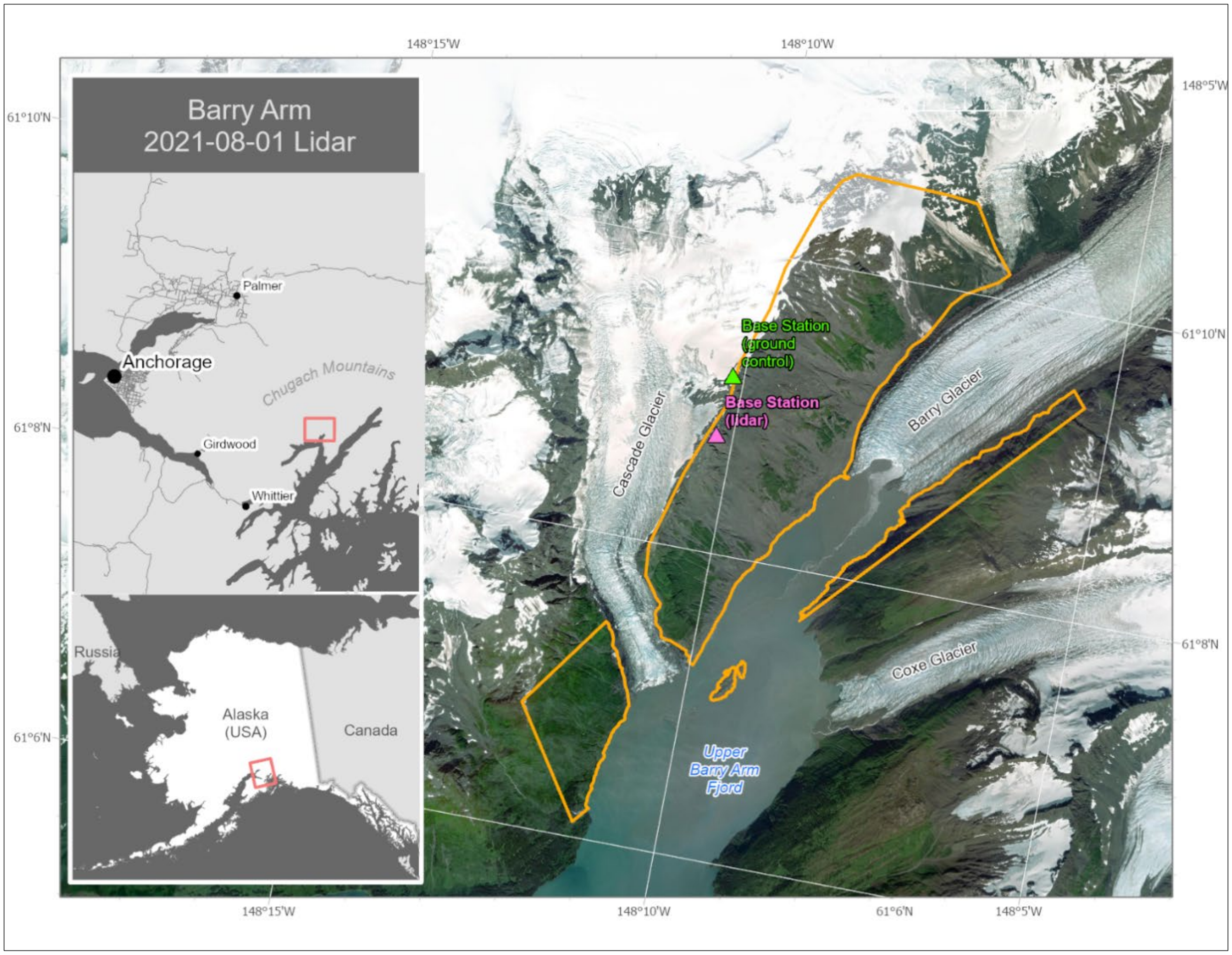
LIDAR-DERIVED ELEVATION DATA FOR UPPER BARRY ARM FJORD, SOUTHCENTRAL ALASKA, COLLECTED AUGUST 1, 2021

Katreen M. Wikstrom Jones and Gabriel J. Wolken

Raw Data File 2026-6



Location map of the survey area with an orthometric image.

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

2026
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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LIDAR-DERIVED ELEVATION DATA FOR UPPER BARRY ARM FJORD, SOUTHCENTRAL ALASKA, COLLECTED AUGUST 1, 2021

Katreen M. Wikstrom Jones[1] and Gabriel J. Wolken[1]

INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, digital terrain model (DTM), surface model (DSM), and intensity model for Upper Barry Arm fjord with focus on the Barry Arm landslide, northeast of Whittier in Prince William Sound, southcentral Alaska, during near snow-free ground conditions. The goal of the survey is to provide snow-free surface elevation data to assess landslide movement using repeat surveys during snow-free conditions. Airborne data were collected on August 1, 2021, and ground control was collected on August 2, 2021, and subsequently processed in Terrasolid and ArcGIS. These data are provided as a Raw Data File under an open end-user license and are available on the DGGS website (http://doi.org/10.14509/31971).

LIST OF DELIVERABLES

- Classified Points
- DSM, DTM, and hydro-enforced DTM
- Intensity Image
- Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR 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 a maximum of 820,000 points per second at a range of 215 m, or a minimum of 50,000 points per second at 820 m (ranges assume ≥ 20 percent natural reflectance). This survey was flown with a pulse refresh rate of 200,000-600,000 pulses per second and a scan rate of 60-180 lines per second. We used a Cessna 180 Skywagon fixed-wing platform to survey from an elevation of approximately 100–300 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 was approximately 21 km^2; however, all derived raster products and statistical analyses exclude glaciers and water bodies, which lie *outside* the orange-outlined areas of interest shown in the cover figure.

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Weather Conditions and Flight Times

The survey area was accessed by air from Whittier air strip and was flown into two parts. The first part of the flight started at 10:47 am AKDT and ended at 1:36 pm AKDT. The second part began at 3:12 pm AKDT and ended at 4:34 pm AKDT (fig. 1). The weather throughout the survey was fair and cloudless.

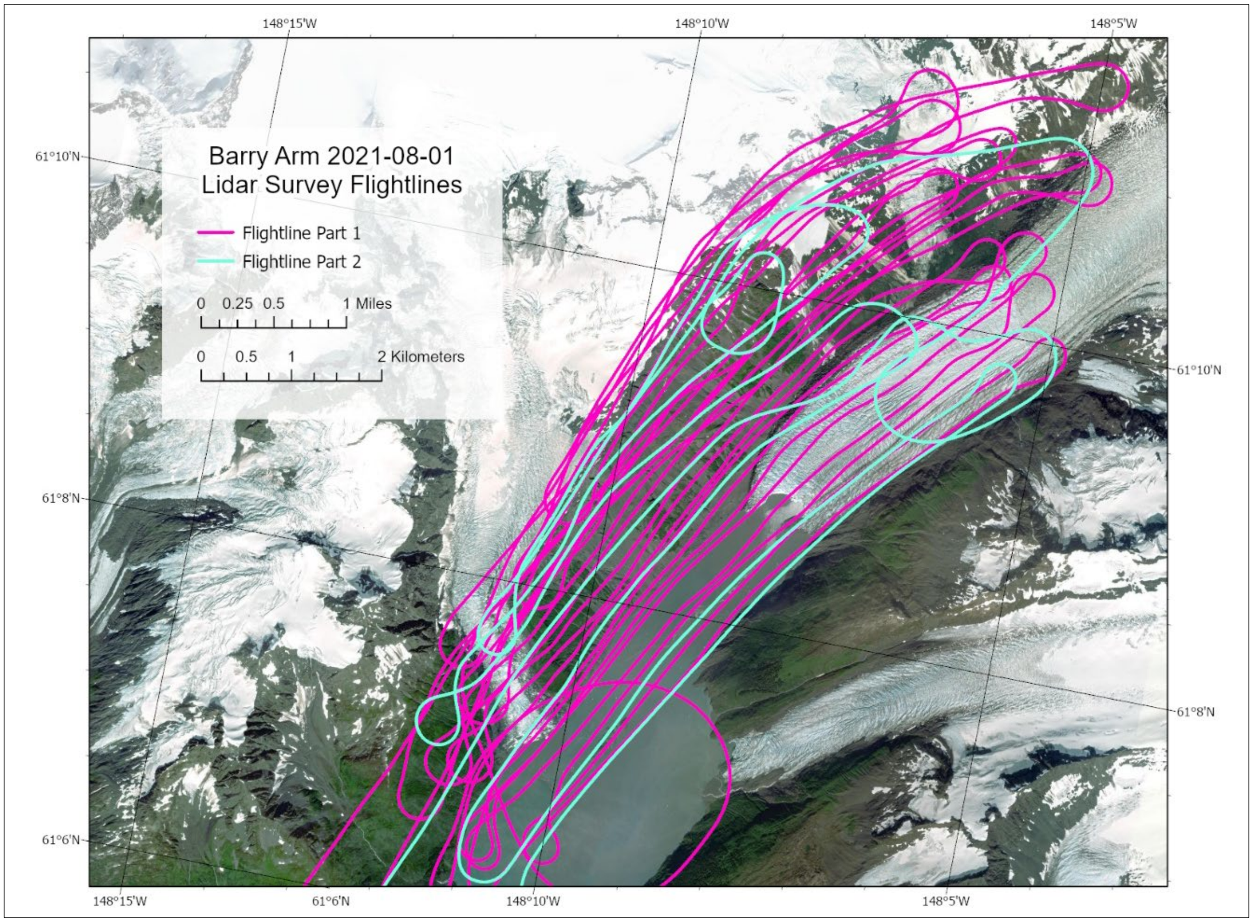

Figure 1. Lidar data collection flightlines.

PROCESSING REPORT

Lidar Dataset Processing

We processed point data in SDCimport for initial filtering and multiple-time-around (MTA) disambiguation. MTA errors corrected in this process stem from ambiguous interpretations of received pulse time intervals and occur more frequently at 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 pulse density is 31.7 pulses/m^2, and the average pulse spacing is 17.8 cm.

We created a macro (an ordered list of point classification commands tailored to this dataset) in Terrasolid software and classified points in accordance with the American Society for Photogrammetry & Remote Sensing (ASPRS) 2025 guidelines (ASPRS, 2025). 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 50-cm DSM was interpolated from maximum elevation values in ground and vegetation classes using a triangulation method. A 50-cm DTM was interpolated from all ground-class returns using a triangulation method and minimum elevation values. We also produced a 1-m intensity image for the area using average binning in ArcGIS Pro, with no normalization or corrections applied. Water bodies and glacier surfaces were erased from the derived raster products.

Classified Point Cloud

Classified point cloud data are provided in LAZ format. Data are classified according to the ASPRS 2025 guidelines (table 1) and include return and intensity information. For classified ground points, the average point density is 21.3 pts/m^2, and the average spacing is 21.7 cm (fig. 2).

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
7	Low Noise
18	High Noise

Digital Surface Model

The DSM represents surface elevations, including heights of vegetation, buildings, powerlines, pipes, bridge decks, etc. The overall DSM is a single-band, 32-bit GeoTIFF file of 50-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 overall DTM is a single-band, 32-bit GeoTIFF file of 50-cm resolution. No Data value is set to -3.40282306074e+38.

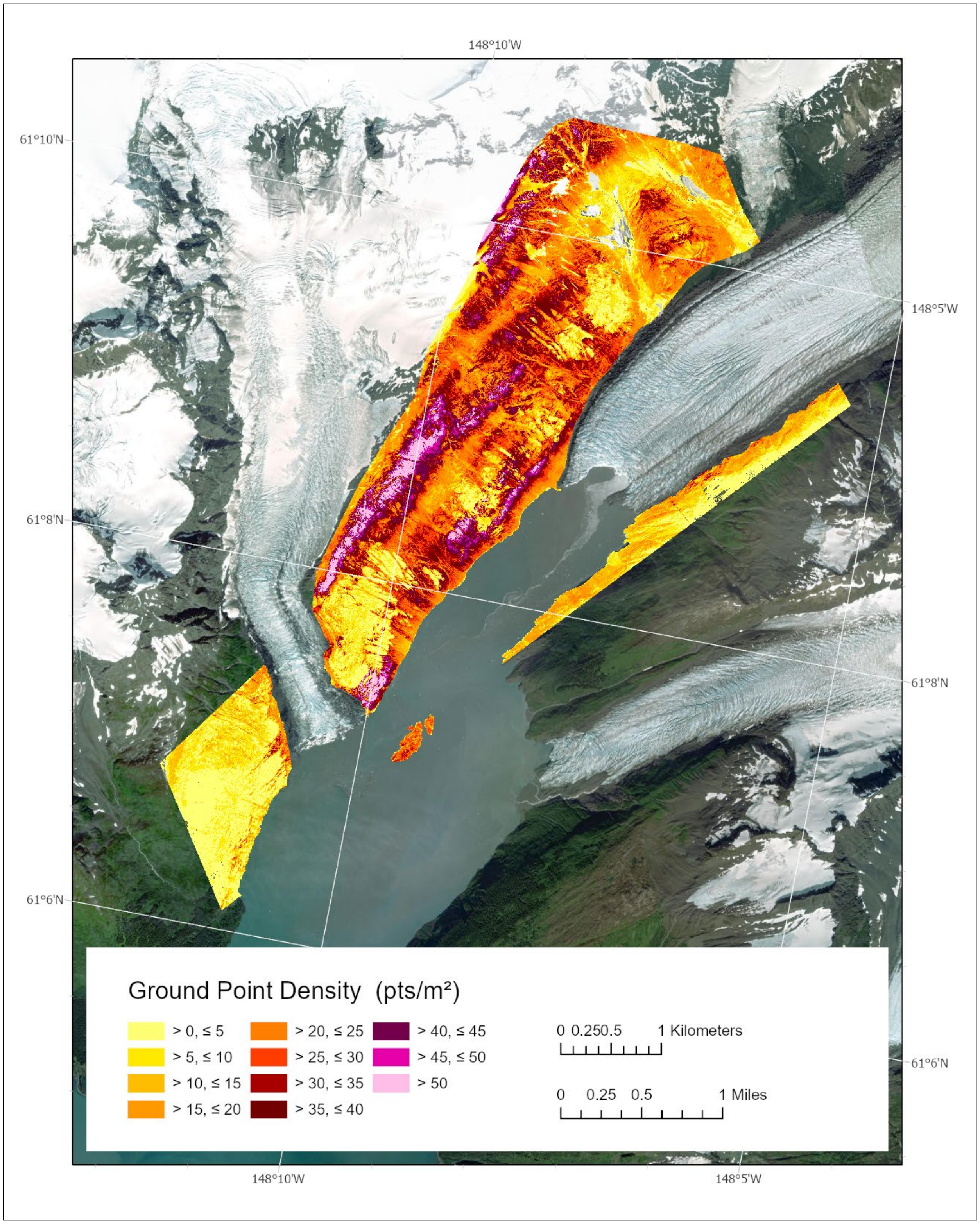

Figure 2. Ground point density for the survey displayed as a raster.

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, 32-bit GeoTIFF file of 1-m resolution. No Data value is set to -3.40282306074e+38.

SURVEY REPORT

Ground Survey Details

Ground control and checkpoints were collected on August 2, 2021. A Trimble R10-2 GNSS receiver with an internal antenna was deployed on the ridge on the west side of the fjord. It provided a base station occupation and real-time kinematic (RTK) corrections to points surveyed with a rover Trimble R10-2 GNSS receiver (internal antenna). We collected 105 ground control and check points across the survey area to use for calibration and to assess the vertical accuracy of point clouds generated from multiple repeat Barry Arm surveys; 96 of these were used for this lidar acquisition, and the remainder were excluded due to insufficient point cloud overlap. Checkpoints were collected on bare earth or minimally vegetated surface.

Coordinate System and Datum

We processed and delivered all data in NAD 83 (2011), UTM 6N, and the vertical datum NAVD 88 (GEOID12 B).

Horizontal Accuracy

Horizontal accuracy was not measured for this collection; it is considered inherent in the airborne GPS/IMU solution.

Vertical Accuracy

We measured a vertical mean offset of +18.9 cm between 82 control points and the point cloud (app. 1). This offset was reduced to +0.5 cm by applying a constant vertical correction to the lidar point data. We used 22 checkpoints to determine the non-vegetated vertical accuracy (NVA) of the point cloud ground class, using a triangulation-based approach. Project NVA was calculated to have a root mean square error (RMSE) of 21.5 cm (app. 2). Relative accuracy was evaluated based on interswath overlap consistency, yielding an RMSE of 0.9 cm.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect. Data quality is consistent throughout the survey, save for gaps over bodies of water, glaciers, and snow-covered surfaces.

ACKNOWLEDGMENTS

These data products were funded by the U.S. Geological Survey Cooperative Agreement Grant #G21AC10362 and collected and processed by DGGS. We thank Clearwater Air and Alpine Air for their aviation expertise and contribution to these data products.

REFERENCES

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

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	437067.351	6780408.464	1296.694	1296.98	0.286
2	437061.131	6780405.827	1296.822	1297.14	0.318
3	437059.275	6780400.624	1295.773	1295.97	0.197
4	437043.322	6780390.621	1290.138	1290.5	0.362
5	437044.513	6780383.2	1286.049	1286.46	0.411
6	437043.211	6780378.213	1286.281	1286.61	0.329
7	437040.77	6780375.856	1285.818	1286.28	0.462
8	437030.483	6780365.847	1285.256	1285.64	0.384
9	437023.005	6780377.63	1288.39	1288.7	0.31
10	437026.215	6780381.31	1288.128	1288.47	0.342
11	437022.876	6780368.769	1286.528	1286.91	0.382
12	437021.768	6780362.216	1285.411	1285.73	0.319
13	437014.035	6780359.755	1284.35	1284.58	0.23
14	437010.116	6780356.679	1283.341	1283.62	0.279
15	436999.193	6780344.583	1278.891	1278.93	0.039
16	436995.764	6780334.244	1275.482	1275.8	0.318
17	436990.65	6780326.312	1273.729	1273.87	0.141
18	436988.012	6780317.191	1270.335	1270.23	-0.105
19	437068.17	6780414.145	1296.036	1296.38	0.344
20	437082.601	6780423.94	1295.362	1295.71	0.348
21	437080.717	6780430.04	1294.214	1294.56	0.346
22	437089.319	6780440.689	1292.752	1293.1	0.348
23	437101.187	6780455.599	1294.556	1294.93	0.374
24	437106.066	6780469.698	1295.577	1295.91	0.333
25	437111.421	6780473.633	1295.629	1295.97	0.341
26	437106.827	6780451.293	1293.967	1294.29	0.323
27	436965.208	6779629.061	1077.626	1077.79	0.164
28	436975.547	6779635.656	1076.045	1076.17	0.125
29	436963.551	6779634.172	1076.641	1076.77	0.129
30	436961.043	6779637.078	1076.989	1077.17	0.181
31	436956.798	6779623.225	1074.804	1074.92	0.116
32	436949.768	6779621.801	1073.077	1073.22	0.143
33	436947.072	6779621.666	1073.262	1073.39	0.128
34	436946.222	6779613.387	1074.048	1074.07	0.022
35	436928.87	6779600.374	1071.164	1071.27	0.106
36	436918.97	6779599.351	1069.548	1069.66	0.112
37	436918.073	6779594.95	1069.294	1069.4	0.106
38	436905.766	6779580.947	1070.57	1070.71	0.14
39	436902.128	6779565.589	1072.455	1072.58	0.125
40	436918.972	6779571.781	1070.287	1070.44	0.153
41	436924.62	6779571.07	1069.28	1069.42	0.14

42	436937.736	6779587.031	1070.296	1070.5	0.204
43	436950.585	6779594.111	1068.083	1068.22	0.137
44	436957.903	6779599.06	1068.28	1068.39	0.11
45	436966.445	6779602.649	1068.82	1068.96	0.14
46	436945.115	6779603.578	1071.791	1071.95	0.159
47	436957.18	6779616.46	1072.942	1073.12	0.178
48	436963.061	6779617.441	1073.523	1073.64	0.117
49	436953.573	6779647.358	1079.82	1080	0.18
50	436962.882	6779659.58	1083.299	1083.47	0.171
51	436972.11	6779659.421	1085.565	1085.69	0.125
52	436975.461	6779661.393	1085.654	1085.78	0.126
53	436985.816	6779663.664	1084.59	1084.76	0.17
54	436987.126	6779668.644	1084.491	1084.61	0.119
55	436982.931	6779686.312	1084.238	1084.4	0.162
56	436975.959	6779678.029	1085.05	1085.19	0.14
57	436971.708	6779668.28	1084.643	1084.78	0.137
58	436974.133	6779731.461	1083.25	1083.45	0.2
59	439050.309	6778331.712	180.577	180.74	0.163
60	439053.391	6778335.031	180.693	180.86	0.167
61	439057.376	6778337.441	181.338	181.43	0.092
62	439061.364	6778342.688	181.71	181.81	0.1
63	439065.519	6778354.675	178.533	178.68	0.147
64	439058.72	6778349.011	180.79	180.94	0.15
65	439049.082	6778344.652	178.458	178.58	0.122
66	439047.578	6778339.717	178.555	178.65	0.095
67	439036.349	6778312.705	175.921	176.02	0.099
68	438479.769	6777777.603	8.523	8.67	0.147
69	438480.41	6777784.55	7.731	7.84	0.109
70	438486.293	6777783.702	7.9	8.02	0.12
71	438503.349	6777794.081	10.237	10.37	0.133
72	436606.33	6778670.565	969.926	970.09	0.164
73	436606.336	6778670.558	969.924	970.08	0.156
74	436592.846	6778649.328	962.851	962.98	0.129
75	436588.814	6778640.338	960.149	960.32	0.171
76	436589.365	6778636.726	959.044	959.24	0.196
77	436591.648	6778625.777	954.748	954.89	0.142
78	436612.686	6778626.208	952.727	952.92	0.193
79	436611.224	6778598.433	951.415	951.53	0.115
80	436614.994	6778617.205	952.238	952.39	0.152
81	436606.658	6778687.618	971.426	971.53	0.104
82	436610.8	6778688.548	971.556	971.67	0.114

Average dz (m)	0.189				
Minimum dz (m)	-0.105				
Maximum dz (m)	0.462				
Average magnitude error (m)	0.192				
Root mean square error (m)	0.215				
Standard deviation (m)	0.103				

APPENDIX 2: CHECKPOINTS

Control Point	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	437068.396	6780405.708	1296.673	1296.76	0.087
2	437055.042	6780396.998	1294.389	1294.51	0.121
3	437036.235	6780375.859	1286.119	1286.26	0.141
4	437023.904	6780368.03	1286.393	1286.52	0.127
5	437003.295	6780340.582	1277.308	1277.16	-0.148
6	436980.085	6780315.727	1269.717	1269.85	0.133
7	437095.741	6780450.287	1295.249	1295.49	0.241
8	437107.324	6780445.113	1292.08	1292.29	0.21
9	436948.973	6779626.028	1074.594	1074.57	-0.024
10	436938.172	6779607.067	1071.917	1071.86	-0.057
11	436906.879	6779572.936	1072.514	1072.47	-0.044
12	436933.093	6779587.499	1070.922	1070.82	-0.102
13	436950.796	6779608.519	1072.187	1072.12	-0.067
14	436967.756	6779656.747	1084.871	1084.8	-0.071
15	436985.179	6779683.438	1085.014	1084.97	-0.044
16	436963.166	6779722.584	1083.021	1083	-0.021
17	439060.709	6778350.082	180.906	180.84	-0.066
18	439039.753	6778332.484	178.066	177.99	-0.076
19	438489.507	6777786.886	9.274	9.21	-0.064
20	436587.396	6778649.833	962.344	962.31	-0.034
21	436608.918	6778614.554	951.814	951.74	-0.074
22	436613.89	6778691.466	971.649	971.58	-0.069
Average dz	0.005				
Minimum dz	-0.148				
Maximum dz	0.241				
Average magnitude error (m)	0.092				
Root mean square error (m)	0.107				
Standard deviation (m)	0.11				