LIDAR-DERIVED ELEVATION DATA FOR PORTAGE, SOUTHCENTRAL ALASKA, COLLECTED OCTOBER 15, 2020

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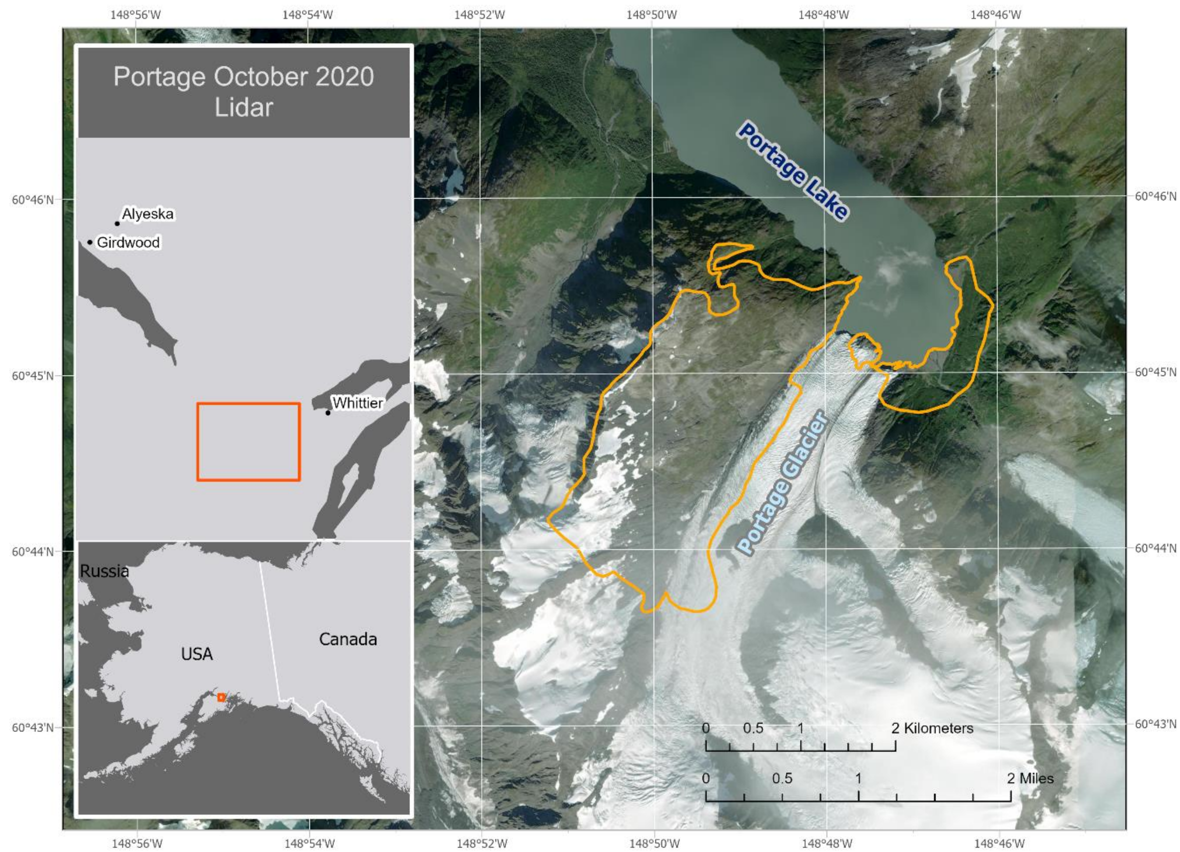
Raw Data File 2024-7



Location map of survey area.

This report has not been reviewed for technical content or
for conformity to the editorial standards of DGGS.

2024
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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LIDAR-DERIVED ELEVATION DATA FOR PORTAGE, SOUTHCENTRAL ALASKA, COLLECTED OCTOBER 15, 2020

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, digital surface model (DSM), digital terrain model (DTM), and an intensity model of slopes above Portage Glacier, Southcentral Alaska, during leaf-off conditions (cover figure). The survey provides snow-free surface elevations for use in landslide and avalanche hazard assessments. Aerial lidar data were collected October 15, 2020, and ground control data were collected November 13, 2020, and subsequently merged and processed using a suite of geospatial processing software. This data collection is released as a Raw Data File with an open end-user license. All files are available to download on the DGGS website at https://doi.org.10.14509/31160. fa

LIST OF DELIVERABLES

Classified Points
DSM and DTM
Intensity Image
Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR laser scanner integrated with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU) designed by Phoenix LiDAR Systems. The sensor can collect a maximum of 820,000 points per second at a range of 215 m, or a minimum of 50,000 points per second at a range of 820 m (ranges assume ≥ 20 percent natural reflectance). The scanner operated with a pulse refresh rate of 600,000 pulses per second at a scan rate of 100 revolutions per second. We used a Cessna 180 Skywagon fixed-wing platform to survey from an elevation of approximately 100–200 m above ground level, at a ground speed of approximately 40 m/s, and with a scan angle set from 80 to 280 degrees. The total survey area covers approximately 6.7 km^2.

Weather Conditions and Flight Times

The survey area was accessed by air from Merrill Field Airport in Anchorage (fig. 1). Data collection occurred between 11:10 am and 11:40 am (AST), and the weather throughout the survey was partly cloudy with no wind.

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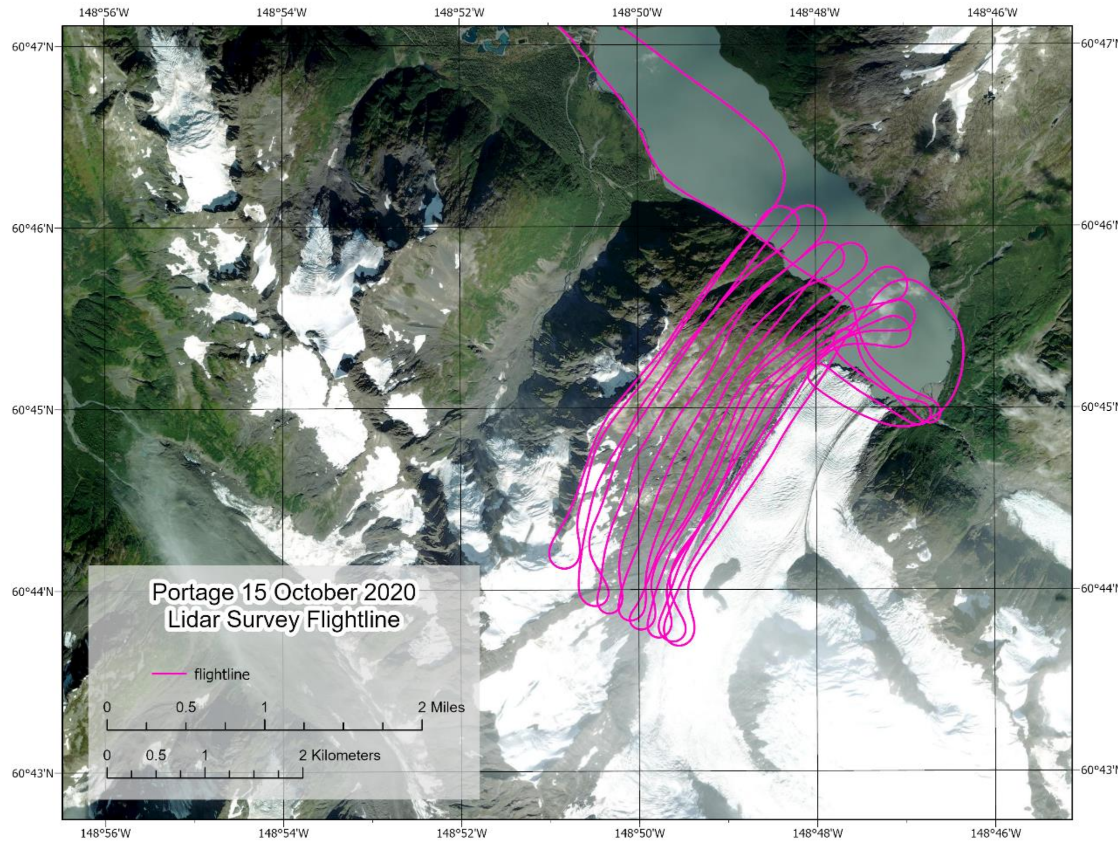

Figure 1. Lidar data collection flightlines.

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 flightline 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 35.7 pulses/m^2 and the average pulse spacing is 16.7 cm.

We created macros in Terrasolid software and classified points in accordance with the American Society for Photogrammetry & Remote Sensing (ASPRS) 2019 guidelines (ASPRS, 2019). 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 20-cm DSM was interpolated from ground, vegetation, bridge deck, and building classes using a triangulation method. A 20-cm DTM was interpolated from all ground-class returns, also using a triangulation method. We also produced a 20-cm intensity image for the entire area 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 2019 guidelines (table 1) and contain return and intensity information. For classified ground points, the average point density (fig. 2) is 23.2 pts/m^2, and the average spacing is 20.7 cm.

Table 1. Point cloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, ≥0.0m, <0.5m
4	Medium Vegetation, ≥0.5m, <3m
5	High Vegetation, ≥3m, ≤60m
6	Building
7	Low Noise
17	Bridge Deck
18	High Noise
30	Noise (manually classified)

Digital Surface Model

The DSM represents surface elevations, including heights of vegetation, buildings, powerlines, bridge decks, etc. The DSM is a single-band, 32-bit GeoTIFF file of 20-cm resolution. No Data value is set to -3.40282306074e+38 (32-bit, floating-point minimum).

Digital Terrain Model

The DTM represents bare earth elevations, excluding vegetation, bridge decks, buildings, etc. The DTM is a single-band, 32-bit GeoTIFF file of 20-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 contributing 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, 16-bit unsigned GeoTIFF file of 20-cm resolution. No Data value is set to 0.

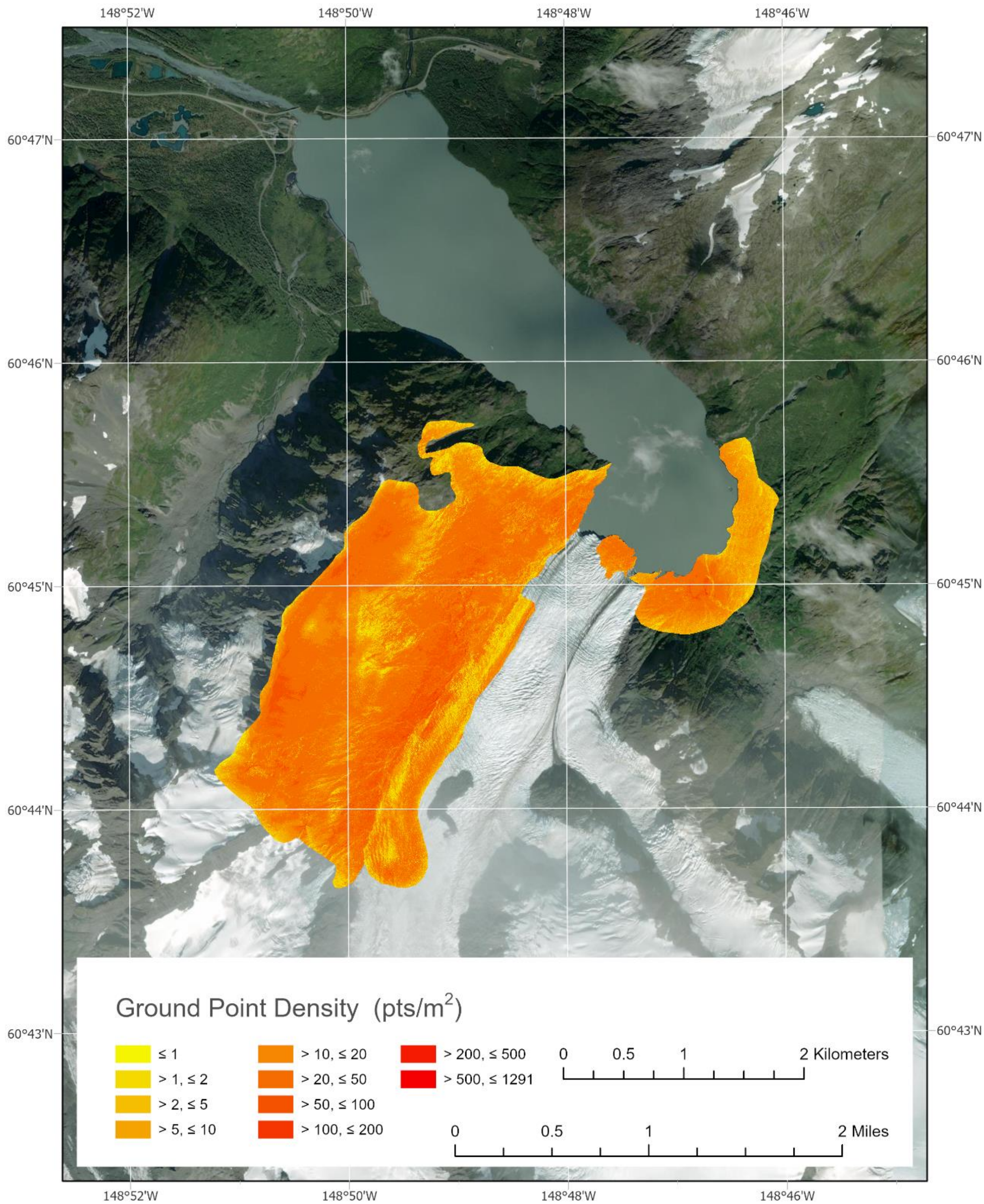

Figure 2. Ground point density for the survey displayed as a 1-meter raster.

SURVEY REPORT

Ground Survey Details

Ground control points were collected November 13, 2020. We deployed a base Trimble R10 GNSS receiver to provide a base station occupation and real-time kinematic (RTK) corrections to points we surveyed with a rover Trimble R10 GNSS receiver/Mesa3 controller. An alluvial fan east of the Portage Glacier terminus served as the base station location. We collected 109 ground control points and checkpoints to use for calibration and to assess the vertical accuracy of the point cloud. Checkpoints were collected on bare earth (gravel or bedrock).

Coordinate System and Datum

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

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

We measured a mean offset of +8.8 cm between 82 control points and the point cloud (app. 1). This offset was reduced to +1.5 cm (app. 2) by applying a constant vertical correction to the lidar point data. We used 21 checkpoints to determine the vertical accuracy of the point cloud ground class using a Triangulated Irregular Network (TIN) approach. The project vertical accuracy has a root mean square error (RMSE) of 10.7 cm (app. 2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 6.2 cm RMSE.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect. Data quality is consistent throughout the survey.

ACKNOWLEDGMENTS

This survey area is on the traditional homelands of the Chugach people. This work was funded by the State of Alaska. We thank Clearwater Air for their aviation expertise and contribution to these data products. 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 State of Alaska.

REFERENCES

The American Society for Photogrammetry & Remote Sensing (ASPRS), 2019, LAS Specification 1.4 - R15. https://www.asprs.org/wp-content/uploads/2019/07 /LAS_1_4_r15.pdf

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
1	402034.402	6737541.813	32.697	32.584	-0.113
2	402034.506	6737550.946	30.439	30.013	-0.426
3	402038.934	6737545.276	31.934	31.843	-0.091
4	402039.032	6737554.853	29.435	29.495	0.060
5	402043.936	6737545.872	31.245	31.229	-0.016
6	402046.043	6737547.144	30.714	30.842	0.128
7	402143.235	6737058.523	29.791	29.463	-0.328
8	402474.277	6736332.778	30.207	30.341	0.134
9	402485.014	6736358.691	30.060	30.212	0.152
10	402502.238	6736365.739	29.982	30.170	0.188
11	402504.804	6736355.731	30.139	30.291	0.152
12	402505.077	6736366.565	29.938	30.089	0.151
13	402512.551	6736365.148	29.935	30.236	0.301
14	402516.754	6736318.151	30.308	30.492	0.184
15	402522.571	6736362.685	30.069	30.207	0.138
16	402532.395	6736318.735	30.209	30.330	0.121
17	402553.267	6736355.744	30.206	30.425	0.219
18	402561.536	6736338.962	29.784	29.976	0.192
19	402564.451	6736217.808	37.025	36.844	-0.181
20	402583.446	6736229.783	36.233	36.220	-0.013
21	402600.021	6736229.607	35.710	35.849	0.139
22	402623.505	6736253.550	47.687	47.848	0.161
23	402634.512	6736244.890	34.510	34.711	0.201
24	402638.224	6736277.356	47.130	47.063	-0.067
25	402644.083	6736284.075	45.200	44.873	-0.327
26	402653.450	6736284.816	43.740	44.056	0.316
27	402654.205	6736295.276	47.877	47.929	0.052
28	402666.400	6736308.795	44.682	44.613	-0.069
29	402669.692	6736311.790	44.253	44.198	-0.055
30	402672.683	6736302.032	45.955	45.723	-0.232
31	402680.459	6736262.418	33.468	33.563	0.095
32	402692.170	6736311.839	40.526	40.795	0.269
33	402710.232	6736323.782	38.798	38.721	-0.077
34	402715.914	6736287.403	33.178	33.241	0.063
35	402724.436	6736352.973	29.471	29.714	0.243
36	402727.095	6736330.476	34.735	34.827	0.092
37	402730.591	6736361.115	29.417	29.644	0.227
38	402731.809	6736349.973	30.224	30.467	0.243
39	402736.699	6736285.771	30.842	30.898	0.056
40	402736.858	6736341.622	33.458	33.290	-0.168

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
41	402736.928	6736360.460	29.861	30.100	0.239
42	402736.930	6736346.261	32.006	32.009	0.003
43	402746.590	6736359.184	30.074	30.205	0.131
44	402753.715	6736291.992	31.304	31.391	0.087
45	402757.947	6736351.033	30.775	30.919	0.144
46	402762.837	6736359.041	30.289	30.411	0.122
47	402770.935	6736289.249	31.461	31.516	0.055
48	402772.742	6736340.701	29.845	29.855	0.010
49	402774.298	6736328.595	30.572	30.792	0.220
50	402776.370	6736319.564	31.129	31.257	0.128
51	402780.823	6736352.582	29.949	30.072	0.123
52	402780.886	6736318.353	31.205	31.242	0.037
53	402780.922	6736361.141	29.723	29.736	0.013
54	402781.518	6736323.821	30.708	30.829	0.121
55	402784.913	6736367.743	29.637	29.728	0.091
56	402789.300	6736364.934	29.285	29.460	0.175
57	402790.426	6736308.325	31.176	31.273	0.097
58	402797.411	6736308.738	30.966	31.073	0.107
59	402819.411	6736308.702	30.837	30.987	0.150
60	402819.722	6736299.524	30.943	31.056	0.113
61	402832.917	6736324.850	30.605	30.741	0.136
62	402835.740	6736302.422	30.788	30.862	0.074
63	402840.050	6736321.388	30.606	30.822	0.216
64	402859.149	6736317.200	30.400	30.524	0.124
65	402870.366	6736308.743	30.396	30.522	0.126
66	402893.995	6736331.550	29.727	29.868	0.141
67	402914.298	6736321.677	29.814	29.944	0.130
68	402930.034	6736361.526	29.410	29.566	0.156
69	402931.880	6736316.205	30.280	30.430	0.150
70	402945.820	6736314.069	30.502	30.631	0.129
71	402950.824	6736369.704	30.101	30.249	0.148
72	402953.834	6736383.108	30.297	30.483	0.186
73	402955.175	6736358.423	30.762	30.888	0.126
74	402955.195	6736339.694	30.871	31.003	0.132
75	402962.914	6736350.233	30.839	30.952	0.113
76	402966.660	6736320.695	31.020	31.164	0.144
77	402966.757	6736397.960	30.576	30.695	0.119
78	402969.776	6736414.264	30.761	30.895	0.134
79	402976.229	6736427.052	30.688	30.797	0.109
80	402977.595	6736399.169	30.860	30.977	0.117
81	402980.057	6736330.313	31.254	31.329	0.075

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
82	402984.550	6736420.313	30.713	30.843	0.130
Average elevation difference (dZ) (m)	0.088				
Minimum dZ (m)	-0.426				
Maximum dZ (m)	0.316				
Average magnitude error (m)	0.141				
Root mean square error (m)	0.160				
Standard deviation (m)	0.135				

APPENDIX 2: CHECK POINTS

Check Point	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Elevation Difference (Corrected Pointcloud Z –Checkpoint Z) (m)
1	402026.151	6737548.581	31.329	31.301	-0.028
2	402034.837	6737538.854	31.903	32.134	0.231
3	402135.245	6737054.459	29.651	29.671	0.020
4	402478.865	6736353.805	30.380	30.466	0.086
5	402505.851	6736321.128	30.336	30.424	0.088
6	402542.735	6736338.834	30.285	30.319	0.034
7	402574.908	6736349.657	29.942	29.991	0.049
8	402661.783	6736298.198	46.588	46.580	-0.008
9	402684.331	6736306.742	42.836	42.467	-0.369
10	402719.283	6736336.638	34.391	34.329	-0.062
11	402732.007	6736333.512	34.887	34.805	-0.082
12	402744.002	6736364.923	30.093	30.157	0.064
13	402768.816	6736364.697	29.866	29.919	0.053
14	402780.607	6736312.519	31.354	31.328	-0.026
15	402784.859	6736306.712	31.455	31.465	0.010
16	402805.005	6736305.179	31.121	31.151	0.030
17	402839.387	6736320.123	30.672	30.693	0.021
18	402906.360	6736342.607	29.694	29.742	0.048
19	402946.678	6736371.629	29.951	30.032	0.081
20	402956.573	6736313.391	30.446	30.487	0.041
21	402975.865	6736437.251	30.254	30.287	0.033
Average elevation difference (dZ) (m)	0.015				
Minimum dZ (m)	-0.369				
Maximum dZ (m)	0.231				
Average magnitude error (m)	0.071				
Root mean square error (m)	0.107				
Standard deviation (m)	0.109				