2022 Ibex Valley, Yukon

LiDAR and Airphoto
Data Capture and Processing

LiDAR and Air Photo Report

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1. Introduction

McElhanney Ltd (MCSL) performed a LiDAR and aerial photography acquisition for Ibex Valley area shown in Figure 1.

The site was flown on June 19th. This report describes the acquisition, post-processing and quality control methodology used to produce the final elevation models.

2. Mission Plan

Project: Ibex Valley

Date: 2022-06-19

Location: Ibex Valley, YT

Topography: low relief

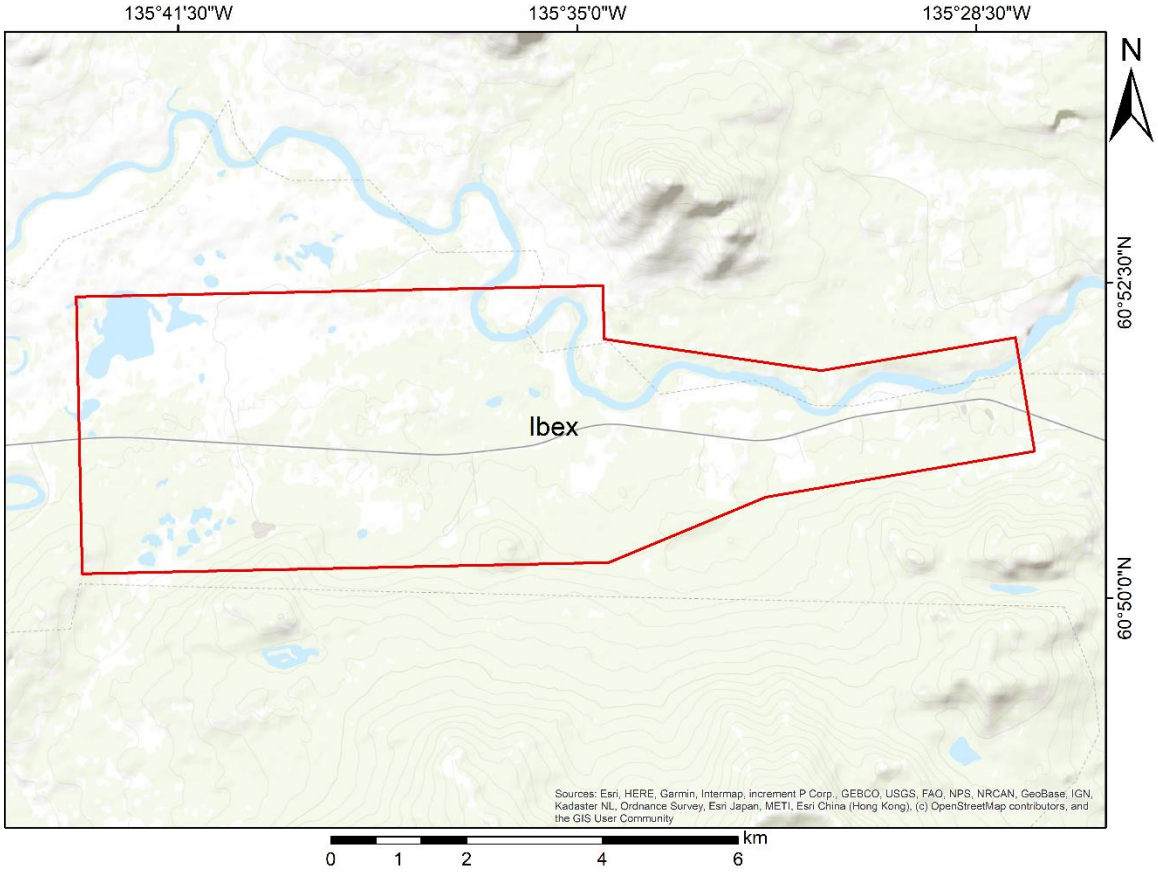

Figure 1 - LiDAR Survey Site

3. Equipment

McElhanney utilized the Leica Terrain Mapper -2 (TM2), Hyperion2+ system for LiDAR Capture (Figure 2).

For Product Specifications please see

https://leica-geosystems.com/products/airborne-systems/topographic-lidar-sensors/leica-terrainmapper-2

The LiDAR system is mounted on Piper Navajo fixed wing aircraft.

On-board camera is Leica MFC150 / Leica MFC150-NIR Camera Head - simultaneous capture.

Figure 2 - Leica TerrainMapper-2 system components

4. Flight Plan

Table 1 - Flight Parameters 2022-06-19

Flight Line Label	Swath Width [m]	Alt MSL [m]	Length [km]	Scan Pattern	Used Laser Pulse Rate [Hz]	Used Scan Rate [Hz]	FOV [deg]	Flown Line Direction [deg]	Line begin time [UTC]	Line end time [UTC]
001	1310	2440	16.13	Circle	2000000	150	40	91.7	20:31:28	20:35:19
002	1310	2440	16.16	Circle	2000000	150	40	271.7	20:25:57	20:29:54
003	1310	2440	16.24	Circle	2000000	150	40	91.7	20:20:40	20:24:33
004	1310	2447	16.23	Circle	2000000	150	40	271.7	20:13:38	20:17:36
005	1310	2432	25.33	Circle	2000000	150	40	271.9	20:00:50	20:06:52

006	1310	2449	16.35	Circle	2000000	150	40	91.7	20:08:12	20:12:11

5. Data Processing

All GPS and IMU data was processed using Inertial Explorer v8.9 software. The laser data was extracted using Leica HxMap 3.6 software. The GPS antenna position in the airplane was calculated by post-processing the raw data at one (1) second intervals for the entire flight. We have used Precise Point Position (PPP) to process the trajectories, and the coordinates were calculated in NAD83(CSRS).

6. Point Density

Bare earth point density varies with canopy closure, understory density and topographic features. Mean density of the point cloud and bare-earth was measured and can be seen in the following table.

Table 2 - Measured point density for project sites

Area	Point-cloud pts/m^2	Bare-earth pts/m^2
Ibex Valley	30.54	10.70

7. Calibration

System: Leica TM-2

LiDAR Calibration flight:

Calibration Date: April 24, 2022 Location: Abbotsford, BC

Base station used for calibration (in NAD83(CSRS) v4e2002):

- BCAB N 49° 03’ 7.81125” W 122° 19’ 46.2715” 72.996m

The LiDAR system calibration was flown over calibration site. The lever arms (offset between GPS antenna IMU and Laser Mirror), were calibrated based on 31 ground survey points.

Lever Arms

GPS Lever arms in (m):

X = -0.218 m Y = -0.224 m Z = 1.298 m

IMU Lever arms in (m):

x: 0 y: 0 z: 0

8. Quality Control

The LiDAR data consistencies have been checked between the flight lines using Terrascan software.

Comparison of Bare Earth LiDAR data with Existing LiDAR Ground Points

According to ASPRS guidelines, the vertical accuracy of LiDAR is as follows:

Area - 01

$$RMSE_z = Sqrt[\sum (Z_{Lidar(i)} - Z_{check(i)})^2 / n] = 0.027\text{m}$$

Area - 02

$$RMSE_z = Sqrt[\sum (Z_{Lidar(i)} - Z_{check(i)})^2 / n] = 0.031\text{m}$$

Area – 03

$$RMSE_z = Sqrt[\sum (Z_{Lidar(i)} - Z_{check(i)})^2 / n] = 0.103\text{m}$$

Area – 04

$$RMSE_z = Sqrt[\sum (Z_{Lidar(i)} - Z_{check(i)})^2 / n] = 0.022\text{m}$$

Area – 05

$$RMSE_z = Sqrt[\sum (Z_{Lidar(i)} - Z_{check(i)})^2 / n] = 0.059\text{m}$$

Where the ”Check” refers to the ground truth (in this project, we used existing LiDAR ground points) and *n* is the number of check points. A total of 2,014 check points were used for this analysis. Figure 3 shows the location of the Check points for this project:

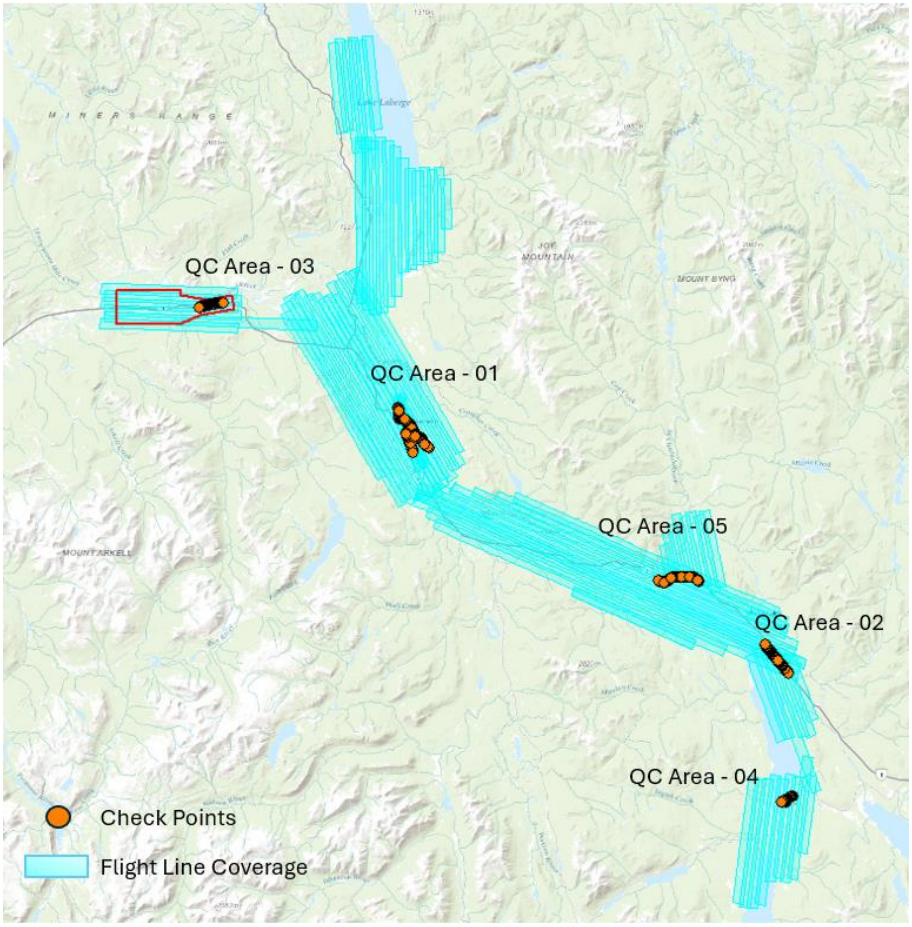

Figure 3 - Controls used for vertical check

QC Area – 01

N=308
Average dz +0.018 m
Minimum dz -0.048 m
Maximum dz +0.064 m
Average magnitude 0.023 m
Root mean square 0.027 m
Std deviation 0.020 m

QC Area - 02

N= 538
Average dz +0.017 m
Minimum dz -0.077 m
Maximum dz +0.100 m
Average magnitude 0.024 m
Root mean square 0.031 m
Std deviation 0.026 m

QC Area – 03

N= 415
Average dz -0.063 m
Minimum dz -0.240 m
Maximum dz +0.122 m
Average magnitude 0.085 m
Root mean square 0.103 m
Std deviation 0.082 m

QC Area – 04

N= 108
Average dz +0.044 m
Minimum dz -0.003 m
Maximum dz +0.097 m
Average magnitude 0.044 m
Root mean square 0.049 m
Std deviation 0.022

QC Area – 05

N= 645
Average dz +0.055 m
Minimum dz -0.023 m
Maximum dz +0.129 m
Average magnitude 0.055 m
Root mean square 0.059 m
Std deviation 0.021 m

9. Deliverables

Final output data is provided in NAD83CSRS UTM Zone 8 and the elevations are based on CGVD28 HT2 and CGVD13 geoid models. The deliverables include:

- Bare Earth & Thinned model key points in las, xyz
- Non Bare Earth in las format
- Index map
- 20 cm Orthophto