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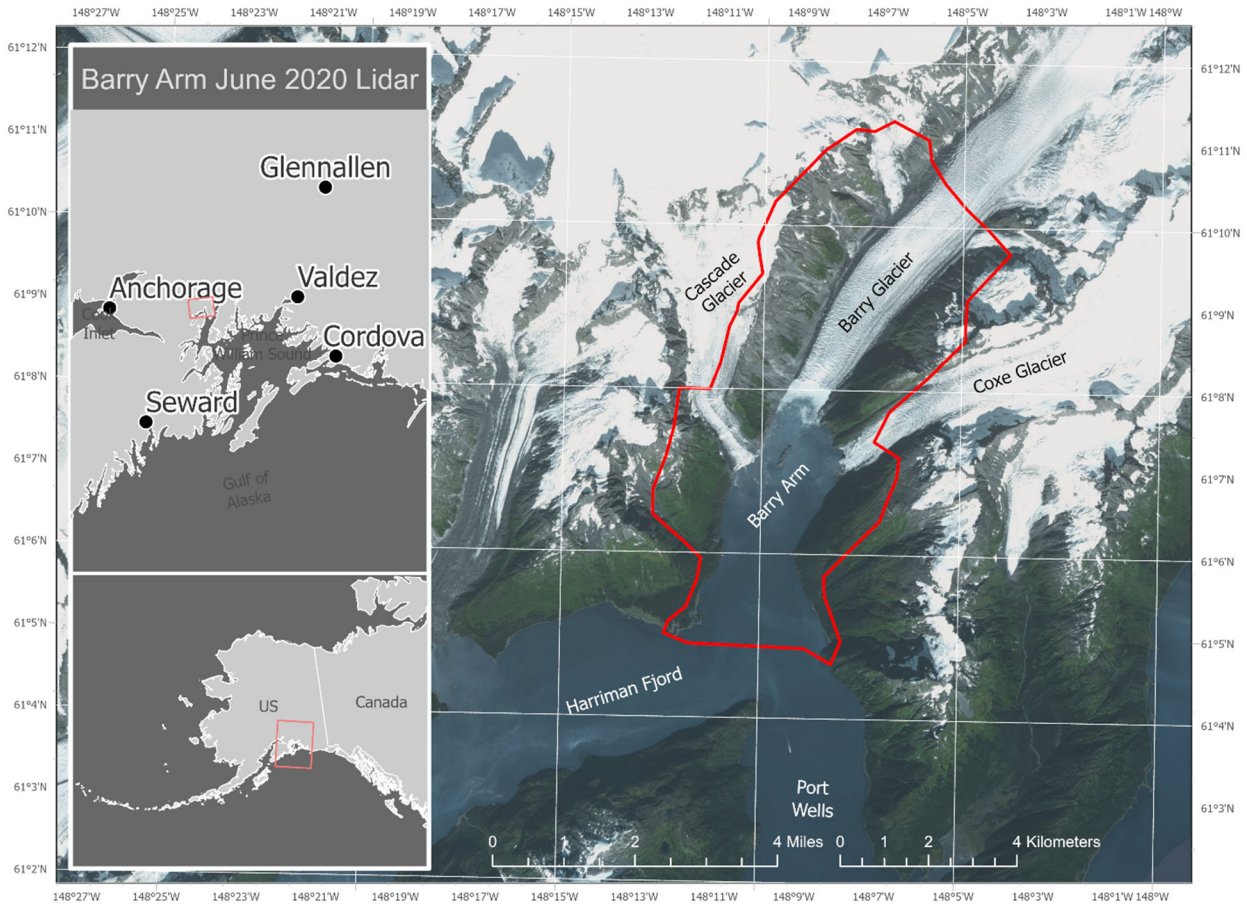
Raw Data File 2021-1



Location map of survey area with orthometric image.

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

2021
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Suggested citation:
Daanen, R.P., Wolken, G.J., Wikstrom Jones, Katreen, and Herbst, A.M., 2021, Lidar-derived elevation data for northern Barry Arm, Southcentral Alaska, June 26, 2020: Alaska Division of Geological & Geophysical Surveys Raw Data File 2021-1, 9 p.
https://doi.org/10.14509/30589

LIDAR-DERIVED ELEVATION DATA FOR NORTHERN BARRY ARM, SOUTHCENTRAL ALASKA, JUNE 26, 2020

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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 of land areas in northern Barry Arm, northwest Prince William Sound, Alaska, during near snow-free ground conditions on June 26, 2020. The goal of the survey is to provide high quality, modern topographic data in the recently deglacierized part of Barry Arm where significant landslide hazards exist. Aerial lidar and ground control data were collected on June 26, 2020, and subsequently processed in Terrasolid and ArcGIS. Ground control was collected on June 26, 2020, as well. This data collection is released as a Raw Data File with an open end-user license. All files can be downloaded free of charge from the DGGS website: https://doi.org/10.14509/30589.

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 integrated with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU). The lidar integration system was designed by Phoenix LiDAR Systems. The sensor is capable of collecting up to 820,000 points per second over a distance of 150 m. This survey was flown with a pulse refresh rate between 200,000 and 600,000 pulses per second at a scan rate between 80 and 150 lines per second. This survey was flown with an average elevation of 200 m above ground level and a ground speed of approximately 36 m/s with a fixed-wing aircraft configuration, using a Cessna 180 aircraft. The scan angle was set from 80 to 280 degrees. The total area surveyed was approximately 40 km^2.

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Weather Conditions and Flight Times

The aerial survey was flown on June 26, 2020, with a Cessna 180. Flight take-off occurred at 10:15am from Merrill Field airport in Anchorage, Alaska, and landing occurred at 4:00 pm. The aircraft landed at the airstrip in Girdwood, Alaska, once during the survey. The weather throughout the survey was overcast.

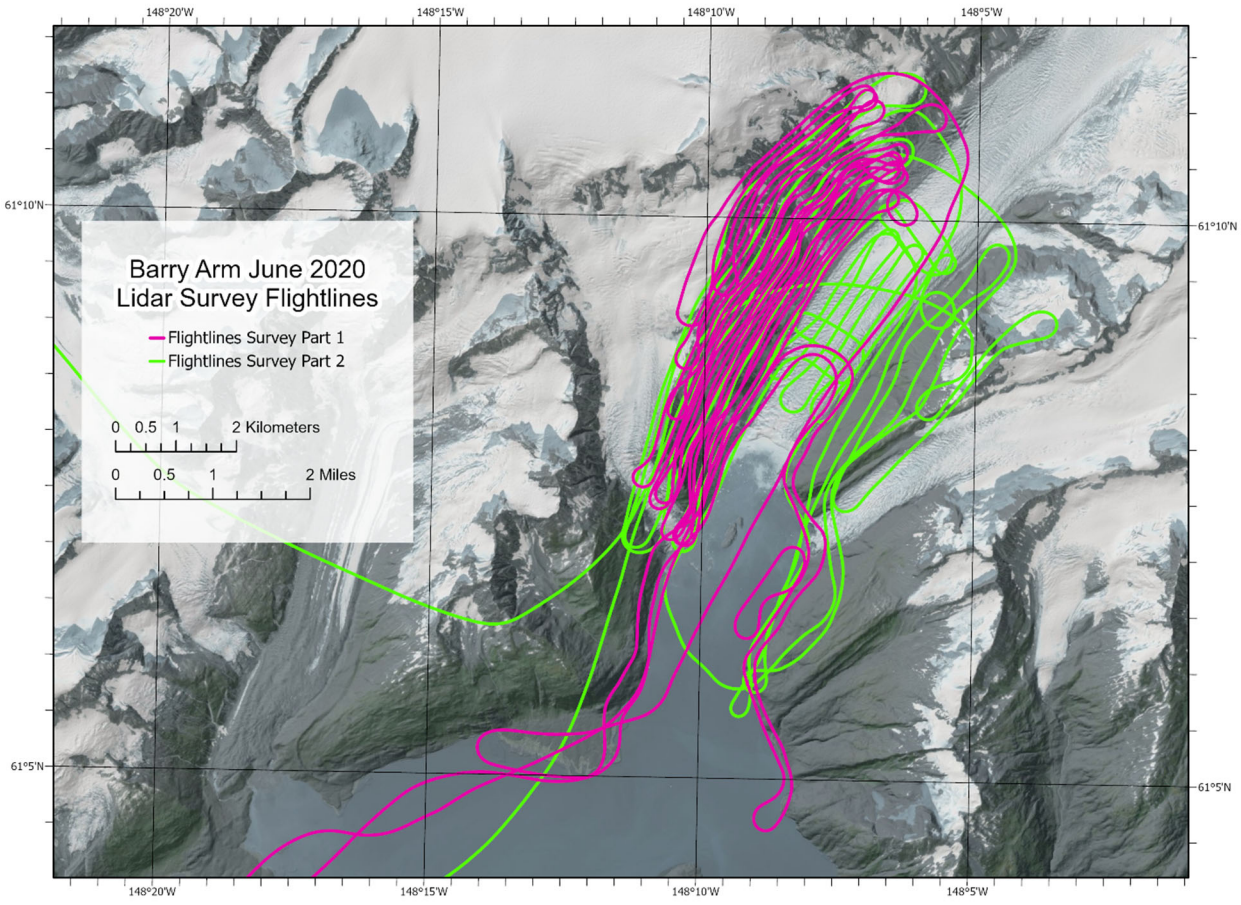

Figure 1. Project flight lines.

PROCESSING REPORT

Lidar Dataset Processing

Point data were processed in SDCimport software for initial filtering and multiple-time-around (MTA) disambiguation. MTA errors, corrected in this process, are the result of imprecise interpretations of received pulse time intervals and occur more frequently with higher pulse refresh rates. Inertial Measurement Unit (IMU) and Global Navigation Satellite System (GNSS) data were processed in Inertial Explorer and used to integrate flightline information with the point cloud in Spatial Explorer software. The point data were calibrated at an incrementally precise scale of sensor

movement and behavior, incorporating sensor velocity, roll, pitch, and yaw fluctuations throughout the survey.

Points were classified in accordance with American Society for Photogrammetry and Remote Sensing (ASPRS) 2014 guidelines, using macros designed in Terrasolid software. Careful attention was given to the interpolation of the project's ground surface to compensate for inconsistent penetration through low vegetation as a function of the scan angle. Once classified, points underwent a geometric transformation and were converted from ellipsoidal heights to GEOID12B (Alaska) orthometric heights.

Raster products were derived from the point cloud using ArcMap. The DTM was interpolated from all ground class returns using a TIN-based method. The DTM was also used to produce a separate hydro-enforced raster based on a digitized shoreline. The DSM was likewise interpolated from only the first return points using a TIN-based method. An intensity image was also produced in ArcMap, using closest-to-mean binning.

Classified Point Cloud

Classified point cloud data is provided in this collection in compressed LAZ format. Data are classified in accordance with ASPRS 2014 guidelines and contain return and intensity information. The average pulse spacing was 7.2 cm and the average density was 12.05 pts/m^2.

Digital Surface Model

The DSM represents surface elevations including heights of vegetation, buildings, bridges, etc. The DSM is a single band, 32-bit GeoTIFF file, with a ground sample distance of 1 meter. No Data value is set to -3.40282306074e+038.

Digital Terrain Model

The DTM represents surface elevations of ground surfaces, excluding vegetation, bridges, buildings, etc. The DTM is a single-band, 32-bit float GeoTIFF file, with a ground sample distance of 1 meter. No Data value is set to -3.40282306074e+038.

Lidar Intensity Image

The lidar intensity image describes the relative amplitude of reflected signals contributing to the point cloud. Lidar intensity is largely a function of scanned object reflectance in relation to the signal frequency, is dependent on ambient conditions, and is not necessarily consistent between separate scans. The intensity image is a single-band, 32-bit float GeoTIFF file with a ground sample distance of 1 meter. No Data value is set to -3.40282306074e+038 (32-bit, floating-point minimum).

Hydro-Enforced DTM

The hydro-enforced DTM represents bare earth surfaces which have undergone a selective "flattening" process, where elevation values for any hydrologic features, as well as any hydrologic obstacles (bridges, culverts, etc.), are replaced with neighboring pixel values. The hydro-enforced

DTM is a single-band, 32-bit float GeoTIFF file, with a ground sample distance of 1 meter. No Data value is set to -3.40282306074e+038.

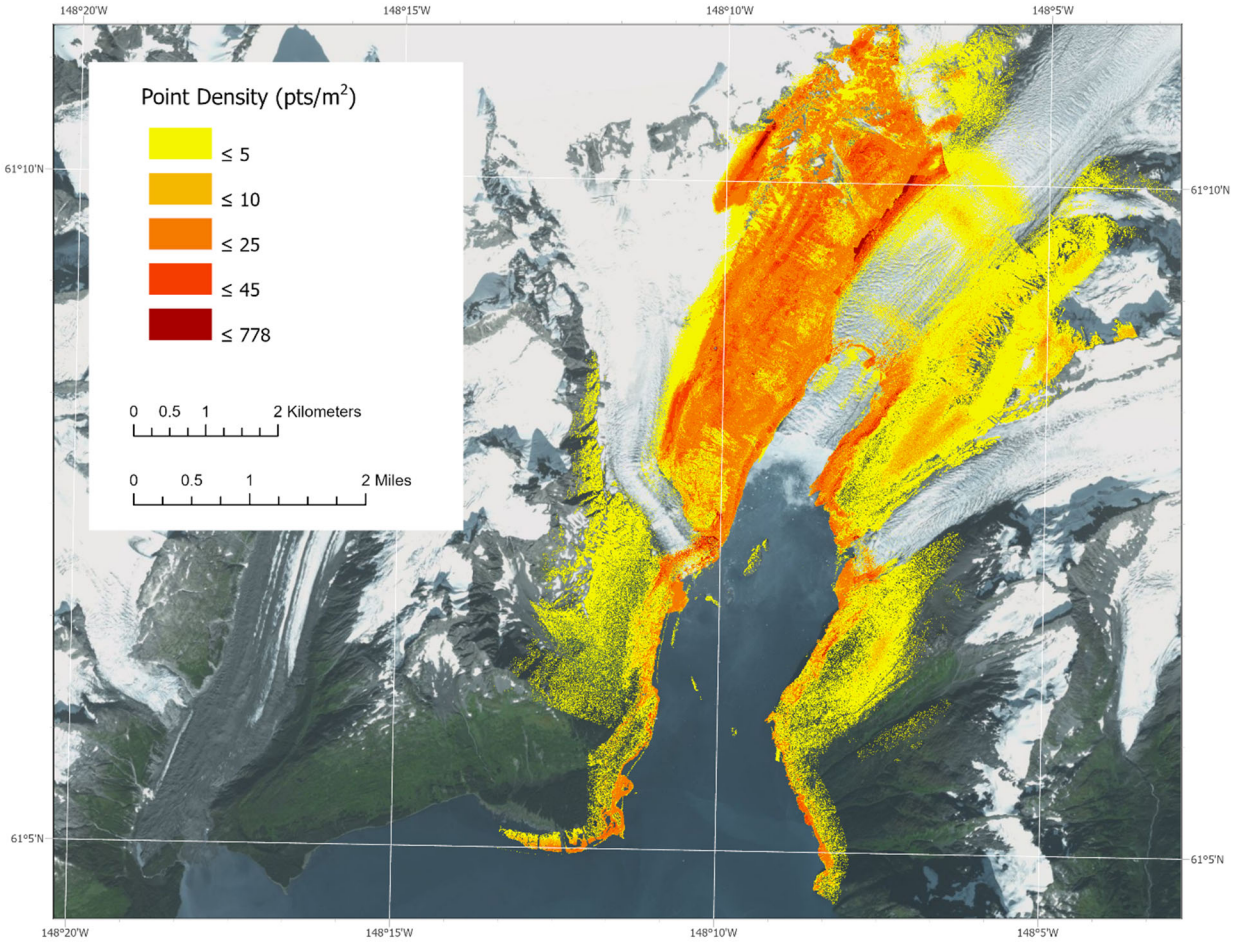

Figure 2. Ground point density for the survey displayed as a 1-meter raster.

SURVEY REPORT

Ground Survey Details

Ground control and check points were collected on June 26, 2020. A Trimble R10-2 GNSS receiver with internal antenna was deployed on the ridge near the center of the study and provided a base station occupation and real-time kinematic (RTK) corrections to points surveyed with a rover Trimble R10-2 GNSS receiver (internal antenna). A total of 106 ground control points and check points were collected to be used for calibration and assessment of the vertical accuracy of the point cloud. All points were collected on bare earth or minimally vegetated surface.

Coordinate System and Datum

All data were processed and delivered in NAD83 (2011) UTM6N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

A mean offset of -19.7 cm was measured between 84 control points and the point cloud (appendix 1). This offset was reduced to -0.6 cm by performing a vertical transformation of the lidar point data. Twenty-two check points were used to determine the non-vegetated vertical accuracy (NVA) of the point cloud ground class, using a TIN-based approach. Project NVA was calculated to have a root mean square error (RMSE) of 7.7 cm (appendix 2). Relative accuracy for this dataset was evaluated as the interswath overlap consistency and was measured at 8.3 cm RMSE.

Data Consistency and Completeness

This data release is complete, and there is no over collect except for aircraft turns that were eliminated from the dataset. The data quality is consistent throughout the survey.

ACKNOWLEDGMENTS

These data products were funded by the State of Alaska and collected and processed by DGGS. We thank Clearwater Air and Alpine Air for their aviation expertise and contribution to these data products.

APPENDIX 1: GROUND CONTROL POINTS

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	437591.962	6779373.098	551.72	551.64	-0.08
2	436713.426	6777598.259	576.13	576.05	-0.08
3	438635.954	6779406.265	1.15	1.06	-0.09
4	437586.279	6779373.005	551.70	551.58	-0.12
5	436698.359	6777611.065	577.39	577.27	-0.12
6	438092.254	6780055.176	534.73	534.60	-0.13
7	438025.996	6780010.381	535.88	535.75	-0.13
8	438074.328	6780047.293	535.65	535.51	-0.14
9	438110.665	6780074.356	536.90	536.76	-0.14
10	437121.962	6779963.546	1077.80	1077.66	-0.14
11	437063.569	6779919.568	1092.55	1092.41	-0.14
12	437603.353	6779347.912	546.07	545.93	-0.14
13	437053.638	6779969.355	1089.89	1089.74	-0.15
14	436659.12	6777643.689	583.41	583.26	-0.15
15	438036.659	6780032.136	539.47	539.32	-0.15
16	437059.688	6779908.314	1094.02	1093.87	-0.15
17	438578.37	6779430.798	1.07	0.92	-0.15
18	437173.064	6779972.558	1059.01	1058.86	-0.15
19	436764.743	6777575.569	581.85	581.70	-0.15
20	436782.216	6777582.11	585.16	585.00	-0.16
21	438597.602	6779433.641	1.74	1.58	-0.16
22	437102.83	6779929.491	1082.19	1082.03	-0.16
23	436738.694	6777566.623	574.90	574.74	-0.16
24	438612.821	6779415.983	1.41	1.25	-0.16
25	438600.134	6779425.974	1.38	1.21	-0.17
26	438059.556	6780032.257	534.94	534.77	-0.17
27	437596.62	6779333.029	547.19	547.02	-0.17
28	436989.148	6779694.531	1085.22	1085.05	-0.17
29	436899.865	6779520.404	1073.92	1073.75	-0.17
30	437058.217	6779878.001	1092.51	1092.34	-0.17
31	437588.839	6779321.496	548.31	548.14	-0.17
32	437152.156	6779922.686	1055.05	1054.87	-0.18
33	438049.541	6780033.66	537.88	537.70	-0.18
34	438040.893	6780022.431	535.42	535.23	-0.19
35	438739.764	6777118.416	4.42	4.23	-0.19
36	437038.714	6779767.095	1092.30	1092.11	-0.19
37	437063.29	6779967.066	1086.52	1086.33	-0.19
38	436762.539	6777587.52	582.10	581.91	-0.19
39	438809.321	6776426.297	2.19	2.00	-0.19

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
40	437052.822	6779879.368	1092.89	1092.70	-0.19
41	438609.673	6779455.663	4.43	4.23	-0.20
42	436979.276	6779659.208	1084.79	1084.59	-0.20
43	436937.771	6779586.708	1070.21	1070.01	-0.20
44	438851.052	6776427.826	4.58	4.38	-0.20
45	437174.411	6779963.277	1059.10	1058.89	-0.21
46	438845.597	6776426.869	4.24	4.03	-0.21
47	437099.469	6779920.163	1082.69	1082.48	-0.21
48	438714.577	6777155.687	3.81	3.60	-0.21
49	437028.041	6779753.279	1091.26	1091.05	-0.21
50	438716.171	6777117.814	2.84	2.63	-0.21
51	436709.936	6777521.463	585.86	585.65	-0.21
52	437005.539	6779715.967	1085.51	1085.30	-0.21
53	436940.402	6779601.176	1071.81	1071.60	-0.21
54	436740.439	6777498.496	574.43	574.21	-0.22
55	438806.177	6776442.733	1.36	1.14	-0.22
56	438805.367	6776436.85	1.58	1.36	-0.22
57	437133.914	6779989.986	1080.46	1080.24	-0.22
58	437574.423	6779362.076	552.91	552.69	-0.22
59	438047.573	6780023.708	535.91	535.69	-0.22
60	438596.605	6779456.506	4.46	4.24	-0.22
61	437041.743	6779790.815	1087.55	1087.33	-0.22
62	436918.501	6779570.779	1070.23	1070.01	-0.22
63	436743.959	6777503.268	573.64	573.41	-0.23
64	438040.59	6780032.095	540.08	539.85	-0.23
65	436984.61	6779683.229	1084.94	1084.71	-0.23
66	436873.024	6779482.811	1073.92	1073.68	-0.24
67	437034.04	6779815.834	1097.63	1097.39	-0.24
68	438839.743	6776438.745	2.49	2.25	-0.24
69	437138.137	6779929.709	1062.37	1062.13	-0.24
70	437127.883	6779983.913	1080.05	1079.81	-0.24
71	438713.084	6777137.841	3.32	3.08	-0.24
72	437164.84	6779944.321	1061.34	1061.10	-0.24
73	437052.283	6779863.405	1093.77	1093.53	-0.24
74	436873.275	6779505.256	1081.58	1081.33	-0.25
75	436862.729	6779470.046	1071.13	1070.87	-0.26
76	438087.15	6780053.167	535.95	535.69	-0.26
77	437175.955	6779992.477	1062.17	1061.90	-0.27
78	437596.238	6779360.879	550.09	549.82	-0.27
79	436947.858	6779642.69	1080.37	1080.10	-0.27
80	437195.609	6780011.539	1065.20	1064.92	-0.28

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
81	438052.134	6780025.833	535.66	535.37	-0.29
82	437571.472	6779313.945	552.59	552.27	-0.32
83	437646.068	6776672.209	29.32	28.99	-0.33
84	437635.514	6776681.925	26.58	26.25	-0.33
Average dz (m)		-0.197			
Minimum dz (m)		-0.332			
Maximum dz (m)		-0.081			
Average magnitude error (m)		0.197			
Root mean square error (m)		0.204			
Standard deviation (m)		0.051			

APPENDIX 2: CHECK POINTS

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	438056.676	6780038.106	536.54	536.64	0.10
2	436715.424	6777580.726	573.06	573.14	0.08
3	437569.37	6779336.199	551.86	551.94	0.08
4	437628.425	6776623.844	36.79	36.84	0.05
5	437605.252	6779335.395	546.35	546.40	0.05
6	438641.658	6779408.426	1.04	1.08	0.04
7	437049.746	6779836.095	1097.47	1097.49	0.02
8	437099.17	6779937.926	1082.44	1082.46	0.02
9	437057.016	6779957.892	1087.72	1087.74	0.02
10	438831.48	6776422.876	3.45	3.46	0.01
11	436725.691	6777527.669	577.17	577.18	0.01
12	437054.73	6779895.159	1093.69	1093.70	0.01
13	437170.289	6779953.716	1060.17	1060.18	0.01
14	437601.908	6779332.037	546.62	546.62	0.01
15	438065.83	6780037.472	535.61	535.60	-0.01
16	438736.779	6777105.668	3.64	3.63	-0.01
17	438031.041	6780014.56	535.25	535.23	-0.02
18	436908.894	6779533.061	1072.59	1072.56	-0.03
19	437615.1	6776693.71	33.01	32.92	-0.09
20	436968.514	6779649.814	1084.67	1084.57	-0.10
21	437013.034	6779730.265	1087.85	1087.71	-0.14
22	437202.15	6780017.197	1067.27	1067.03	-0.24

Number	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
Average dz (m)	-0.006				
Minimum dz (m)	-0.241				
Maximum dz (m)	0.1				
Average magnitude (m)	0.052				
Root mean square error (m)	0.077				
Standard deviation (m)	0.078				