	122.530	122.619	0.089
006	436893.420	7175317.530	123.083	123.227	0.144
013	436907.777	7175308.640	122.928	123.049	0.121
021	436880.936	7175223.073	121.911	122.054	0.143
030	436915.093	7175281.533	122.196	122.384	0.188
042	436958.884	7175265.373	122.520	122.629	0.109
044	436952.652	7175231.907	122.508	122.642	0.134
045	436953.317	7175230.935	122.495	122.625	0.130
065	436947.011	7175240.026	122.346	122.472	0.126
068	436974.402	7175276.274	122.539	122.691	0.152
069	436977.551	7175286.764	122.350	122.420	0.070
072	436984.478	7175270.702	122.563	122.738	0.175
081	437035.207	7175271.824	121.930	122.034	0.104
114	437002.429	7175259.622	122.362	122.510	0.148

Table A3-2. Vertical ground control point summary

Vertical Ground Control Point Summary Statistic	Calculated Value (m)
Average elevation difference (dZ) (m)	0.125
Minimum dZ (m)	0.048
Maximum dZ (m)	0.188
Average magnitude error (m)	0.125
Root mean square error (m)	0.130
Standard deviation (m)	0.037

Table A4-1 Nonvegetated vertical checkpoints

Check Point Name	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Point Cloud Z (m)	Elevation Difference (Corrected Point Cloud Z – Checkpoint Z) (m)
011	436884.421	7175310.487	122.366	122.351	-0.015
019	436879.250	7175259.269	122.252	122.289	0.037
037	436918.697	7175303.411	122.908	122.938	0.030
038	436929.497	7175298.695	122.744	122.758	0.014
039	436937.462	7175295.208	122.760	122.789	0.029
043	436957.200	7175256.516	122.466	122.468	0.002
057	436945.805	7175220.890	122.180	122.154	-0.026
070	436981.933	7175289.297	122.387	122.417	0.030
075	437023.414	7175255.352	121.919	121.832	-0.087
096	437047.285	7175256.087	122.047	122.031	-0.016
098	437036.450	7175239.328	121.856	121.847	-0.009
106	437015.466	7175217.608	122.076	122.098	0.022
108	437008.935	7175220.476	121.895	121.954	0.059
111	436992.465	7175191.430	122.549	122.609	0.060
113	437011.116	7175243.917	122.313	122.339	0.026

Table A4-2. Nonvegetated vertical checkpoint statistics

Nonvegetated Vertical Checkpoint Statistic	Calculated Value (m)
Average elevation difference (dZ) (m)	0.010
Minimum dZ (m)	-0.087
Maximum dZ (m)	0.060
Average magnitude error (m)	0.031
Root mean square error (m)	0.038
Standard deviation (m)	0.037

Table A5-1. Vegetated vertical checkpoints

Check Point Name	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Point Cloud Z (m)	Elevation Difference (Corrected Point Cloud Z – Checkpoint Z) (m)
002	436871.493	7175347.066	122.874	123.040	0.166
003	436891.799	7175325.742	122.407	122.520	0.113
004	436885.419	7175319.630	122.350	122.511	0.161
012	436882.816	7175312.087	122.156	122.314	0.158
018	436885.493	7175271.225	121.866	122.011	0.145
020	436875.181	7175253.781	122.108	122.321	0.213
026	436884.772	7175221.089	121.631	121.829	0.198
027	436890.237	7175225.403	121.874	122.086	0.212
028	436899.448	7175284.584	121.981	122.091	0.110
029	436912.226	7175275.828	121.771	121.981	0.210
035	436912.791	7175274.237	121.765	121.932	0.167
036	436927.040	7175269.797	121.947	122.238	0.291
040	436951.617	7175285.251	121.938	122.145	0.207
041	436960.597	7175286.895	121.983	122.181	0.198
058	436939.054	7175210.720	121.607	121.711	0.104
063	436937.747	7175204.848	121.624	121.748	0.124
064	436968.091	7175223.416	121.791	122.066	0.275
066	436950.303	7175242.615	121.856	121.969	0.113
067	436948.223	7175247.188	121.973	122.030	0.057
071	436985.298	7175289.721	122.005	122.145	0.140
073	437014.552	7175255.921	122.280	122.244	-0.036
074	437019.356	7175256.935	121.991	122.068	0.077
080	437025.600	7175275.186	121.635	121.781	0.146
090	437026.235	7175285.302	121.606	121.809	0.203
091	437027.250	7175264.656	122.234	122.230	-0.004

Check Point Name	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Point Cloud Z (m)	Elevation Difference (Corrected Point Cloud Z – Checkpoint Z) (m)
097	437041.647	7175249.532	121.655	121.728	0.073
103	437010.750	7175232.338	121.961	122.219	0.258
104	437015.927	7175227.905	122.259	122.508	0.249
105	437022.066	7175222.170	122.055	122.201	0.146
106	437015.466	7175217.608	122.076	122.084	0.008
107	437018.477	7175213.150	121.592	121.630	0.038
108	437008.935	7175220.476	121.895	121.942	0.047
109	436995.638	7175202.075	121.695	121.772	0.077
110	436987.901	7175198.964	121.689	121.981	0.292
115	436975.745	7175268.824	121.857	122.103	0.246
116	436970.832	7175264.370	121.762	121.974	0.212
117	436963.596	7175263.072	121.916	122.073	0.157
118	436954.783	7175255.694	121.806	121.874	0.068
119	436956.853	7175274.520	121.872	122.124	0.252

Table A5-2. Vegetated vertical checkpoint statistics

Vegetated Vertical Checkpoint Statistic	Calculated Value (m)
Average elevation difference (dZ) (m)	0.151
Minimum dZ (m)	-0.036
Maximum dZ (m)	0.292
Average magnitude error (m)	0.153
Root mean square error (m)	0.172
Standard deviation (m)	0.083