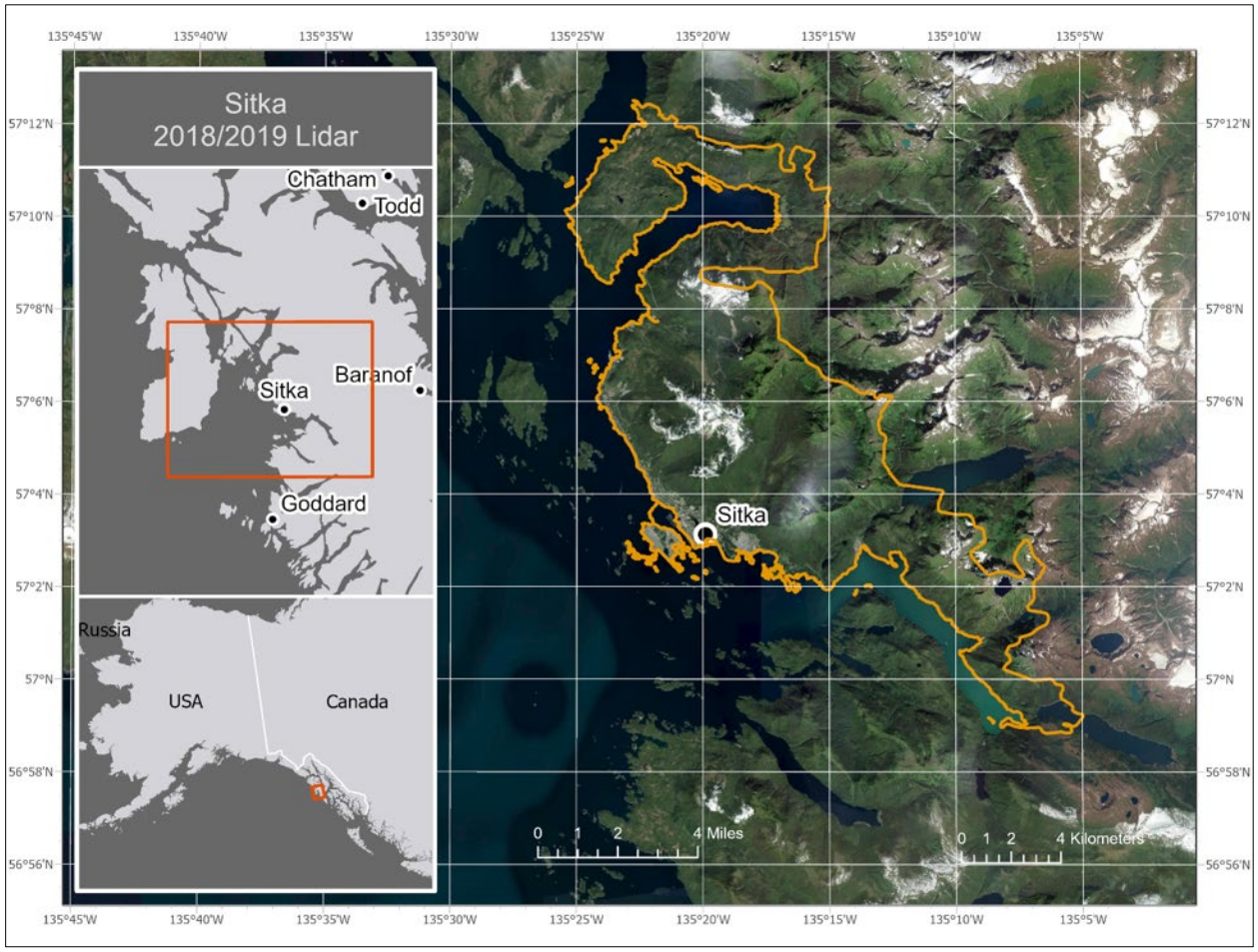
Lidar-derived elevation data for Sitka, Southeast Alaska, collected April 27-29, 2018, and September 27-28, 2019

Jenna M. Zechmann, Gabriel J. Wolken, Ronald P. Daanen, Katreen M. Wikstrom Jones, and Andrew M. Herbst

Raw Data File 2026-19



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.

State of Alaska
Department of Natural Resource
Division of Geological & Geophysical Surveys

STATE OF ALASKA
Mike Dunleavy, Governor

DEPARTMENT OF NATURAL RESOURCES
John Crowther, Commissioner

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
Erin A. Campbell, State Geologist & Director

Publications produced by the Division of Geological & Geophysical Surveys are available to download from the DGGS website (dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road | Fairbanks, Alaska 99709-3707
Phone: 907.451.5010 | Fax 907.451.5050
dggspubs@alaska.gov

DGGS publications are also available at:
Alaska State Library, Historical
Collections & Talking Book Center
395 Whittier Street
Juneau, Alaska 99801

Alaska Resource Library and
Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503

Suggested citation:
Zechmann, J.M., Wolken, G.J., Daanen, R.P., Wikstrom Jones, K.M., and Herbst, A.M., 2026, Lidar-derived elevation data for Sitka, Southeast Alaska, collected April 27-29, 2018, and September 27-28, 2019: Alaska Division of Geological & Geophysical Surveys Raw Data File 2026-19, 14 p.
https://doi.org/10.14509/32132.

Lidar-derived elevation data for Sitka, Southeast Alaska, collected April 27-29, 2018, and September 27-28, 2019

Jenna M. Zechmann[1], Gabriel J. Wolken[1], Ronald P. Daanen[1**], Katreen M. Wikstrom Jones[1], and Andrew M. Herbst[1*]

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 intensity model of Sitka, Southeast Alaska, during leaf-on ground conditions (cover figure). The survey provides snow-free surface elevations for studying landslide hazards. Ground control data were collected April 27-30, 2018, and aerial lidar data were collected April 27-29, 2018 and September 18-27, 2019, and subsequently processed using a suite of geospatial processing software. These data and accompanying documentation are released as a Raw Data File and are available from the DGGS website at https://doi.org/10.14509/32132.

DATA PRODUCTS

- 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 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 a range of 820 m (ranges assume ≥ 20% natural reflectance). The scanner operated with a pulse refresh rate of 100,000-200,000 pulses per second in alpine areas and 400,000-820,000 pulses per second over forested areas, at a scan rate between 20 and 200 revolutions per second. We used a Cessna 180 Skywagon fixed-wing platform and a Bell 206 JetRanger to survey from elevations of 60-400 m above ground level, at a ground speed of ~40 m/s (Cessna 180 Skywagon) or ~30 m/s (Bell 206 JetRanger), and with a scan angle set from 55 to 305 degrees (2018) or 90 to 270 degrees (2019). The total survey area covers ~168 km^2.

Weather Conditions and Collection Times

The survey area was accessed by air (fig. 1) from Sitka Rocky Gutierrez Airport. See table 1 for data collection start and end times, aircraft used, and weather conditions.

[1] Alaska Division of Geological & Geophysical Surveys, 3354 College Road, Fairbanks, AK 99709
* Former DGGS
** In memoriam

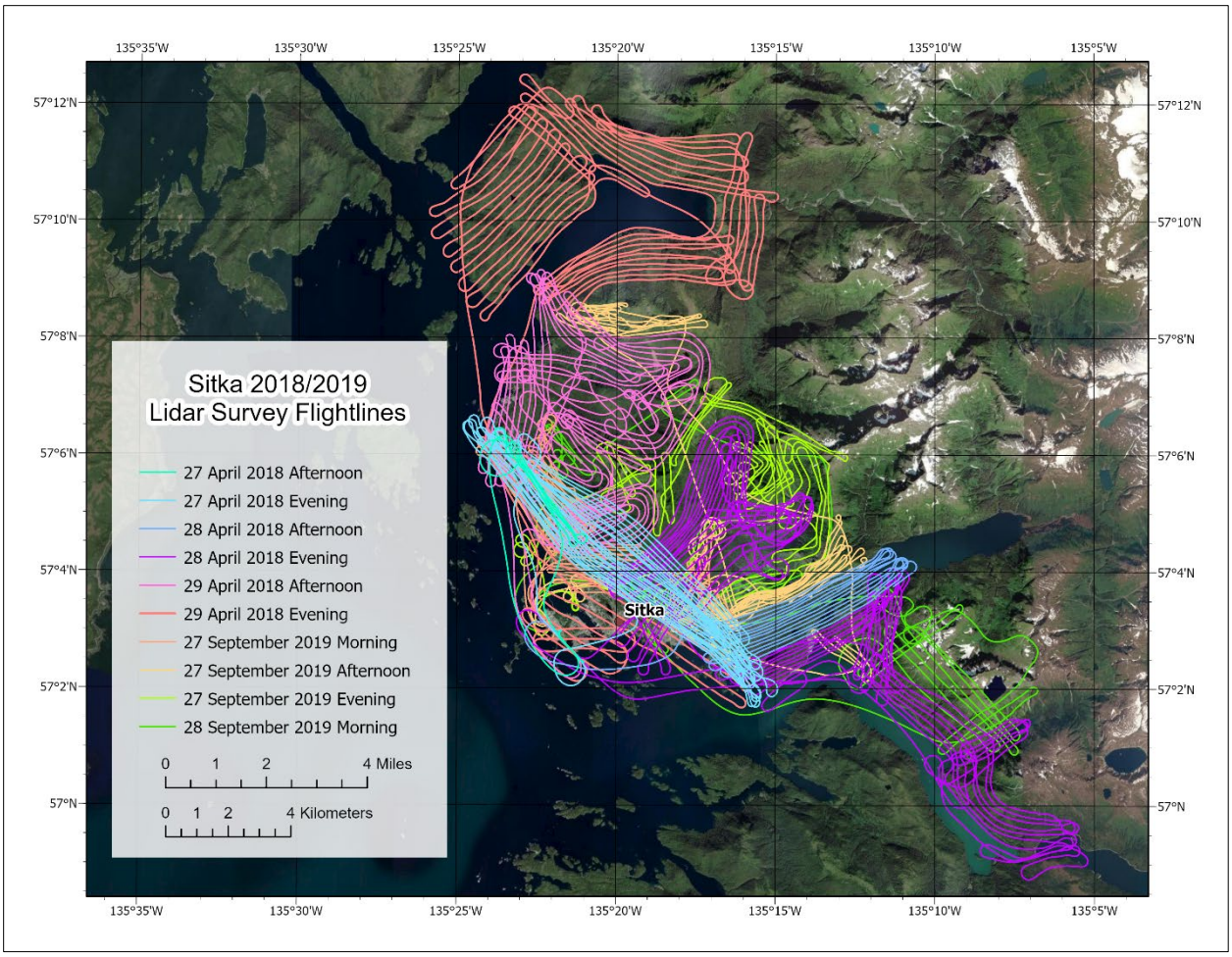


Figure 1. Lidar data collection flightlines.

Table 1. Lidar data acquisition start and end times, aircraft type, and weather conditions for the lidar collection survey.

Date	Start	End	Aircraft	Weather
27 April 2018	3:50 pm	4:00 pm	Cessna 180	Partially cloudy
27 April 2018	5:30 pm	7:30 pm	Cessna 180	Partially cloudy
28 April 2018	3:10 pm	4:40 pm	Cessna 180	Partially cloudy
28 April 2018	5:40 pm	8:00 pm	Cessna 180	Partially cloudy
29 April 2018	2:50 pm	5:10 pm	Cessna 180	Partially cloudy
29 April 2018	5:40 pm	8:30 pm	Cessna 180	Partially cloudy
27 Sept. 2019	9:30 am	12:00 pm	Bell 206 JetRanger	Clear
27 Sept. 2019	1:10 pm	3:40 pm	Bell 206 JetRanger	Clear
27 Sept. 2019	4:20 pm	5:50 pm	Bell 206 JetRanger	Clear
28 Sept. 2019	9:20 am	11:00 am	Bell 206 JetRanger	Clear

PROCESSING REPORT

Lidar Dataset Processing

We processed point data using SDCimport software 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 48.6 pulses/m^2, and the average pulse spacing is 14.4 cm.

Macros (ordered lists of point classification commands tailored to this dataset) were created in Terrasolid software and used to classify points in accordance with 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.

We used ArcGIS Pro to derive raster products from the point cloud. A 50-cm DSM was interpolated from maximum return values from ground, vegetation, bridge deck, and building classes using a binning method. A 50-cm DTM was interpolated from all ground class returns using a binning method and minimum values. We also produced a 1-meter 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 2025 guidelines (table 2) and contain return and intensity information. Point cloud elevation information was recorded, processed, and published rounded to the nearest centimeter. For classified ground points, the average density (fig. 2) is 6.17 pts/m^2, and the average point spacing is 40.3 cm.

Table 2. Point cloud class code definitions

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, ≥0.0m, <0.2m
4	Medium Vegetation, ≥0.2m, ≤3m
5	High Vegetation, >3m, ≤60m
6	Building
7	Low Noise
17	Bridge Deck
18	High Noise

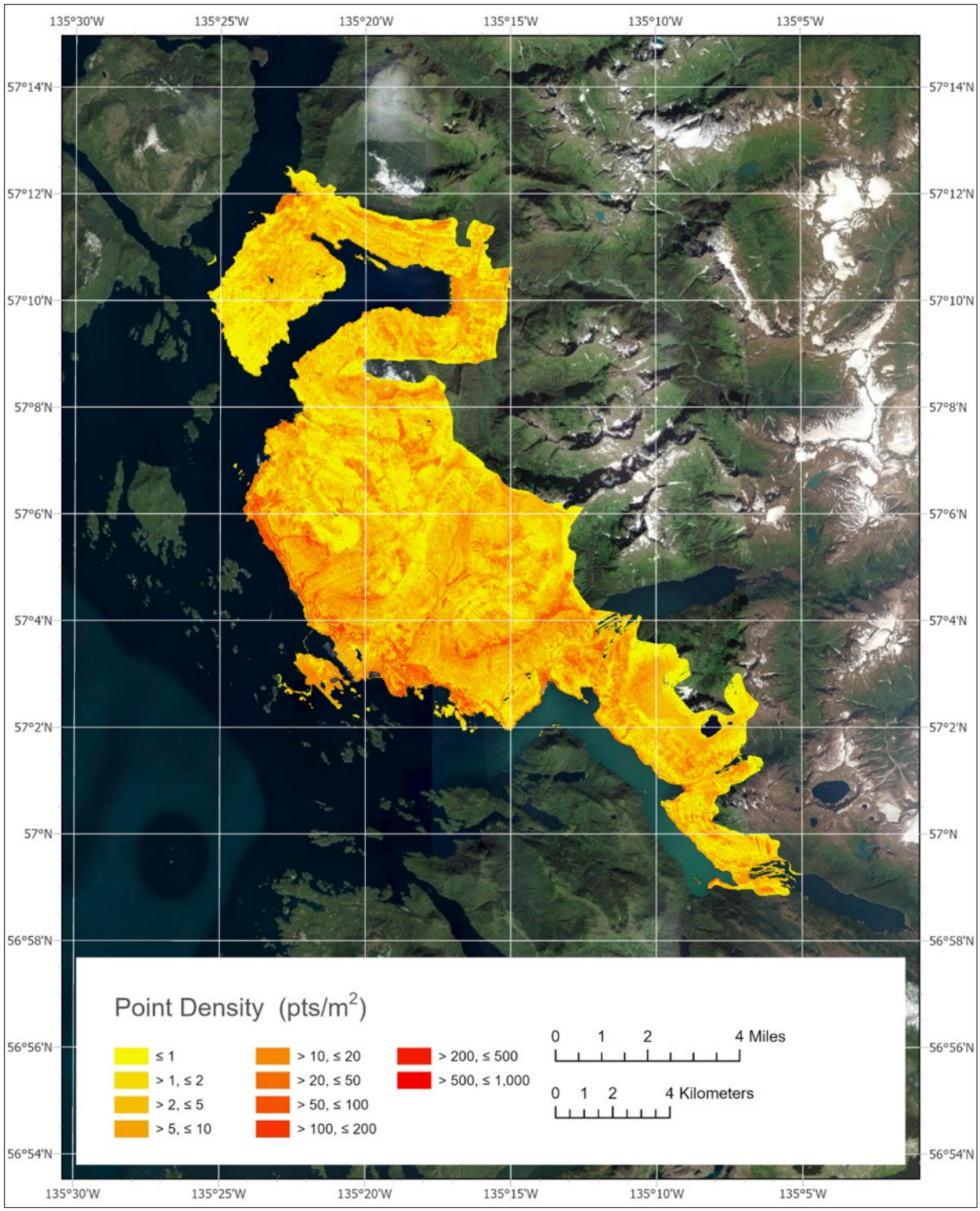


Figure 2. Ground point density for the survey displayed as a raster.

Digital Surface Model

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

SURVEY REPORT

Ground Survey Details

Ground control points were collected April 27-30, 2018 (Daanen and others, 2020). We deployed a base Trimble R7 GNSS receiver to provide base station occupation and real-time kinematic (RTK) corrections to points. We surveyed with a rover Trimble R8 GNSS receiver/Trimble Juno 5 Series controller. We collected 234 ground control points and check points, not all of which overlapped with the April 27-29, 2018, and September 27-28, 2019, point cloud. Daanen and others (2020) reported Easting values to 1 decimal place and Northing values to the nearest whole number. Of the 234 ground control points and check points collected in 2018, 195 could be used for calibration and vertical accuracy assessment of the 2018 and 2019 point cloud. Ground control points and check points were collected on bare earth.

Coordinate System and Datum

We processed and delivered all data in NAD83 (2011), UTM8N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

We measured a mean offset of -79 cm between 156 control points and the point cloud (see tables A1-1 and A1-2). This offset was reduced to -9 cm by applying a rubber-sheet vertical correction to the lidar point data. We used 39 check points to assess the non-vegetated vertical accuracy of the point cloud ground class using a Triangulated Irregular Network (TIN)

approach. The project's vertical accuracy has a root mean square error (RMSE) of 14 cm (tables A2-1 and A2-2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 9 cm RMSE.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect except for aircraft turns that were eliminated from the dataset. The data quality is consistent throughout the survey.

ACKNOWLEDGMENTS

The area of this survey lies within the traditional homelands of the Tlingit peoples. These data products were funded by the State of Alaska and by National Park Service awards #P17AC00903 and #P15AC01879 and collected and processed by DGGS. We thank Coastal Helicopters and 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 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

Daanen, R.P., Wolken, G.J., and Herbst, A.M., 2020, Lidar-derived elevation data for Sitka, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2020-13, 11 p. https://doi.org/10.14509/30531

In Memoriam, Ronald P. Daanen

APPENDIX: SURVEY CONTROL AND CHECK POINTS

Table A1-1. Vertical ground control points

GCP Point Name	Easting (m)	Northing (m)	GCP Z (m)	Point cloud Z (m)	Elevation Difference (Point cloud Z – GCP Z) (m)
GCP-2	484863.0	6321108	23.335	22.66	-0.675
GCP-3	484888.8	6321141	21.967	21.34	-0.627
GCP-4	484910.3	6321179	20.031	19.41	-0.621
GCP-6	484997.7	6321296	13.478	12.85	-0.628
GCP-7	485002.1	6321343	12.151	11.51	-0.641
GCP-8	485025.2	6321382	11.078	10.40	-0.678
GCP-9	485111.2	6321425	10.418	9.74	-0.678
GCP-11	485224.2	6321532	8.183	7.59	-0.593
GCP-12	485311.8	6321601	8.784	8.20	-0.584
GCP-13	485323.0	6321655	8.646	8.04	-0.606
GCP-14	485413.8	6321701	10.224	9.56	-0.664
GCP-16	487759.3	6322427	10.842	10.20	-0.642
GCP-17	487755.5	6322435	10.901	10.23	-0.671
GCP-18	487755.6	6322448	10.865	10.18	-0.685
GCP-19	487766.4	6322440	11.192	10.58	-0.612
GCP-21	485931.6	6323021	14.301	13.59	-0.711
GCP-22	485904.4	6322997	15.095	14.45	-0.645
GCP-23	485878.9	6322963	15.377	14.75	-0.627
GCP-24	485859.6	6322921	14.993	14.35	-0.643
GCP-26	485847.8	6322808	12.784	12.07	-0.714
GCP-27	485853.8	6322734	10.466	9.72	-0.746
GCP-28	485870.0	6322676	9.043	8.44	-0.603
GCP-29	485509.6	6321717	11.924	11.14	-0.784
GCP-31	483340.7	6321938	43.297	42.60	-0.697
GCP-32	483315.1	6321957	44.156	43.51	-0.646
GCP-33	483294.9	6321980	44.145	43.50	-0.645
GCP-34	481878.1	6322696	7.037	6.38	-0.657
GCP-36	481524.1	6323292	27.432	26.49	-0.942
GCP-37	481328.7	6323880	22.854	22.15	-0.704
GCP-38	481288.5	6323913	23.063	22.31	-0.753
GCP-39	481041.9	6324038	36.103	35.38	-0.723
GCP-41	479915.6	6323625	12.020	11.37	-0.650

GCP Point Name	Easting (m)	Northing (m)	GCP Z (m)	Point cloud Z (m)	Elevation Difference (Point cloud Z – GCP Z) (m)
GCP-42	479818.4	6324459	36.283	35.59	-0.693
GCP-43	478971.4	6324535	29.730	29.02	-0.710
GCP-44	479002.1	6324524	29.369	28.70	-0.669
GCP-46	478921.3	6324747	28.137	27.50	-0.637
GCP-47	478939.4	6324730	27.882	27.26	-0.622
GCP-48	478968.1	6324752	28.815	28.17	-0.645
GCP-49	478944.6	6324762	28.851	28.19	-0.661
GCP-51	478120.8	6325871	59.968	59.08	-0.888
GCP-52	476900.3	6326944	9.867	9.19	-0.677
GCP-53	476434.6	6328664	55.130	54.43	-0.700
GCP-54	476440.5	6328660	55.191	54.49	-0.701
GCP-59	478029.1	6322993	8.563	7.92	-0.643
GCP-60	478029.1	6322993	8.561	7.92	-0.641
GCP-61	478087.2	6322977	7.739	7.11	-0.629
GCP-62	477529.9	6329109	143.770	143.13	-0.640
GCP-64	476814.0	6327701	41.635	41.03	-0.605
GCP-65	476842.5	6327692	42.003	41.18	-0.823
GCP-66	476852.3	6327679	41.790	41.00	-0.790
GCP-67	476809.7	6327688	40.814	40.11	-0.704
GCP-69	476773.3	6327626	35.784	35.03	-0.754
GCP-70	476755.7	6327595	33.153	32.38	-0.773
GCP-71	477596.0	6326152	52.179	51.50	-0.679
GCP-72	477603.2	6326129	50.547	49.82	-0.727
GCP-74	477613.4	6326068	44.585	43.85	-0.735
GCP-75	477614.2	6326040	42.007	41.21	-0.797
GCP-76	477590.6	6326030	41.729	40.86	-0.869
GCP-77	477590.5	6326006	41.492	40.72	-0.772
GCP-79	477648.3	6325977	37.940	37.09	-0.850
GCP-80	477717.4	6325911	40.798	39.69	-1.108
GCP-81	479063.0	6323738	16.498	15.94	-0.558
GCP-82	479077.0	6323743	17.425	16.90	-0.525
GCP-84	480615.0	6322905	9.897	9.21	-0.687
GCP-85	480626.5	6322898	9.528	8.86	-0.668
GCP-86	480626.6	6322937	11.208	10.52	-0.688

GCP Point Name	Easting (m)	Northing (m)	GCP Z (m)	Point cloud Z (m)	Elevation Difference (Point cloud Z – GCP Z) (m)
GCP-87	480824.3	6323839	28.724	28.05	-0.674
GCP-89	480805.7	6323839	28.701	28.06	-0.641
GCP-90	480815.4	6323826	29.061	28.39	-0.671
GCP-91	480815.4	6323826	29.065	28.39	-0.675
GCP-92	481775.4	6323103	37.358	36.46	-0.898
GCP-94	481879.0	6323190	64.166	62.95	-1.216
GCP-95	482001.1	6323072	60.137	59.48	-0.657
GCP-96	482017.4	6323054	61.005	60.40	-0.605
GCP-97	482034.1	6323066	61.050	60.28	-0.770
GCP-101	486767.4	6324291	80.421	79.41	-1.011
GCP-102	487813.1	6324333	142.422	141.66	-0.762
GCP-103	487793.0	6324321	142.228	141.44	-0.788
GCP-104	487773.8	6324329	142.376	141.59	-0.786
GCP-106	487757.3	6324334	142.519	141.72	-0.799
GCP-107	487769.8	6324361	144.967	144.20	-0.767
GCP-108	486475.3	6322680	23.679	22.96	-0.719
GCP-109	487787.9	6321603	17.551	16.70	-0.851
GCP-111	491001.7	6319067	8.935	8.29	-0.645
GCP-112	490991.5	6319117	8.451	7.81	-0.641
GCP-113	490976.8	6319101	6.743	6.11	-0.633
GCP-114	491721.6	6316573	36.249	35.60	-0.649
GCP-116	493068.6	6315969	123.776	123.00	-0.776
GCP-117	493064.1	6315995	123.736	123.04	-0.696
GCP-118	485709.7	6323162	56.115	55.34	-0.775
GCP-119	485709.7	6323162	56.125	55.34	-0.785
GCP-121	485603.4	6323105	103.947	103.28	-0.667
GCP-122	485538.7	6323058	104.083	103.31	-0.773
GCP-123	485442.1	6323071	105.617	104.84	-0.777
GCP-124	485287.9	6323020	105.698	104.93	-0.768
GCP-126	485151.4	6322951	119.026	118.23	-0.796
GCP-127	485081.3	6322897	112.440	111.75	-0.690
GCP-130	484878.0	6322752	65.464	64.77	-0.694
GCP-131	484815.5	6322649	59.398	58.69	-0.708
GCP-134	484607.3	6322360	43.870	43.18	-0.690

GCP Point Name	Easting (m)	Northing (m)	GCP Z (m)	Point cloud Z (m)	Elevation Difference (Point cloud Z – GCP Z) (m)
GCP-135	484574.9	6322294	39.875	38.95	-0.925
GCP-137	484498.7	6322103	39.256	38.52	-0.736
GCP-138	484508.9	6321933	37.263	36.62	-0.643
GCP-141	486048.3	6322513	6.696	5.90	-0.796
GCP-142	486052.7	6322538	6.924	6.25	-0.674
GCP-143	486069.7	6322635	6.776	6.03	-0.746
GCP-144	486061.6	6322648	6.855	6.13	-0.725
GCP-146	486052.7	6322621	7.273	6.56	-0.713
GCP-147	486076.1	6322619	6.630	5.96	-0.670
GCP-148	486047.2	6322792	7.339	6.50	-0.839
GCP-149	486045.0	6322803	7.442	6.68	-0.762
GCP-151	477848.5	6332278	11.967	11.09	-0.877
GCP-152	477829.9	6332265	11.832	10.98	-0.852
GCP-153	477807.9	6332249	11.829	10.94	-0.889
GCP-154	477754.2	6332515	8.669	7.71	-0.959
GCP-156	478145.6	6332014	9.105	8.29	-0.815
GCP-157	479078.5	6331430	18.195	17.33	-0.865
GCP-158	479105.9	6331451	18.392	17.42	-0.972
GCP-159	479098.3	6331411	17.989	17.07	-0.919
GCP-161	479376.8	6331555	25.316	24.41	-0.906
GCP-163	480093.0	6330753	71.753	70.94	-0.813
GCP-166	480422.0	6330203	78.070	77.32	-0.750
GCP-168	480548.5	6331188	51.027	50.11	-0.917
GCP-170	480603.8	6331206	52.015	51.13	-0.885
GCP-171	480692.9	6331170	53.620	52.68	-0.940
GCP-172	480776.1	6331158	56.127	55.34	-0.787
GCP-173	480807.3	6331133	57.193	56.24	-0.953
GCP-176	481082.3	6331557	263.634	262.52	-1.114
GCP-177	481075.3	6331562	263.528	262.76	-0.768
GCP-183	477291.9	6331895	5.423	4.44	-0.983
GCP-184	476876.9	6339287	3.846	2.85	-0.996
GCP-186	476949.9	6339336	3.428	2.41	-1.018
GCP-187	477003.9	6339322	3.871	2.76	-1.111
GCP-188	476106.9	6338671	4.059	2.89	-1.169

GCP Point Name	Easting (m)	Northing (m)	GCP Z (m)	Point cloud Z (m)	Elevation Difference (Point cloud Z – GCP Z) (m)
GCP-189	476114.3	6338670	4.096	3.02	-1.076
GCP-195	476119.9	6333387	4.228	3.18	-1.048
GCP-197	477088.3	6335280	4.440	3.33	-1.110
GCP-200	478073.4	6335814	4.286	3.23	-1.056
GCP-203	479059.1	6336535	4.317	3.48	-0.837
GCP-206	478936.6	6337839	3.871	2.87	-1.001
GCP-207	478971.1	6337872	3.847	2.78	-1.067
GCP-208	480060.5	6337667	3.639	2.70	-0.939
GCP-209	480073.7	6337653	3.763	2.62	-1.143
GCP-212	479900.2	6337474	4.263	3.10	-1.163
GCP-213	481832.0	6337165	3.802	2.78	-1.022
GCP-214	481850.4	6337164	3.869	2.72	-1.149
GCP-217	482853.8	6336843	3.802	2.76	-1.042
GCP-221	482626.4	6335495	5.170	4.03	-1.140
GCP-222	482626.5	6335495	5.180	4.03	-1.150
GCP-223	482665.9	6335500	3.713	2.61	-1.103
GCP-226	481335.8	6335664	3.805	2.86	-0.945
GCP-227	481355.2	6335655	3.364	2.27	-1.094
GCP-228	481328.4	6335653	4.744	3.75	-0.994
GCP-230	479799.8	6335593	3.470	2.40	-1.070
GCP-233	477291.9	6331895	5.421	4.44	-0.981
GCP-234	477291.9	6331895	5.429	4.44	-0.989

Table A1-2. Vertical ground control point summary

Vertical Ground Control Point Summary Statistic	Calculated Value (m)
Average elevation difference (dZ) (m)	-0.79
Minimum dZ (m)	-1.22
Maximum dZ (m)	-0.53
Average magnitude error (m)	0.79
Root mean square error (m)	0.81
Standard deviation (m)	0.16

Table A2-1 Vertical check points

Check Point Name	Easting (m)	Northing (m)	Check point Z (m)	Corrected Point Cloud Z (m)	Elevation Difference (Corrected Point Cloud Z –Check point Z) (m)
GCP-1	484645.2	6321154	26.221	26.26	0.039
GCP-5	484957.2	6321237	15.923	15.93	0.007
GCP-10	485165.8	6321475	9.356	9.36	0.004
GCP-15	485509.6	6321717	11.955	11.77	-0.185
GCP-20	487774.0	6322421	11.225	11.21	-0.015
GCP-25	485849.9	6322873	14.096	14.04	-0.056
GCP-30	485509.6	6321717	11.923	11.77	-0.153
GCP-35	481872.6	6322713	7.532	7.50	-0.032
GCP-40	481036.3	6324139	37.361	37.30	-0.061
GCP-45	478967.7	6324501	29.339	29.36	0.021
GCP-50	478027.0	6325429	45.473	45.60	0.127
GCP-55	475833.8	6329480	9.747	9.65	-0.097
GCP-63	476656.0	6327884	45.875	45.74	-0.135
GCP-68	476794.7	6327660	38.543	38.55	0.007
GCP-73	477609.8	6326102	48.033	48.04	0.007
GCP-78	477615.4	6326003	38.477	38.34	-0.137
GCP-83	480627.9	6322920	10.453	10.41	-0.043
GCP-88	480817.2	6323849	28.582	28.59	0.008
GCP-93	481891.8	6323208	65.539	65.44	-0.099
GCP-100	485499.2	6321719	12.136	12.10	-0.036
GCP-105	487788.1	6324340	142.354	142.27	-0.084
GCP-110	489427.3	6320005	14.497	14.55	0.053
GCP-115	493053.0	6315957	124.214	124.30	0.086
GCP-120	485622.3	6323261	86.334	86.28	-0.054
GCP-125	485204.0	6323003	119.852	119.72	-0.132
GCP-133	484660.0	6322461	49.510	49.45	-0.060

GCP-139	484506.4	6321839	39.190	39.02	-0.170
GCP-145	486053.2	6322644	7.058	7.02	-0.038
GCP-150	486042.2	6322817	7.475	7.40	-0.075
GCP-155	477764.3	6332527	9.175	8.89	-0.285
GCP-160	479073.9	6331578	20.587	20.39	-0.197
GCP-169	480565.5	6331205	51.427	51.15	-0.277
GCP-174	481070.8	6331218	89.830	89.71	-0.120
GCP-185	476919.5	6339310	3.636	3.37	-0.266
GCP-190	476077.2	6338610	3.798	3.62	-0.178
GCP-204	478834.7	6337836	4.178	3.95	-0.228
GCP-216	482832.1	6336875	3.640	3.41	-0.230
GCP-224	482666.0	6335499	3.702	3.40	-0.302
GCP-231	479789.1	6335529	3.723	3.51	-0.213

Table A2-2. Vertical check point statistics

Vertical Check Point Statistic	Calculated Value (m)
Average elevation difference (dZ) (m)	-0.09
Minimum dZ (m)	-0.30
Maximum dZ (m)	0.13
Average magnitude error (m)	0.11
Root mean square error (m)	0.14
Standard deviation (m)	0.11