City of Iqaluit

Unnamed Lake

August 16-17, 2019

Introduction

Aethon Aerial Solutions (AAS) conducted an aerial survey of the Unnamed Lake site in Iqaluit for the City of Iqaluit on August 16-17, 2019. The project site (see Figure 1) was located approximately 6 km [E] of CYFB (Iqaluit airport) and covered 28.9 square km. The project area was surveyed in 3 flights at 750' AGL.

Survey Summary:

- Survey area: Unnamed Lake
- Collection dates: August 16-17, 2019
- Survey platform: B206
- Horizontal Datum: NAD83 CSRS, 2010 Epoch
- Vertical Datum: CGVD2013
- Geoid Model: CGG2013
- Projection: UTM Zone 19 [N]
- Deliverables:
  - Classified (unclassified, ground, water) LiDAR .las point cloud
  - 1 m ASCII (.xyz) grid
  - 7 cm RGB Orthomosaic in GeoTIFF and .ecw formats

Survey Equipment

AAS partnered with Universal Helicopters to use their Bell 206 helicopter as the survey aircraft.

The sensor platforms included:

- Riegl VUX-1 laser scanner
- KVH1750 IMU
- Novatel GNSS 638/615
- Nikon D810 digital SLR

Ground Survey Equipment

- Leica iCON gps60 base station
- Leica iCON gps60 rover

Survey Control

AAS surveyors utilized an NRCAN control monument named PALUG at the project site (see Figures 2 and 3). The monument is a HP3D brass cap embedded in the ground. Coordinates for the PALUG control monument were taken from NRCAN's published values and also checked using NRCAN's Precise Point Positioning service (see Table 1 and Figure 4). All AAS data has been referenced to the PALUG published coordinates from NRCAN. A second monument named 301 was utilized near the project site and is included in Table 1. Coordinates used for 301 were derived by a differential correction survey from PALUG.

Table 1 – PALUG control monument and permanent control spike 301 location.

NAME	SOURCE	LATITUDE	LONGITUDE	ELLIPSOIDAL HEIGHT (m)	CGG2013 GEOID ADJUSTMENT (m)
PALUG	NRCAN Published	63º 44' 39.413803''	-68º 28' 55.656848''	107.473	9.931
UTM Zone 19 [N]		EASTING (m)	NORTHING (m)	ORTHOMETRIC HEIGHT (m)	
		525561.320	7068622.867	117.404	

NAME	SOURCE	LATITUDE	LONGITUDE	ELLIPSOIDAL HEIGHT (m)	CGG2013 GEOID ADJUSTMENT (m)
PALUG	NRCAN PPP	63º 44' 39.41406''	-68º 28' 55.65713''	107.449	9.931
UTM Zone 19 [N]		EASTING (m)	NORTHING (m)	ORTHOMETRIC HEIGHT (m)	
		525561.316	7068622.875	117.380	

NAME	SOURCE	EASTING (m)	NORTHING (m)	ORTHOMETRIC HEIGHT (m)
301	Differential Correction	527151.2024	7070357.9979	171.8568

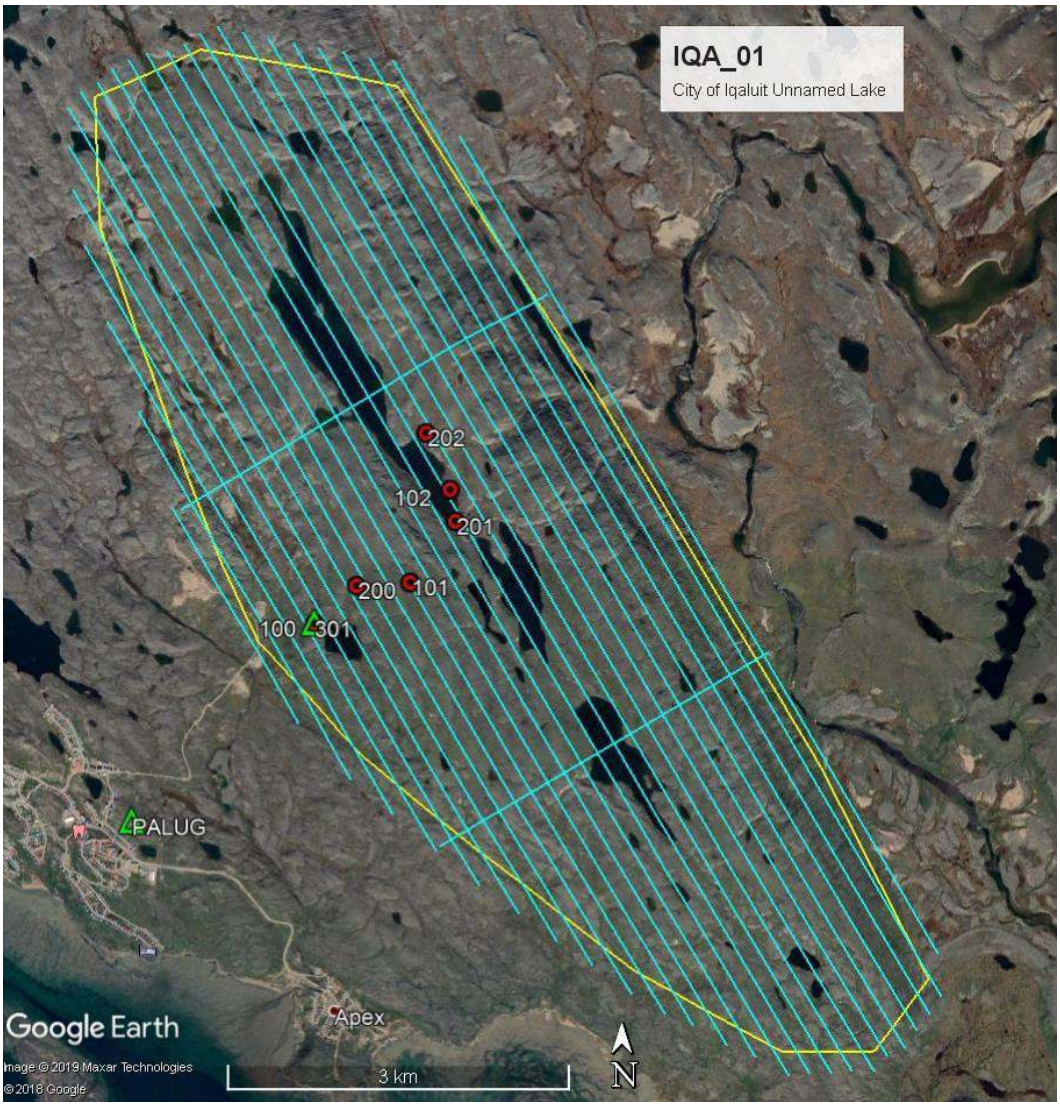

Figure 1 – Unnamed Lake survey area flight lines (blue), area of interest (yellow), GCPs (red markers) and control point locations (green triangle) overlain on Google Earth imagery.

Check Point Data

AAS surveyors established 6 ground control targets (approximately 3ftx3ft) within the survey area from control point 301 for LiDAR and orthomosaic data analysis. 3 of the points were used for calibration and processing of the LiDAR data. The remaining 3 points have been compared vertically to the delivered LiDAR data in Table 3. 4 of the established ground control targets were painted to accurately georeference and assess the quality of the orthomosaic. (see Table 4).

Table 3 – LiDAR ground targets and vertical accuracy measurements.

SURVEYED GROUND CONTROL POINT					LiDAR
POINT NUMBER	**COMMENT**	**EASTING (m)**	**NORTHING (m)**	**ORTHO. HEIGHT (m)**	**MEASURED Z DIFFERENCE (m)**
1	200	527551.008	7070691.160	201.983	0.065
2	201	528391.550	7071253.310	205.802	0.018
3	202	528134.018	7072009.439	225.333	0.015
				MEAN	**0.033**
				RMSE	**0.040**
				STDEV	**0.028**

Table 4 – Orthomosaic ground targets and horizontal accuracy measurements.

SURVEYED GROUND CONTROL POINT					RGB IMAGERY
POINT NUMBER	**COMMENT**	**EASTING (m)**	**NORTHING (m)**	**ORTHO. HEIGHT (m)**	**MEASURED X-Y DIFFERENCE (m)**
1	100	527167.297	7070357.656	172.408	0.060
2	101	528021.931	7070723.655	244.707	0.000
3	102	528344.503	7071525.336	213.792	0.055
4	200	527551.008	7070691.160	201.982	0.110
				MEAN	**0.056**
				RMSE	**0.068**
				STDEV	**0.045**

Data Acquisition

AAS surveyors flew the survey on August 16-17, 2019 to cover the project area of 28.9 km^2 in 3 flights of 26 flight lines at 750 ft AGL.

The flying speed was 40 knots (ground speed). AAS' GPS base station was set up on the PALUG control monument and operated continuously during data acquisition logging at a 1 second interval.

LiDAR data was collected using a Riegl VUX-1 scanner operating at 200 kHz at 750' AGL resulting in an overall point density of 17.3 points/m^2.

Data Processing

LiDAR

Calibration

A calibration pattern is flown at the AAS test facility to compute the roll, pitch and heading offsets for the IMU and laser scanner. Sloped targets are set out in various orientations and a calibration flight pattern is flown over. New calibration values are computed every time the IMU is attached to the laser scanner.

Project specific calibration adjustments are made on a flightline-to-flightline basis and are unique to each flight.

Classification

ASPRS standard classified LiDAR point clouds version 1.2 are delivered in LAS format (see Table 5 below).

Table 5 – LiDAR point classification scheme.

CLASS NAME	CLASS NUMBER
Unclassified	1
Ground	2
Water	9

Automated classification algorithms determined the ground points from non-ground points. Skilled LiDAR technicians inspected the automated ground classification and adjusted any misclassified points where necessary. The next step is to classify the water from all remaining points which are left as unclassified.

Orthomosaic

The completed aerial triangulation, LiDAR ground points and DEM are used to accurately georeference the orthophotos. Colour balancing and image touch ups are done to ensure a seamless orthomosaic is generated. The orthomosaic is exported in tiles in GeoTIFF and ECW formats at 7 cm pixel resolution.

Final Remarks

AAS appreciates the opportunity to complete this survey for the City of Iqaluit and is available to answer any questions regarding the data collection and deliverables.

Please feel free to contact me at my coordinates below,

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APPENDIX

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AETHON AERIAL SOLUTIONS™

RTK & BASE FIELD NOTES

Client: City of Iqaluit Project Code: IQA01

Completed by: B Vallieres Date: Aug 13 / 19

Job Name: Unnamed Lake Base Location: Palvg

Temperature: 15 Wind: 0 Cloud: 1/8

Survey Equip: ISON60 UAV-☐ Marine-☐ Manned-☑ Airframe: B206

Base File Name: _____ Base Stn ID: 300 Marker Type: Mon

Coordinate System: N83 (2010) UTM Zone: 19

Base Height: 1,200 Start Time: 0918 End Time: 1810 Raw Data Logging ☑

Base Coords - N: _____m E: _____m Z: _____m

e base position: Known-☑ Unknown-☐

Point #	Rod Height	Description
301	2.000	1510 - 1540 raw log.

enter Δ horizontal and Δ vertical values in description for check shots

Figure 2 – AAS base station setup sheet for PALUG control monument.

Figure 3 – Image of PALUG control monument and base station near the Unnamed Lake survey site.

CSRS-PPP 2.26.1 (2019-05-31)

LEIC225n18-58000.19o
300

Data Start	Data End	Duration of Observations
2019-08-13 13:18:59.00	2019-08-13 22:11:06.00	8:52:07
Processing Time		**Product Type**
13:10:06 UTC 2019/08/14		NRCan Rapid
Observations	**Frequency**	**Mode**
Phase and Code	Double	Static
Elevation Cut-Off	**Rejected Epochs**	**Estimation Steps**
7.5 degrees	0.00 %	1.00 sec
Antenna Model	**APC to ARP**	**ARP to Marker**
LEIICG60 NONE	L1 = 0.130 m L2 = 0.134 m	H:1.560m / E:0.000m / N:0.000m

(APC = antenna phase center; ARP = antenna reference point)

Estimated Position for LEIC225n18-58000.19o

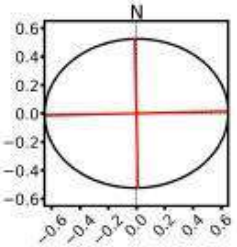
	Latitude (+n)	Longitude (+e)	Ell. Height
NAD83(CSRS) (2010)†	63° 44' 39.41406"	-68° 28' 55.65713"	107.449 m
Sigmas(95%)	0.004 m	0.005 m	0.013 m
A priori*	63° 44' 39.45627"	-68° 28' 55.73950"	106.774 m
Estimated – A priori	-1.307 m	1.130 m	0.675 m

Orthometric Height CGVD2013 (CGG2013a)

117.380 m

(click for height reference information)

95% Error Ellipse (cm)
semi-major: 0.650 cm
semi-minor: 0.524 cm
semi-major azimuth: 88° 44' 2.34"



UTM (North) Zone 19

7068622.875 m (N)
525561.316 m (E)

Scale Factors
0.999608 (point)
0.999591 (combined)

*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG)

Figure 4 – NRCAN PPP report for the PALUG control monument near the Unnamed Lake survey site.