FINAL REPORT

Acquisition and Processing of LiDAR and Orthophoto in Malcolm Knapp Research Forest (MKRF) Project

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Submitted to:

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1. Introduction

McElhanney Consulting Services Ltd (MCSL) has performed a LiDAR and Orthophoto survey for Malcolm Knapp Research Forest (MKRF) near Maple Ridge, BC. The coverage area is approximately 60 square kilometres, as shown in Figure 1.

In addition, we acquired Near Infra-Red (NIR) images for the purposes of NIR orthophoto production. The acquisition was completed in May 13th, 2010.

This report describes the acquisition, post-processing and quality control methodology used to produce the final elevation models.

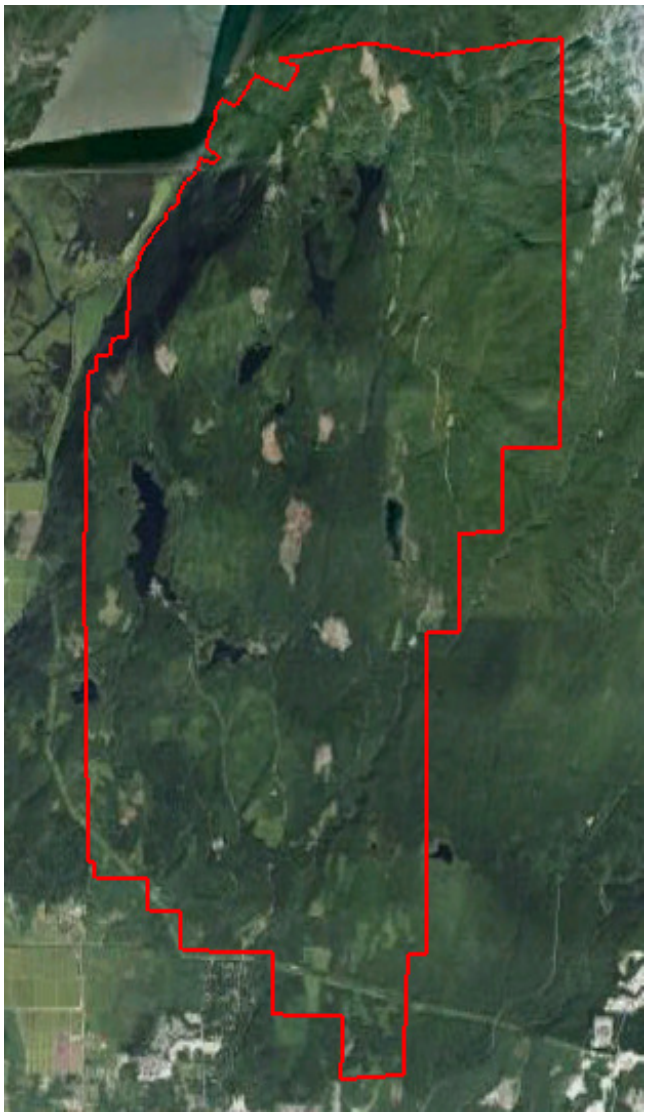

Figure 1 – LiDAR/Airphoto Survey Site

2. LiDAR and Orthophoto data Viewers

All data provided can be viewed using Free-ware viewers. The following are links to free viewers available on Internet:

LIDAR – LAS file

PointVue
http://www.geocue.com/utilities/pointvue.html

Orthophoto Images - ECW / TIF-TFW

ERViewer
http://www.erdas.com/Products/ERDASProductInformation/tabid/84/currentid/2585/objectid/2585/default.aspx

LiDAR with Orthophoto Images

MarsExplorer
http://www.merrick.com/index.php/services/geospatial-solutions/mars-software/downloads/freeview-download-form/

Others:

LP 360
http://www.qcoherent.com/

Lasedit
http://lasedit.software.informer.com/

QuickTerrain Reader
http://appliedimagery.com/download.php

3. Mission Plan

Project: LiDAR and RGB/NIR imageries for MKRF site in BC
LiDAR and Photo Acquisition Date: May 13th, 2010.
Location: MKRF site, Maple Ridge, BC
Total Days: 1 day
Total LiDAR Flying Time (hrs): 3 hrs
Topography: hills
Vegetation: leaf on

4. LiDAR Acquisition

McElhanney utilized the ALS50-II Leica system (Figure 2). ALS50-II 150kHz pulse rate is attainable at up to 570 m AGL for single pulse and 1569 m AGL for multi-pulse.

For Product Specifications of Leica ALS50-II please see
http://www.leica-geosystems.com/shared/downloads/inc/downloader.asp?id-9036

The ALS50-II was mounted on Selkirk (Cessna 206) C-GVS Aircraft.

Figure 2 – ALS50-II Leica components (Leica LiDAR Manual, 2007)

We also used Rolleimetric AIC P65+ with RGB lens and Rolleimetric AIC P45 with NIR lens for aerial photography. They were mounted in the same plate as LiDAR system.

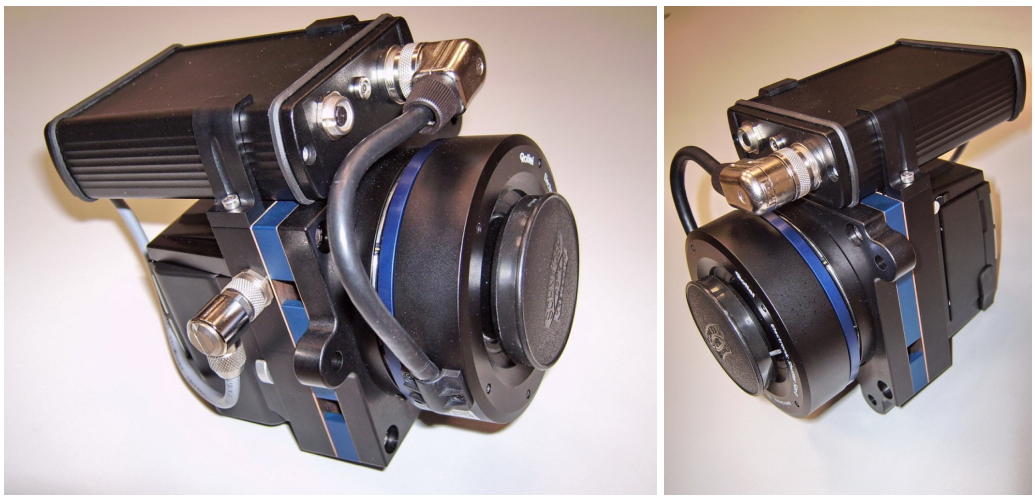

Figure 3 – Rolliemetric RGB (left) and NIR (right) Cameras

5. Flight Plan

Figure 3 illustrates the flight lines. The flight planning was designed to acquire average point density of 1 pt/m². A 50% average overlap between flight lines, was chosen to ensure enough LiDAR returns.

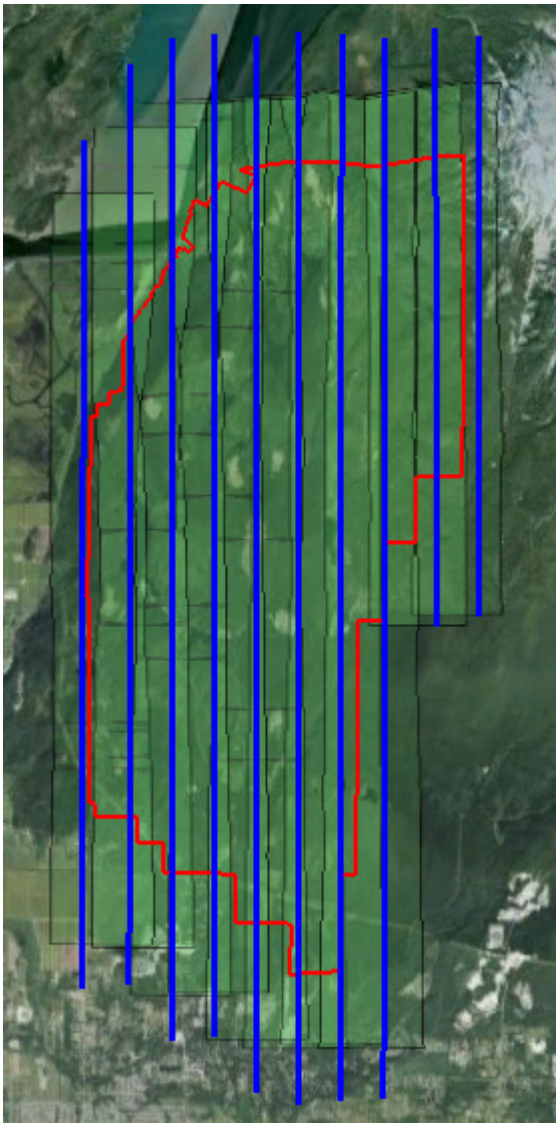

Figure 4 –LiDAR Flight Lines

Table 1: The Flight Parameters

Flight Line #	Length [km]	Alt MSL [ft]	Min Alt AGL [m]	Max Alt AGL [m]	Min Swath Width [km]	Max Swath Width [km]	Target Speed [kts]	FOV [deg]	Swath Width [m]	Used Scan Rate [Hz]
46	11.7900	9767.0000	2189.0000	3000.0000	1.1700	1.6100	120.0000	30.0000	1608.0000	32.2000
47	12.8100	9767.0000	2178.0000	3000.0000	1.1700	1.6100	120.0000	30.0000	1608.0000	32.2000
48	13.9300	9767.0000	2178.0000	3000.0000	1.1700	1.6100	120.0000	30.0000	1608.0000	32.2000
49	13.9500	9813.0000	2201.0000	3000.0000	1.1800	1.6100	120.0000	30.0000	1608.0000	32.2000
50	14.6700	9816.0000	2218.0000	3000.0000	1.1900	1.6100	120.0000	30.0000	1608.0000	32.2000
51	14.8800	9872.0000	2235.0000	3000.0000	1.2000	1.6100	120.0000	30.0000	1608.0000	32.2000
52	14.8000	10026.0000	2282.0000	3000.0000	1.2200	1.6100	120.0000	30.0000	1608.0000	32.2000
53	14.7200	10030.0000	2236.0000	3000.0000	1.2000	1.6100	120.0000	30.0000	1608.0000	32.2000
54	8.2200	10653.0000	2083.0000	3000.0000	1.1200	1.6100	120.0000	30.0000	1608.0000	32.2000
55	8.0500	10164.0000	1539.0000	3000.0000	0.8200	1.6100	120.0000	30.0000	1608.0000	32.2000

6. Data Processing

All GPS data was processed using GrafNav software v.8.3. IMU data was processed using Leica IPAS Pro v.1.3 and the laser data was extracted using ALS Post Processor v.2.68. The GPS antenna position in the airplane was calculated by post–processing the raw data at 1 second intervals for the entire flight relative to the coordinates of BC Active Control Station BCSF in NAD83-CSRS.

Table 2: The geodetic coordinates of the Base stations used for LiDAR processing

Base Point	Latitude	Longitude	Ellipsoidal Height (m)
BCSF	49 11 31.49655 N	-122 51 36.24849 W	83.735

The estimated values for the GPS antenna position were used with the laser ranges and platform angles to compute all individual X, Y, and Z coordinates for each laser return in each flight line. The result is a processed point cloud containing all measured points.

7. Point Density

Bare earth point density varies with canopy closure, understory density and topographic features. Mean density of the point cloud was calculated at 3.1 pts/m² , and mean density of Bare earth was at 0.5 pts/m².

8. Quality Control

Various steps are taken throughout the project to ensure required data accuracy is met.

8.1 Calibration

The LiDAR system calibration was flown at the British Columbia Institute of Technology (BCIT) site in Burnaby, B.C. The lever arms (offset between GPS antenna IMU and Laser Mirror, were measured as:

Lever Arms
GPS Lever arms in (m):
x: 0.08 y: 0.178 z: -1.248

IMU Lever arms in (m):
x: -0.269 y: 0.207 z: -0.004

There were a total number of 5 flight lines for calibration: 4 basic lines for Attune software analysis and 1 redundant line for better accuracy. The lines were planned as follows:

- 2 orthogonal at low altitude
- 2 orthogonal at higher altitude
- 1 line at higher altitude

The calibration flight parameters used for this project are as follow:

Roll Error: -0.00091715 rad
Pitch Error: 0.00822460 rad
Heading Error: -0.00461812 rad

8.2 Ground Survey Checks

For this project, there were no survey ground checks. The absolute value of the orthometric height may be therefore, up to 30 cm different from actual ground heights, due to atmospheric and other systematic errors.

The LiDAR data is tied to BCFS, and is checked with existing mapping for portion of the site, where some data was available from 2009 McElhanney orthophotos. (As part of lower mainland project)

The final LiDAR data is in UTM10-NAD83-CSRS, and the orthometric heights are based on Ht2 geoid model.

9. LiDAR Data and Classification

The 3Dimensional laser returns (point cloud) were automatically classified using Microstation (v8), Terrascan. A series of algorithms based on topography were created to separate laser returns that hit the ground from the ones that hit objects above the ground.

Steps taken are:

- Classified LiDAR surface as Bare earth
- Classified other features as non-bare earth or default
- Formatted to ASPRS .LAS V1.0
    - Class 1 - Default (non-bare earth)
    - Class 2 – Ground points (bare earth)
    - Class 7 - Low points (outliers)
- 113 tiles each 1km x1km generated for LiDAR data (Figure 5)
- File Prefix BE – Bare Earth only

As per the terms of contract agreement, the data has not been edited.

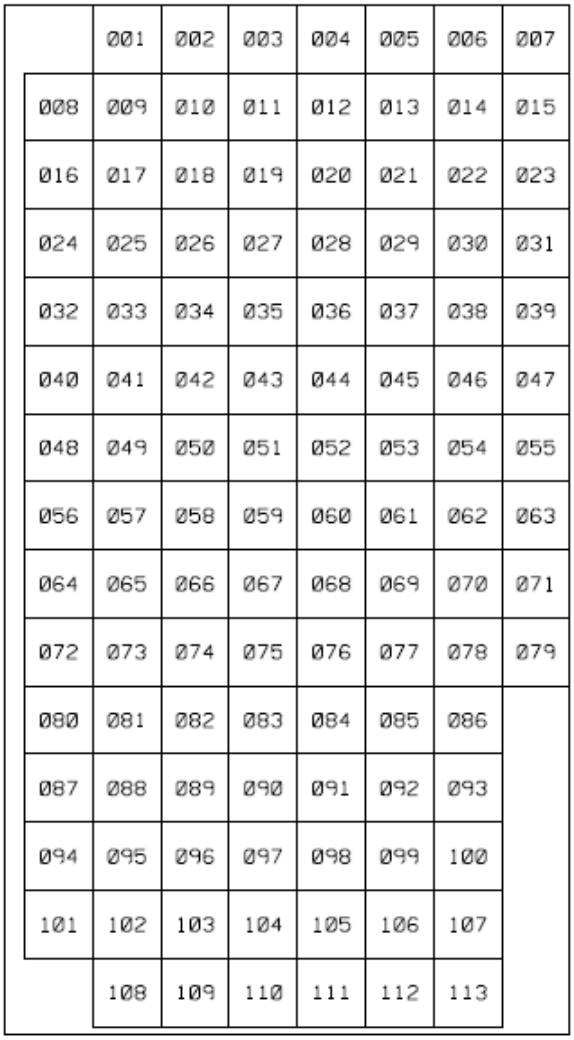

Figure 5 –LiDAR data tile key map**.**

10. Airphoto Acquisition

- Colour Digital Airphotos captured with RolleiMetric AIC P65+ camera, acquired simultaneously with LiDAR capture
- NIR Digital Airphotos captured with RolleiMetric AIC P45+ camera, acquired simultaneously with LiDAR capture

11. Digital Airphoto Direct Import (DI)

- For RGB, the boresight values (omega, phi, kappa) were directly imported in KLT software
- For NIR, AT was created using automatic strip-AT in KLT
- Control for the project derived from LiDARGrammetry (differential rectification processed using bare earth LiDAR data)

Checks with LiDARGrammetry:

- Capture of some Breaklines (Road/Drainage) and some cultural features (Buildings)
- Photogrammetric data is draped over LiDAR surface to match Z values

12. Digital Orthophoto

- KLT software used to rectify (cubic convolution algorithm) and mosaic images
- LiDAR Bare Earth files used for surface generation
- 30cm Pixel size for images
- Accuracy 2 pixels to a 95% confidence level in areas clear of heavy ground cover

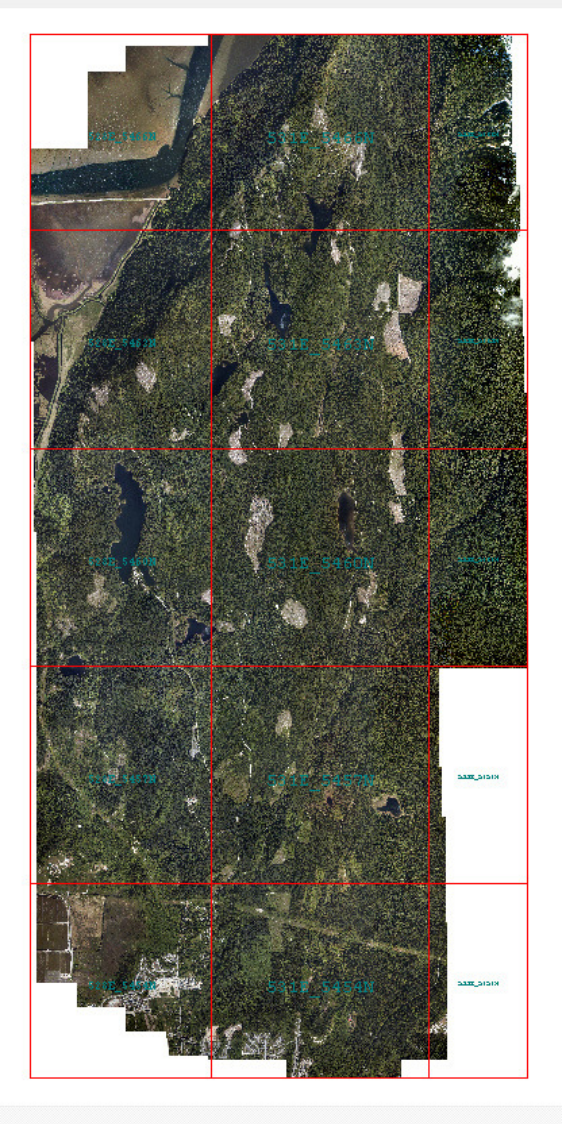

Figure 6– RGB-Orthophoto image key maps

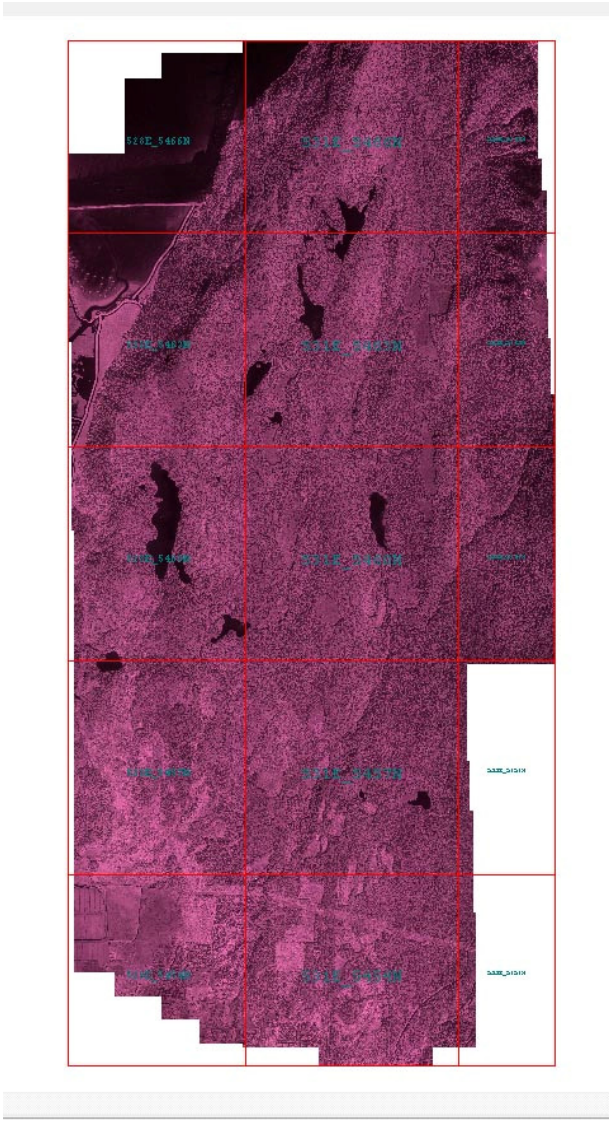

Figure 7– NIR-Orthophoto image key maps

13. Deliverables

All LiDAR Data Products, ASCII files and Digital Orthophotos are delivered on hard drive. It includes:

1. LiDAR Point clouds in ASCII XYZ and LAS format
2. Classified (not edited) LiDAR Bare Earth, in XYZ format.
3. Mosaic 30 cm RGB orthophotos TIFF and TFW format
4. Mosaic 30 cm NIR orthophotos TIFF and TFW format
5. RGB-Raw Ortho rectified frames
6. NIR-Raw Ortho rectified frames