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Final Report

For project:

Cochrane LiDAR

Prepared for:

**Ontario Ministry of Natural Resources and Forestry –
Provincial Mapping Unit
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Introduction

The Ontario Ministry of Natural Resources & Forestry contracted Airborne Imaging, A Clean Harbors Company, in the fall of 2016 to acquire and deliver digital elevation data derived from airborne LiDAR (Light Detection and Ranging) to cover three regions in Ontario: Cochrane, Peterborough and Lake Erie Watershed.

This report covers the fall 2016 and spring 2017 acquisition of the Cochrane project and focuses on LiDAR acquisition details, such as flight parameters, project control, ground truthing results, data processing technique and deliverables.

This project started in October 2016 but snow fall in mid-November prevented further data collection for 2016. At that date, 62% had been acquired. The remaining 38% of the project was collected in the spring of 2017, with an additional short flight to fly one line in the fall of 2017.

Project Schedule & Personnel

Roly Tang, an Airborne Imaging surveyor was sent to the Cochrane area on October 4, 2016 to establish the geodetic network and collect ground truth points. The aircraft and Lidar system arrived in the Cochrane area on October 10 in anticipation of the go ahead from the Ontario government for the “leaf-off” condition. The go ahead for the Cochrane area was given on October 13, 2016. A second aircraft and Lidar system was assigned to the Peterborough area, and Airborne Imaging juggled the two Lidar systems according to local weather forecasts to acquire Lidar data where the weather was most suitable. Priority was given to the Cochrane area. Twelve missions were flown before snow and low temperatures halted acquisition with heavy snow fall the week-end of November 19, 2016.

For the next flying season of spring 2017, two Lidar systems were also affected to the Cochrane/Peterborough/Lake Erie projects. Depending on snow melt and full leaf-on status, the Lidar systems were deployed between the three projects. Ten more missions were flown between May 26 and June 12, 2017, with an additional flight for one line on September 30, 2017 to complete the Cochrane project.

A typical Lidar acquisition crew consisted of one Project Manager, one Lidar Operator and one Pilot. Due to crew rotation, various individuals were assigned to this project. Below is a list of personnel:

Project Manager

John Anderson
Paul Williams
Oscar Duran
Allyson Fox

Lidar Operator

Don Tarr
Gord Westergard
Andrew Blair
Roger Rutledge
Chris Johnson
Corey Doucette

Pilot

Pauline Seiter
Sebastian Proulx
Daniel Kockel
Thomas Sornasse
Owen Kamerman

LiDAR System & Flight Parameters

KASI Aviation, an air charter company located in Montreal provided the Piper Navajo aircrafts for this project. For the 2016 and 2017 acquisitions, the aircrafts assigned to this project were C-GKSI and C-GMEC.

The LiDAR systems utilized on this project were Leica ALS70-HP, capable of laser pulse rates up to 500,000 Hz with Multiple Pulse in the Air (MPIA) technology.

Flight Height: 1000 m AGL

Speed: 140 knots

Flightline Spacing: 550 m

Single Pass Swath width: 690 m

Overlap: 20%

Scan Angle or FOV: 38° effective (40° minus 1° clipped on each side of the scan edge)

Scan Frequency: 53Hz

Scan Pulse Rate: 500 KHz

Density: 8 Points per m²

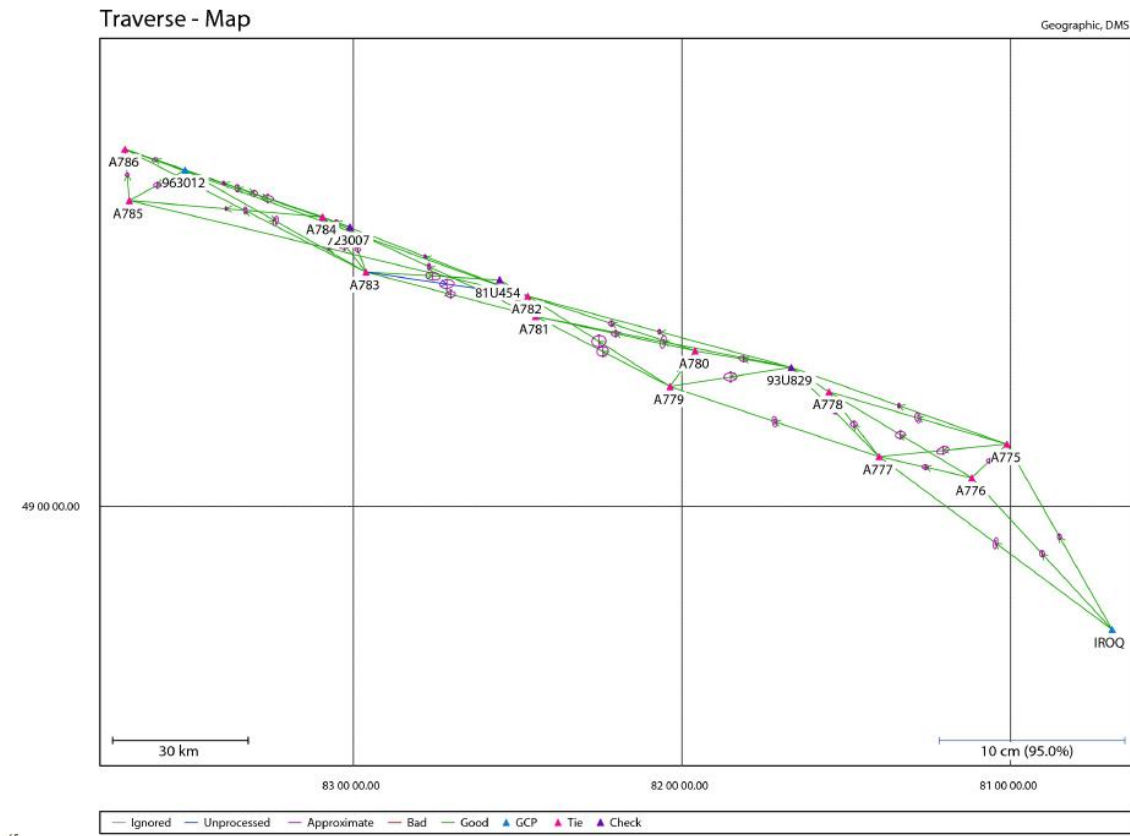
Project Control

A full geodetic network was observed locally to support the Lidar acquisition. Five published government control stations were included in the network plus twelve newly established base stations to be used during Lidar collection and ground truth collection (A775 to A786). Two of the five government stations are permanent tracking stations, HRST and IROQ and were held fixed in the fully constrained least-squares adjustment. The other three government stations are permanent monuments. The control network and therefore all subsequent Lidar data are based on the Nad83 CSRS (epoch 2010.0) horizontal datum and the CGVD2013 vertical datum. See summary table below for the points in our geodetic network.

Cochrane Control Listing

Station Name	Unique Id	Latitude	Longitude	Easting UTM17	Northing UTM17	H-Ellips (m)	Undul CGG2013	H-Orthom (m)
LOWTHER	723007	49 33 15.33943	-83 00 34.95583	354647.416	5491013.674	216.386	-37.653	254.039
81U454	81U454	49 26 57.99253	-82 33 16.33061	387325.993	5478581.665	193.390	-37.139	230.529
93U829	93U829	49 16 33.80333	-81 40 04.82107	451411.124	5458359.074	203.101	-37.337	240.438
HRST RACS-GLCORS	963012	49 40 02.76908	-83 30 39.73565	318812.317	5504683.265	229.304	-38.069	267.372
A775		49 07 25.84093	-81 00 42.23818	499143.961	5441223.224	237.636	-37.656	275.292
A776		49 03 25.99507	-81 07 06.28407	491348.956	5433823.537	232.231	-37.547	269.778
A777		49 05 56.72039	-81 24 02.09752	470758.574	5438548.394	229.429	-37.416	266.845
A778		49 13 39.64102	-81 33 10.44807	459744.077	5452913.271	221.926	-37.383	259.309
A779		49 14 17.02615	-82 02 09.29256	424592.962	5454436.998	197.161	-37.252	234.413
A780		49 18 31.63116	-81 57 35.96766	430219.407	5462226.300	194.541	-37.263	231.804
A781		49 22 37.33803	-82 26 44.10843	395068.296	5470375.541	191.263	-37.035	228.298
A782		49 25 02.47845	-82 28 09.43141	393435.246	5474890.674	189.250	-37.076	226.326
A783		49 27 53.48513	-82 57 39.62027	357910.948	5480982.163	203.810	-37.480	241.290
A784		49 34 27.94645	-83 05 36.33442	348655.417	5493420.757	209.796	-37.736	247.532
A785		49 36 25.74770	-83 40 52.34236	306295.845	5498406.604	228.311	-38.025	266.335
A786		49 42 32.09742	-83 41 40.11632	305742.989	5509752.757	212.115	-38.205	250.321
cannet-IROQ	CIRO	48 45 20.87943	-80 41 29.64321	522669.595	5400355.666	247.272	-37.205	284.478

Below is an overview map of the geodetic network.



See Appendix G at the end of this report for the Full Control Report with listings of:

- Final Adjusted Coordinates
- Traverse Overview
- Control Sheets
- Control Point Photos
- Traverse Report
- Minimally Constrained Network Adjustment
- Fully Constrained Network Adjustment

Check Points

Control check points were surveyed from different methods to use as vertical check and accuracy assessment. The kinematic method was used for calibration purposes, Fast Static and RTK methods for Non-Vegetated Vertical Accuracy Assessment (NVA) and the RTK method in vegetated areas for the Vegetated Vertical Accuracy Assessment (VVA).

Kinematic GPS

The first method called kinematic are profiles surveyed on open roads from a truck-mounted GPS receiver while driving. The post-processed kinematic coordinates, collected at an interval of one second are derived from a base station that is part of our geodetic

network.

Whenever possible, we try to select roads that are perpendicular to the flight line azimuth so the control points intersect as many Lidar strips as possible. See the dark blue circles on the map below.

The output coordinates are analyzed and filtered to ensure only very reliable positions are kept. All points collected while moving slower than 2 meters per second are rejected. This removes all points when the truck was stationary that could skew the statistics.

The following points are also rejected:

- Points with a Quality Level worse than 1.
- Points with a forward/reverse vertical separation worse than 3 cm.
- Points with less than two solutions (forward & reverse).
- Points with a standard deviation worse than 2sigma.

Thirteen sections of road were surveyed throughout the project giving us more than 25,000 surveyed points on the road. We estimate that the vertical accuracy of these points is better than 5 cm.

During the calibration of the Lidar strips, the Lidar strips are matched vertically to these reliable kinematic points. These points are not used for the vertical accuracy assessment of the Lidar point cloud, but rather just for calibration monitoring and shifting.

Fast Static GPS

In order to meet the recommended ASPRS minimum number of points for a 6085 square kilometer project, fast static and RTK points were surveyed in areas distributed throughout the project.

The second method called Fast Static are individual points surveyed on open roads from a truck-mounted GPS receiver while staying stationary during a minimum of five minutes. The post-processed static coordinates are derived from a base station that is part of our geodetic network.

149 Fast Static points were surveyed on the Cochrane project.
See the gold circles on the map below.

These points are used just for the vertical accuracy assessment of the Lidar point cloud, and were not used to determine any vertical shift applied to the point cloud.

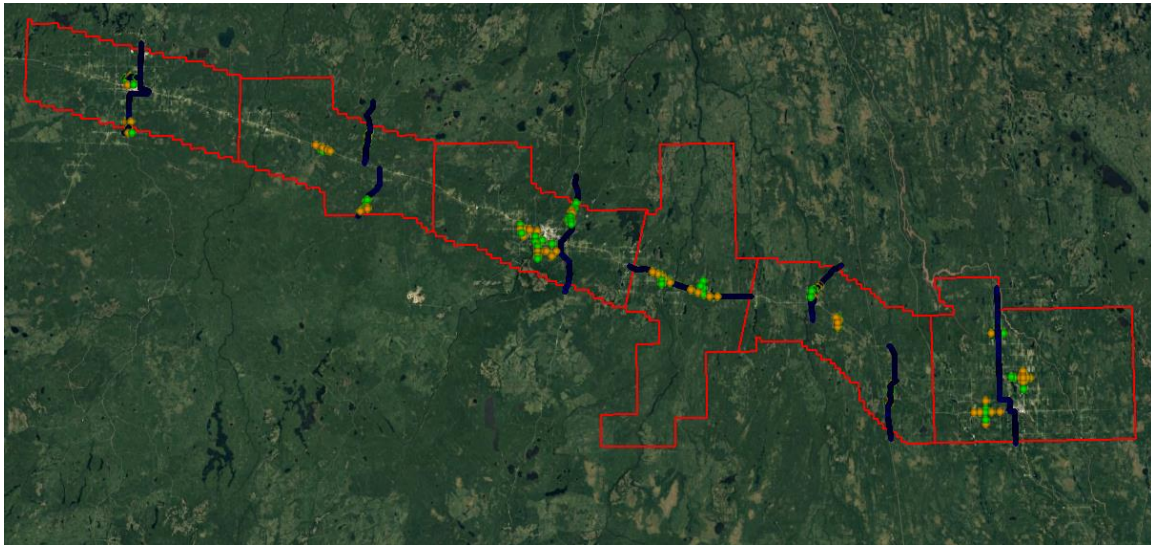
Real-time Kinematic GPS (RTK)

The third method called Real-Time Kinematic are individual points surveyed on open surfaces from a pole-mounted GPS receiver, surveyed while walking to various locations. A nearby base station broadcasted via radio modem the differential corrections to the roving GPS receiver. The surveyor held the pole and antenna in a fixed position for a period necessary for the differential corrections from the base station to indicate that a fixed solution was acquired. The static period usually last about six epochs (6 seconds). A full loss of lock on the satellites was intentionally induced by turning the antenna upside down and the points surveyed again as a check.

Another 157 points were surveyed in open areas distributed throughout the project. These points are used to assess the Non-Vegetated vertical Accuracy (NVA). See the green circles on the map below.

These points are used just for the vertical accuracy assessment of the Lidar point cloud, and were not used to determine any vertical shift applied to the point cloud.

The same RTK method was used to survey points in vegetated areas like tall grass, crops, brush, weeds and different tree type covers. These points are used to assess the Vegetated Vertical Accuracy (VVA).



Field Calibration of Lidar Strips

Three calibration sites have been established near each of the bases of operations: the Hearst, Kapuskasing and Timmins airports. Each calibration site consists of a primary control station, and surveyed kinematic points on a road adjacent to the airport. Approximately 2km long strips of Lidar data are then flown with two passes in opposing directions during each mission. The flight lines are orientated perpendicular and centered over the kinematic points and nearby buildings. They are flown once at the start of mission, and a second time at the end of mission.

Calibration of raw LiDAR data for each flight mission is essential to meet the required accuracy. Airborne Imaging spends the extra time and effort to fly two calibration passes at the beginning and two more at the end of each mission. As the field Project Manager produces the point cloud in the field, he/she uses these calibration passes to calibrate the point cloud to the best of his ability. The boresight values between the mounted sensors are solved and monitored twice per mission. The inertial errors associated with aircraft sensor roll, pitch, and heading are normally stable and consistent. For the most part the

changes between calibrations are minimal but monitoring it within missions and between missions gives us a better control on the systems' behaviors.

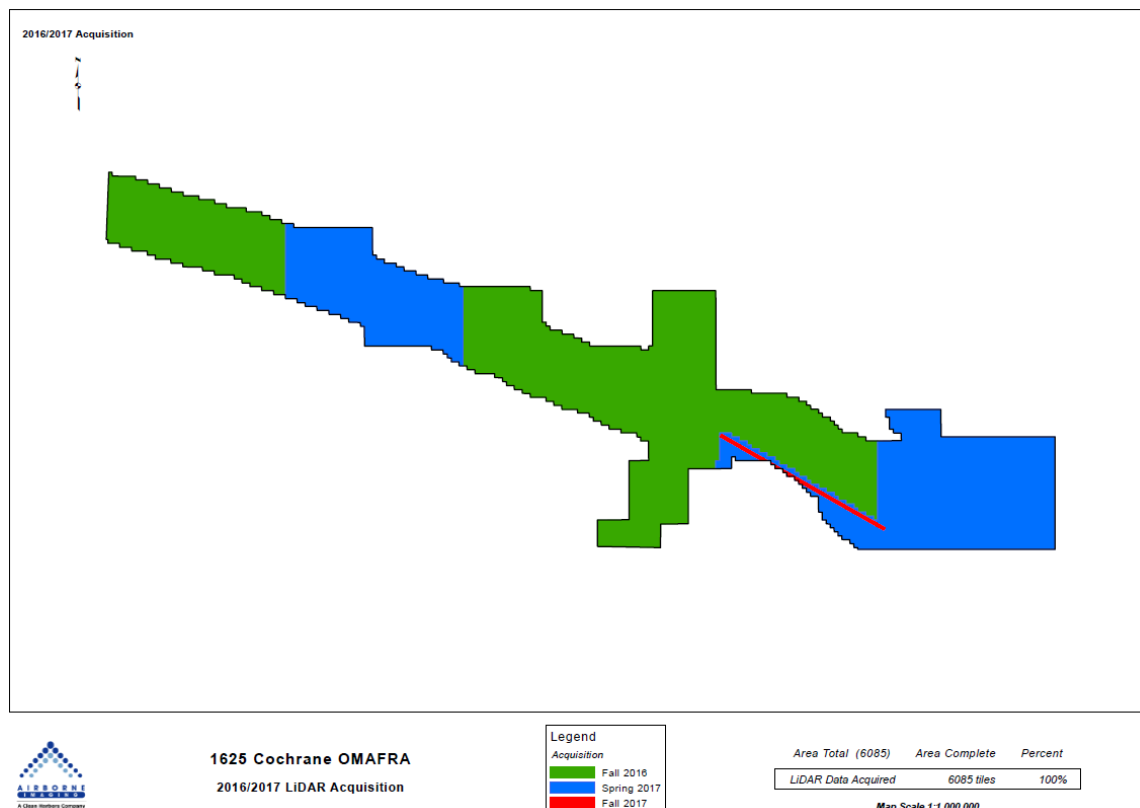
A final, more in depth calibration takes also place later when the field produced point cloud arrives in the office in Calgary.

Lidar Acquisition

The intent was to collect the entire 6085 square kilometer Cochrane project during the fall of 2016. Unfortunately, a few events prevented it. Bad weather was the main reason why the entire area was not all acquired, but a system malfunction and repair also prevented data acquisition for five days. As mentioned in the "Project Schedule and Personnel" section above, two Lidar systems were used to acquire data on the Cochrane and Peterborough areas according to weather patterns between the two areas. Between mid-October and mid-November 2016, twelve missions were acquired on the Cochrane project for a total of 3761 square kilometers.

After acquisition was done on the Peterborough project and snow melted in the Cochrane area, data acquisition resumed on the Cochrane project. Ten missions were flown between May 26 and June 12, 2017. One additional flight line was also flown on September 30, 2017.

See map below for the area covered during the three seasons.



See Appendix A for the Daily Lidar Field Acquisition Report and Appendix B for the Mission Flightlogs.

LiDAR Data Processing

Tiling

The entire point cloud is tiled into 1000m X 1000m tiles based on the UTM17 projection. The extents fall on the even integer and the tiles named according to the lower left Easting and Northing (truncated). The software used for point cloud manipulation is TerraSolid's TerraScan/TerraModeler applications. At this stage, the files are stored in .las version 1.2.

Mission (lift) and flight line naming convention

Airborne Imaging's convention for naming missions (or lifts) is the following:

e.g. 0716288a where

07 is the Lidar system unique identifier. System 07 and 79 are Leica ALS70-HP.
16 is the collection year (2016)
288 is the Julian day of acquisition (sequential day of the year since January 1)
a is the sequential mission or lift of the day (a = 1st mission, b = 2nd mission, ...)

While importing the raw point cloud strips into tiles, the flight line numbers adopted are as follows.

e.g. 071628804 where

The first seven characters are the same as described in the mission folder name above, plus a sequential strip number for that day:

"04" is the fourth strip acquired that day, 05 is the fifth, ...

Note that the Leica ALS70 sensor measures data from two channels on each strip which we separate for calibration and manipulation purposes. Because of limitations of the 64bit field to store the strip identifier, we typically add 300 to the Julian day for the second channel.

So basically from sensor 07, on Julian Day 288, there would be two .las files for strip 04 named: 071628804 and 071658804.

Inside all .las files, the strip number (28804 and 58804) corresponds to the point source ID in the .las files. The Lidar system number is also stored in the .Las files in the "user_data" field.

Calibration

During field processing and after each mission, the point cloud strips from the "calibration

passes” are compared to each other to ensure relative accuracy. The outside edges of scan can be compared in open areas to detect vertical differences which would point to roll or scale miss-calibration values. Man-made features such as pitched-roof buildings are also useful to check for horizontal alignment. If the calibration values (angles between the laser sensor and the IMU) are found to have changed from the previous mission, it would show in the repeatability of the measured data sets. Corrective measures would then be taken to fine tune the proper angular values. Once the data fit well together, it is compared to a ground profile to validate the elevations in an absolute accuracy point of view. Statistics and visual graphs of the elevation differences are produced to confirm accuracy requirements. Once the calibration values are obtained, the mission point cloud data is then generated in the field as preliminary calibrated. The point cloud and supporting files are burned to Blue-Ray discs and shipped to the processing center in Calgary.

Once the data has arrived in the office, an experienced calibration specialist reviews the field calibration. The strips are imported into tiles and the TerraMatch software is used to assess and improve any flight line separation between passes. Typically, the adjustments are made on the entire mission for roll and pitch. Occasionally, further corrections are required by individual flight lines for roll, pitch and DZ.

Once the flight lines fit well relatively to one another, the unclassified point cloud is compared to the kinematic profiles surveyed on roads. If any vertical biases are observed, an elevation correction (DZ) is applied to the mission.

Below is a table of calibration tracking and statistical results after calibration and shifts.

1625_Cochrane Calibration/Kinematic results						
Mission	Tmach (yes/no)	Tmatch Description	DZ Applied	Statistics after Tmatch and after shift		
				Kinematic		
				Dz	Std Dev	RMS
0716288a	Y	P by FL, then R&DZ by FL	-3cm	-0.3cm	3.0cm	3.1cm
0716300a	Y	P by FL, then R&DZ by FL	+2cm	+0.0cm	2.9cm	2.9cm
0716301a	Y	RZ2 P	0	+1.1cm	1.9cm	2.2cm
0716305a	Y	RZ 3 P	-1cm	-0.0cm	1.8cm	1.8cm
0716309a	N		-3cm	N/A	N/A	N/A
0716311a	Y	RZ P	-1cm	-0.2cm	1.5cm	1.5cm
0716317a	Y	RZ P	-1cm	-0.1cm	1.5cm	1.5cm
0716317a east	Y	P RZ	-1cm	+0.3cm	1.4cm	1.4cm
0716318a	Y	P RZ	-1cm	-0.1cm	2.5cm	2.5cm
0716321a	Y	P RZ2	-1cm	-0.2cm	1.9cm	1.9cm
7916317a	Y	RZ P	-1cm	+0.4cm	1.5cm	1.6cm
7916318a	Y	RZ	-1cm	+0.3cm	1.7cm	1.7cm
7916318b	Y	P3 RZ	-1cm	-0.2cm	1.9cm	1.9cm
7917146a	Y	RP	+4 cm	-0.0 cm	3.6 cm	3.6 cm
7917147a	Y	RP	-1 cm	+0.4 cm	3.5 cm	3.5 cm
7917154a	Y	RP	0	+0.5 cm	3.4 cm	3.5 cm
7917155a	Y	RP	-3 cm	+0.7 cm	3.1 cm	3.1 cm
7917157a	Y	RP	-3 cm	-0.3 cm	2.7 cm	2.7 cm
7917158a	Y	RP	-3 cm	+2.1 cm	4.2 cm	4.6 cm
7917159a	Y	RP	-2 cm	+0.6 cm	3.2 cm	3.3 cm
7917160a	Y	RP	-2 cm	+0.5 cm	4.4 cm	4.4 cm
7917163a	Y	RP	+2 cm	-0.8 cm	2.2 cm	2.2 cm
0717273b	Y	RP	+4 cm	+0.3 cm	2.9 cm	2.9 cm

Intensity normalization

The native intensity values collected normally range between approximately 0 and 1000. They were then normalized to 16bit by multiplying their values by 64 with the Lastools software. The resulting intensities range between 0 and 65535.

Point Cloud Classification

Point classification is done with the TerraScan software, using macros that are set-up to measure the angles and distances between points to determine what classification a point should be: ground, non-ground, ... The angle and distance values in the macros can be varied to be more or less aggressive with the classification of points from the unclassified class to ground by varying the incidence angles and estimated distances among neighboring points.

Following the USGS minimum classification scheme, the points are classified in the following classes:

Code	Description
1	Processed, but unclassified
2	Bare earth
7	Low noise
9	Water
10	Ignored ground (near a breakline)
17	Bridge decks
18	High noise

To better understand areas where the classification (mathematical models) did not represent the ground accurately, the points that are classified as bare earth are extracted and turned into viewable TIN and grid surfaces. These surfaces are viewed in conjunction with the point cloud for inspection of areas that appear rough, artificially flattened or cut, no data areas, or have other viewable anomalies. In cleaning up ground points, an effort is concentrated in areas where few ground points have been left in the bare earth model and the ground appears rough or lower and flatter than it may be in reality. The scarcity of ground points may be a result from no penetration through a dense vegetation layer, or too aggressive values with the macro. A manual inspection of these areas plays a major role in resolving any issues or irregularities with the bare earth model. A manual effort is also made to make sure that bridge decks have been classified to class 17. Both Bare Earth and Full Feature grids are created to visually inspect the data. The Bare Earth grids are produced by using the ground classified points, where the grid is created from the TIN. The Full Feature grids are produced by using all non-noise points and creating a grid surface of the highest elevations within the cell size.

Water Classification & Hydro-Flattening

Once the ground class has reached the final level of classification accuracy, the water delineation process is initiated. The rivers and water bodies are digitized as break lines according to USGS specifications of a minimum of 8000 m² for water bodies and 30 m nominal width for streams and rivers. Ponds and lakes have their elevations set constant to just below ground. Stream and river hydro lines are collected using the downstream method. Once all hydro lines have been collected for an area, the ground points inside the hydro lines are classified to class 9 – Water. The ground points outside of the hydro lines but within 35 cm are classified to class 10 – Ignored ground (near breaklines). Using the TIN of class 2 – Bare earth, the hydro lines are used as constraints to generate the final 50 cm hydro-flattened DEMs in XYZ format, then converted to Erdas .img format with the Global Mapper software.

Point Density / Point Distribution issue

After delivery of the final data to the Ontario MNRF, some observations were brought up by the Ministry regarding point density / point spacing. These observations were most noticeable on two lifts, 7917158a and 7917163a, but also to a lesser degree on lifts 7917146a and 7917159a. On some localized areas, the point distribution failed to meet the “one point within a 70cm cell, 90% of the time”. After inspection of the data, it was

determined that strong winds and turbulence caused the aircraft's pitch to compensate up and down, resulting in a worse than usual accordion effect of compressed and stretched scan lines in the point cloud. The Ministry produced an acceptance report stating that with the project's circumstances, the Lidar products are "acceptable to meet the primary application of the data which is producing a bare earth 0.5 m Digital Terrain Model".

Deliverables

CGVD28 to CGVD2013 for mission 0716288a

Please note, the first mission was acquired on October 14, 2016 while the vertical datum requested was still CGVD28. On October 26, 2016 it was decided that the vertical datum be changed to CGVD2013. Since the point cloud for that mission had already been produced with the CGVD28 datum, the tiled mission was shifted to CGVD2013 by using a localized grid difference file between the HT2.0 and CGVD2013 undulation models. All subsequent missions were positioned using the CGVD2013 vertical model. All Lidar data on this project is therefore on the CGVD2013 vertical datum.

Raw Point Cloud strips re-construction

Since the missions had to be tiled into manageable file sizes at the calibration stage, the Raw Point Cloud strips had to be re-constructed from the final calibrated and shifted tiles. Using the TerraScan and Lastools software, the strips were re-exported from the tiles, sorted by time and converted to .las version 1.4 with the proper datum information in OGC-WKT format. The strips were then compressed from .las to .laz format.

The Cochrane project fell entirely within UTM zone 17 and was projected as such.

See below for a table of the folder structure and description of each deliverables.

Folder	Sub-Folder	Content and Description	
COCHRANE_ EPSG2958	DTM	Hydro-flattened 50cm Bare Earth DEMs, 1km X 1km (ERDAS Imagine .img format)	e.g. 1km172840550802016LCOCHRANE.img
	METADATA	Metadata, FGDC compliant (.xml format) for each of the following deliverables: Breaklines	Cochrane_Lidar_metadata_Breaklines.xml
		DEM	Cochrane_Lidar_metadata_DEM.xml
		Las	Cochrane_Lidar_metadata_LAS.xml
		Project	Cochrane_Lidar_metadata_Project.xml
		Vertical comparisons between Lidar point cloud TIN surface and kinematic surveyed points (Excel format)	Cochrane_NVA_Kinematic_comparisons_Final.xlsx
		Vertical comparisons between Lidar point cloud TIN surface and NVA Fast Static surveyed points (Excel format)	Cochrane_NVA_FastStatic_comparisons_Final.xlsx
		Vertical comparisons between Lidar point cloud TIN surface and NVA RTK surveyed points (Excel format)	Cochrane_NVA_RTK_comparisons_Final.xlsx
		Vertical comparisons between Lidar point cloud TIN surface and VVA RTK surveyed points (Excel format)	Cochrane_VVA_RTK_comparisons_Final.xlsx
		Vertical comparisons between Lidar point cloud TIN surface and Ground Control surveyed points (Excel format)	Cochrane_Ground_control_comparisons_Final.xlsx
		List of Lifts with flight parameters (Excel format)	Cochrane_lifts.xlsx
		List of Geodetic control points with coordinates (Excel format)	Cochrane_ControlStationListing.xlsx
		Final Lidar report (Word format)	Cochrane Lidar Final Report June 2018.doc
		Final Lidar report (PDF format)	Cochrane Lidar Final Report June 2018.pdf
	POINTCLOUD	Classified Point Cloud, 1km X 1km (zipped .las v1.4 format)	e.g. 1km172840550802016LCOCHRANE.laz
	PROJECT_POLYGON	Metadata per lift (or missions) with flight parameters, flight line number, ... (ESRI shape format)	e.g. 0716288a_Lift_metadata.shp
		Hydro break lines (ESRI shape format)	Cochrane_hydro_breaklines_2017.shp
		Project extent (ESRI shape format)	Cochrane_project_extent.shp
		Tile index (ESRI shape format)	Cochrane_TileIndex.shp
	RAWPOINTCLOUD	Calibrated Raw Point cloud strips (one folder per lift), each strip separated for channel 1 & 2 (zipped .las v1.4 format)	e.g. 0716301a/071630103.laz (for channel 1) e.g. 0716301a/071660103.laz (for channel 2)

Vertical Accuracy Assessment

Kinematic

Below is a summary of the statistics between the point cloud TIN from the ground class and the kinematic points surveyed on the road:

Number of points:	23429	
Average dz:	0.000	m
Minimum dz:	-0.119	m
Maximum dz:	0.252	m
Average magnitude:	0.021	m
Root mean square:	0.028	m
Std deviation:	0.028	m

Kinematic Vertical
Accuracy (95%): 0.055 m

For a complete listing of the kinematic points and their differences, please refer to the spreadsheet named "Cochrane_Kinematic_comparisons_Final.xlsx" provided with the deliverables.

This Kinematic vertical accuracy assessment is provided only as a reference. It is biased because during calibration, the point cloud was vertically shifted to these points. It should not be used as an independent check for accuracy assessments.

The independent assessment of vertical accuracy is made against the two "Non-Vegetated" points surveyed (Fast Static and RTK).

Fast Static

Below is a summary of the statistics between the full point cloud TIN and the fast static points surveyed on the road:

Number of points:	129	
Average dz:	0.004	m
Minimum dz:	-0.157	m
Maximum dz:	0.094	m
Average magnitude:	0.025	m
Root mean square:	0.034	m
Std deviation:	0.034	m

Fast Static Vertical

Accuracy (95%): 0.066 m

See Appendix C for the List of Vertical Differences for the Fast Static points.

For a complete listing of the Fast Static points and their differences, please refer to the spreadsheet named "Cochrane_NVA_FastStatic_comparisons_Final.xlsx" provided with the deliverables.

This Fast Static vertical accuracy assessment can be used as an independent check for the Non-Vegetated Accuracy (NVA).

RTK (NVA)

Below is a summary of the statistics between the point cloud TIN from the ground class and the RTK points surveyed on the road (NVA):

Number of points:	152	
Average dz:	-0.007	m
Minimum dz:	-0.110	m
Maximum dz:	0.090	m
Average magnitude:	0.026	m
Root mean square:	0.035	m
Std deviation:	0.035	m

RTK Vertical

Accuracy (95%): 0.069 m

See Appendix D for the List of Vertical Differences for the RTK (NVA) points.

For a complete listing of the RTK (NVA) points and their differences, please refer to the spreadsheet named "Cochrane_NVA_RTK_comparisons_Final.xlsx" provided with the deliverables.

This RTK vertical accuracy assessment can be used as an independent check for the Non-Vegetated Accuracy (NVA).

The required QL0 NVA vertical accuracy for the project is 0.096 cm (95%). The above two independent checks prove that the data meets the NVA vertical accuracy requirements.

Geodetic Points

As an extra check, the points from the geodetic network that were flush with ground level were also compared to the Lidar ground surface.

Below is a summary of the statistics between the full point cloud TIN and the geodetic points reliably at ground level:

Number of points:	13	
Average dz:	0.003	m
Minimum dz:	-0.068	m
Maximum dz:	0.056	m
Average magnitude:	0.028	m
Root mean square:	0.035	m
Std deviation:	0.036	m

Geodetic Points Vertical Accuracy (95%): 0.069 m		
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See Appendix E for the List of Vertical Differences for the Geodetic Points.

VVA

The elevations of the points surveyed in various vegetated land covers types were compared to the Lidar ground surface. Since the elevation differences for this type of accuracy does not follow a normal distribution, the percentile method is used and not the 95% confidence level.

Of the 152 VVA points surveyed, seven points had an absolute vertical difference greater than 14.7 cm (the QL0 VVA specification).

At the 95th percentile, the accuracy is 14.7 cm, which meets exactly the required specifications.

See Appendix F for the List of Vertical Differences for the Vegetated Points.

Conclusion

This is the final report covering the 2016 and 2017 portions of the Cochrane Lidar project. Topics such as field operations, control, data processing and preliminary accuracy results were explained. The area was unfortunately not entirely acquired as originally planned within one season (mainly due to poor weather) but the full project was eventually entirely acquired in 2017. Vertical accuracies of vegetated and non-vegetated surfaces meet the QLO requirements for this project.

Appendix A

Daily Lidar Field Acquisition Report

Project: 1625_OMAFRA_Cochrane

Date	Data Acqui.	Mission 1	Mission 2	Mission 3	Description
October 6, 2016	No				Aircraft C-GKSI arrives at Kapuskasing (System 07)
October 7, 2016	No				Wait for approval to start
October 8, 2016	No				Wait for approval to start
October 9, 2016	No				Wait for approval to start
October 10, 2016	No				Wait for approval to start
October 11, 2016	No				Wait for approval to start
October 12, 2016	No				Wait for approval to start
October 13, 2016	No				Approval to Fly the Cochrane area
October 14, 2016	Yes	0716288a			One mission flown
October 15, 2016	No				Bad weather
October 16, 2016	No				Bad weather
October 17, 2016	No				Bad weather
October 18, 2016	No				Bad weather
October 19, 2016	No				Bad weather
October 20, 2016	No				Bad weather. Mission attempted with no production
October 21, 2016	No				Bad weather
October 22, 2016	No				Bad weather
October 23, 2016	No				Bad weather
October 24, 2016	No				Bad weather
October 25, 2016	No				Bad weather
October 26, 2016	Yes	0716300a			One mission flown
October 27, 2016	Yes	0716301a			One mission flown
October 28, 2016	No				Bad weather
October 29, 2016	No				Bad weather
October 30, 2016	No				Bad weather
October 31, 2016	Yes	0716305a			One mission flown
November 1, 2016	No				Bad weather
November 2, 2016	No				Bad weather
November 3, 2016	No				Bad weather
November 4, 2016	Yes	0716309a			Very little production, intermittent system problem
November 5, 2016	No				No production due to intermittent problem
November 6, 2016	Yes	0716311a			Very little production, intermittent system problem
November 7, 2016	No				Fly to Connecticut for system repairs at Leica
November 8, 2016	No				System in repairs and return to Peterborough
November 9, 2016	No				Two aircrafts in Peterborough
November 10, 2016	No				Two aircrafts in Peterborough
November 11, 2016	No				Bad weather & repositioning to Cochrane
November 12, 2016	Yes	0716317a	7916317a		Two missions flown
November 13, 2016	Yes	0716318a	7916318a	7916318b	Three missions flown
November 14, 2016	No				Bad weather & aircraft maintenance
November 15, 2016	No				Bad weather & aircraft maintenance
November 16, 2016	Yes	0716321a			One mission flown
November 17, 2016	No				Bad weather
November 18, 2016	No				Bad weather
November 19, 2016	No				Bad weather / snow
November 20, 2016	No				Bad weather / snow
November 21, 2016	No				Bad weather / snow
November 22, 2016	No				Aircraft with system 07 repositioning to Peterborough

Daily Lidar Field Acquisition Report

Project: 1625_OMAFRA_Cochrane

Date	Aircraft One	C-GMEC	Leica (79)	Description
	Acquisition?	Mission 1	Mission 2	
May 25, 2017	No			Local weather improving, aircraft mobilizes to Kapuskasing
May 26, 2017	Yes	7917146a		Flight cut short due to rain
May 27, 2017	Yes	7917147a		Flight cut short due to rain
May 28, 2017	No			Rain / low cloud
May 29, 2017	No			Rain / low cloud
May 30, 2017	No			Rain / low cloud
May 31, 2017	No			Rain / low cloud
June 1, 2017	No			Rain / low cloud
June 2, 2017	No			Low clouds
June 3, 2017	Yes	7917154a		Full Mission
June 4, 2017	Yes	7917155a		Flight cut short due to low clouds and turbulence
June 5, 2017	No			Rain / low cloud
June 6, 2017	Yes	7917157a		Flight cut short due to low clouds
June 7, 2017	Yes	7917158a		Flight cut short due to low clouds
June 8, 2017	Yes	7917159a		Flight cut short due to low clouds
June 9, 2017	Yes	7917160a		Flight cut short due to low clouds
June 10, 2017	Yes	7917161a		Flight cut short due to low clouds
June 11, 2017	No			Rain / low cloud
June 12, 2017	Yes	7917163a		Project Complete
June 13, 2017				

Appendix B

Mission Flightlogs

6249 @ 3501 15849 1782
 @ 1146 19:00 @ 1157 1850
 @ 1479 1479 @ 1479 1479
 @ 1571-1571

LIDAR Flight Log

Julian Day	288	Flight	A
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Date	OCT. 14 2016	Aircraft	C-GKST
Project	1625-OMAFRA-CORRAVE	Pilot	SEITER
Location	KAPUSKASINGO CYYU	Operator	TALL
Mission Objective			

System	Leica ALS50-II
Unit	03
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp. Off	
Data Drive	1

Additional Notes	WIND - 3 KPH TEMP D - (0.6)° HUM - 96 ALT - 30.2-1 0° @ 4000' @ 14:12
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Aircraft Block Time			
Engine On	1208	Ramp Out	1223
Engine Off	1845	Ramp In	1835
Total	6.6 hrs	Total	6.6 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	1215	Start	End
Post Mission	183630	183630	184130

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp		Comments
			Start	End	Time	nmi to End		
CAL-CYYU	071628801	27	1233	1234			161014 - 123346	
CAL-CYYU	02	207	1237	1238			- 123758	
X-TIE (ULOOI)	03	20	1243	1250			- 124347	
0086	04	292	1253	1255			- 125352	
0087	05	112	1258	1259			- 125824	
0088	06	292	1303	1305			- 130325	
0089	07	112	1308	1310			- 130821	
0090	08	292	1314	1316			- 131402	
0091	09	112	1319	1329			- 131953	
0092	10	292	1332	1342			- 133239	
0093	11	112	1345	1355			- 134517	
0094	12	292	1358	1409			- 135859	
0095	13	112	1412	1423			- 141213	
0096	14	292	1426	1437			- 142648	
0097	071628815	112	1440	1451			- 144043	



LIDAR Flight Log

Julian Day	288	Flight	A
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Date	07-14-16	Aircraft	C-GKST
Project	1625-0MAFEA-COCHEN-6	Pilot	SEITER
Location	KARASASINE C-334	Operator	TARL
Mission Objective			

System	Leica ALS50-II
Unit	03
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	1

Additional Notes
W-3Kph
Temp 0
Hum. 96%
Alt. 30.21

Aircraft Block Time			
Engine On	1208	Ramp Out	1223
Engine Off	1845	Ramp In	1835
Total	6.6 hrs	Total	6.1 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission		Start	End
Post Mission		1215	1222
		183630	184130

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End			
0098	071628816	292	1455	1506		161014-145523	
0099	17	112	1510	1522		-151046	
0100	18	292	1525	1537		-152543	
0101	19	112	1540	1552		-154043	
0102	20	292	1555	1607		-155530	
0103	21	112	1610	1622		-161028	
0104	22	292	1625	1637		-162535	
0105	23	112	1641	1653		-164117	
0106	24	292	1656	1658		-165632	
0107	25	112	1711	1722		-171116	
0108	26	292	1726	1738		-172606	
0109	27	112	1741	1753		-174159	
0110	28	292	1756	1807		-175623	7-min 13-sec PUFFY CLOS
01-0334	29	27	1818	18235		161014-181812	PUFFYS ON CALS 3700'
01-0334	30	207	1822	1823		161014-182259	PUFFYS 3300'
01-0334	Not Used	27	182641	182702		161014-182641	WEST UNDER CLOUDS 2800' (UA) REF



LIDAR Flight Log

Julian Day	300	Flight	A
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Date	Oct 26, 2016	Aircraft	PA-31 C-GKSI
Project	1625 OMARA-Cochise	Pilot	P. SEITER
Location	KARUSKASING, ON.	Operator	G. Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	2

Additional Notes
Temp- 1.0C
Wind- 100 @ 7kts
Pressure- 30.47
Ceiling- 4000
Vis- 15 miles

Aircraft Block Time			
Engine On	1956	Ramp Out	2010
Engine Off	0232	Ramp In	0223
Total	6.6 hrs	Total	6.1 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	2003	Start	End
Post Mission	0223	0223	0228

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
CAL	071630001	206.6	2018	2019			161026-201859	139 kts 3877 ft
CAL	02	026.6	2022	2023			202257	130 kts 3990 ft
111	03	112.0	2031	2043			203155	
112	04	292.0	2046	2058			204652	
113	05	112.0	2102	2113			210200	
114	06	292.0	2116	2127			211641	
115	07	112.0	2131	2142			213131	
116	08	292.0	2145	2157			214551	
117	09	112.0	2201	2212			220106	
118	10	292.0	2215	2227			221559	
119	11	112.0	2230	2241			223040	
120	12	292.0	2245	2256			224506	
121	13	112.0	2259	2310			225957	
122	14	292.0	2314	2325			231434	
123	071630015	112.0	2328	2340			232857	



LIDAR Flight Log

Julian Day	301	Flight	A
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Date	Oct 27, 2016	Aircraft	PA-31 C-GKSI
Project	1625 OMAFRA-COCHANE	Pilot	P. SEITER
Location	KARUSKASING, ONT	Operator	G. Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	

AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°

Additional Notes			
Temp-	-3°C	Wind-	170 @ 11 kts
Pressure-	30.34	Ceiling-	19000
Vis-	15 miles		

Static Alignment			GPS Time
Pre Mission	1451	End	1456
Post Mission	2132	End	2137

AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°

Engine On	1444	Ramp Out	1502	Takeoff	1506
Engine Off	2141	Ramp In	2132	Landing	2128
Total	7.0 hrs	Total	6.4 hrs		

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
CAL	071630101	206.6	1512	1512			161027.151207	139 kts 3918 ft
CAL	02	026.6	1516	1516			151623	141 kts 3894 ft
X-LINE	03	102.7	1521	1529			152157	
182	04	192.7	1534	1539			153458	
181	05	012.7	1542	1547			154259	
180	06	192.7	1551	1556			155118	
179	07	012.7	1559	1604			155923	
178	08	192.7	1607	1612			160750	
177	09	012.7	1615	1620			161548	
176	10	192.7	1624	1632			162415	
175	11	012.7	1635	1643			163537	
174	12	192.7	1646	1655			164656	
173	13	012.7	1658	1707			165830	
172	14	192.7	1711	1721			171128	
171	071630115	012.7	1724	1734			172427	



LIDAR Flight Log

Julian Day	301	Flight	A
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Date	Oct 27, 2016	Aircraft	PA-31 C-GKSI
Project	1625 OMAGRA - Cocoroc	Pilot	P. SEITER
Location	KAPUSKASING, ONT	Operator	G. Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	

Additional Notes
Temp- 1°C
Wind- 180 @ 7kts
Pressure- 30.29
Celling- 17000
Vis- 15 miles

Aircraft Block Time			
Engine On	1444	Ramp Out	1502
Engine Off	2141	Ramp In	2132
Total	7.0 hrs	Total	6.4 hrs

Mission Plan			
AGL Height	1600 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40° Deg's

Static Alignment		GPS Time	
Pre Mission	1451	Start	End
Post Mission	2132	1456	2137

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
170	0716301116	192.7	1738	1749			161027 - 173821	
169	17	012.7	1752	1803			175207	
168	18	192.7	1807	1819			180713	
167	19	012.7	1822	1834			182228	
166	20	192.7	1838	1852			183827	
165	21	012.7	1856	1910			185602	
164	22	192.7	1914	1929			191429	
163	23	012.7	1933	1948			193313	
162	24	192.7	1952	2008			195235	
161	25	012.7	2011	2027			201126	
160	26	192.7	2030	2046			203023	
159	27	012.7	2049	2104			204906	
CAL	28	026.6	2118	2118			211826	139 kts 3924 ft
CAL	071630129	206.6	2122	2122			212200	135 kts 3842 ft



LIDAR Flight Log

Julian Day	305	Flight	A
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Date	OCT 31, 2016	Aircraft	PA-31 C-GKSI
Project	1625 OMAFRA-Cochrane	Pilot	PROULX / Kocika
Location	KAPUSKASING, ON	Operator	G.Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	3

Additional Notes
Temp- 0°C
Wind- 220 @ 7 kts
Pressure- 30.16
Ceiling- 6000
Vis- 15 miles

Aircraft Block Time			
Engine On	1253	Ramp Out	1307
Engine Off	1858	Ramp In	1848
Total	6.1 hrs	Total	5.5 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°
		Deg's	

Static Alignment		GPS Time	
Pre Mission	1300	Start	End
Post Mission	1849	1305	1854

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End	Time	nmi to End	
CAL	071630501	206.6	1327	1328		161031-132748	132 kts 3906 m
CAL	02	026.6	1332	1332		133221	139 kts 3860 m
158	03	192.7	1346	1401		134601	
157	04	012.7	1405	1421		140546	
156	05	192.7	1426	1442		142614	
155	06	012.7	1446	1502		144607	
154	07	192.7	1506	1522		150624	
153	08	012.7	1526	1541		152636	
152	09	192.7	1546	1602		154625	
151	10	012.7	1606	1622		160628	
150	11	192.7	1627	1643		162701	
149	12	012.7	1646	1702		164636	
148	13	192.7	1707	1724		170742	
147	14	012.7	1727	1743		172740	
146	071630515	192.7	1748	1804		174824	



Julian Day

309

Flight

A

Date

Nov 4, 2016

Aircraft

PA-31 C-GKSI

Project

1625-0MAFRA-Cochrane

Pilot

PROULX / KOCKEL

Location

KAPUSKASING, ON

Operator

G. Westergard

Mission Objective

System

Leica ALS70

Unit

7207

IMU

Honeywell Micro IRS

GPS Rx

NovAtel OEMV

Roll Comp.

Off

Data Drive

Additional Notes

Temp- -30C
Wind- 210 @ 7kts
Pressure- 30.15
Ceiling- Clear
Vis- 15 miles

LIDAR Flight Log

Static Alignment		GPS Time	
Start	End	Start	End
Pre Mission	1330	1330	1335
Post Mission	1512	1512	1517

Mission Plan			
AGL Height	m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°

Aircraft Block Time			
Engine On	1317	Ramp Out	1336
Engine Off	1522	Ramp In	1510
Total	2.1 hrs	Total	1.5 hrs

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp		Comments
			Start	End		Time	nmi to End	
CAL	071630901	206.6	1346	1346				134 kts 3807 ft
CAL	02	026.6	1351	1352				136 kts 3920 ft
117	03	292.0	1358	1359				WEST 2 nmi
144	04	192.7	1414	1430				
143	071630905	012.7	1433	—	1445	9.5 nmi		TDC data field time out error.
TEST		—	—	—				Clouds
								No Cals.
								Data logger cannot access
								hard drive.
								on landing.



LIDAR Flight Log

Julian Day	311	Flight	A
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Date	Nov 6, 2016	Aircraft	PA-31 C-GKSI
Project	1625 AMARA - COCHRANE	Pilot	SORNASSE/KOCKEL
Location	KAPUSKASING, ON	Operator	G. Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	/

Additional Notes	
Temp-	1°C
Wind-	200 @ 5kts
Pressure-	30.23
Ceiling-	21000
Vis-	15 miles

Aircraft Block Time			
Engine On	1252	Ramp Out	1310
Engine Off	1542	Ramp In	
Total	2.8 hrs	Total	2.3 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°

Static Alignment		GPS Time	
Pre Mission	1304	Start	End
Post Mission	1533	1533	1538

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
CAL	071631101	206.6	1322	1322			161106 - 132216	134 kts 3941 ft
CAL	02	026.6	1326	1326			132621	134 kts 3860 ft
144	03	192.7	1337	1353			133753	
143	04	012.7	1357	1413			135739	
142	05	192.7	1417	1433			141748	
141	06	012.7	1437	1453			143713	
140	07	192.7	1457	1505		17 nmi	145725	TDC data fetch error.
Test		G	1511	1512			151109	
CAL	08	206.6	1518	1518			151811	131 kts 3969 ft
CAL	071631109	026.6	1523	1523			152314	126 kts 3988 ft

"TDC data fetch time out error due to no mem switch signal on 110 Aug 1 connection on TDC" Pg 1 of 1



LIDAR Flight Log

Julian Day	317	Flight	A
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Date	Nov 12, 2016	Aircraft	PA-31 C-GKSI
Project	1625 - OMAIRA - COCHRANE	Pilot	PROULX/KOCKEL
Location	KARUKASING, ON	Operator	G.Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	2

Additional Notes
Temp- 3°C
Wind- 250 @ 16 kts
Pressure- 29.83
Ceiling- 18000
Vis- 15 miles

Aircraft Block Time			
Engine On	1336	Ramp Out	1350
Engine Off	1944	Ramp In	1935
Total	6.2 hrs	Total	5.7 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°

Static Alignment		GPS Time	
Pre Mission	1343	Start	End
Post Mission	1936	1936	1941

Flight Line	LIDAR File Name	Flight Direction		GPS Time		Line Aborted		ALS Time Stamp	Comments
		Start	End	Start	End	Time	nmi to End		
CAL	071631701	206.6	1403	1403				161112.140307	107 kts 3953 ft
CAL	02	026.6	1406	1407				140653	126 kts 3912 ft
140	03	192.7	1419	1436				141943	
139	04	012.7	1441	1458				144148	
138	05	192.7	1501	1518				150149	
137	06	012.7	1521	1537				152150	
136	07	192.7	1540	1557				154059	
135	08	012.7	1600	1616				160055	
134	09	192.7	1619	1634				161919	
KAR		0	1644	1649				—	A778
X-LINE	10	029.3	1701	1708				170143	
183	11	119.3	1713	1714				171348	
184	12	299.3	1721	1729				172138	
185	13	119.3	1737	1744				173731	
186	071631714	299.3	1752	1801				175213	

Julian Day 317 Flight A

Date 2016/11/12
Project 162500A FRAA Caching
Location 0440
Mission Objective

Aircraft CG MEC
Pilot Seiter
Operator Blair

Additional Notes
WIND - 250° @ 16 Kts
Temp - 20°C
Ceiling - 10000'
Vis - 15nm
Altimeter - 29.87

System Leica ALS70
Unit 7179
IMU Honeywell Micro IRS
GPS Rx NovAtel OEM V
Roll Comp.
Data Drive A

Mission Plan
AGL Height 1000 m Laser Pulse Rate 500KHz
Target Speed 140 kts Scan Rate 53.4 Hz
Laser Current 100 % FOV 40 Deg's

Aircraft Block Time				Mission Plan		Static Alignment		GPS Time	
Engine On	1306	Ramp Out	Takeoff	1331		Pre Mission	1320	Start	End
Engine Off	1412	Ramp In	Landing	1909		Post Mission	1905		
Total	6.1 hrs	Total	hrs	Total	5.6 hrs				

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
Colib 0440	791631701	026°	1338	1338			161112-133808	
Colib 0440	02	206°	1342	1343			134247	
Run 2N		6	1344	1349				
Run A786		6	1414	1419				
X Tie	03	015°	1424	1430			142454	
1	04	105°	1441	1446			144140	
2	05	285°	1452	1508			145222	
3	06	105°	1516	1528			151641	
4	07	285°	1531	1547			153133	
5	08	105°	1553	1604			155346	
6	09	285°	1608	1623			160817	
7	10	105°	1628	1639			162846	
8	11	285°	1643	1657			164300	
9	12	105°	1702	1713			170229	
10	791631713	285°	1716	1729			171638	



LIDAR Flight Log

Julian Day	318	Flight	A
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Date	Nov 13, 2016	Aircraft	PA-31 C-GKSI
Project	1625 OMAIRA-Cochrane	Pilot	SONASSE/KOCKEL
Location	KAPUSKASING, ON	Operator	G.Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	/

Additional Notes
Temp- 3°C
Wind- 250 @ 5kts
Pressure- 29.88
Ceiling- 16000
Vis- 15 miles

Aircraft Block Time			
Engine On	1319	Ramp Out	1332
Engine Off	1931	Ramp In	1921
Total	6.2 hrs	Total	5.8 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 Khz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°
		Deg's	

Static Alignment		GPS Time	
Pre Mission	1326	Start	End
Post Mission			1331

Flight Line	LIDAR File Name	GPS Time		Flight Direction	Line Aborted		ALS Time Stamp	Comments
		Start	End		Time	nmi to End		
CAL	071631B01	1346	1347	206.6			161113-134650	130 kts 3902 ft
CAL	02	1350	1350	026.6			135028	142 kts 3976 ft
KAR		1403	1408	05			---	4778
190	03	1414	1418	299.3			141415	flew West 10 nmi
191	04	1423	1431	119.3			142319	
192	05	1436	1445	299.3			143624	
193	06	1449	1459	119.3			144940	
194	07	1503	1513	299.3			150313	
195	08	1516	1526	119.3			151634	
196	09	1530	1540	299.3			153012	
197	10	1544	1554	119.3			154428	
198	11	1558	1609	299.3			155837	
199	12	1612	1623	119.3			161259	
200	13	1627	1638	299.3			162719	
201	071631B14	1641	1652	119.3			164139	



LIDAR Flight Log

Julian Day	318	Flight	A
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Date	Nov 13, 2016	Aircraft	PA-31 C-GKSI
Project	1625 OMAREKA-COCHURANE	Pilot	SORANSH KOCKEL
Location	KAPUSKASING, ON	Operator	G.Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	/

Additional Notes
Temp- 11°C
Wind- 270 @ 11 kts
Pressure- 29.83
Ceiling- CLEAR
Vis- 15 miles

Aircraft Block Time			
Engine On	1319	Ramp Out	1332
Engine Off	1931	Ramp In	1921
Total	6.2 hrs	Total	5.8 hrs

Mission Plan			
AGL Height	1600 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°
		Deg's	

Static Alignment		GPS Time	
Pre Mission	1326	Start	End
Post Mission	1922	1331	1927

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End	Time	nmi to End	
202	071631815	299.3	1657	1707		161113 - 165707	
203	16	119.3	1711	1721		171110	
204	17	299.3	1725	1737		172542	
205	18	119.3	1741	1751		174107	
206	19	299.3	1756	1807		175611	
207	20	119.3	1810	1821		181051	
208	21	299.3	1826	1837		182602	
209	22	119.3	1840		1845	16 nmi	NEED EAST 16 nmi
KAR		0	1845	1850		—	A778
CAL	23	206.6	1907	1910		190949	127 kts 3885 ft
CAL	071631824	026.6	1913	1913		191328	136 kts 4007 ft

Julian Day 318

Flight A

Date 2016/11/13

Aircraft CG MEC

Project 1125 OMARPA Cadenas

Pilot SETLER

Location CYYU

Operator BLAIR

Mission Objective

System Leica ALS70

Unit 7179

IMU Honeywell Micro IRS

GPS Rx NovAtel OEM V

Roll Comp.

Data Drive 7207(2)

Additional Notes

WIND - 250° @ 5Ks

Temp - 30C

Ceiling - UNLIMITED

Vis - 15NM

Altimeter - 291.68

31%



LIDAR Flight Log

Aircraft Block Time				Mission Plan				Static Alignment		GPS Time	
Engine On	1256	Ramp Out	Takeoff	1315	AGL Height	1000 m	Laser Pulse Rate	500K Hz	Pre Mission	Start	End
Engine Off	1800	Ramp In	Landing	1800	Target Speed	140 kts	Scan Rate	54.3 Hz			
Total	5.2 hrs	Total	Total	4.8 hrs	Laser Current	100 %	FOV	40 Deg's	Post Mission	1802	1807

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
0116 CYYU	791631801	026°	1320	1320			16113-132016	
0116 CYYU	02	206°	1324	1324			132408	
RUN IN		6	1327	1332				
KAR A706		6	1346	1351				
14	03	105°	1353	1358			135343	WOLF/INIE
15	04	285°	1401	1413			140139	
16	05	105°	1416	1428			141628	
17	06	285°	1431	1443			143137	
18	07	105°	1446	1457			144615	
19	08	285°	1501	1512			150100	
20	09	105°	1515	1527			151526	
21	10	285°	1530	1542			153010	
22	11	105°	1545	1556			154538	
23	12	285°	1600	1612			160008	
24	791631813	105°	1615	1627			161549	



LIDAR Flight Log

Julian Day	318	Flight	B
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GMEC

Date	Nov 13, 2016	Aircraft	PA-31 C-GKSH
Project	1625 OMAFRA-Cochrane	Pilot	SESTER/KOCKEL
Location	KAPUS KASING, ON	Operator	G.Westergard
Mission Objective			

System	Leica ALS70
Unit	7207-7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	Off
Data Drive	/

Additional Notes	
Temp-	12°C
Wind-	240 @ 6 kts
Pressure-	29.55
Ceiling-	CLEAR
Vis-	15 miles

Aircraft Block Time			
Engine On	2119	Ramp Out	2131
Engine Off	0114	Ramp In	0106
Total	4.0 hrs	Total	3.5 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 Khz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40°

Static Alignment		GPS Time	
Pre Mission		Start	End
Post Mission		2123	2128
		0106	0111

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End	Time	nmi to End	
CAL	791631820	026.6	2138	2138			161113-213807 135 kts 3925 ft
CAL	21	206.6	2142	2142			214213 137 kts 3846 ft
KAR		G	2155	2200			A778
209	22	119.3	2207	2214			220738 FLEW EAST 16 nmi
210	23	299.3	2218	2229			221855
211	24	119.3	2233	2244			223338
212	25	299.3	2248	2258			224813
213	26	119.3	2302	2313			230217
214	27	299.3	2317	2328			231718
215	28	119.3	2332	2342			233205
216	29	299.3	2346	2357			234643
217	30	119.3	0001	0012			161114-000135
218	31	299.3	0017	—	0022	12 nmi	001710 NEED WEST 13 nmi
KAR		G	0024	0029			A778
CAL	32	206.6	0047	0048			004746 135 kts 3983 ft
CAL	791631833	026.6	0051	0052			005157 140 kts 3953 ft



LIDAR Flight Log

Julian Day	321	Flight	A
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Date	Nov 16, 2016	Aircraft	PA-31 C-GKSI
Project	1625 OMATPA-COCHURANE	Pilot	SORNASSE KAREK
Location	KAPUS KASING, ONT	Operator	G. Westergard
Mission Objective			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp. Off	
Data Drive	/

Additional Notes
Temp- 5°C
Wind- 260 @ 5kt
Pressure- 29.85
Ceiling- 3000
Vis- 15 miles

Aircraft Block Time			
Engine On	2147	Ramp Out	2203
Engine Off	0157	Ramp In	0148
Total	4.2 hrs	Total	3.7 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	46°

Static Alignment		GPS Time	
Pre Mission	2157	Start	End
Post Mission	0149	0149	0154

Flight Line	LIDAR File Name	Flight Direction		GPS Time		Line Aborted	ALS Time Stamp	Comments
		Start	End	Start	End	Time	nmi	to End
CAL	071632101	206.6	2212	2212	2212		161116_221214	132 kts 3937 ft
CAL	02	026.6	2216	2216	2216		221623	141 kts 3929 ft
KAR		G	2237	2242	2242		—	A 786
028	03	104.9	2251	2303	2303		225112	
029	04	284.9	2306	2318	2318		230659	
030	05	104.9	2322	2334	2334		232217	
031	06	284.9	2337	2349	2349		233738	
032	07	104.9	2352	0004	0004		235252	
033	08	284.9	0008	0019	0019		161117_000812	
034	09	104.9	0023	0035	0035		002308	
035	10	284.9	0038	0049	0049		003819	
036	11	104.9	0053	0104	0104		005306	
KAR		G	0112	0117	0117		—	A 786
CAL	12	206.6	0137	0137	0137		013710	141 kts 4005 ft
CAL	071632113	026.6	0141	0141	0141		014121	139 kts 3838 ft



LIDAR Flight Log

Julian Day 146 Flight A

Date 11/26/2017 Aircraft C-GMEL
 Project 1125 ONAFA- COCHLEWIE Pilot S. L. W. A. S. S.
 Location CYYU - KAPUSKING Operator H. P. E. R. S. O. U. T. H.
 Mission Objective

System Leica ALS70
 Unit 7179
 IMU Honeywell Micro IRS
 GPS Rx NovAtel OEM V
 Roll Comp.
 Data Drive 4

Additional Notes

Aircraft Block Time			
Engine On 1227	Ramp Out 1259	Takeoff 1303	
Engine Off 1554	Ramp In 1545	Landing 1544	
Total 3.5 hrs	Total	Total 2.7 hrs	

Mission Plan			
AGL Height 1000 m	Laser Pulse Rate 500 Hz		
Target Speed 140 kts	Scan Rate 53.4 Hz		
Laser Current 100 %	FOV 40 Deg's		

Static Alignment		GPS Time	
Pre Mission	1243	Start	End
Post Mission	1545	Start	End

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nm1 to End		
CAL	71714601	206	1309	1309			170526-130948	RAIN
CAL	07	26	1313	1314			170526-131345	RAIN
KAR		G	1324	1329				
Y TIE	03	30	1339	1346			170526-133907	
0037	04	120	1351	1358			170526-135154	
0038	05	300	1402	1409			170526-140210	
0039	06	120	1412	1420			170526-141235	
0040	07	300	1423	1431			170526-142335	
0041	08	120	1435	1443			170526-143535	
0042	09	300	1446	1455			170526-144658	LIGHT RAIN FAIR END
0043	10	120	1458	1506			170526-145810	LIGHT RAIN FAIR END
KAR		G	1512	1517				
CAL	11	20	1533	1534			170526-153358	
CAL	71714612	206	1537	1537			170526-153722	



LIDAR Flight Log

Julian Day 154 Flight 1A

Date	June 3, 2017	Aircraft	PA-31C-GMEC
Project	1625-0MAFRA-Cochrane	Pilot	T. Scarnasse
Location	Kapus Kasinua	Operator	C. Johnson
Mission Objective			

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	4

Additional Notes	
Wind:	
Temp:	
Pressure:	
Clouds:	
Visibility:	

Aircraft Block Time			
Engine On	12:50	Ramp Out	Takeoff 13:06
Engine Off	21:39	Ramp In	Landing 21:27
Total	8.8 hrs	Total	8.4 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	13:54	Start	End
Post Mission	21:30	21:30	21:35

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp		Comments
			Start	End		Time	nmi to End	
0040	791715401	026°	13:12	13:12				170603
0041	02	206°	13:15	13:16				
0042	03	0	13:25	13:30				
0043	04	121°	13:34	13:38				Pickup half line East
0044	05	301°	13:42	13:51				
0045	06	121°	13:54	14:04				
0046	07	301°	14:08	14:18				
0047	08	121°	14:22	14:32				
0048	09	301°	14:35	14:46				
0049	10	121°	14:50	15:01				
0050	11	301°	15:04	15:15				
0051	12	121°	15:19	15:31				
0052	13	301°	15:34	15:47				
0053	14	121°	15:51	16:03				
0054	15	301°	16:06	16:18				
0055	16	121°	16:18	16:30				
0056	17	301°	16:30	16:42				
0057	18	121°	16:42	16:54				



LIDAR Flight Log

Julian Day 154 Flight 1A

Date June 3/2017 Aircraft PA-31C Gemini
 Project 1250MFA-Cochran Pilot T. Sorra
 Location Kapskas INO Operator C. Johnson
 Mission Objective

System Leica ALS70
 Unit 7179
 IMU Honeywell Micro IRS
 GPS Rx NovAtel OEMV
 Roll Comp.
 Data Drive 4

Additional Notes
 Wind:
 Temp:
 Pressure:
 Clouds:
 Visibility:

Aircraft Block Time			
Engine On	12:50	Ramp Out	Takeoff 13:06
Engine Off	21:39	Ramp In	Landing 21:27
Total	8.8 hrs	Total	8.4 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	12:54	Start	End
Post Mission	21:30	21:30	21:35

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End	Time	nm1 to End	
0058	791715415	121°	16:21	16:34		162151	
0059	16	301°	16:38	16:49		163802	
0060	17	121°	16:53	7:05		165324	
0061	18	301°	17:08	17:20		170824	
0062	19	121°	17:24	17:36		172418	
0063	20	301°	17:39	17:51		173907	
0064	21	121°	17:54	18:06		175411	
0065	22	301°	18:09	18:21		180918	
0066	23	121°	18:24	18:36		182427	
0067	24	301°	18:39	18:51		183938	
0068	25	121°	18:55	19:07		185513	
0069	26	301°	19:10	19:22		191022	
0070	27	121°	19:25	19:36		192503	
0071	28	301°	19:41	19:50		194129	
0072	791715429	121°	19:53	20:03		195338	

Julian Day 154 Flight - A



Julian Day	154	Flight - A
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Date	June 3, 2017	Aircraft-31C-GMFC
Project	11250MAERA-Cochrane	Pilot T. Sennese
Location	Kapuskasing	Operator C. Johnson
Mission Objective		

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	4

Additional Notes:
 Wind:
 Temp:
 Pressure:
 Clouds:
 Visibility:

Aircraft Block Time			
Engine On	12:50	Ramp Out	
Engine Off	2:39	Ramp In	
Total	8:8 hrs	Total	hrs
		Total	8:4 hrs
			Landing 2:27
			Takeoff 13:06

Mission Plan	
AGL Height	1000 m
Target Speed	140 kts
Laser Current	100 %
Laser Pulse Rate	500 KHz
Scan Rate	53.4 Hz
FOV	40 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	12:54	12:59
Post Mission	21:30	21:35

[illegible]



LIDAR Flight Log

Julian Day 155 Flight 1A

Date	June 4, 2017	Aircraft	PA-31C-GMEC
Project	1650MAFBA Cochrane	Pilot	T. Sornmasse
Location	Kapus Kasinag	Operator	C. Johnson
Mission Objective			

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	1

Additional Notes	
Wind:	
Temp:	
Pressure:	
Clouds:	
Visibility:	

Aircraft Block Time			
Engine On	13:54	Ramp Out	Takeoff 13:12
Engine Off	18:44	Ramp In	Landing 18:32
Total	5.8 hrs	Total	5.3 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	12:58	Start	End
Post Mission	18:36	18:41	

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp		Comments
			Start	End		Time	nm to End	
071	791715501	086°	13:16	13:16				170604
072	02	206°	13:20	13:20				132001
073		05	13:30	13:35				Re-fly East 10 nmi
074	03	121°	13:37	13:41				Re-fly East 10 nmi
075	04	301°	13:45	13:49				
076	05	121°	13:58	14:06				
077	06	301°	14:10	14:17				
078	07	121°	14:20	14:28				
079	08	301°	14:33	14:40				
080	09	121°	14:43	14:50				
081	10	301°	14:53	15:00				
082	11	121°	15:03	15:10				
083	12	301°	15:13	15:19				
084	13	121°	15:23	15:28				
085	791715514	301°	15:32	15:37				



LIDAR Flight Log

Julian Day 155 Flight 1A

Date	<u>June 4, 2017</u>	Aircraft	<u>PA-31C-GMEC</u>
Project	<u>50MAREB-Cochrane</u>	Pilot	<u>T. Sorraesse</u>
Location	<u>Kapuskasing</u>	Operator	<u>C. Johnson</u>
Mission Objective			

System	<u>Leica ALS70</u>
Unit	<u>7179</u>
IMU	<u>Honeywell Micro IRS</u>
GPS Rx	<u>NovAtel OEMV</u>
Roll Comp.	
Data Drive	<u>1</u>

Additional Notes				
Wind:				
Temp:				
Pressure:				
Clouds:				
Visibility:				

Aircraft Block Time				
Engine On	<u>12:54</u>	Ramp Out		Takeoff
Engine Off	<u>18:44</u>	Ramp In		Landing
Total	<u>5.8</u>	hrs	Total	<u>5.3</u>
			hrs	

Mission Plan				
AGL Height	<u>1000</u>	m	Laser Pulse Rate	<u>500</u> KHz
Target Speed	<u>140</u>	kts	Scan Rate	<u>53.4</u> Hz
Laser Current	<u>100</u>	%	FOV	<u>40</u> Deg's

Static Alignment		GPS Time	
Pre Mission	<u>12:58</u>	Start	<u>13:02</u>
Post Mission	<u>18:36</u>	End	<u>18:41</u>

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End	Time	nmi	to End
X-TIE	791715515	040°	15:43	15:50		154344	
KAR		G	15:55	16:00		0	A784
KAR		G	16:23	16:28		0	A778
0219	16	119°	16:38	16:49		163816	
0220	17	299°	16:52	17:03		165225	
0221	18	119°	17:06	17:18		170654	
0222	19	299°	17:21	17:32		172144	
0223	20	119°	17:36	17:47		173616	
0224	21	299°	17:50	17:56		175040	EAST 13 Nmi FLOWN
KAR		G	17:59	18:04		0	
CAL	22	026°	18:23	18:23		182310	
CAL	791715523	206°	18:26	18:26		182635	



LIDAR Flight Log

Julian Day 157 Flight 1A

Date June 6, 2017 Aircraft PA-31C-G MEC
 Project 125.0MAFRA-Cochrane Pilot T. Sommers
 Location Mission Objective Operator C. Johnson

System Leica ALS70
 Unit 7179
 IMU Honeywell Micro IRS
 GPS Rx NovAtel OEMV
 Roll Comp.
 Data Drive A

Additional Notes
 Wind:
 Temp:
 Pressure:
 Clouds:
 Visibility:

Aircraft Block Time			
Engine On 12:41	Ramp Out	Takeoff 12:58	
Engine Off 14:47	Ramp In	Landing 17:35	
Total 5.1 hrs	Total	4.6 hrs	

Mission Plan			
AGL Height 1000 m	Laser Pulse Rate 500 KHz		
Target Speed 40 kts	Scan Rate 53.4 Hz		
Laser Current 100 %	FOV 40 Deg's		

Static Alignment		GPS Time	
Pre Mission	12:46	Start	End
Post Mission	17:38		17:43

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End			
CAL	791715701	206°	13:04	13:04		130429	170606
CAL	02	026°	13:08	13:09		130856	
KAR		G	13:18	13:23			A784
046	03	121°	13:28	13:34		132853	130856
KAR		G	13:40	13:45			A784
KAR		G	14:11	14:16			A778
224	04	299°	14:23	14:29		142336	130856
225	05	119°	14:32	14:43		143236	
226	06	299°	14:47	14:58		144701	
227	07	119°	15:01	15:12		150150	
228	08	299°	15:17	15:28		151711	
229	09	119°	15:32	15:43		153229	
230	10	299°	15:47	15:58		154728	
231	11	119°	16:02	16:13		160216	low clouds
232	791715712	299°	16:15	16:26		161557	



LIDAR Flight Log

Julian Day 158 Flight 1A

Date	June 7, 2017	Aircraft	PA-31C-G-MEC
Project	625 DMAREBA - Cochise	Pilot	T. Schumacher
Location		Operator	C. Schumacher
Mission Objective			

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	1

Additional Notes	
Wind:	
Temp:	
Pressure:	
Clouds:	
Visibility:	

Aircraft Block Time			
Engine On	14:50	Ramp Out	Takeoff 15:12
Engine Off	21:48	Ramp In	Landing 21:37
Total	7.0 hrs	Total	6.4 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	15:03	Start	End
Post Mission	21:39	21:39	21:44

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Abort		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
CAL	791715801	206°	15:18	15:18			151822	170607
CAL	02	026°	15:22	15:22			152225	
KAR		0°	15:45	15:50			-0-	
234	03	270°	15:57	16:00			155703	
235	04	090°	16:04	16:08			160437	
236	05	270°	16:12	16:16			161236	
237	06	090°	16:20	16:23			162008	
238	07	270°	16:28	16:31			162803	
239	08	090°	16:35	16:38			163515	156 KTS EAST END
240	09	270°	16:43	16:46			164325	
241	10	090°	16:50	16:53			165011	
242	11	270°	16:58	17:01			165815	
243	12	090°	17:06	17:09			170600	
244	13	270°	17:14	17:17			171442	
245	791715814	090°	17:23	17:26			172327	



LIDAR Flight Log

Julian Day 158 Flight 1A

Date June 7, 2017
 Project 1625 DMARFA-Cochise
 Location
 Mission Objective

System Leica ALS70
 Unit 7179
 IMU Honeywell Micro IRS
 GPS Rx NovAtel OEMV
 Roll Comp.
 Data Drive 1

Additional Notes
 Wind:
 Temp:
 Pressure:
 Clouds:
 Visibility:

Aircraft Block Time			
Engine On 14:50	Ramp Out	Takeoff 15:12	
Engine Off 21:48	Ramp In	Landing 21:37	
Total 7.0 hrs	Total	Total 6.4 hrs	

Mission Plan			
AGL Height 1000 m	Laser Pulse Rate 500 KHz		
Target Speed 140 kts	Scan Rate 53.4 Hz		
Laser Current 100 %	FOV 40 Deg's		

Static Alignment		GPS Time	
Pre Mission	15:03	Start	End
Post Mission	21:39	21:39	21:44

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmi to End		
246	291715815	270°	17:37	17:47			173735	
247	16	090°	17:51	18:00			175141	
248	17	270°	18:05	18:16			180540	
249	18	090°	18:20	18:30			182004	
250	19	270°	18:33	18:44			183354	
251	20	090°	18:48	18:58			184801	
252	21	270°	19:01	19:12			190158	
253	22	090°	19:15	19:26			191555	160 KTS @ B.O.L
254	23	270°	19:30	19:40			193004	
255	24	090°	19:44	19:54			194424	
256	25	270°	19:58	20:09			195810	
257	26	090°	20:12	20:22			201237	160 KTS @ 8 NMI
258	27	270°	20:26	20:37			202637	
X-TIE	28	180°	20:43	20:52			204330	
KAR		CS	20:56	21:01			-0-	
CAL	29	206°	21:28	21:38			212824	
CAL 291715930	026°	21:32	21:33				213856	



LIDAR Flight Log

Julian Day 159 Flight 1A

Date	June 8, 2017	Aircraft	PA-31C-GMEC
Project	1625-DMAFBA-Cochrane	Pilot	T. Sornasse
Location	KadusKASING/area	Operator	C. Johnson
Mission Objective			

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	A

Additional Notes	
Wind:	
Temp:	
Pressure:	
Clouds:	
Visibility:	

Aircraft Block Time			
Engine On	12:36	Ramp Out	Takeoff 12:51
Engine Off	18:56	Ramp In	Landing 18:46
Total	6.3 hrs	Total	5.9 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	40 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	12:40	Start	End
Post Mission	12:45		

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp	Comments
			Start	End	Time nml to End		
CAL	791715901	026°	12:58	12:59		125838	170608
CAL	02	206°	13:03	13:04		130336	
KAR		C5	13:24	13:29		-0-	
259	03	090°	13:39	13:49		133914	
260	04	270°	13:53	14:04		35356	
261	05	090°	14:07	14:18		40737	
262	06	270°	14:21	14:32		42143	
263	07	090°	14:35	14:45		43521	
264	08	270°	14:49	15:00		44954	
265	09	090°	15:04	15:14		50411	
266	10	270°	15:19	15:29		51906	
267	11	090°	15:33	15:44		53328	
268	12	270°	15:47	15:58		54746	
269	13	090°	16:01	16:11		60131	
270	791715914	270°	16:15	16:26		61554	



LIDAR Flight Log

Julian Day 159 Flight 1A

Date	June 8, 2017	Aircraft	PA-31C-GAMEC
Project	1850NAFRA-Cochrane	Pilot	T. Sor NASSE
Location		Operator	C. JOHNSON
Mission Objective			

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	4

Additional Notes	
Wind:	
Temp:	
Pressure:	
Clouds:	
Visibility:	

Aircraft Block Time			
Engine On	12:36	Ramp Out	12:51
Engine Off	18:56	Ramp In	18:46
Total	6.3 hrs	Total	5.9 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission		Start	End
Post Mission		18:40	18:45
		18:48	18:53

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nml to End		
271	791715915	090°	16:29	16:39			162919	
272	16	270°	16:44	16:54			164402	
273	17	090°	16:58	17:08			165809	
274	18	270°	17:12	17:23			171250	
275	19	090°	17:27	17:37			172730	
276	20	270°	17:41	17:52			174121	
KAR		Or	17:56	18:01			Or	
CAL	21	206°	18:32	18:32			183212	Off Line / Refly
CAL	22	026°	18:36	18:36			183631	
CAL	791715923	206°	18:40	18:40			184037	



LIDAR Flight Log

Julian Day 160 Flight 1A

Date June 9, 2017 Aircraft PA-31C-GINEC
 Project 1625.0MAFRA-Cochranville Pilot T. SORRISSE
 Location Operator C. Johnson
 Mission Objective

System Leica ALS70
 Unit 7179
 IMU Honeywell Micro IRS
 GPS Rx NovAtel OEMV
 Roll Comp.
 Data Drive 4

Additional Notes
 Wind:
 Temp:
 Pressure:
 Clouds:
 Visibility:

Aircraft Block Time			
Engine On	20:18	Ramp Out	Takeoff 20:33
Engine Off	22:03	Ramp In	Landing 01:51
Total	5.8 hrs	Total	5.3 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	20:23	Start	End
Post Mission	01:54	20:28	01:59

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted	ALS Time Stamp		Comments
			Start	End		Time	nmi to End	
CAL	791716001	206°	20:37	20:39				170609
CAL	02	026°	20:43	20:44				
KAR		0°	21:06	21:11				
277	03	090°	21:20	21:30				212027
278	04	270°	21:34	21:45				213426
279	05	090°	21:48	21:59				214854
280	06	270°	22:03	22:14				220324
281	07	090°	22:17	22:28				221745
282	08	270°	22:32	22:43				223217
283	09	090°	22:48	22:58				224800
284	10	270°	23:02	23:13				2302
285	11	090°	23:16	23:26				231628
286	12	270°	23:30	23:41				233053
287	13	090°	23:44	23:55				234451
288	791716014	270°	23:58	00:09				235850

Date	June 9/2017	Aircraft PA-31C-GMEC
Project	645.0MAFRA Catchment	Pilot T. Sarrafosse
Location		Operator C. Johnson
Mission Objective		

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	4

Additional Notes:
Wind:
Temp:
Pressure:
Clouds:
Visibility:

Aircraft Block Time			
Engine On	20:18	Ramp Out	
Engine Off	03:03	Ramp In	
Total	5.8 hrs	Total	5.3 hrs

Mission Plan	
AGL Height	1000 m
Target Speed	40 kts
Laser Current	100 %
Laser Pulse Rate	500 KHz
Scan Rate	53.4 Hz
FOV	40 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	20:23	20:28
Post Mission	01:54	01:59

[illegible]



LIDAR Flight Log

Julian Day 163 Flight 1A

Date	June 12, 2017	Aircraft	DA-31C-GMEC
Project	US S. OMAERA-Cochrane	Pilot	T. Sornasse
Location		Operator	C. JOHNSON
Mission Objective			

System	Leica ALS70
Unit	7179
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEMV
Roll Comp.	
Data Drive	I

Additional Notes	
Wind:	
Temp:	
Pressure:	
Clouds:	
Visibility:	

Aircraft Block Time			
Engine On	16:18	Ramp Out	Takeoff 16:31
Engine Off	20:23	Ramp In	Landing 20:13
Total	4.1 hrs	Total	3.7 hrs

Mission Plan			
AGL Height	1000 m	Laser Pulse Rate	500 KHz
Target Speed	140 kts	Scan Rate	53.4 Hz
Laser Current	100 %	FOV	40 Deg's

Static Alignment		GPS Time	
Pre Mission	16:22	Start	End
Post Mission	20:16	20:21	

Flight Line	LIDAR File Name	Flight Direction	GPS Time		Line Aborted		ALS Time Stamp	Comments
			Start	End	Time	nmil to End		
CAL	791716301	206°	16:38	16:38			163817	170612
CAL	07	026°	16:43	16:43			164331	
KAR		0	17:04	17:09				
293	03	090°	17:15	17:20			171530	EAST 12.4 NMi
294	04	270°	17:25	17:36			172530	
295	05	090°	17:46	17:57			174631	17:40 ABOVE LINE TOO LOW
296	06	270°	18:01	18:12			180119	
297	07	090°	18:16	18:27			181630	
298	08	270°	18:32	18:43			183238	
299	09	090°	18:47	18:58			184756	
300	10	270°	19:02	19:13			190239	
292	11	090°	19:17	19:22			191735	West 12.4 NMi
KAR		0	19:26	19:31				
CAL	12	206°	19:59	19:59			195932	
CAL	791716313	026°	20:04	20:04			200428	

LIDAR Flight Log

Date	2017/09/30	Aircraft	C-47SI
Project	1625-0MA-NA-cockpit	Pilot	own
Location	Kapuskasing ON	Operator	C. Duvette
Mission Objective			
Complete missing 1/2 line			

System	Leica ALS70
Unit	7207
IMU	Honeywell Micro IRS
GPS Rx	NovAtel OEM V
Roll Comp.	
Data Drive	1

Additional Notes

Aircraft Block Time		
Engine On 19:22	Ramp Out	Takeoff 19:36
Engine Off 21:16	Ramp In	Landing 21:04
Total 1.9 hrs	Total	Total 1.5 hrs

Mission Plan	
AGL Height	450 m
Target Speed	140 kts
Laser Current	100 %
Laser Pulse Rate	50 Hz
Scan Rate	53.4 Hz
FOV	40 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	19:29	19:34
Post Mission	21:07	21:12

[illegible]

Appendix C

List of Vertical Differences for the Fast Static points

Number	Easting	Northing	Known Z	Laser Z	Dz
Temp201_01	494597.813	5451803.418	268.942	269.030	0.088
Temp201_02	494586.542	5452843.732	269.036	269.110	0.074
Temp201_03	494605.119	5454856.152	252.953	252.900	-0.053
Temp201_04	494604.559	5456282.964	242.225	242.260	0.035
Temp201_05	494606.220	5458527.400	240.144	240.170	0.026
Temp201_06	494594.315	5460507.403	252.136	252.140	0.004
Temp201_07	494586.156	5451690.531	268.229	268.280	0.051
Temp201_08	494591.771	5450030.692	255.921	255.990	0.069
Temp201_09	494580.238	5448027.201	273.723	273.770	0.047
Temp201_10	494631.891	5446040.582	279.243	279.190	-0.053
Temp201_11	494624.821	5443900.794	256.455	256.490	0.035
Temp201_12	494573.861	5441861.638	266.719	266.710	-0.009
Temp201_13	494595.897	5451801.977	268.953	268.990	0.037
Temp202_01	497082.651	5434114.687	276.180	276.220	0.040
Temp202_02	496788.074	5434830.868	279.711	279.750	0.039
Temp202_03	496484.031	5436433.477	273.696	273.730	0.034
Temp202_04	494607.641	5436493.031	280.039	279.970	-0.069
Temp202_05	494577.599	5438206.134	276.999	277.020	0.021
Temp202_06	494579.739	5440357.966	271.074	271.110	0.036
Temp202_07	494573.924	5441862.134	266.728	266.710	-0.018
Temp202_10	497083.157	5434104.135	276.227	276.230	0.003
Temp202_11	497778.864	5432994.788	269.994	270.030	0.036
Temp202_12	497786.107	5431526.147	264.089	264.110	0.021
Temp202_13	497776.235	5430268.233	263.294	263.280	-0.014
Temp202_14	497763.038	5428968.849	266.499	266.490	-0.009
Temp202_15	497767.009	5427886.212	267.602	267.620	0.018
Temp202_17	497082.679	5434105.414	276.165	276.230	0.065
Temp204_01	430831.911	5460418.042	227.872	227.860	-0.012
Temp204_02	432447.471	5459972.701	232.542	232.560	0.018
Temp204_03	433780.571	5459924.436	237.027	237.080	0.053
Temp204_04	435301.955	5459870.514	238.194	238.220	0.026
Temp204_05	436978.468	5459846.804	241.648	241.660	0.012
Temp204_06	438370.174	5459768.436	240.811	240.820	0.009
Temp204_07	439832.539	5459714.242	234.770	234.800	0.030
Temp204_08	440922.311	5459707.697	237.208	237.240	0.032
Temp204_09	430845.973	5460408.977	228.108	228.130	0.022
Temp204_10	429252.168	5461054.536	229.137	229.170	0.033
Temp204_11	427959.592	5461552.715	227.293	227.300	0.007
Temp204_12	426573.144	5462021.317	228.267	228.260	-0.007
Temp204_13	425073.644	5462521.620	226.048	226.030	-0.018
Temp204_14	424151.717	5462864.938	223.240	223.290	0.050
Temp204_15	424671.550	5462687.344	232.453	232.390	-0.063
Temp204_16	430831.836	5460417.876	227.873	227.870	-0.003
Temp205_01	421820.273	5464450.841	228.575	228.550	-0.025
Temp205_02	423085.821	5463527.384	230.647	230.660	0.013
Temp205_03	424154.304	5462864.210	223.187	223.220	0.033
Temp205_04	421818.938	5464479.710	228.682	228.690	0.008
Temp205_05	420460.343	5465310.434	229.578	229.580	0.002
Temp205_06	419112.756	5465830.522	231.675	231.690	0.015

Temp205_07	417563.937	5466050.208	238.112	238.120	0.008
Temp205_08	416109.975	5466103.988	241.064	241.090	0.026
Temp205_09	415134.061	5466567.544	241.904	241.900	-0.004
Temp205_10	421818.943	5464449.110	228.619	228.610	-0.009
Temp206_01	402719.880	5478511.370	247.455	247.480	0.025
Temp206_02	403487.511	5480365.167	235.244	235.280	0.036
Temp206_08	402715.456	5478513.297	247.403	247.400	-0.003
Temp206_09	402330.988	5476676.726	237.662	237.630	-0.032
Temp206_10	402531.802	5475544.836	238.260	238.200	-0.060
Temp206_11	402045.281	5474199.169	226.788	226.740	-0.048
Temp206_12	400585.340	5472677.619	229.862	229.840	-0.022
Temp206_13	400148.611	5471877.093	229.402	229.380	-0.022
Temp206_14	400135.377	5470260.111	237.375	237.390	0.015
Temp206_15	400589.512	5469152.045	232.608	232.560	-0.048
Temp206_16	402715.281	5478512.914	247.393	247.410	0.017
Temp207_01	401171.190	5468672.057	246.116	246.080	-0.036
Temp207_02	400589.638	5469151.628	232.573	232.540	-0.033
Temp207_03	401806.029	5467003.001	245.745	245.740	-0.005
Temp207_04	401892.732	5465689.221	246.813	246.780	-0.033
Temp207_05	401685.415	5464237.616	249.238	249.280	0.042
Temp207_08	401179.103	5468673.910	246.229	246.180	-0.049
Temp501_01	359084.349	5497048.368	243.844	243.860	0.016
Temp501_02	358963.637	5498527.710	241.081	241.060	-0.021
Temp501_07	358490.805	5494492.876	249.556	249.580	0.024
Temp501_08	358067.247	5493174.117	256.080	256.080	0.000
Temp501_09	358044.051	5491450.384	242.987	242.970	-0.017
Temp501_10	357774.836	5489986.647	239.599	239.580	-0.019
A203_01	454860.691	5461058.553	241.462	241.470	0.008
A203_02	454701.097	5459424.451	242.266	242.270	0.004
A203_03	454648.136	5458311.424	241.719	241.740	0.021
A203_04	454156.883	5457198.181	237.969	237.940	-0.029
A203_05	454255.503	5455774.199	238.614	238.600	-0.014
A203_06	454342.170	5454518.583	238.967	238.950	-0.017
A203_07	454872.948	5461057.452	241.583	241.560	-0.023
A203_08	456367.987	5462189.625	250.314	250.340	0.026
A203_09	457146.248	5463200.127	248.859	248.860	0.001
A203_10	458376.487	5464248.382	259.892	259.890	-0.002
A203_11	458880.844	5465046.013	251.530	251.490	-0.040
A203_13	454863.693	5461068.609	241.375	241.390	0.015
A777_01	470768.235	5438537.113	267.388	267.370	-0.018
A777_02	470905.382	5440101.745	267.681	267.680	-0.001
A777_03	471921.039	5440874.143	274.839	274.820	-0.019
A777_04	471834.305	5442689.593	269.450	269.460	0.010
A777_05	471865.377	5444373.246	272.124	272.130	0.006
A777_06	471873.930	5446279.911	269.814	269.820	0.006
A777_07	471498.003	5447546.213	266.656	266.700	0.044
A777_08	470814.430	5448530.492	267.699	267.740	0.041
A777_09	470766.139	5438532.471	267.404	267.450	0.046
A777_10	470914.015	5437023.135	271.234	271.260	0.026
A777_11	470242.602	5435468.910	264.917	264.920	0.003

A777_12	470120.452	5434062.027	263.535	263.590	0.055
A777_13	470248.099	5432532.435	264.540	264.540	0.000
A777_14	470424.746	5431023.887	267.252	267.250	-0.002
A777_16	470766.756	5438533.551	267.445	267.430	-0.015
A783_01	356993.461	5480060.828	238.160	238.140	-0.020
A783_02	356547.141	5479447.562	238.537	238.380	-0.157
A783_04	358243.863	5482204.442	236.456	236.550	0.094
A783_05	358968.195	5483324.269	230.664	230.650	-0.014
A783_06	359871.857	5484011.463	232.376	232.390	0.014
A783_07	360522.197	5484825.687	228.952	228.970	0.018
A783_08	360984.561	5485580.470	226.595	226.580	-0.015
A783_09	361004.281	5487172.872	235.183	235.150	-0.033
A783_10	361047.012	5488827.919	236.701	236.690	-0.011
a785_04	306365.264	5500165.139	261.814	261.800	-0.014
a785_05	306434.998	5502189.863	265.534	265.550	0.016
a785_06	306494.237	5503921.219	252.494	252.450	-0.044
a785_07	306542.510	5504999.881	246.111	246.100	-0.011
a785_08	306579.971	5505874.179	243.863	243.870	0.007
a785_09	307426.546	5506202.847	241.752	241.740	-0.012
A786_01	305752.602	5509770.107	249.780	249.790	0.010
A786_02	306689.611	5509785.906	249.740	249.750	0.010
A786_03	309019.100	5509728.318	239.496	239.480	-0.016
A786_04	309007.006	5511370.003	248.938	248.920	-0.018
A786_05	309081.828	5512921.269	254.864	254.850	-0.014
A786_06	309162.927	5515298.510	244.781	244.790	0.009
A786_07	309016.628	5507992.392	238.579	238.600	0.021
A786_07	310726.433	5506649.584	239.505	239.490	-0.015
A786_10	308952.846	5506145.104	241.611	241.620	0.009
A786_11	306692.658	5506205.499	240.681	240.680	-0.001
A786_12	305751.200	5509769.141	249.793	249.800	0.007

Average dz 0.004
 Minimum dz -0.157
 Maximum dz 0.094
 Average magnitude 0.025
 Root mean square 0.034
 Std deviation 0.034

Appendix D

List of Vertical Differences for the RTK (NVA) points

Number	Easting	Northing	Known Z	Laser Z	Dz
1501	393344.18	5475116.84	224.24	224.25	0.01
1502	393360.97	5475140.14	223.51	223.57	0.06
1503	393418.71	5475007.52	226.09	226.11	0.02
1504	392584.40	5475258.01	217.20	217.17	-0.03
1505	391344.24	5475274.28	222.02	222.06	0.04
1506	392057.23	5473656.84	222.97	222.99	0.02
1507	391368.04	5476266.42	223.09	223.09	0.00
1509	394624.41	5473601.97	216.83	216.81	-0.02
1510	394600.41	5472419.82	221.80	221.81	0.01
1511	395046.08	5474777.99	212.89	212.89	0.00
1512	395076.98	5470389.10	228.94	228.94	0.00
1513	395055.06	5469332.29	235.67	235.63	-0.04
1514	395105.02	5471694.73	226.06	226.06	0.00
1515	396554.61	5470363.94	231.67	231.68	0.01
1516	397005.58	5470362.81	227.37	227.41	0.04
1517	398163.37	5471944.63	223.00	222.98	-0.02
1518	398146.30	5471934.52	222.47	222.50	0.03
1519	398114.58	5469288.55	234.54	234.55	0.01
1520	396125.75	5472759.93	221.83	221.80	-0.03
1521	399076.93	5470318.18	234.83	234.84	0.01
1522	402378.04	5477620.00	240.97	240.97	0.00
1523	402460.21	5476084.72	239.64	239.63	-0.01
1524	402494.73	5476605.83	236.68	236.66	-0.02
1525	402498.65	5476581.74	235.25	235.30	0.05
1526	401553.90	5477029.28	227.50	227.49	-0.01
1527	402356.50	5478779.23	228.78	228.78	0.00
1528	402546.01	5479019.09	234.79	234.81	0.02
1529	403130.26	5479574.60	239.98	239.96	-0.02
1530	403599.77	5480661.05	229.59	229.60	0.01
1531	402706.31	5478520.21	247.50	247.54	0.04
1532	356736.78	5479756.73	239.72	239.70	-0.02
1533	357553.70	5480616.47	238.04	238.00	-0.04
1534	357905.71	5480987.86	241.21	241.21	0.00
1535	358026.30	5481899.75	237.82	237.78	-0.04
1536	358245.84	5482198.63	236.81	236.81	0.00
1537	358232.09	5482188.92	237.05	237.02	-0.03
1538	358291.28	5480572.29	235.15	235.13	-0.02
1539	358283.19	5480249.29	230.12	230.16	0.04
1540	358304.27	5480270.22	231.42	231.36	-0.06
1541	358597.52	5496023.77	244.53	244.50	-0.03
1542	358618.27	5496016.86	245.65	245.60	-0.05
1543	359014.34	5496907.64	244.96	244.97	0.01
1544	358741.51	5496571.68	244.32	244.26	-0.06
1545	358598.46	5495823.20	246.15	246.12	-0.03
1546	358495.71	5494492.53	249.58	249.61	0.03
1547	358540.20	5495316.46	246.06	246.04	-0.02
1548	305694.44	5509769.54	250.37	250.36	-0.01
1549	305949.01	5509055.94	250.99	251.00	0.01
1550	306213.80	5509495.63	250.67	250.66	-0.01

1551	306684.76	5509518.69	249.79	249.84	0.05
1552	306715.53	5510029.52	249.17	249.20	0.03
1553	308191.64	5509769.26	249.52	249.54	0.02
1554	308220.05	5509759.65	250.40	250.39	-0.01
1555	306199.75	5508192.02	247.38	247.39	0.01
1556	306280.06	5508128.65	246.45	246.46	0.01
1557	307528.03	5508256.13	242.76	242.74	-0.02
1562	306346.74	5500092.95	261.76	261.75	-0.01
1563	306327.20	5500080.05	260.59	260.64	0.05
1564	305788.74	5500117.44	263.26	263.29	0.03
1565	306821.46	5500140.54	258.95	258.97	0.02
1566	306902.87	5500143.31	259.22	259.23	0.01
1567	348741.86	5493627.52	248.91	248.92	0.01
1568	348723.94	5493585.19	248.60	248.60	0.00
1569	347360.51	5494234.69	250.29	250.30	0.01
1570	347203.76	5494277.33	250.50	250.54	0.04
1571	350392.51	5492897.83	241.29	241.29	0.00
1572	349724.39	5493126.18	244.25	244.31	0.06
1573	349735.81	5493115.96	244.26	244.25	-0.01
1574	348653.62	5492957.91	246.91	246.90	-0.01
1575	421819.78	5464471.45	228.85	228.85	0.00
1576	421874.09	5464479.93	228.05	228.09	0.04
1577	421825.80	5464821.69	224.17	224.23	0.06
1578	419888.96	5465489.78	229.32	229.33	0.01
1579	419898.58	5465519.97	229.89	229.87	-0.02
1580	421056.62	5465034.34	228.28	228.24	-0.04
1581	423609.55	5463162.45	226.31	226.30	-0.01
1582	422412.88	5463999.54	232.23	232.23	0.00
1583	422429.38	5464018.52	234.48	234.48	0.00
1584	421798.87	5462859.69	236.24	236.24	0.00
1585	421790.88	5462860.16	236.75	236.69	-0.06
1586	421800.71	5463658.51	244.91	244.88	-0.03
1587	430220.56	5462233.80	231.96	231.95	-0.01
1588	430838.21	5463372.47	227.81	227.77	-0.04
1589	430816.47	5461835.01	231.99	231.96	-0.03
1590	430855.01	5460436.56	227.80	227.79	-0.01
1591	430831.68	5460393.08	228.62	228.59	-0.03
1592	428121.03	5461492.94	227.45	227.42	-0.03
1593	428117.71	5461521.02	227.10	227.13	0.03
1594	429614.45	5460897.39	228.00	227.94	-0.06
1595	429605.15	5460873.35	228.35	228.30	-0.05
1596	433853.33	5459927.52	237.32	237.29	-0.03
1598	432114.87	5460007.97	231.74	231.74	0.00
1599	432111.78	5459989.89	232.45	232.44	-0.01
1600	454310.41	5460742.09	236.45	236.43	-0.02
1601	454745.43	5459385.62	242.33	242.33	0.00
1602	454747.59	5459399.82	242.31	242.33	0.02
1603	454738.77	5459428.09	242.61	242.60	-0.01
1604	454084.44	5459450.43	238.52	238.50	-0.02
1605	454080.96	5459424.80	239.37	239.34	-0.03

1606	455672.50	5461423.64	248.35	248.38	0.03
1607	455677.40	5461437.19	249.41	249.39	-0.02
1608	456111.10	5461904.57	249.78	249.78	0.00
1609	454894.39	5461049.81	242.14	242.11	-0.03
1610	454849.20	5461090.70	241.41	241.42	0.01
1611	459738.68	5452896.41	259.36	259.34	-0.02
1612	459436.06	5454973.90	261.26	261.24	-0.02
1613	460130.05	5454479.44	261.55	261.50	-0.05
1614	459752.52	5454523.98	260.65	260.59	-0.06
1615	459747.15	5453848.10	260.07	260.02	-0.05
1616	459744.83	5453864.72	260.13	260.12	-0.01
1617	470838.89	5438666.87	266.82	266.74	-0.08
1618	471268.55	5440373.05	270.48	270.43	-0.05
1619	471245.25	5440309.46	269.97	269.93	-0.04
1620	471247.55	5440413.39	270.70	270.67	-0.03
1621	470632.15	5436244.32	268.96	268.92	-0.04
1622	470784.74	5437581.15	270.27	270.26	-0.01
1623	470799.71	5437587.99	271.32	271.31	-0.01
1624	491350.14	5433953.58	270.16	270.16	0.00
1625	488933.07	5433941.28	266.91	266.95	0.04
1626	488925.93	5433964.07	267.01	267.00	-0.01
1627	490171.99	5433970.99	261.94	261.94	0.00
1628	494578.88	5433985.13	274.27	274.32	0.05
1629	494569.73	5433970.23	274.61	274.59	-0.02
1630	492751.58	5433950.49	271.36	271.34	-0.02
1631	491508.73	5436371.42	268.67	268.67	0.00
1632	491507.98	5436388.01	268.73	268.71	-0.02
1633	491508.04	5436205.08	269.52	269.50	-0.02
1634	491502.76	5434544.48	267.40	267.29	-0.11
1635	491365.52	5431428.32	280.25	280.15	-0.10
1636	491368.63	5431413.08	280.61	280.51	-0.10
1637	491391.88	5432315.27	277.75	277.65	-0.10
1638	491385.00	5432339.77	277.40	277.33	-0.07
1639	499828.73	5441206.66	269.11	269.09	-0.02
1640	501373.45	5441113.42	254.79	254.77	-0.02
1641	500667.18	5441196.24	269.38	269.45	0.07
1642	500661.15	5441221.67	269.60	269.61	0.01
1643	499823.99	5438790.90	263.17	263.09	-0.08
1644	499816.03	5440284.61	268.26	268.29	0.03
1645	499827.95	5440285.92	268.27	268.27	0.00
1646	499826.16	5442641.46	272.84	272.82	-0.02
1647	499815.05	5441556.20	268.73	268.82	0.09
1648	499828.08	5441564.03	270.33	270.34	0.01
1650	497257.27	5441433.40	246.69	246.73	0.04
1651	499251.36	5441215.03	273.52	273.51	-0.01
1652	499213.95	5441205.67	274.57	274.55	-0.02
1653	494587.41	5449723.63	263.10	263.11	0.01
1654	495774.26	5450879.99	262.08	262.07	-0.01
1655	494589.44	5450870.85	254.06	254.07	0.01
1656	493123.37	5450893.57	255.38	255.41	0.03

1657	494596.14	5453597.04	273.37	273.30	-0.07
1658	494592.43	5452844.16	269.36	269.35	-0.01
1659	494591.74	5452066.80	271.51	271.55	0.04

Average dz -0.007
 Minimum dz -0.110
 Maximum dz 0.090
 Average magnitude 0.026
 Root mean square 0.035
 Std deviation 0.035

Appendix E

List of Vertical Differences for the Geodetic Points

Cochrane Geodetic Control versus Lidar Ground Surface

Station Name	Easting UTM17	Northing UTM17	H-Orthom (m)	Lidar Ground Elev	DZ	Comment
723007	354647.416	5491013.674	254.039	254.000	-0.039	
81U454	387325.993	5478581.665	230.529	removed	*	Deep Bench Mark of unknown depth
93U829	451411.124	5458359.074	240.438	240.370	-0.068	
963012	318812.317	5504683.265	267.372	removed	*	Monument on top of a concrete pillar
A775	499143.961	5441223.224	275.292	275.310	0.018	
A776	491348.956	5433823.537	269.778	269.790	0.012	
A777	470758.574	5438548.394	266.845	266.880	0.035	
A778	459744.077	5452913.271	259.309	259.340	0.031	
A779	424592.962	5454436.998	234.413	234.370	-0.043	
A780	430219.407	5462226.300	231.804	231.860	0.056	
A781	395068.296	5470375.541	228.298	228.340	0.042	
A782	393435.246	5474890.674	226.326	226.320	-0.006	
A783	357910.948	5480982.163	241.290	241.280	-0.010	
A784	348655.417	5493420.757	247.532	247.540	0.008	
A785	306295.845	5498406.604	266.335	outside	*	Outside of project area
A786	305742.989	5509752.757	250.321	250.320	-0.001	
IROQ	522669.595	5400355.666	284.478	outside	*	Outside of project area

Average dz	0.003
Minimum dz	-0.068
Maximum dz	0.056
Average magnitude	0.028
Root mean square	0.035
Std deviation	0.036

Appendix F

List of Vertical Differences for the Vegetated Points

Cochrane Final VVA vertical differences

Station	Descriptor	Easting	Northing	RTK Height	Lidar Height	Differences
2501	WILLOWS	393448.059	5475100.001	225.144	225.26	0.116
2502	MIXED TREES	392651.915	5475244.022	216.121	216.16	0.039
2503	TALL GRASS	391376.192	5475286.409	221.255	221.27	0.015
2504	TALL GRASS	391631.266	5474402.575	222.728	222.71	-0.018
2505	MIXED TREES	391652.633	5474417.446	222.188	222.26	0.072
2506	TALL WILLOW	391376.264	5476220.579	221.501	221.55	0.049
2507	TALL GRASS	394611.926	5473615.121	216.230	216.39	0.160
2508	MIXED TREES	394592.239	5472480.400	221.119	221.22	0.101
2509	TALL GRASS	394613.206	5472450.355	221.386	221.39	0.004
2510	TALL GRASS	395030.388	5474794.207	212.085	212.28	0.195
2511	crops	395051.751	5470358.339	228.306	228.35	0.044
2512	brush	395024.996	5468781.851	236.125	236.25	0.125
2513	brush forested land	395053.020	5469470.560	236.194	236.23	0.036
2514	forested land	395087.148	5471428.030	226.754	226.84	0.086
2515	brush tall weeds	396436.345	5470357.026	232.614	232.74	0.126
2516	tall weeds	398185.064	5471952.344	222.753	222.85	0.097
2517	brush tall weeds	398179.814	5471937.583	222.959	223.06	0.101
2518	tall weeds	398109.845	5469273.796	234.340	234.46	0.120
2519	tall weeds	396105.318	5472753.441	222.012	222.35	0.338
2520	tall weeds	399065.089	5470306.759	234.910	234.97	0.060
2521	tall weeds brush	402369.058	5477633.403	240.358	240.71	0.352
2522	forested land	402250.190	5476988.805	238.828	238.83	0.002
2523	tall weeds brush	402465.421	5476077.950	239.425	239.45	0.025
2524	tall weeds brush	402476.129	5476597.236	236.591	236.77	0.179
2525	forested land	401727.981	5477074.988	228.433	228.46	0.027
2526	brush tall weeds	402235.597	5477829.957	232.836	232.92	0.084
2527	tall weeds	402793.867	5479237.071	241.365	241.50	0.135
2528	forested land	402803.610	5479240.470	241.783	241.95	0.167
2529	tall weeds	403160.350	5479532.388	239.798	239.91	0.112
2530	tall weeds	403594.275	5480645.301	229.992	230.36	0.368
2531	tall weeds	402725.267	5478525.218	246.857	246.97	0.113
2532	forested land	356725.912	5479762.422	238.792	238.83	0.038
2533	forested land	357533.927	5480628.193	237.955	237.94	-0.015
2534	forested land	357895.192	5480993.939	241.445	241.49	0.045
2535	tall weeds	357920.897	5480993.757	241.095	241.12	0.025
2536	short grass forested land	357987.869	5481910.645	239.401	239.39	-0.011
2537	forested land short grass	358255.637	5482182.741	237.443	237.45	0.007
2538	tall weeds	358280.191	5482176.474	236.395	236.47	0.075
2539	sand forested land tall weeds	358278.046	5480555.595	234.417	234.46	0.043
2540	forested land tall weeds	358285.460	5480282.049	232.619	232.60	-0.019
2541	forested land short grass	358581.944	5495982.807	245.162	245.12	-0.042
2542	tall weeds	358604.880	5496021.528	244.848	244.84	-0.008
2543	forested land short grass	359028.783	5496903.021	244.083	244.09	0.007
2544	brush	358559.395	5496475.260	246.220	246.24	0.020
2545	tall weeds	358519.443	5496449.437	246.280	246.25	-0.030
2546	tall weeds	358509.951	5495931.380	245.715	245.68	-0.035
2547	forested land	358474.720	5495966.285	245.269	245.26	-0.009

2548	tall weeds	358589.579	5495835.353	246.006	246.00	-0.006
2549	tall weeds	358474.106	5494492.161	248.489	248.52	0.031
2550	tall weeds brush	305691.653	5509743.271	250.104	250.17	0.066
2551	forested land	305923.483	5509050.023	251.964	251.96	-0.004
2552	tall weeds	305952.759	5509070.490	250.492	250.49	-0.062
2553	forested land tall weeds	306216.746	5509522.292	250.709	250.75	0.041
2554	forested land	306703.040	5510036.160	249.146	249.20	0.054
2555	tall weeds	308177.717	5509750.225	249.592	249.67	0.078
2556	tall weeds	306228.077	5508229.455	246.743	246.87	0.127
2557	brush	306204.279	5508208.161	247.001	247.12	0.119
2558	tall weeds	307514.681	5508237.784	241.298	241.44	0.142
2564	tall weeds	305788.361	5500107.613	262.681	262.77	0.089
2565	tall weeds	306838.501	5500155.660	258.404	258.46	0.056
2566	tall weeds	348721.790	5493611.273	247.739	247.83	0.091
2567	tall weeds	347366.740	5494251.358	249.034	249.09	0.056
2568	tall weeds	350376.584	5492883.938	240.344	240.42	0.076
2569	brush	349708.343	5493133.892	244.037	244.13	0.093
2570	tall weeds	349745.982	5493114.113	244.039	244.10	0.061
2571	tall weeds	348646.263	5492925.416	246.507	246.58	0.073
2572	tall weeds	421829.628	5464516.308	227.409	227.50	0.091
2573	brush	421832.082	5464529.871	227.148	227.22	0.072
2574	forested land	421818.274	5464849.414	223.953	223.97	0.017
2575	tall weeds	419887.249	5465482.220	229.311	229.40	0.089
2576	brush	421082.102	5465037.853	227.726	227.74	0.014
2577	tall weeds	421049.850	5465056.636	227.805	227.81	0.005
2578	tall weeds	423616.591	5463195.435	226.900	226.90	0.000
2579	brush tall weeds	423587.141	5463219.698	225.413	225.50	0.087
2580	brush tall weeds	422423.464	5464004.138	233.981	234.03	0.049
2581	tall weeds	422447.678	5464025.764	234.024	234.11	0.086
2582	tall weeds forested land	421773.750	5462844.166	236.055	236.14	0.085
2583	tall weeds	421803.591	5462844.446	237.036	237.12	0.084
2584	tall weeds	421818.894	5463658.735	244.831	244.89	0.059
2585	tall weeds forested land	421833.047	5463658.906	244.904	245.01	0.106
2586	forested land tall weeds	430218.053	5462248.175	231.900	231.93	0.030
2587	crops	430218.395	5462218.636	231.561	231.59	0.029
2588	tall weeds	430231.885	5462243.550	231.825	231.92	0.095
2589	tall weeds	430832.487	5463378.151	227.781	227.79	0.009
2590	forested land tall weeds	430800.120	5461832.791	231.558	231.62	0.062
2591	tall weeds	430804.682	5461822.061	231.340	231.47	0.130
2592	tall weeds	430813.744	5460421.025	227.642	227.69	0.048
2593	forested land tall weeds	428173.490	5461498.963	227.425	227.41	-0.015
2594	tall weeds	428149.044	5461514.873	227.497	227.56	0.063
2595	tall weeds	429601.584	5460840.270	227.828	227.82	-0.008
2596	forested land tall weeds	433846.511	5459959.070	235.889	235.93	0.041
2597	tall weeds	432105.287	5460008.248	231.306	231.38	0.074
2598	brush forested land	454288.703	5460767.767	236.849	236.86	0.011
2599	tall weeds	454275.179	5460761.408	237.305	237.31	0.005
2600	tall weeds	454068.155	5459457.044	239.262	239.35	0.088
2601	brush tall weeds	454050.277	5459480.297	238.949	238.99	0.041
2602	tall weeds	455688.091	5461432.712	248.653	248.70	0.047

2603	forested land	455690.073	5461419.204	248.657	248.67	0.013
2604	forested land tall weeds	454809.572	5461037.784	240.516	240.58	0.064
2605	tall weeds	454821.447	5461039.592	241.028	241.11	0.082
2606	tall weeds	459735.680	5452887.351	259.430	259.48	0.050
2607	brush tall weeds	459825.625	5452879.985	259.446	259.48	0.034
2608	forested land	459760.297	5454937.500	260.313	260.31	-0.003
2609	tall weeds	459758.145	5454947.117	260.472	260.47	-0.002
2610	tall weeds forested land	459744.723	5454523.258	260.320	260.27	-0.050
2611	tall weeds forested land	459750.568	5453854.333	259.932	259.98	0.048
2612	forested land tall weeds	470890.635	5438692.793	266.275	266.35	0.075
2613	forested land tall weeds	471284.710	5440351.844	270.531	270.55	0.019
2614	tall weeds	471244.957	5440335.529	270.156	270.12	-0.036
2615	forested land tall weeds	471258.221	5440293.564	269.003	269.13	0.127
2616	brush tall weeds	471230.696	5440426.874	269.296	269.43	0.134
2617	brush tall weeds	470932.132	5438916.791	267.248	267.22	-0.028
2618	forested land tall weeds	470956.941	5438862.452	267.547	267.53	-0.017
2619	tall weeds	470625.395	5436202.987	267.612	267.64	0.028
2620	forested land tall weeds	470781.833	5437559.861	269.732	269.80	0.068
2621	tall weeds	470777.215	5437582.185	269.968	270.00	0.032
2622	tall weeds	491360.026	5433965.090	269.339	269.41	0.071
2623	tall weeds brush	491338.375	5433926.376	268.994	269.08	0.086
2624	tall weeds	488917.386	5433942.584	266.817	266.88	0.063
2625	tall weeds brush	488920.118	5433901.412	269.041	269.09	0.049
2626	tall weeds	490211.959	5433954.893	262.134	262.19	0.056
2627	tall weeds brush	490169.205	5433938.816	261.253	261.33	0.077
2628	tall weeds	492747.109	5433963.559	270.513	270.57	0.057
2629	forested land tall weeds	491503.704	5436383.920	268.449	268.53	0.081
2630	tall weeds	491517.516	5436222.651	268.986	268.94	-0.046
2631	forested land tall weeds	491490.709	5434567.807	267.162	267.12	-0.042
2632	forested land tall weeds	491385.427	5431581.078	279.389	279.40	0.011
2633	tall weeds	491398.472	5432316.557	277.124	277.06	-0.064
2634	tall weeds	499891.627	5441220.876	268.364	268.39	0.026
2635	brush tall weeds	501414.252	5441127.014	254.812	254.89	0.078
2636	tall weeds	500675.737	5441219.758	269.304	269.34	0.036
2637	tall weeds	499836.799	5438801.836	262.375	262.43	0.055
2638	tall weeds brush	499841.188	5438778.605	262.342	262.37	0.028
2639	crops	499814.400	5440279.482	268.296	268.38	0.084
2640	tall weeds	499816.193	5440290.653	268.131	268.17	0.039
2641	brush tall weeds	499815.657	5442647.521	272.285	272.36	0.075
2642	tall weeds brush	497222.927	5441431.360	246.049	246.07	0.021
2643	tall weeds	497236.081	5441439.902	246.590	246.66	0.070
2644	tall weeds brush	497947.951	5441195.013	248.049	248.11	0.061
2645	crops	497970.054	5441189.808	248.408	248.41	0.002
2646	coniferous forested land	499260.256	5441225.686	273.119	273.12	0.001
2647	crops	499194.400	5441229.485	274.299	274.38	0.081
2648	tall weeds	494575.175	5449715.670	262.395	262.44	0.045
2649	tall weeds brush	494577.022	5449733.833	261.335	261.36	0.025
2650	forested land tall weeds	495782.460	5450868.429	261.957	261.97	0.013
2651	tall weeds	494605.438	5450860.467	253.263	253.41	0.147
2652	forested land tall weeds	493132.672	5450917.125	255.018	255.04	0.022

2653	tall weeds	493123.793	5450905.321	255.513	255.56	0.047
2654	brush tall weeds	494610.208	5453590.320	272.532	272.56	0.028
2655	crops	494581.321	5452849.552	268.838	268.93	0.092
2656	tall weeds	494603.758	5452077.279	270.920	271.06	0.140
2657	crops	494604.025	5452068.584	271.255	271.38	0.125

Average dz 0.057
 Average magnitude 0.065
 Maximum dz 0.368
 Minimum dz -0.064
 Root mean square 0.087
 Std deviation 0.066

Appendix G
Full Control Report



NAD83CSRS Static Control Report

- a.) Final Adjusted Coordinates
- b.) Traverse Overview
- c.) Control Sheets
- d.) Control Point Photo's
- e.) Traverse Report
- f.) Minimally Constrained Network Adjustment
- g.) Fully Constrained Network Adjustment



a.) Final Adjusted Coordinates

Project: 1625_OMAFRA-Cochrane_full
Program: GrafNet Version 8.50.4320
Profile: Aii Network Summary
Source: Network

Datum: NAD83CSRS(2010), (processing datum)
Control IDs: IROQ, 963012
Geoid: CGG2013n83.wpg (Absolute correction)

Map projection Info:

Defined grid: UTM, Zone 17

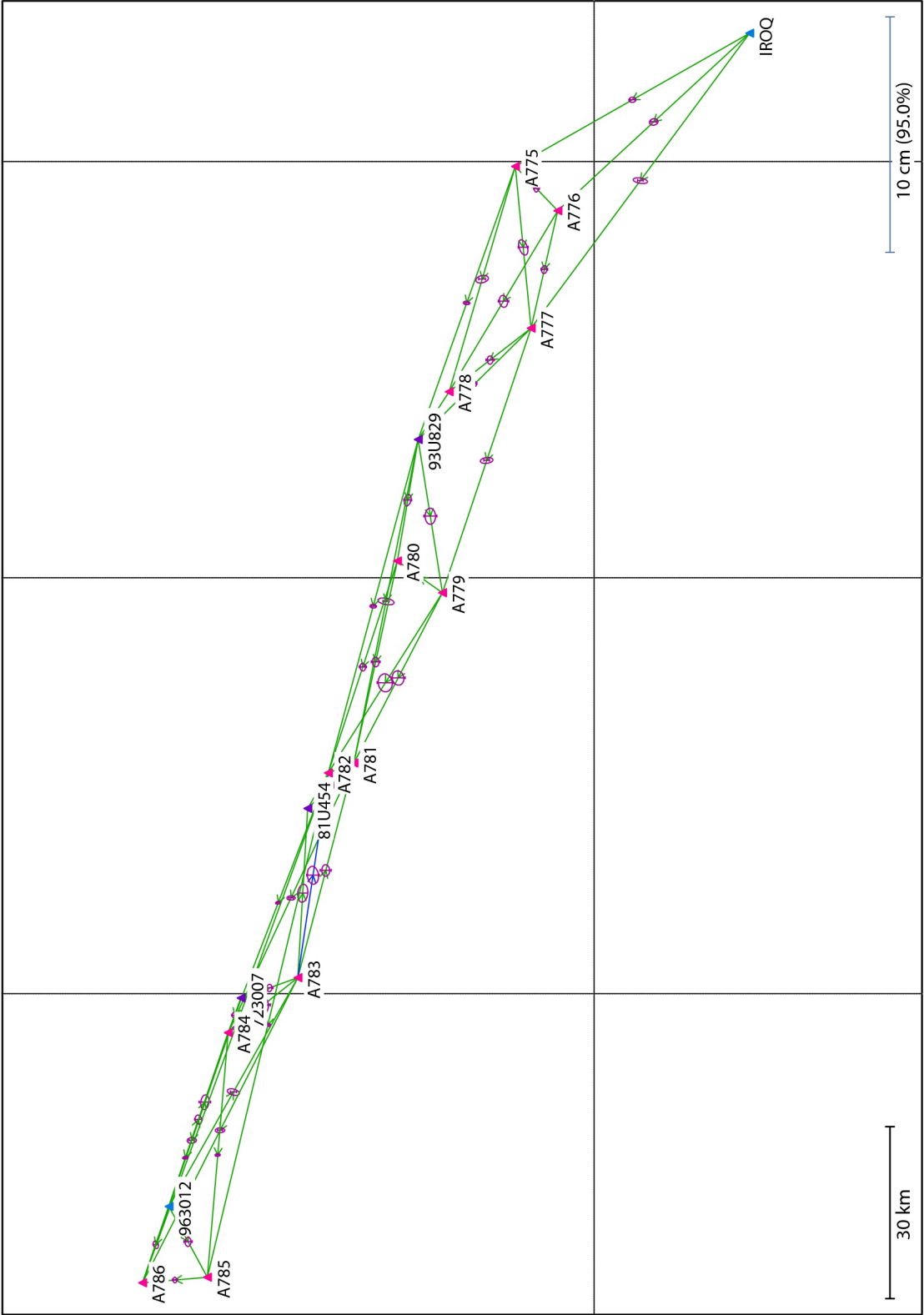
Station	Latitude (+/-D M S)	Longitude (+/-D M S)	H-Ell (m)	Undulation (m)	H-MSL (m)	Northing (m)	Easting (m)
723007	49 33 15.33943	-83 00 34.95583	216.386	-37.653	254.039	5491013.674	354647.416
810454	49 26 57.99253	-82 33 16.33061	193.390	-37.139	230.529	5478581.665	387325.993
930829	49 16 33.80333	-81 40 04.82107	203.101	-37.337	240.438	5458359.074	451411.124
963012	49 40 02.76908	-83 30 39.73565	229.304	-38.069	267.372	5504683.265	318812.317
A775	49 07 25.84093	-81 00 42.23818	237.636	-37.656	275.292	5441223.224	499143.961
A776	49 03 25.99507	-81 07 06.28407	232.231	-37.547	269.778	5433823.537	491348.956
A777	49 05 56.72039	-81 24 02.09752	229.429	-37.416	266.845	5438548.394	470758.574
A778	49 13 39.64102	-81 33 10.44807	221.926	-37.383	259.309	5452913.271	459744.077
A779	49 14 17.02615	-82 02 09.29256	197.161	-37.252	234.413	5454436.998	424592.962
A780	49 18 31.63116	-81 57 35.96766	194.541	-37.263	231.804	5462226.300	430219.407
A781	49 22 37.33803	-82 26 44.10843	191.263	-37.035	228.298	5470375.541	395068.296
A782	49 25 02.47845	-82 28 09.43141	189.250	-37.076	226.326	5474890.674	393435.246
A783	49 27 53.48513	-82 57 39.62027	203.810	-37.480	241.290	5480982.163	357910.948
A784	49 34 27.94645	-83 05 36.33442	209.796	-37.736	247.532	5493420.757	348655.417
A785	49 36 25.74770	-83 40 52.34236	228.311	-38.025	266.335	5498406.604	306295.845
A786	49 42 32.09742	-83 41 40.11632	212.115	-38.205	250.321	5509752.757	305742.989
IROQ	48 45 20.87943	-80 41 29.64321	247.272	-37.205	284.478	5400355.666	522669.595



b.) Traverse Overview

Traverse - Map

Geographic, DMS



49 00 00.00

81 00 00.00

82 00 00.00

83 00 00.00

— Ignored — Unprocessed — Approximate — Bad — Good — GCP ▲ Tie ▲ Check



c.) Control Sheets

Site Identification					
Name	Province	NTS (National Topographic System) map sheet	Unique Number	Provincial Identifier	Network
81U454	Ontario	042G07	81U454		49082

Station Coordinates

CGG2013 is the new default geoid

Coordinates

Geographic

Geoid

CGG2013a

Reference Frame

NAD83(CSRS)

Epoch

2010.0

The velocities were interpolated from the national grid.

Latitude

N49° 26' 57.992441"

Longitude

W82° 33' 16.330094"

h (Ellipsoidal Height)(metres)

193.380

Vφ (mm/y)

-1.76

Vλ (mm/y)

1.69

Vh (mm/y)

6.44

N (Geoid Height)(metres)

-37.139 ± 0.008

H (Orthometric Height)(metres)

230.519

Published date and project ID

2001-01-01 M01707

Vertical Data					
Vertical Datum	Elevation (m)	Order	Method	Gravity (mGal)	Published Year
CGVD2013 (2010.0)	230.460	First order	Differential	980953.6 ± 1	2013
CGVD28	230.361	First order	Differential	980953.6 ± 1	1981

Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Datum point(dbm/grd rod)	1995	Geodetic survey division - nrcan	Good	None

Location
Accessible by passenger car or light truck and a walk of less than 50 m. Val Rita Deep bench mark under access cover on the nw side of highway no. 11 at junction with a road heading west, 1.1 km northwest of roman catholic church, 3.6 km se of bridge over lost creek, 0.7 km southeast of junction with tremblay road, 12.7 m northwest of mile post 76 from cochrane along c.n.r. Track, 24.1 m east of centre of road heading southwest, 19.3 m from centre line of highway, 15.0 m northeast of centre of track, slightly below road level. Suitable for gps.

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Geodetic Reference Systems Information
(<mailto:nrcan.geodeticinformationservices.nrcan@canada.ca>)

Date modified: 2016-12-13

Site Identification					
Name	Province	NTS (National Topographic System) map sheet	Unique Number	Provincial Identifier	Network
93U829	Ontario	042H05	93U829		VA100M20

Station Coordinates

CGG2013 is the new default geoid

Coordinates

Geographic

Geoid

CGG2013a

Reference Frame

NAD83(CSRs)

Epoch

2010.0

The velocities were interpolated from the national grid.

Latitude

N49° 16' 33.803166"

Longitude

W81° 40' 4.821163"

h (Ellipsoidal Height)(metres)

203.044

Vφ (mm/y)

-1.80

Vλ (mm/y)

1.65

Vh (mm/y)

6.63

N (Geoid Height)(metres)

-37.338 ± 0.010

H (Orthometric Height)(metres)

240.382

Published date and project ID

2001-01-01 M01707

Vertical Data					
Vertical Datum	Elevation (m)	Order	Method	Gravity (mGal)	Published Year
CGVD2013 (2010.0)	240.330	First order	Differential	980919.0 ± 1.8	2013
CGVD28	240.226	First order	Differential	980919.0 ± 1.8	1994

Station Marker

Marker Type	Inspected in	Established by	Status	Comments
Brass/bronze tablet or cap	1995	Geodetic survey division - nrcan	Good	None

Location
Accessible by passenger car or light truck and a walk of less than 50 m. Smooth Rock Falls Helix pipe with brass cap on north side of trans-canada highway (no. 11), at junction with township road heading south along kendrey and haggart township boundary, 2.2 km west of centre of highway bridge for mattagami river, 16.0 m from highway centre line, 5 m east of centre of approach to trail, 5 m east of projection of centre of road, 2.3 m south of township boundary marker, 1 m below highway level. Suitable for gps.

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Geodetic Reference Systems Information
(<mailto:nrcan.geodeticinformationservices.nrcan@canada.ca>)

Date modified: 2016-12-13

Site Identification					
Name	Province	NTS (National Topographic System) map sheet	Unique Number	Provincial Identifier	Network
LOWTHER	Ontario	042G11	723007	001723007	ASTRO72

Station Coordinates		
CGG2013 is the new default geoid		
Coordinates Geographic		
Geoid CGG2013a		
Reference Frame NAD83(CSRs)		
Epoch 2010.0		
The velocities were interpolated from the national grid.		
Latitude	Longitude	h (Ellipsoidal Height)(metres)
N49° 33' 15.339652"	W83° 00' 34.955964"	216.402
Vφ (mm/y)	Vλ (mm/y)	Vh (mm/y)
-1.75	1.72	6.43
N (Geoid Height)(metres)	H (Orthometric Height)(metres)	Published date and project ID
-37.654 ± 0.009	254.056	2001-01-01 M01707

Vertical Data
Use the value of <u>H (Orthometric Height)</u> from the coordinates above.

Station Marker				
Marker Type	Inspected in	Established by	Status	Comments
Brass/bronze tablet or cap	1980	Geodetic survey division - nrcan	Good	None

Location
Accessible by passenger car or light truck and a walk of less than 50 m. Located Approx 10.4 Km E Of Mattice Along Hwy 11 And 1.0 Km W of entrance rd to microwave tower. On top of grassy knoll approx 30 m s of c/l of hwy 11. Mkd by a stpd br tab set in a 30 cm dia of conc cyl. The az is mkd by br tab set in a 30 cm dia conc cyl 6189.85 m hor distance from sta. Reference c is a gsc bm no 1177 stpd also 723007c. The az to 723007az was determined by laplace observation.

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Date modified: 2016-12-13

Site Identification					
Name	Province	NTS (National Topographic System) map sheet	Unique Number	Provincial Identifier	Network
HRST RACS-GLCORS	Ontario	042G12	963012	HRST	REGIONAL

Station Coordinates

CGG2013 is the new default geoid

Coordinates

Geographic

Geoid

CGG2013a

Reference Frame

NAD83(CSRs)

Epoch

2010.0 - Epoch of adjustment

Latitude

N49° 40' 2.768886" ± 0.0005m

Longitude

W83° 30' 39.735433" ± 0.0004m

h (Ellipsoidal Height)(metres)

229.303 ± 0.0012m

Vφ (mm/y)

-1.78 ± 0.06

VA (mm/y)

1.74 ± 0.05

Vh (mm/y)

6.48 ± 0.16

N (Geoid Height)(metres)

-38.070 ± 0.011

H (Orthometric Height)(metres)

267.373

Published date and project ID

2013-04-18 M12701

Vertical Data					
Vertical Datum	Elevation (m)	Order	Method	Gravity (mGal)	Published Year
CGVD2013 (2010.0)	267.373	First order	Differential	980948.8 ± 1.6	2013
CGVD28	267.276	First order	Differential	980948.8 ± 1.6	1999

Location

HRST is a continuously tracking GNSS station and is part of the Canadian Active Control System (CACS). The station is located in Hearst, Ontario.

The GNSS reference mark consists of a brass plate with a forced centering stainless steel bolt embedded on top of a 1.5 m high, 0.40 m diameter concrete pillar, anchored to a large rock outcrop to a depth of 1.52 m by steel reinforcing rods.

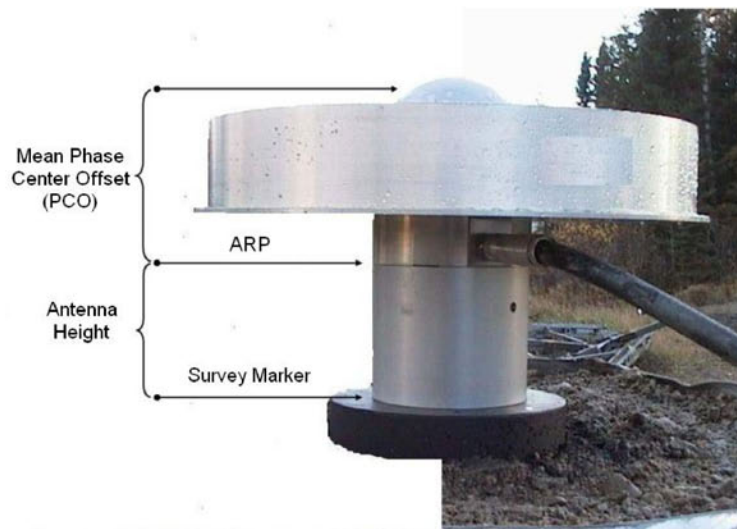
Equipment on site

	Model/Type	Start date
Receiver	TRIMBLE 5700	2008-05-30 13:37:00
Clock	Internal	2002-06-05 00:00:00

Antenna

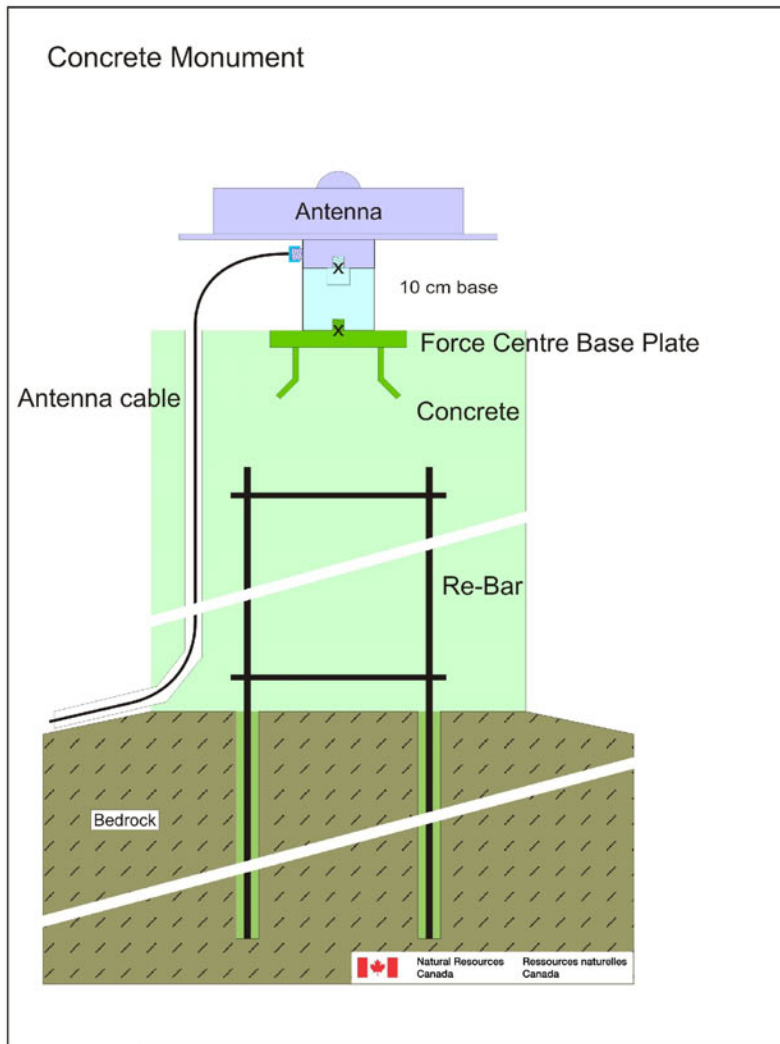
Model	Start date	Height (m)	Phase center offset (mm)			
			GPS L1	GPS L2	GLONASS L1	GLONASS L2
TRM29659.00 NONE	2009-12-20 16:27:00	0.100	90.99	120.4	90.99	120.4
TRM41249.00 NONE	2002-06-21 20:58:00	0.100	55.91	58		

Typical antenna



Larger image https://webapp.geod.nrcan.gc.ca/cacs/Typical_Antenna_en.jpg

monument diagram



Larger image https://webapp.geod.nrcan.gc.ca/cacs/HRST_SKETCH.jpg

monument





Larger image (https://webapp.geod.nrcan.gc.ca/cacs/HRST_MONU.jpg)

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(<mailto:nrcan.geodeticinformationservices.nrcan@canada.ca>)

Date modified: 2016-12-13

Site Identification					
Name	Province	NTS (National Topographic System) map sheet	Unique Number	Provincial Identifier	Network
cannet-IROQ	Ontario	042A15	CIRO		CANNET

Station Coordinates

CGG2013 is the new default geoid

Coordinates

Geographic

Geoid

CGG2013a

Reference Frame

NAD83(CSRs)

Epoch

2010.0 - Epoch of adjustment

The velocities were interpolated from the national grid.

Latitude

N48° 45' 20.879612" ± 0.0004m

Longitude

W80° 41' 29.643447" ± 0.0002m

h (Ellipsoidal Height)(metres)

247.272 ± 0.0007m

Vφ (mm/y)

-1.88

Vλ (mm/y)

1.60

Vh (mm/y)

6.45

N (Geoid Height)(metres)

-37.206 ± 0.015

H (Orthometric Height)(metres)

284.478

Published date and project ID

2015-09-24 M15-703

Vertical Data

Use the value of H (Orthometric Height) from the coordinates above.

Station Marker				
Marker Type	Inspected in	Established by	Status	Comments

Unknown		Cansel (cannet)	None
---------	--	-----------------	------

Location
No description available

Contact for more information (<http://www.can-net.ca/>)

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(<mailto:nrcan.geodeticinformationservices.nrcan@canada.ca>)

Date modified: 2016-12-13



d.) Control Point Photo's

81u454



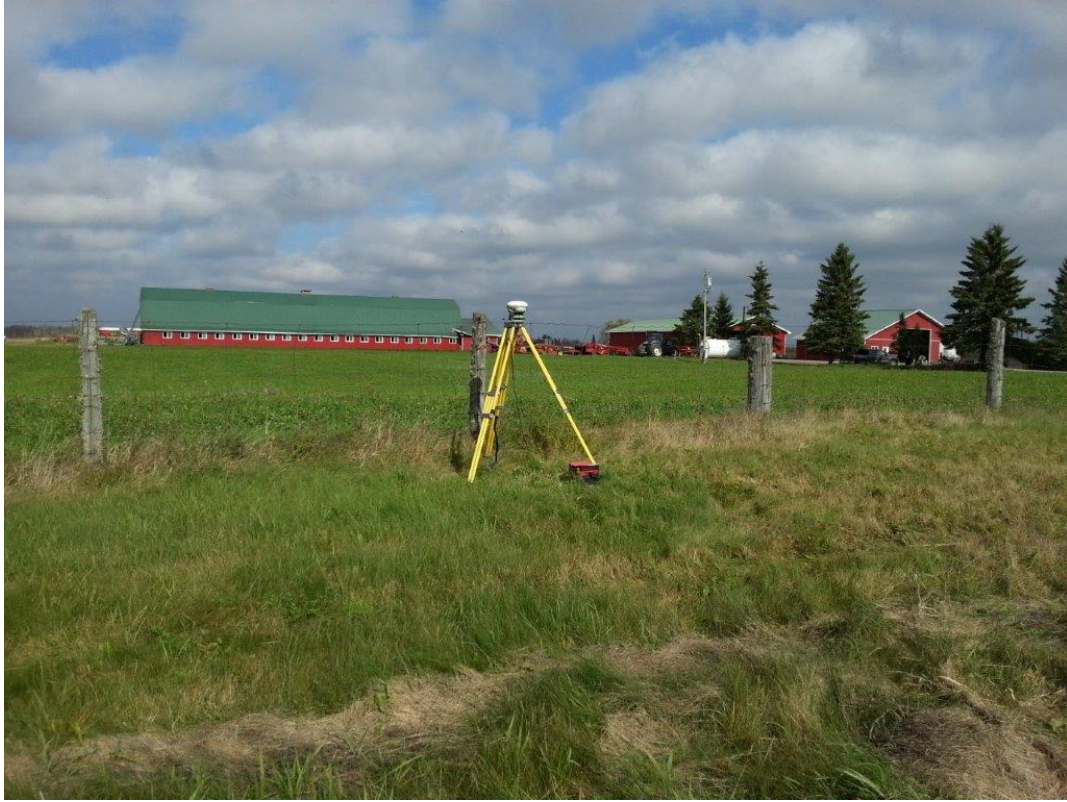
93u829



723007



A775



A776



A777



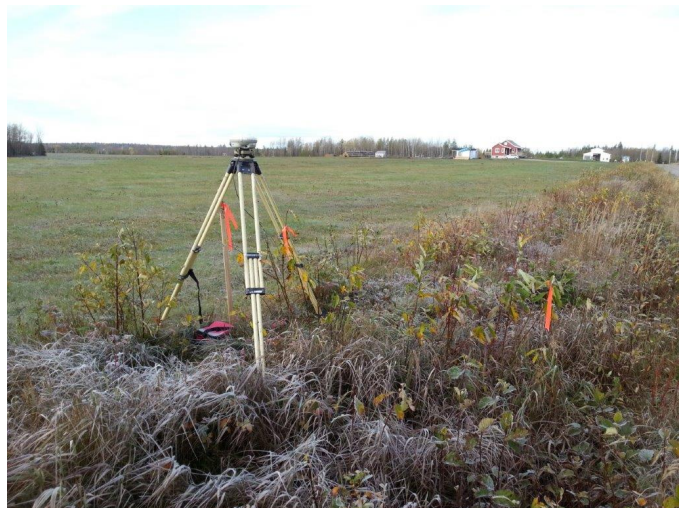
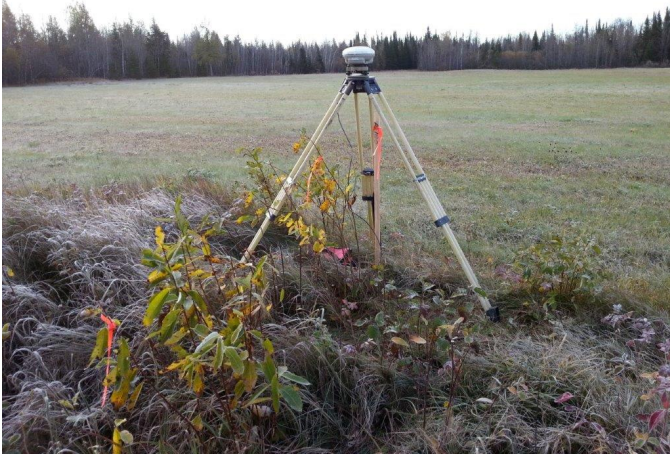
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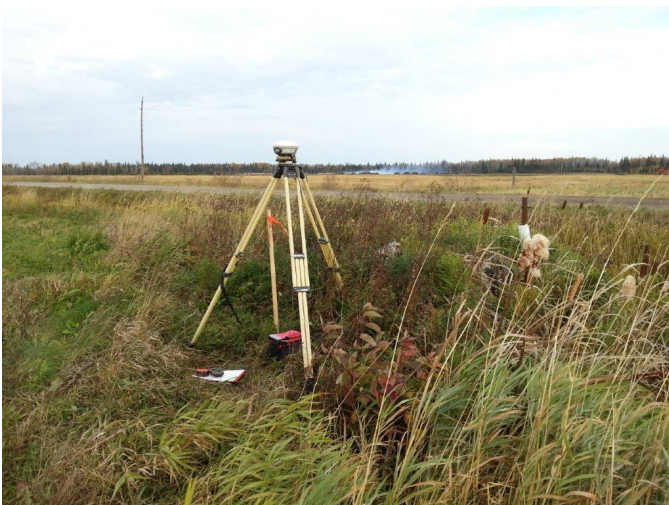
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A780



A781



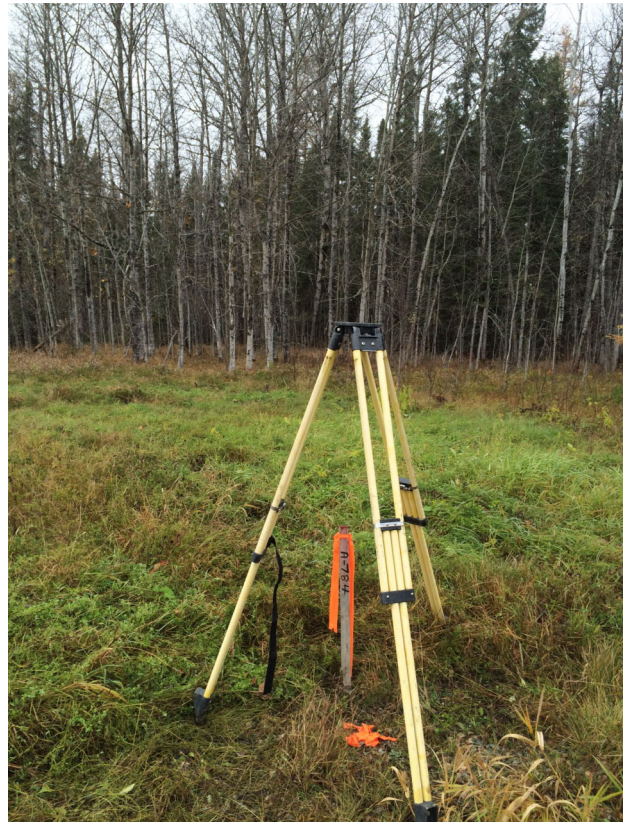
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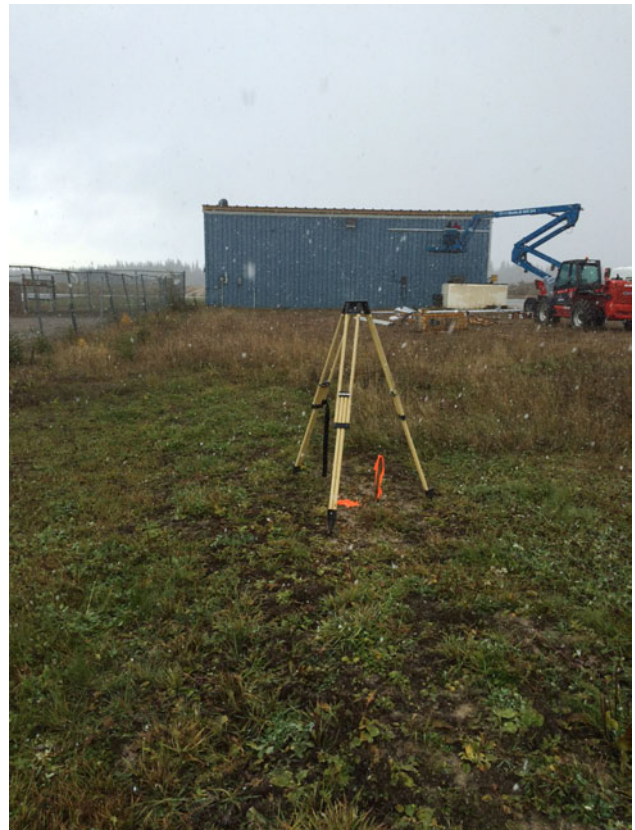
A784



A785



A786





e.) Traverse Report

```

*****
* GrafNet - GRAPHIC GPS NETWORK PROCESSING *
*          SOFTWARE PACKAGE                *
*                                          *
* TRAVERSE SOLUTION:                     *
*                                          *
* Copyright NovAtel Inc. (2014)          *
*                                          *
* Version: 8.50.4320                     *
*                                          *
* PROJECT: 1625_OMAFRA-Cochrane_min      *
*****

```

DATUM: NAD83CSRS(2010)
 GRID: UTM, Zone 17
 UNITS: metres (see Preferences to change)
 GEOID: C:\Users\air019\Documents\AI\Waypoint_GrafNAV\SupportFiles\Geoids\CGG2013n83.wpg

```

*****
STATIONS (STATUS):
*****

```

Station	Type	HgtStatus	Result	Coordinates derived from...				
723007	Check-3D	OK	Good	A781	93U829	A775	IROQ	
81U454	Check-3D	OK	Good	A782	93U829	A775	IROQ	
93U829	Check-3D	OK	Good	A775	IROQ			
963012	Check-3D	OK	Good	723007	A781	93U829	A775	IROQ
A775	Loop Tie	OK	Good	IROQ				
A776	Loop Tie	OK	Good	IROQ				
A777	Loop Tie	OK	Good	IROQ				
A778	Loop Tie	OK	Good	A775	IROQ			
A779	Loop Tie	OK	Good	A777	IROQ			
A780	Loop Tie	OK	Good	93U829	A775	IROQ		
A781	Loop Tie	OK	Good	93U829	A775	IROQ		
A782	Loop Tie	OK	Good	93U829	A775	IROQ		
A783	Loop Tie	OK	Good	A781	93U829	A775	IROQ	
A784	Loop Tie	OK	Good	A781	93U829	A775	IROQ	
A785	Loop Tie	OK	Good	A782	93U829	A775	IROQ	
A786	Loop Tie	OK	Good	A782	93U829	A775	IROQ	
IROQ	Control-3D	OK	Pub(3D)	(-)				

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*****
STATIONS (COORDINATES):
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Station	Latitude (D M S)		Longitude (D M S)		Grid-E (m)	Grid-N (m)	EllHgt (m)	OrthoHgt (m)
723007	49	33	15.34003	-83 00	34.95689	354647.395	5491013.693	216.366
81U454	49	26	57.99289	-82 33	16.33118	387325.982	5478581.677	193.386
93U829	49	16	33.80368	-81 40	04.82147	451411.116	5458359.085	203.093
963012	49	40	02.76982	-83 30	39.73706	318812.290	5504683.289	229.289
A775	49	07	25.84121	-81 00	42.23854	499143.954	5441223.233	237.632
A776	49	03	25.99515	-81 07	06.28432	491348.951	5433823.539	232.229
A777	49	05	56.72051	-81 24	02.09750	470758.575	5438548.397	229.433
A778	49	13	39.64129	-81 33	10.44786	459744.081	5452913.279	221.923
A779	49	14	17.02617	-82 02	09.29253	424592.963	5454436.998	197.178
A780	49	18	31.63156	-81 57	35.96794	430219.401	5462226.313	194.515
A781	49	22	37.33841	-82 26	44.10934	395068.278	5470375.553	191.227
A782	49	25	02.47887	-82 28	09.43214	393435.232	5474890.687	189.242
A783	49	27	53.48546	-82 57	39.62104	357910.932	5480982.174	203.768
A784	49	34	27.94697	-83 05	36.33571	348655.392	5493420.774	209.774
A785	49	36	25.74814	-83 40	52.34306	306295.831	5498406.618	228.303
A786	49	42	32.09783	-83 41	40.11688	305742.979	5509752.770	212.106
IROQ	48	45	20.87961	-80 41	29.64345	522669.590	5400355.672	247.272

 LOOP, CHECK & DUPLICATE TIES:

Name/Session	Type	Result	DEast (m)	DNorth (m)	DHeight (m)
POINT 723007	CheckPnt	Good	-0.0186	0.0116	-0.0368
A783 to 723007	LoopTie	Good	0.0069	0.0208	-0.0005
A783 to 723007 (1)	Duplicate	Good	-0.0028	0.0088	0.0139
A783 to 723007 (3)	Duplicate	Good	0.0097	0.0091	0.0089
A784 to 723007	LoopTie	Good	0.0036	0.0003	0.0011
A786 to 723007	LoopTie	Good	-0.0076	0.0060	-0.0100
POINT 81U454	CheckPnt	Good	-0.0218	0.0138	0.0057
A782 to 81U454 (2)	Duplicate	Good	0.0030	-0.0009	-0.0015
A781 to 81U454	LoopTie	Good	0.0124	-0.0055	0.0394
A783 to 81U454	LoopTie	Good	0.0054	-0.0038	0.0529
A783 to 81U454 (2)	Duplicate	Good	0.0074	0.0041	0.0296
POINT 93U829	CheckPnt	Good	-0.0061	0.0158	0.0480
POINT 963012	CheckPnt	Good	-0.0331	0.0283	-0.0146
723007 to 963012 (3)	Duplicate	Bad	-0.0074	0.0020	0.0279
IROQ to A775 (2)	Duplicate	Good	-0.0011	0.0023	-0.0013
IROQ to A775 (1)	Duplicate	Good	0.0000	0.0000	0.0000
IROQ to A776 (1)	Duplicate	Good	-0.0011	-0.0045	-0.0026
A775 to A776	LoopTie	Good	-0.0001	-0.0087	-0.0015
A775 to A776 (2)	Duplicate	Good	0.0041	-0.0030	0.0003
IROQ to A777 (2)	Duplicate	Good	0.0000	0.0000	0.0000
93U829 to A777	LoopTie	Good	0.0064	-0.0082	0.0083
A775 to A777 (2)	Duplicate	Good	0.0113	-0.0083	0.0106
A775 to A777	LoopTie	Good	0.0049	0.0053	0.0119
A775 to A777 (3)	Duplicate	Good	0.0052	-0.0011	0.0035
A776 to A777	LoopTie	Good	0.0047	0.0059	0.0003
A776 to A777 (3)	Duplicate	Good	0.0102	0.0089	0.0015
A775 to A778 (1)	Duplicate	Good	0.0089	-0.0022	0.0026
A776 to A778	LoopTie	Good	0.0087	0.0024	0.0040
A776 to A778 (2)	Duplicate	Good	0.0069	0.0120	-0.0032
A777 to A778	LoopTie	Good	0.0054	0.0094	-0.0130
A777 to A778 (3)	Duplicate	Good	0.0035	-0.0021	-0.0028
93U829 to A778	LoopTie	Good	0.0154	-0.0000	0.0062
93U829 to A779 (1)	Duplicate	Good	0.0047	-0.0142	0.0087
93U829 to A779	LoopTie	Good	0.0079	-0.0093	0.0353
93U829 to A780 (1)	Duplicate	Good	0.0047	0.0034	-0.0218
A779 to A780	LoopTie	Good	-0.0066	0.0127	-0.0447
A779 to A780 (2)	Duplicate	Good	-0.0082	0.0074	-0.0578
93U829 to A781 (2)	Duplicate	Good	-0.0106	0.0015	-0.0426
A779 to A781	LoopTie	Good	-0.0184	0.0084	-0.0492
A779 to A781 (2)	Duplicate	Good	-0.0186	0.0168	-0.0631
A780 to A781	LoopTie	Good	-0.0173	0.0032	-0.0245
A779 to A782	LoopTie	Good	-0.0179	0.0071	-0.0344
A780 to A782	LoopTie	Good	-0.0091	-0.0004	0.0151
A781 to A782	LoopTie	Good	0.0024	0.0042	0.0352
A781 to A782 (4)	Duplicate	Good	0.0019	0.0065	0.0346
A781 to A783 (1)	Duplicate	Good	0.0086	-0.0021	0.0005
A782 to A783	LoopTie	Good	-0.0011	-0.0045	-0.0290
A782 to A783 (3)	Duplicate	Good	0.0057	-0.0053	-0.0293
963012 to A783	LoopTie	Good	0.0256	-0.0148	-0.0356
963012 to A783 (3)	Duplicate	Good	0.0256	-0.0148	-0.0356
A782 to A784 (1)	Duplicate	Good	-0.0146	0.0026	0.0065
A782 to A784	LoopTie	Good	-0.0152	0.0045	-0.0145
963012 to A784	LoopTie	Good	-0.0024	-0.0050	-0.0101
A783 to A784	LoopTie	Good	-0.0148	0.0065	0.0361
A783 to A784 (3)	Duplicate	Good	-0.0055	0.0060	0.0146
963012 to A785	LoopTie	Good	0.0114	-0.0137	0.0033
963012 to A785 (2)	Duplicate	Good	0.0120	-0.0047	0.0096
963012 to A785 (3)	Duplicate	Good	0.0120	-0.0047	0.0096
A784 to A785	LoopTie	Good	0.0128	-0.0025	0.0148
A784 to A785 (2)	Duplicate	Good	0.0126	-0.0023	0.0135
963012 to A786	LoopTie	Good	0.0179	-0.0087	0.0119
963012 to A786 (1)	Duplicate	Good	0.0179	-0.0087	0.0119
963012 to A786 (4)	Duplicate	Good	0.0167	-0.0081	0.0109
A783 to A786 (1)	Duplicate	Good	0.0203	0.0017	0.0237
A783 to A786	LoopTie	Good	0.0203	0.0017	0.0237

A784 to A786	LoopTie	Good	0.0129	-0.0029	0.0130
A784 to A786 (2)	Duplicate	Good	0.0129	-0.0029	0.0130
A785 to A786	LoopTie	Good	0.0021	-0.0021	-0.0012
A785 to A786 (3)	Duplicate	Good	0.0016	0.0003	-0.0018

RMS (tie points)			0.0111	0.0073	0.0233
RMS (check points)			0.0221	0.0185	0.0312
			=====		

f.) Minimally Constrained Network
Adjustment

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*****
* NETWORK - WEIGHTED GPS NETWORK ADJUSTMENT *
* *
* (c) Copyright NovAtel Inc., (2014) *
* *
* Version: 8.50.4320 *
* *
* FILE: 1625_OMAFRA-Cochrane_min.net *
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DATUM:          'NAD83CSRS (2010)'
GRID:           UTM, Zone 17
SCALE FACTOR:   8.1539
CONFIDENCE LEVEL: 95.00 %   (Scale factor is 2.4479)

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*****
INPUT CONTROL/CHECK POINTS
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STA ID	TYPE	-- LATITUDE --	-- LONGITUDE --	ELLHGT -	HZ-SD	V-SD
723007	CHK-3D	49 33 15.33965	-83 00 34.95596	216.403		
81U454	CHK-3D	49 26 57.99244	-82 33 16.33009	193.380		
93U829	CHK-3D	49 16 33.80317	-81 40 04.82116	203.045		
963012	CHK-3D	49 40 02.76890	-83 30 39.73540	229.304		
IROQ	GCP-3D	48 45 20.87961	-80 41 29.64345	247.272	0.00500	0.00500

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*****
INPUT VECTORS
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SESSION NAME	VECTOR(m) DX/DY/DZ	----- Covariance (m) [unscaled] ----- standard deviations in brackets
A775 to 93U829 (1)	-49217.1307 5489.0312 11035.3636	2.0431e-006 (0.0014) -1.1748e-007 1.5777e-006 (0.0013) 2.2735e-007 -9.1800e-007 1.3136e-006 (0.0011)
93U829 to A777 (1)	21477.9716 -11880.9334 -12843.8015	6.5629e-007 (0.0008) -2.7904e-007 2.4056e-006 (0.0016) 1.8295e-007 -1.3760e-006 2.9311e-006 (0.0017)
93U829 to A778 (1)	8886.9125 -2822.1061 -3497.8257	2.1755e-006 (0.0015) -8.2461e-008 8.3743e-006 (0.0029) 1.9472e-007 -3.6022e-006 8.6321e-006 (0.0029)
93U829 to A779 (1)	-26058.9512 -6961.2517 -2762.3837	1.2952e-006 (0.0011) -6.5867e-007 4.9375e-006 (0.0022) 6.9206e-007 -2.7747e-006 5.6304e-006 (0.0024)
93U829 to A779 (2)	-26058.9563 -6961.2386 -2762.4070	5.2887e-006 (0.0023) -2.6556e-006 2.0825e-005 (0.0046) 1.7158e-006 -9.0878e-006 2.0026e-005 (0.0045)
93U829 to A780 (1)	-21417.6470 -287.5181 2367.6386	1.9418e-006 (0.0014) -9.9575e-007 4.4740e-006 (0.0021) 2.1836e-007 -2.8914e-006 5.8908e-006 (0.0024)
93U829 to A780 (2)	-21417.6446 -287.5009 2367.6242	2.0700e-006 (0.0014) -1.8685e-007 9.0806e-006 (0.0030) 1.0047e-006 -2.3838e-006 7.5520e-006 (0.0027)
93U829 to A781 (1)	-57161.1645 632.5393 7310.8702	1.2055e-005 (0.0035) -1.1878e-006 4.3872e-006 (0.0021) 7.1401e-008 -2.3260e-006 3.7802e-006 (0.0019)

93U829 to A781 (2)	-57161.1502	6.9901e-006	(0.0026)
	632.5120	1.2372e-006	8.5518e-006 (0.0029)
	7310.9017	5.2958e-007	-3.4752e-006 5.0045e-006 (0.0022)
93U829 to A782 (2)	-59313.7765	2.0175e-006	(0.0014)
	3783.0107	-1.4214e-007	1.7401e-006 (0.0013)
	10227.6428	2.2953e-007	-9.9145e-007 1.3844e-006 (0.0012)
723007 to 963012 (1)	-37107.3121	2.9021e-006	(0.0017)
	5260.7997	-5.4668e-007	1.8106e-005 (0.0043)
	8166.5165	7.4021e-007	-7.6423e-006 1.6662e-005 (0.0041)
963012 to A783 (1)	41530.8370	7.1763e-006	(0.0027)
	-12327.7214	-2.0244e-006	4.9718e-006 (0.0022)
	-14632.7869	6.7756e-007	-2.3230e-006 2.8510e-006 (0.0017)
963012 to A783 (3)	41530.8370	7.1763e-006	(0.0027)
	-12327.7214	-2.0244e-006	4.9718e-006 (0.0022)
	-14632.7869	6.7756e-007	-2.3230e-006 2.8510e-006 (0.0017)
963012 to A784 (3)	30888.3542	2.3164e-006	(0.0015)
	-4294.3660	-1.7670e-006	8.1949e-006 (0.0029)
	-6716.5722	8.4320e-007	-3.6208e-006 5.7508e-006 (0.0024)
963012 to A785 (1)	-11645.8632	1.4814e-006	(0.0012)
	-6447.5487	-3.0769e-007	6.8483e-006 (0.0026)
	-4343.1484	1.9920e-007	-3.7498e-006 8.6421e-006 (0.0029)
963012 to A785 (2)	-11645.8634	2.6419e-006	(0.0016)
	-6447.5515	-1.1983e-006	7.7067e-006 (0.0028)
	-4343.1590	2.0446e-007	-2.9658e-006 7.8243e-006 (0.0028)
963012 to A785 (3)	-11645.8634	2.6419e-006	(0.0016)
	-6447.5515	-1.1983e-006	7.7067e-006 (0.0028)
	-4343.1590	2.0446e-007	-2.9658e-006 7.8243e-006 (0.0028)
963012 to A786 (1)	-13547.9289	1.2907e-006	(0.0011)
	2032.3572	-7.4039e-007	3.8192e-006 (0.0020)
	2971.7088	-8.1971e-008	-1.2192e-006 3.4363e-006 (0.0019)
963012 to A786 (2)	-13547.9289	1.2907e-006	(0.0011)
	2032.3572	-7.4039e-007	3.8192e-006 (0.0020)
	2971.7088	-8.1971e-008	-1.2192e-006 3.4363e-006 (0.0019)
963012 to A786 (4)	-13547.9276	1.2907e-006	(0.0011)
	2032.3562	-7.4039e-007	3.8192e-006 (0.0020)
	2971.7092	-8.1971e-008	-1.2192e-006 3.4363e-006 (0.0019)
A775 to A776 (1)	-6828.3284	8.3926e-007	(0.0009)
	-6738.5314	-1.2986e-007	3.9218e-006 (0.0020)
	-4856.3805	1.6807e-007	-2.0253e-006 4.1138e-006 (0.0020)
A775 to A776 (2)	-6828.3321	1.3799e-006	(0.0012)
	-6738.5351	-9.6309e-007	4.1863e-006 (0.0020)
	-4856.3857	5.3407e-007	-1.6846e-006 3.8369e-006 (0.0020)
A775 to A777 (1)	-27739.1565	4.8167e-006	(0.0022)
	-6391.9098	-4.1144e-006	1.4338e-005 (0.0038)
	-1808.4495	-7.0774e-007	-3.8021e-006 1.2284e-005 (0.0035)
A775 to A777 (2)	-27739.1643	5.4677e-007	(0.0007)
	-6391.9015	-2.4061e-007	2.0324e-006 (0.0014)
	-1808.4396	1.6484e-007	-1.1889e-006 2.5859e-006 (0.0016)
A775 to A777 (3)	-27739.1567	1.6898e-006	(0.0013)
	-6391.9105	-2.8541e-007	7.5161e-006 (0.0027)
	-1808.4390	4.2991e-007	-3.8691e-006 7.8899e-006 (0.0028)
A775 to A778 (1)	-40330.2117	1.4388e-005	(0.0038)
	2666.9253	-1.5181e-006	5.1783e-006 (0.0023)
	7537.5420	1.7590e-007	-2.5867e-006 4.3913e-006 (0.0021)

A775 to A778 (3)	-40330.2024	6.6539e-006	(0.0026)
	2666.9233	1.2439e-006	6.7945e-006 (0.0026)
	7537.5426	7.1197e-007	-2.8767e-006 4.2885e-006 (0.0021)
A776 to A777 (1)	-20910.8275	1.2286e-006	(0.0011)
	346.6192	-1.6507e-007	5.8016e-006 (0.0024)
	3047.9463	2.8554e-007	-2.8234e-006 5.4743e-006 (0.0023)
A776 to A777 (3)	-20910.8327	1.2771e-005	(0.0036)
	346.6168	-1.3034e-005	6.5405e-005 (0.0081)
	3047.9433	1.7365e-006	-1.8542e-005 3.6355e-005 (0.0060)
A776 to A778 (1)	-33501.8835	3.3671e-006	(0.0018)
	9405.4597	-2.0442e-006	1.4133e-005 (0.0038)
	12393.9254	6.4182e-007	-7.2440e-006 1.2171e-005 (0.0035)
A776 to A778 (2)	-33501.8799	5.8373e-006	(0.0024)
	9405.4482	-4.8988e-006	1.7255e-005 (0.0042)
	12393.9246	-1.1243e-006	-4.4679e-006 1.5014e-005 (0.0039)
A777 to A778 (1)	-12591.0543	1.6866e-006	(0.0013)
	9058.8199	-1.1042e-006	5.8816e-006 (0.0024)
	9345.9833	1.1261e-006	-4.0246e-006 8.5666e-006 (0.0029)
A777 to A778 (3)	-12591.0547	2.0000e-006	(0.0014)
	9058.8354	-9.5920e-007	8.2603e-006 (0.0029)
	9345.9831	6.9427e-007	-3.5535e-006 5.7436e-006 (0.0024)
A777 to A779 (1)	-47536.9239	6.7835e-006	(0.0026)
	4919.6767	7.9736e-007	4.2909e-006 (0.0021)
	10081.4143	8.8067e-007	-2.1618e-006 3.4182e-006 (0.0018)
A779 to A780 (1)	4641.3116	6.2734e-007	(0.0008)
	6673.7290	-2.5571e-007	2.3340e-006 (0.0015)
	5130.0362	1.8382e-007	-1.3211e-006 2.8781e-006 (0.0017)
A779 to A780 (2)	4641.3138	8.6351e-007	(0.0009)
	6673.7247	-1.2486e-007	3.9362e-006 (0.0020)
	5130.0496	1.4272e-007	-2.0728e-006 4.8066e-006 (0.0022)
A779 to A781 (1)	-31102.1968	6.8625e-006	(0.0026)
	7593.7709	-4.4042e-006	2.7174e-005 (0.0052)
	10073.2885	2.7107e-006	-1.4654e-005 1.8333e-005 (0.0043)
A779 to A781 (2)	-31102.1946	2.0607e-006	(0.0014)
	7593.7556	-1.2718e-006	7.7610e-006 (0.0028)
	10073.2936	1.0698e-006	-4.6295e-006 1.0040e-005 (0.0032)
A779 to A782 (2)	-33254.8108	1.0370e-005	(0.0032)
	10744.2528	-7.7188e-006	3.6222e-005 (0.0060)
	12990.0507	5.9333e-006	-1.7293e-005 2.4563e-005 (0.0050)
A780 to A781 (2)	-35743.5002	2.1620e-006	(0.0015)
	920.0242	-1.3547e-006	8.2291e-006 (0.0029)
	4943.2626	1.0134e-006	-4.8952e-006 9.9405e-006 (0.0032)
A780 to A782 (3)	-37896.1241	1.4064e-006	(0.0012)
	4070.5228	-6.3194e-007	5.0907e-006 (0.0023)
	7860.0074	3.8369e-007	-2.9742e-006 6.2708e-006 (0.0025)
A781 to 81U454 (1)	-8636.6014	2.0452e-006	(0.0014)
	5029.8710	-1.0042e-006	6.1217e-006 (0.0025)
	5240.7899	1.0477e-006	-3.9364e-006 1.2150e-005 (0.0035)
A781 to 723007 (1)	-42458.2139	4.8065e-006	(0.0022)
	9667.4004	-8.7068e-007	7.4406e-006 (0.0027)
	12829.4296	6.5240e-007	-3.3032e-006 4.5607e-006 (0.0021)
A781 to A782 (1)	-2152.6170	3.7270e-007	(0.0006)
	3150.4907	-7.3895e-008	1.7125e-006 (0.0013)
	2916.7431	1.0052e-007	-8.1928e-007 1.4345e-006 (0.0012)

A781 to A782 (4)	-2152.6162	3.0100e-007	(0.0005)
	3150.4886	-1.8618e-007	1.1337e-006 (0.0011)
	2916.7421	1.3901e-007	-6.7597e-007 1.3840e-006 (0.0012)
A781 to A783 (1)	-38034.6738	2.9322e-006	(0.0017)
	2600.4946	-1.4442e-006	1.4373e-005 (0.0038)
	6363.1235	7.7864e-007	-8.0075e-006 1.3404e-005 (0.0037)
A781 to A783 (3)	-38034.6650	2.9628e-006	(0.0017)
	2600.4937	-1.3856e-006	1.4487e-005 (0.0038)
	6363.1225	7.3935e-007	-8.0842e-006 1.3457e-005 (0.0037)
A781 to A784 (2)	-48677.1745	3.0318e-006	(0.0017)
	10633.8365	-2.8164e-008	2.4318e-006 (0.0016)
	14279.3630	2.7557e-007	-1.3635e-006 1.7783e-006 (0.0013)
A782 to 81U454 (1)	-6483.9732	1.1121e-006	(0.0011)
	1879.3717	-3.4095e-007	3.8007e-006 (0.0019)
	2324.0436	2.9632e-007	-2.6498e-006 7.1409e-006 (0.0027)
A782 to 81U454 (2)	-6483.9761	1.0035e-006	(0.0010)
	1879.3710	-6.8462e-007	3.9785e-006 (0.0020)
	2324.0453	3.9903e-007	-2.2384e-006 4.1782e-006 (0.0020)
A782 to A783 (2)	-35882.0500	1.7479e-006	(0.0013)
	-549.9929	-7.0287e-007	9.4165e-006 (0.0031)
	3446.3749	5.7272e-007	-5.0511e-006 8.1252e-006 (0.0029)
A782 to A783 (3)	-35882.0568	1.7479e-006	(0.0013)
	-549.9933	-7.0287e-007	9.4165e-006 (0.0031)
	3446.3755	5.7272e-007	-5.0512e-006 8.1252e-006 (0.0029)
A782 to A784 (1)	-46524.5482	2.7590e-006	(0.0017)
	7483.3691	5.1408e-008	2.5905e-006 (0.0016)
	11362.5837	3.1851e-007	-1.4017e-006 1.8049e-006 (0.0013)
A782 to A784 (3)	-46524.5458	1.2745e-006	(0.0011)
	7483.3542	1.4714e-007	1.0949e-006 (0.0010)
	11362.5985	1.0234e-007	-6.4075e-007 8.6014e-007 (0.0009)
A782 to A785 (1)	-89058.7644	1.4554e-006	(0.0012)
	5330.1687	1.1943e-007	1.1720e-006 (0.0011)
	13736.0188	8.5201e-008	-7.0570e-007 1.0299e-006 (0.0010)
A782 to A786 (1)	-90960.8234	1.5343e-006	(0.0012)
	13810.0736	1.3283e-007	1.2075e-006 (0.0011)
	21050.8858	1.2370e-007	-6.9286e-007 1.0033e-006 (0.0010)
A783 to 81U454 (2)	29398.0704	7.0306e-006	(0.0027)
	2429.3645	-1.4564e-006	2.6766e-005 (0.0052)
	-1122.3314	-3.7831e-006	-8.6087e-006 1.4489e-005 (0.0038)
A783 to 723007 (1)	-4423.5463	1.1571e-006	(0.0011)
	7066.9094	-4.0754e-007	5.0747e-006 (0.0023)
	6466.2908	3.9879e-007	-3.1367e-006 6.3417e-006 (0.0025)
A783 to 723007 (2)	-4423.5538	2.5112e-006	(0.0016)
	7066.8899	-1.3707e-006	1.3424e-005 (0.0037)
	6466.2940	2.8525e-007	-6.5414e-006 9.9522e-006 (0.0032)
A783 to 723007 (3)	-4423.5583	6.2720e-007	(0.0008)
	7066.9044	-2.2582e-007	2.7469e-006 (0.0017)
	6466.2944	9.4076e-008	-1.5551e-006 3.1330e-006 (0.0018)
A783 to 81U454 (1)	29398.0697	5.0199e-006	(0.0022)
	2429.3857	-1.9528e-006	1.2556e-005 (0.0035)
	-1122.3440	3.2706e-006	-8.3598e-007 1.9496e-005 (0.0044)
A783 to A784 (1)	-10642.4969	5.5239e-006	(0.0024)
	8033.3630	-2.8864e-006	2.6474e-005 (0.0051)
	7916.2088	1.2405e-006	-1.2734e-005 2.4578e-005 (0.0050)

A783 to A784 (3)	-10642.5046	2.2591e-006	(0.0015)
	8033.3483	-8.1849e-007	9.4998e-006 (0.0031)
	7916.2255	-4.5266e-007	-4.0362e-006 7.0007e-006 (0.0026)
A783 to A786 (1)	-55078.7922	4.0813e-006	(0.0020)
	14360.0631	3.4830e-008	2.9616e-006 (0.0017)
	17604.5168	4.7427e-007	-1.6988e-006 2.4888e-006 (0.0016)
A783 to A786 (2)	-55078.7922	4.0813e-006	(0.0020)
	14360.0631	3.4830e-008	2.9616e-006 (0.0017)
	17604.5168	4.7427e-007	-1.6988e-006 2.4888e-006 (0.0016)
A784 to 723007 (1)	6218.9570	9.4412e-007	(0.0010)
	-966.4361	-6.2845e-007	3.2268e-006 (0.0018)
	-1449.9344	4.0915e-007	-2.0223e-006 4.3131e-006 (0.0021)
A784 to A785 (1)	-42534.2160	1.2316e-006	(0.0011)
	-2153.1864	1.5076e-007	1.0086e-006 (0.0010)
	2373.4187	5.9478e-008	-5.8945e-007 8.0542e-007 (0.0009)
A784 to A785 (2)	-42534.2157	1.2744e-006	(0.0011)
	-2153.1873	1.4809e-007	1.0587e-006 (0.0010)
	2373.4196	7.1947e-008	-6.3639e-007 8.6603e-007 (0.0009)
A784 to A786 (1)	-44436.2750	1.2690e-006	(0.0011)
	6326.7176	1.6091e-007	1.0459e-006 (0.0010)
	9688.2874	1.0365e-007	-5.8385e-007 7.8267e-007 (0.0009)
A784 to A786 (2)	-44436.2750	1.2690e-006	(0.0011)
	6326.7176	1.6091e-007	1.0459e-006 (0.0010)
	9688.2874	1.0365e-007	-5.8385e-007 7.8267e-007 (0.0009)
A785 to A786 (1)	-1902.0612	6.3226e-007	(0.0008)
	8479.9055	-2.9100e-007	2.7243e-006 (0.0017)
	7314.8693	1.4957e-007	-1.4468e-006 2.8023e-006 (0.0017)
A785 to A786 (3)	-1902.0605	6.0788e-007	(0.0008)
	8479.9033	-2.4175e-007	2.6237e-006 (0.0016)
	7314.8682	1.3524e-007	-1.4161e-006 2.7903e-006 (0.0017)
A786 to 723007 (3)	50655.2305	3.7484e-006	(0.0019)
	-7293.1546	2.2748e-008	3.8823e-006 (0.0020)
	-11138.2251	5.8883e-007	-1.9547e-006 2.9023e-006 (0.0017)
IROQ to A776 (1)	-34893.9136	7.1229e-006	(0.0027)
	20008.6923	-6.0693e-007	3.1373e-006 (0.0018)
	22022.0832	9.5575e-008	-1.8003e-006 2.8947e-006 (0.0017)
IROQ to A775 (1)	-28065.5868	2.2054e-006	(0.0015)
	26747.2274	-1.0924e-007	3.4024e-006 (0.0018)
	26878.4656	3.2225e-007	-1.5588e-006 2.0217e-006 (0.0014)
IROQ to A775 (2)	-28065.5853	6.1792e-006	(0.0025)
	26747.2250	-5.1181e-007	3.2679e-006 (0.0018)
	26878.4651	7.5272e-008	-1.7929e-006 3.0047e-006 (0.0017)
IROQ to A775 (3)	-28065.5868	2.2054e-006	(0.0015)
	26747.2274	-1.0924e-007	3.4024e-006 (0.0018)
	26878.4656	3.2225e-007	-1.5588e-006 2.0217e-006 (0.0014)
IROQ to A776 (2)	-34893.9145	3.3180e-006	(0.0018)
	20008.6904	-2.2982e-009	4.9848e-006 (0.0022)
	22022.0783	4.6141e-007	-2.1161e-006 2.8141e-006 (0.0017)
IROQ to A777 (2)	-55804.7379	9.6066e-006	(0.0031)
	20355.3145	-6.8049e-007	3.3109e-006 (0.0018)
	25070.0286	1.3619e-007	-1.9632e-006 3.1187e-006 (0.0018)
IROQ to A777 (3)	-55804.7379	9.6066e-006	(0.0031)
	20355.3145	-6.8049e-007	3.3109e-006 (0.0018)
	25070.0286	1.3619e-007	-1.9632e-006 3.1187e-006 (0.0018)

 OUTPUT VECTOR RESIDUALS (East, North, Height - Local Level)

SESSION NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)	- PPM -	DIST - (km)	STD - (m)
A775 to 93U829 (1)	-0.0001	-0.0018	0.0039	0.084	50.7	0.0063
93U829 to A777 (1)	-0.0013	-0.0017	-0.0038	0.156	27.7	0.0070
93U829 to A778 (1)	0.0037	0.0020	0.0016	0.454	10.0	0.0125
93U829 to A779 (1)	-0.0042	-0.0041	-0.0164	0.642	27.1	0.0098
93U829 to A779 (2)	-0.0011	0.0007	0.0102	0.379	27.1	0.0194
93U829 to A780 (1)	0.0020	0.0018	-0.0033	0.198	21.6	0.0100
93U829 to A780 (2)	-0.0027	-0.0016	0.0184	0.869	21.6	0.0123
93U829 to A781 (1)	0.0091	-0.0009	0.0281	0.513	57.6	0.0128
93U829 to A781 (2)	-0.0013	0.0007	-0.0146	0.255	57.6	0.0129
93U829 to A782 (2)	0.0058	-0.0017	0.0002	0.099	60.3	0.0065
723007 to 963012 (1)	0.0102	-0.0036	-0.0121	0.424	38.4	0.0175
963012 to A783 (1)	0.0172	-0.0025	-0.0095	0.434	45.7	0.0111
963012 to A783 (3)	0.0172	-0.0025	-0.0095	0.434	45.7	0.0111
963012 to A784 (3)	-0.0043	0.0008	-0.0018	0.149	31.9	0.0115
963012 to A785 (1)	-0.0025	-0.0053	-0.0028	0.462	14.0	0.0118
963012 to A785 (2)	-0.0019	0.0036	0.0035	0.385	14.0	0.0122
963012 to A785 (3)	-0.0019	0.0036	0.0035	0.385	14.0	0.0122
963012 to A786 (1)	0.0013	0.0003	0.0074	0.535	14.0	0.0083
963012 to A786 (2)	0.0013	0.0003	0.0074	0.535	14.0	0.0083
963012 to A786 (4)	0.0001	0.0010	0.0063	0.456	14.0	0.0083
A775 to A776 (1)	-0.0023	-0.0026	-0.0034	0.450	10.8	0.0085
A775 to A776 (2)	0.0019	0.0031	-0.0015	0.368	10.8	0.0088
A775 to A777 (1)	-0.0029	0.0101	0.0037	0.390	28.5	0.0160
A775 to A777 (2)	0.0035	-0.0035	0.0025	0.194	28.5	0.0065
A775 to A777 (3)	-0.0026	0.0037	-0.0047	0.229	28.5	0.0118
A775 to A778 (1)	-0.0029	-0.0020	0.0019	0.096	41.1	0.0140
A775 to A778 (3)	-0.0118	0.0003	-0.0008	0.287	41.1	0.0120
A776 to A777 (1)	-0.0009	0.0046	-0.0061	0.364	21.1	0.0101
A776 to A777 (3)	0.0046	0.0077	-0.0049	0.482	21.1	0.0306
A776 to A778 (1)	-0.0008	-0.0034	0.0050	0.166	36.9	0.0156
A776 to A778 (2)	-0.0026	0.0062	-0.0022	0.190	36.9	0.0176
A777 to A778 (1)	0.0015	0.0049	-0.0056	0.417	18.1	0.0115
A777 to A778 (3)	-0.0004	-0.0066	0.0046	0.447	18.1	0.0114
A777 to A779 (1)	-0.0011	0.0035	-0.0131	0.278	48.8	0.0109
A779 to A780 (1)	-0.0004	0.0010	-0.0011	0.162	9.6	0.0069
A779 to A780 (2)	-0.0020	-0.0043	-0.0143	1.564	9.6	0.0089
A779 to A781 (1)	-0.0001	-0.0025	0.0039	0.137	33.6	0.0207
A779 to A781 (2)	-0.0003	0.0059	-0.0101	0.348	33.6	0.0127
A779 to A782 (2)	-0.0031	-0.0046	-0.0093	0.290	37.3	0.0241
A780 to A781 (2)	-0.0055	0.0040	-0.0149	0.454	36.1	0.0129
A780 to A782 (3)	-0.0008	-0.0004	-0.0032	0.086	38.9	0.0102
A781 to 81U454 (1)	0.0060	-0.0042	0.0074	0.921	11.3	0.0129
A781 to 723007 (1)	-0.0023	-0.0060	-0.0100	0.262	45.4	0.0117
A781 to A782 (1)	-0.0011	0.0034	0.0073	1.697	4.8	0.0054
A781 to A782 (4)	-0.0016	0.0058	0.0067	1.869	4.8	0.0048
A781 to A783 (1)	0.0081	0.0004	0.0047	0.242	38.7	0.0158
A781 to A783 (3)	-0.0005	0.0026	0.0042	0.127	38.7	0.0159
A781 to A784 (2)	0.0060	-0.0038	-0.0138	0.300	51.8	0.0077
A782 to 81U454 (1)	-0.0030	0.0020	-0.0041	0.764	7.1	0.0099
A782 to 81U454 (2)	0.0000	0.0011	-0.0056	0.805	7.1	0.0086
A782 to A783 (2)	0.0020	-0.0012	0.0030	0.106	36.1	0.0125
A782 to A783 (3)	0.0089	-0.0019	0.0028	0.264	36.1	0.0125
A782 to A784 (1)	-0.0051	-0.0003	0.0205	0.437	48.5	0.0076
A782 to A784 (3)	-0.0056	0.0015	-0.0005	0.120	48.5	0.0051
A782 to A785 (1)	-0.0022	-0.0004	-0.0004	0.025	90.3	0.0055
A782 to A786 (1)	-0.0050	0.0003	0.0011	0.054	94.4	0.0055
A783 to 81U454 (2)	0.0014	0.0028	-0.0066	0.246	29.5	0.0198
A783 to 723007 (1)	-0.0047	0.0003	-0.0003	0.448	10.6	0.0101
A783 to 723007 (2)	0.0051	0.0123	-0.0146	1.873	10.6	0.0145
A783 to 723007 (3)	0.0078	0.0006	-0.0052	0.896	10.6	0.0073
A783 to 81U454 (1)	-0.0005	-0.0051	0.0167	0.592	29.5	0.0174
A783 to A784 (1)	-0.0085	0.0002	0.0181	1.288	15.5	0.0215
A783 to A784 (3)	0.0009	-0.0003	-0.0034	0.231	15.5	0.0124
A783 to A786 (1)	0.0120	-0.0014	-0.0072	0.236	59.6	0.0088
A783 to A786 (2)	0.0120	-0.0014	-0.0072	0.236	59.6	0.0088

A784 to 723007 (1)	-0.0047	-0.0019	0.0049	1.092	6.5	0.0083
A784 to A785 (1)	0.0009	0.0001	0.0004	0.024	42.7	0.0050
A784 to A785 (2)	0.0007	0.0002	-0.0009	0.027	42.7	0.0051
A784 to A786 (1)	-0.0018	0.0003	0.0001	0.040	45.9	0.0050
A784 to A786 (2)	-0.0018	0.0003	0.0001	0.040	45.9	0.0050
A785 to A786 (1)	-0.0007	-0.0015	0.0004	0.145	11.4	0.0071
A785 to A786 (3)	-0.0012	0.0010	-0.0003	0.136	11.4	0.0070
A786 to 723007 (3)	-0.0013	0.0005	0.0068	0.133	52.4	0.0093
IROQ to A776 (1)	-0.0017	-0.0008	-0.0013	0.051	45.9	0.0104
IROQ to A775 (1)	0.0016	-0.0024	0.0031	0.090	47.2	0.0079
IROQ to A775 (2)	0.0005	-0.0001	0.0018	0.040	47.2	0.0101
IROQ to A775 (3)	0.0016	-0.0024	0.0031	0.090	47.2	0.0079
IROQ to A776 (2)	-0.0006	0.0037	0.0013	0.085	45.9	0.0095
IROQ to A777 (2)	-0.0062	0.0024	-0.0051	0.130	64.5	0.0114
IROQ to A777 (3)	-0.0062	0.0024	-0.0051	0.130	64.5	0.0114

RMS	0.0051	0.0034	0.0082			

\$ - This session is flagged as a 3-sigma outlier

CHECK POINT RESIDUALS (East, North, Height - Local Level)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
723007	-0.0099	0.0006	-0.0119
81U454	-0.0174	0.0100	0.0087
93U829	-0.0046	0.0116	0.0550
963012	-0.0140	0.0137	-0.0018

RMS	0.0124	0.0103	0.0285

CONTROL POINT RESIDUALS (ADJUSTMENT MADE)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
IROQ	0.0000	0.0000	-0.0000

RMS	0.0000	0.0000	0.0000

OUTPUT STATION COORDINATES (LAT/LONG/HT)

STA_ID	-- LATITUDE --	-- LONGITUDE --	ELLHGT -	ORTHOHGT
723007	49 33 15.33967	-83 00 34.95646	216.3911	254.0445
81U454	49 26 57.99277	-82 33 16.33096	193.3887	230.5275
93U829	49 16 33.80354	-81 40 04.82139	203.1000	240.4374
963012	49 40 02.76934	-83 30 39.73610	229.3022	267.3707
A775	49 07 25.84113	-81 00 42.23846	237.6353	275.2913
A776	49 03 25.99527	-81 07 06.28435	232.2301	269.7773
A777	49 05 56.72059	-81 24 02.09781	229.4279	266.8444
A778	49 13 39.64122	-81 33 10.44837	221.9249	259.3082
A779	49 14 17.02636	-82 02 09.29289	197.1602	234.4123
A780	49 18 31.63138	-81 57 35.96800	194.5400	231.8030
A781	49 22 37.33825	-82 26 44.10880	191.2617	228.2965
A782	49 25 02.47868	-82 28 09.43177	189.2487	226.3251
A783	49 27 53.48538	-82 57 39.62051	203.8067	241.2869
A784	49 34 27.94668	-83 05 36.33486	209.7952	247.5308
A785	49 36 25.74794	-83 40 52.34279	228.3095	266.3344
A786	49 42 32.09765	-83 41 40.11675	212.1144	250.3198
IROQ	48 45 20.87961	-80 41 29.64345	247.2720	284.4775

 OUTPUT STATION COORDINATES (GRID)

STA_ID	- EASTING - (m)	- NORTHING - (m)	- ELLHGT - (m)	ORTHOHGT (m)
723007	354647.4034	5491013.6816	216.3911	254.0445
81U454	387325.9863	5478581.6728	193.3887	230.5275
93U829	451411.1177	5458359.0810	203.1000	240.4374
963012	318812.3088	5504683.2740	229.3022	267.3707
A775	499143.9554	5441223.2305	237.6353	275.2913
A776	491348.9508	5433823.5428	232.2301	269.7773
A777	470758.5685	5438548.3998	229.4279	266.8444
A778	459744.0708	5452913.2770	221.9249	259.3082
A779	424592.9555	5454437.0044	197.1602	234.4123
A780	430219.4003	5462226.3070	194.5400	231.8030
A781	395068.2891	5470375.5480	191.2617	228.2965
A782	393435.2391	5474890.6815	189.2487	226.3251
A783	357910.9428	5480982.1710	203.8067	241.2869
A784	348655.4087	5493420.7647	209.7952	247.5308
A785	306295.8366	5498406.6119	228.3095	266.3344
A786	305742.9809	5509752.7642	212.1144	250.3198
IROQ	522669.5904	5400355.6717	247.2720	284.4775

 OUTPUT VARIANCE/COVARIANCE

STA_ID	SE/SN/SUP (95.00 %) (m)	CX matrix (m)----- (not scaled by confidence level) (ECEF, XYZ cartesian)			
723007	0.0156	4.1077e-005			
	0.0145	-2.2112e-006	4.9410e-005		
	0.0191	2.2603e-006	-1.3264e-005	4.6165e-005	
81U454	0.0155	4.0856e-005			
	0.0150	-2.8720e-006	5.1450e-005		
	0.0200	2.4571e-006	-1.4413e-005	5.2285e-005	
93U829	0.0141	3.3537e-005			
	0.0132	-8.9876e-007	3.5535e-005		
	0.0156	9.8620e-007	-5.7711e-006	3.4123e-005	
963012	0.0157	4.1629e-005			
	0.0145	-2.2553e-006	4.8295e-005		
	0.0187	1.9985e-006	-1.2188e-005	4.4674e-005	
A775	0.0134	2.9922e-005			
	0.0127	-4.1897e-007	3.0155e-005		
	0.0139	5.0924e-007	-2.5941e-006	2.8932e-005	
A776	0.0136	3.0954e-005			
	0.0130	-7.0141e-007	3.2678e-005		
	0.0146	6.6048e-007	-3.8108e-006	3.1231e-005	
A777	0.0136	3.1025e-005			
	0.0129	-6.4931e-007	3.1263e-005		
	0.0144	5.0208e-007	-3.4530e-006	3.0667e-005	
A778	0.0141	3.3671e-005			
	0.0136	-1.4491e-006	3.8077e-005		
	0.0162	1.1155e-006	-6.5590e-006	3.6068e-005	
A779	0.0148	3.6645e-005			
	0.0138	-1.4168e-006	4.1676e-005		
	0.0173	1.8077e-006	-9.1192e-006	4.0071e-005	
A780	0.0148	3.6756e-005			
	0.0141	-1.7172e-006	4.3034e-005		

	0.0178	1.7306e-006	-9.9157e-006	4.2556e-005
A781	0.0150	3.8116e-005		
	0.0138	-1.6014e-006	4.2293e-005	
	0.0174	1.7262e-006	-9.4300e-006	3.9878e-005
A782	0.0150	3.8083e-005		
	0.0138	-1.5484e-006	4.1929e-005	
	0.0173	1.7086e-006	-9.3087e-006	3.9489e-005
A783	0.0154	4.0109e-005		
	0.0142	-1.9221e-006	4.6885e-005	
	0.0185	1.9966e-006	-1.1906e-005	4.3579e-005
A784	0.0155	4.0215e-005		
	0.0139	-1.4506e-006	4.4035e-005	
	0.0178	1.8955e-006	-1.0509e-005	4.1086e-005
A785	0.0156	4.0864e-005		
	0.0140	-1.4471e-006	4.4995e-005	
	0.0181	1.9400e-006	-1.1099e-005	4.2060e-005
A786	0.0156	4.0635e-005		
	0.0140	-1.4577e-006	4.4659e-005	
	0.0180	1.9539e-006	-1.0838e-005	4.1663e-005
IROQ	0.0122	2.5000e-005		
	0.0122	-5.2793e-020	2.5000e-005	
	0.0122	1.0914e-019	2.5011e-019	2.5000e-005

VARIANCE FACTOR = 1.0000

Note: Values < 1.0 indicate statistics are pessimistic, while
values > 1.0 indicate optimistic statistics. Entering this
value as the network adjustment scale factor will bring
variance factor to one.



g.) Fully Constrained Network Adjustment

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*****
* NETWORK - WEIGHTED GPS NETWORK ADJUSTMENT *
* *
* (c) Copyright NovAtel Inc., (2014) *
* *
* Version: 8.50.4320 *
* *
* FILE: 1625_OMAFRA-Cochrane_full.net *
*****

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DATUM:          'NAD83CSRS(2010)'
GRID:           UTM, Zone 17
SCALE_FACTOR:   7.3374
CONFIDENCE LEVEL: 95.00 %   (Scale factor is 2.4479)

```

```

*****
INPUT CONTROL/CHECK POINTS
*****

```

STA_ID	TYPE	-- LATITUDE --	-- LONGITUDE --	ELLHGT -	HZ-SD	V-SD
723007	CHK-3D	49 33 15.33965	-83 00 34.95596	216.402		
81U454	CHK-3D	49 26 57.99244	-82 33 16.33009	193.380		
93U829	CHK-3D	49 16 33.80317	-81 40 04.82116	203.045		
963012	GCP-3D	49 40 02.76890	-83 30 39.73540	229.304	0.00500	0.00500
IROQ	GCP-3D	48 45 20.87961	-80 41 29.64345	247.272	0.00500	0.00500

```

*****
INPUT VECTORS
*****

```

SESSION NAME	VECTOR(m)	----- Covariance (m) [unscaled] -----
	DX/DY/DZ	standard deviations in brackets
723007 to A783 (1)	4423.5458 -7066.9101 -6466.2878	1.1571e-006 (0.0011) -4.0714e-007 5.0735e-006 (0.0023) 3.9823e-007 -3.1365e-006 6.3426e-006 (0.0025)
723007 to A784 (1)	-6218.9558 966.4335 1449.9369	9.4431e-007 (0.0010) -6.2888e-007 3.2270e-006 (0.0018) 4.0973e-007 -2.0225e-006 4.3132e-006 (0.0021)
723007 to A786 (3)	-50655.2304 7293.1547 11138.2251	3.7521e-006 (0.0019) 2.0165e-008 3.8822e-006 (0.0020) 5.8786e-007 -1.9540e-006 2.9005e-006 (0.0017)
93U829 to A779 (1)	-26058.9512 -6961.2517 -2762.3837	1.2952e-006 (0.0011) -6.5867e-007 4.9375e-006 (0.0022) 6.9206e-007 -2.7747e-006 5.6304e-006 (0.0024)
A775 to 93U829 (1)	-49217.1307 5489.0312 11035.3636	2.0431e-006 (0.0014) -1.1748e-007 1.5777e-006 (0.0013) 2.2735e-007 -9.1800e-007 1.3136e-006 (0.0011)
93U829 to A777 (1)	21477.9716 -11880.9334 -12843.8015	6.5629e-007 (0.0008) -2.7904e-007 2.4056e-006 (0.0016) 1.8295e-007 -1.3760e-006 2.9311e-006 (0.0017)
93U829 to A778 (1)	8886.9125 -2822.1061 -3497.8257	2.1755e-006 (0.0015) -8.2461e-008 8.3743e-006 (0.0029) 1.9472e-007 -3.6022e-006 8.6321e-006 (0.0029)
93U829 to A779 (2)	-26058.9563 -6961.2386 -2762.4070	5.2887e-006 (0.0023) -2.6556e-006 2.0825e-005 (0.0046) 1.7158e-006 -9.0878e-006 2.0026e-005 (0.0045)
93U829 to A780 (1)	-21417.6470 -287.5181 2367.6386	1.9418e-006 (0.0014) -9.9575e-007 4.4740e-006 (0.0021) 2.1836e-007 -2.8914e-006 5.8908e-006 (0.0024)

93U829 to A780 (2)	-21417.6446	2.0700e-006	(0.0014)
	-287.5009	-1.8685e-007	9.0806e-006 (0.0030)
	2367.6242	1.0047e-006	-2.3838e-006 7.5520e-006 (0.0027)
93U829 to A781 (1)	-57161.1645	1.2055e-005	(0.0035)
	632.5393	-1.1878e-006	4.3872e-006 (0.0021)
	7310.8702	7.1401e-008	-2.3260e-006 3.7802e-006 (0.0019)
93U829 to A781 (2)	-57161.1502	6.9901e-006	(0.0026)
	632.5120	1.2372e-006	8.5518e-006 (0.0029)
	7310.9017	5.2958e-007	-3.4752e-006 5.0045e-006 (0.0022)
93U829 to A782 (2)	-59313.7765	2.0175e-006	(0.0014)
	3783.0107	-1.4214e-007	1.7401e-006 (0.0013)
	10227.6428	2.2953e-007	-9.9145e-007 1.3844e-006 (0.0012)
963012 to 723007 (1)	37107.3122	2.9003e-006	(0.0017)
	-5260.8007	-5.3093e-007	1.8113e-005 (0.0043)
	-8166.5154	7.2505e-007	-7.6404e-006 1.6659e-005 (0.0041)
963012 to A783 (1)	41530.8370	7.1763e-006	(0.0027)
	-12327.7214	-2.0244e-006	4.9718e-006 (0.0022)
	-14632.7869	6.7756e-007	-2.3230e-006 2.8510e-006 (0.0017)
963012 to A783 (3)	41530.8370	7.1763e-006	(0.0027)
	-12327.7214	-2.0244e-006	4.9718e-006 (0.0022)
	-14632.7869	6.7756e-007	-2.3230e-006 2.8510e-006 (0.0017)
963012 to A784 (3)	30888.3542	2.3164e-006	(0.0015)
	-4294.3660	-1.7670e-006	8.1949e-006 (0.0029)
	-6716.5722	8.4320e-007	-3.6208e-006 5.7508e-006 (0.0024)
963012 to A785 (1)	-11645.8632	1.4814e-006	(0.0012)
	-6447.5487	-3.0769e-007	6.8483e-006 (0.0026)
	-4343.1484	1.9920e-007	-3.7498e-006 8.6421e-006 (0.0029)
963012 to A785 (2)	-11645.8634	2.6419e-006	(0.0016)
	-6447.5515	-1.1983e-006	7.7067e-006 (0.0028)
	-4343.1590	2.0446e-007	-2.9658e-006 7.8243e-006 (0.0028)
963012 to A785 (3)	-11645.8634	2.6419e-006	(0.0016)
	-6447.5515	-1.1983e-006	7.7067e-006 (0.0028)
	-4343.1590	2.0446e-007	-2.9658e-006 7.8243e-006 (0.0028)
963012 to A786 (1)	-13547.9289	1.2907e-006	(0.0011)
	2032.3572	-7.4039e-007	3.8192e-006 (0.0020)
	2971.7088	-8.1971e-008	-1.2192e-006 3.4363e-006 (0.0019)
963012 to A786 (2)	-13547.9289	1.2907e-006	(0.0011)
	2032.3572	-7.4039e-007	3.8192e-006 (0.0020)
	2971.7088	-8.1971e-008	-1.2192e-006 3.4363e-006 (0.0019)
963012 to A786 (4)	-13547.9276	1.2907e-006	(0.0011)
	2032.3562	-7.4039e-007	3.8192e-006 (0.0020)
	2971.7092	-8.1971e-008	-1.2192e-006 3.4363e-006 (0.0019)
A775 to A776 (1)	-6828.3284	8.3926e-007	(0.0009)
	-6738.5314	-1.2986e-007	3.9218e-006 (0.0020)
	-4856.3805	1.6807e-007	-2.0253e-006 4.1138e-006 (0.0020)
A775 to A776 (2)	-6828.3321	1.3799e-006	(0.0012)
	-6738.5351	-9.6309e-007	4.1863e-006 (0.0020)
	-4856.3857	5.3407e-007	-1.6846e-006 3.8369e-006 (0.0020)
A775 to A777 (1)	-27739.1565	4.8167e-006	(0.0022)
	-6391.9098	-4.1144e-006	1.4338e-005 (0.0038)
	-1808.4495	-7.0774e-007	-3.8021e-006 1.2284e-005 (0.0035)
A775 to A777 (2)	-27739.1643	5.4677e-007	(0.0007)
	-6391.9015	-2.4061e-007	2.0324e-006 (0.0014)
	-1808.4396	1.6484e-007	-1.1889e-006 2.5859e-006 (0.0016)

A775 to A777 (3)	-27739.1567	1.6898e-006	(0.0013)
	-6391.9105	-2.8541e-007	7.5161e-006 (0.0027)
	-1808.4390	4.2991e-007	-3.8691e-006 7.8899e-006 (0.0028)
A775 to A778 (1)	-40330.2117	1.4388e-005	(0.0038)
	2666.9253	-1.5181e-006	5.1783e-006 (0.0023)
	7537.5420	1.7590e-007	-2.5867e-006 4.3913e-006 (0.0021)
A775 to A778 (3)	-40330.2024	6.6539e-006	(0.0026)
	2666.9233	1.2439e-006	6.7945e-006 (0.0026)
	7537.5426	7.1197e-007	-2.8767e-006 4.2885e-006 (0.0021)
A776 to A777 (1)	-20910.8275	1.2286e-006	(0.0011)
	346.6192	-1.6507e-007	5.8016e-006 (0.0024)
	3047.9463	2.8554e-007	-2.8234e-006 5.4743e-006 (0.0023)
A776 to A777 (3)	-20910.8327	1.2771e-005	(0.0036)
	346.6168	-1.3034e-005	6.5405e-005 (0.0081)
	3047.9433	1.7365e-006	-1.8542e-005 3.6355e-005 (0.0060)
A776 to A778 (1)	-33501.8835	3.3671e-006	(0.0018)
	9405.4597	-2.0442e-006	1.4133e-005 (0.0038)
	12393.9254	6.4182e-007	-7.2440e-006 1.2171e-005 (0.0035)
A776 to A778 (2)	-33501.8799	5.8373e-006	(0.0024)
	9405.4482	-4.8988e-006	1.7255e-005 (0.0042)
	12393.9246	-1.1243e-006	-4.4679e-006 1.5014e-005 (0.0039)
A777 to A778 (1)	-12591.0543	1.6866e-006	(0.0013)
	9058.8199	-1.1042e-006	5.8816e-006 (0.0024)
	9345.9833	1.1261e-006	-4.0246e-006 8.5666e-006 (0.0029)
A777 to A778 (3)	-12591.0547	2.0000e-006	(0.0014)
	9058.8354	-9.5920e-007	8.2603e-006 (0.0029)
	9345.9831	6.9427e-007	-3.5535e-006 5.7436e-006 (0.0024)
A777 to A779 (1)	-47536.9239	6.7835e-006	(0.0026)
	4919.6767	7.9736e-007	4.2909e-006 (0.0021)
	10081.4143	8.8067e-007	-2.1618e-006 3.4182e-006 (0.0018)
A779 to A780 (1)	4641.3116	6.2734e-007	(0.0008)
	6673.7290	-2.5571e-007	2.3340e-006 (0.0015)
	5130.0362	1.8382e-007	-1.3211e-006 2.8781e-006 (0.0017)
A779 to A780 (2)	4641.3138	8.6351e-007	(0.0009)
	6673.7247	-1.2486e-007	3.9362e-006 (0.0020)
	5130.0496	1.4272e-007	-2.0728e-006 4.8066e-006 (0.0022)
A779 to A781 (1)	-31102.1968	6.8625e-006	(0.0026)
	7593.7709	-4.4042e-006	2.7174e-005 (0.0052)
	10073.2885	2.7107e-006	-1.4654e-005 1.8333e-005 (0.0043)
A779 to A781 (2)	-31102.1946	2.0607e-006	(0.0014)
	7593.7556	-1.2718e-006	7.7610e-006 (0.0028)
	10073.2936	1.0698e-006	-4.6295e-006 1.0040e-005 (0.0032)
A779 to A782 (2)	-33254.8108	1.0370e-005	(0.0032)
	10744.2528	-7.7188e-006	3.6222e-005 (0.0060)
	12990.0507	5.9333e-006	-1.7293e-005 2.4563e-005 (0.0050)
A780 to A781 (2)	-35743.5002	2.1620e-006	(0.0015)
	920.0242	-1.3547e-006	8.2291e-006 (0.0029)
	4943.2626	1.0134e-006	-4.8952e-006 9.9405e-006 (0.0032)
A780 to A782 (3)	-37896.1241	1.4064e-006	(0.0012)
	4070.5228	-6.3194e-007	5.0907e-006 (0.0023)
	7860.0074	3.8369e-007	-2.9742e-006 6.2708e-006 (0.0025)
A781 to 81U454 (1)	-8636.6014	2.0452e-006	(0.0014)
	5029.8710	-1.0042e-006	6.1217e-006 (0.0025)
	5240.7899	1.0477e-006	-3.9364e-006 1.2150e-005 (0.0035)

A781 to A782 (1)	-2152.6170	3.7270e-007	(0.0006)
	3150.4907	-7.3895e-008	1.7125e-006 (0.0013)
	2916.7431	1.0052e-007	-8.1928e-007 1.4345e-006 (0.0012)
A781 to A782 (4)	-2152.6162	3.0100e-007	(0.0005)
	3150.4886	-1.8618e-007	1.1337e-006 (0.0011)
	2916.7421	1.3901e-007	-6.7597e-007 1.3840e-006 (0.0012)
A783 to A781 (1)	38034.6739	2.9297e-006	(0.0017)
	-2600.4963	-1.4339e-006	1.4373e-005 (0.0038)
	-6363.1214	7.6718e-007	-8.0061e-006 1.3406e-005 (0.0037)
A783 to A781 (3)	38034.6718	2.1818e-006	(0.0015)
	-2600.4816	-9.6200e-007	9.5984e-006 (0.0031)
	-6363.1428	6.3970e-007	-5.6489e-006 1.0959e-005 (0.0033)
A781 to A784 (2)	-48677.1745	3.0318e-006	(0.0017)
	10633.8365	-2.8164e-008	2.4318e-006 (0.0016)
	14279.3630	2.7557e-007	-1.3635e-006 1.7783e-006 (0.0013)
A782 to 81U454 (1)	-6483.9732	1.1121e-006	(0.0011)
	1879.3717	-3.4095e-007	3.8007e-006 (0.0019)
	2324.0436	2.9632e-007	-2.6498e-006 7.1409e-006 (0.0027)
A782 to 81U454 (2)	-6483.9761	1.0035e-006	(0.0010)
	1879.3710	-6.8462e-007	3.9785e-006 (0.0020)
	2324.0453	3.9903e-007	-2.2384e-006 4.1782e-006 (0.0020)
A783 to A782 (2)	35882.0438	6.3813e-006	(0.0025)
	549.9983	-4.0648e-006	2.5696e-005 (0.0051)
	-3446.3818	1.0293e-006	-8.1387e-006 1.6924e-005 (0.0041)
A783 to A782 (3)	35882.0570	1.7465e-006	(0.0013)
	549.9914	-6.9635e-007	9.4196e-006 (0.0031)
	-3446.3734	5.6612e-007	-5.0525e-006 8.1264e-006 (0.0029)
A782 to A784 (1)	-46524.5482	2.7590e-006	(0.0017)
	7483.3691	5.1408e-008	2.5905e-006 (0.0016)
	11362.5837	3.1851e-007	-1.4017e-006 1.8049e-006 (0.0013)
A782 to A784 (3)	-46524.5458	1.2745e-006	(0.0011)
	7483.3542	1.4714e-007	1.0949e-006 (0.0010)
	11362.5985	1.0234e-007	-6.4075e-007 8.6014e-007 (0.0009)
A782 to A785 (1)	-89058.7644	1.4554e-006	(0.0012)
	5330.1687	1.1943e-007	1.1720e-006 (0.0011)
	13736.0188	8.5201e-008	-7.0570e-007 1.0299e-006 (0.0010)
A782 to A786 (1)	-90960.8234	1.5343e-006	(0.0012)
	13810.0736	1.3283e-007	1.2075e-006 (0.0011)
	21050.8858	1.2370e-007	-6.9286e-007 1.0033e-006 (0.0010)
A783 to 81U454 (2)	29398.0704	7.0306e-006	(0.0027)
	2429.3645	-1.4564e-006	2.6766e-005 (0.0052)
	-1122.3314	-3.7831e-006	-8.6087e-006 1.4489e-005 (0.0038)
A783 to 81U454 (1)	29398.0697	5.0199e-006	(0.0022)
	2429.3857	-1.9528e-006	1.2556e-005 (0.0035)
	-1122.3440	3.2706e-006	-8.3598e-007 1.9496e-005 (0.0044)
A783 to A784 (1)	-10642.4969	5.5239e-006	(0.0024)
	8033.3630	-2.8864e-006	2.6474e-005 (0.0051)
	7916.2088	1.2405e-006	-1.2734e-005 2.4578e-005 (0.0050)
A783 to A784 (3)	-10642.5046	2.2591e-006	(0.0015)
	8033.3483	-8.1849e-007	9.4998e-006 (0.0031)
	7916.2255	-4.5266e-007	-4.0362e-006 7.0007e-006 (0.0026)
A783 to A786 (1)	-55078.7922	4.0813e-006	(0.0020)
	14360.0631	3.4830e-008	2.9616e-006 (0.0017)
	17604.5168	4.7427e-007	-1.6988e-006 2.4888e-006 (0.0016)

A783 to A786 (2)	-55078.7922	4.0813e-006	(0.0020)
	14360.0631	3.4830e-008	2.9616e-006 (0.0017)
	17604.5168	4.7427e-007	-1.6988e-006 2.4888e-006 (0.0016)
A784 to A785 (1)	-42534.2160	1.2316e-006	(0.0011)
	-2153.1864	1.5076e-007	1.0086e-006 (0.0010)
	2373.4187	5.9478e-008	-5.8945e-007 8.0542e-007 (0.0009)
A784 to A785 (2)	-42534.2157	1.2744e-006	(0.0011)
	-2153.1873	1.4809e-007	1.0587e-006 (0.0010)
	2373.4196	7.1947e-008	-6.3639e-007 8.6603e-007 (0.0009)
A784 to A786 (1)	-44436.2750	1.2690e-006	(0.0011)
	6326.7176	1.6091e-007	1.0459e-006 (0.0010)
	9688.2874	1.0365e-007	-5.8385e-007 7.8267e-007 (0.0009)
A784 to A786 (2)	-44436.2750	1.2690e-006	(0.0011)
	6326.7176	1.6091e-007	1.0459e-006 (0.0010)
	9688.2874	1.0365e-007	-5.8385e-007 7.8267e-007 (0.0009)
A785 to A786 (1)	-1902.0612	6.3226e-007	(0.0008)
	8479.9055	-2.9100e-007	2.7243e-006 (0.0017)
	7314.8693	1.4957e-007	-1.4468e-006 2.8023e-006 (0.0017)
A785 to A786 (3)	-1902.0605	6.0788e-007	(0.0008)
	8479.9033	-2.4175e-007	2.6237e-006 (0.0016)
	7314.8682	1.3524e-007	-1.4161e-006 2.7903e-006 (0.0017)
IROQ to A776 (1)	-34893.9136	7.1229e-006	(0.0027)
	20008.6923	-6.0693e-007	3.1373e-006 (0.0018)
	22022.0832	9.5575e-008	-1.8003e-006 2.8947e-006 (0.0017)
IROQ to A775 (1)	-28065.5868	2.2054e-006	(0.0015)
	26747.2274	-1.0924e-007	3.4024e-006 (0.0018)
	26878.4656	3.2225e-007	-1.5588e-006 2.0217e-006 (0.0014)
IROQ to A775 (2)	-28065.5853	6.1792e-006	(0.0025)
	26747.2250	-5.1181e-007	3.2679e-006 (0.0018)
	26878.4651	7.5272e-008	-1.7929e-006 3.0047e-006 (0.0017)
IROQ to A775 (3)	-28065.5868	2.2054e-006	(0.0015)
	26747.2274	-1.0924e-007	3.4024e-006 (0.0018)
	26878.4656	3.2225e-007	-1.5588e-006 2.0217e-006 (0.0014)
IROQ to A776 (2)	-34893.9145	3.3180e-006	(0.0018)
	20008.6904	-2.2982e-009	4.9848e-006 (0.0022)
	22022.0783	4.6141e-007	-2.1161e-006 2.8141e-006 (0.0017)
IROQ to A777 (2)	-55804.7379	9.6066e-006	(0.0031)
	20355.3145	-6.8049e-007	3.3109e-006 (0.0018)
	25070.0286	1.3619e-007	-1.9632e-006 3.1187e-006 (0.0018)
IROQ to A777 (3)	-55804.7379	9.6066e-006	(0.0031)
	20355.3145	-6.8049e-007	3.3109e-006 (0.0018)
	25070.0286	1.3619e-007	-1.9632e-006 3.1187e-006 (0.0018)

 OUTPUT VECTOR RESIDUALS (East, North, Height - Local Level)

SESSION NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)	- PPM -	DIST - (km)	STD - (m)
723007 to A783 (1)	-0.0025	-0.0020	0.0058	0.626	10.6	0.0096
723007 to A784 (1)	0.0001	0.0027	-0.0023	0.547	6.5	0.0079
723007 to A786 (3)	-0.0029	-0.0004	-0.0004	0.057	52.4	0.0088
93U829 to A779 (1)	-0.0039	-0.0041	-0.0163	0.634	27.1	0.0093
A775 to 93U829 (1)	0.0006	-0.0023	0.0042	0.095	50.7	0.0060
93U829 to A777 (1)	-0.0018	-0.0012	-0.0040	0.164	27.7	0.0066
93U829 to A778 (1)	0.0033	0.0024	0.0014	0.434	10.0	0.0119
93U829 to A779 (2)	-0.0007	0.0008	0.0103	0.382	27.1	0.0184
93U829 to A780 (1)	0.0024	0.0016	-0.0032	0.199	21.6	0.0095
93U829 to A780 (2)	-0.0024	-0.0017	0.0186	0.873	21.6	0.0117
93U829 to A781 (1)	0.0100	-0.0011	0.0286	0.527	57.6	0.0122
93U829 to A781 (2)	-0.0004	0.0004	-0.0141	0.244	57.6	0.0123
93U829 to A782 (2)	0.0064	-0.0023	0.0004	0.114	60.3	0.0061
963012 to 723007 (1)	-0.0065	0.0043	0.0036	0.223	38.4	0.0166
963012 to A783 (1)	0.0132	-0.0021	-0.0083	0.344	45.7	0.0105
963012 to A783 (3)	0.0132	-0.0021	-0.0083	0.344	45.7	0.0105
963012 to A784 (3)	-0.0044	0.0019	-0.0026	0.171	31.9	0.0109
963012 to A785 (1)	-0.0029	-0.0043	-0.0035	0.445	14.0	0.0112
963012 to A785 (2)	-0.0023	0.0046	0.0028	0.420	14.0	0.0115
963012 to A785 (3)	-0.0023	0.0046	0.0028	0.420	14.0	0.0115
963012 to A786 (1)	0.0009	0.0011	0.0067	0.488	14.0	0.0079
963012 to A786 (2)	0.0009	0.0011	0.0067	0.488	14.0	0.0079
963012 to A786 (4)	-0.0003	0.0018	0.0056	0.423	14.0	0.0079
A775 to A776 (1)	-0.0023	-0.0025	-0.0034	0.447	10.8	0.0081
A775 to A776 (2)	0.0019	0.0033	-0.0016	0.380	10.8	0.0083
A775 to A777 (1)	-0.0027	0.0100	0.0037	0.387	28.5	0.0152
A775 to A777 (2)	0.0037	-0.0036	0.0025	0.201	28.5	0.0062
A775 to A777 (3)	-0.0024	0.0037	-0.0046	0.224	28.5	0.0112
A775 to A778 (1)	-0.0027	-0.0020	0.0020	0.094	41.1	0.0133
A775 to A778 (3)	-0.0115	0.0002	-0.0007	0.281	41.1	0.0114
A776 to A777 (1)	-0.0007	0.0044	-0.0060	0.353	21.1	0.0096
A776 to A777 (3)	0.0048	0.0074	-0.0048	0.477	21.1	0.0290
A776 to A778 (1)	-0.0006	-0.0037	0.0052	0.172	36.9	0.0148
A776 to A778 (2)	-0.0024	0.0059	-0.0020	0.181	36.9	0.0167
A777 to A778 (1)	0.0015	0.0049	-0.0055	0.415	18.1	0.0109
A777 to A778 (3)	-0.0004	-0.0066	0.0047	0.449	18.1	0.0108
A777 to A779 (1)	-0.0002	0.0031	-0.0127	0.267	48.8	0.0103
A779 to A780 (1)	-0.0003	0.0009	-0.0011	0.151	9.6	0.0065
A779 to A780 (2)	-0.0020	-0.0044	-0.0143	1.566	9.6	0.0084
A779 to A781 (1)	0.0004	-0.0028	0.0043	0.154	33.6	0.0196
A779 to A781 (2)	0.0003	0.0056	-0.0096	0.333	33.6	0.0121
A779 to A782 (2)	-0.0027	-0.0053	-0.0091	0.293	37.3	0.0228
A780 to A781 (2)	-0.0049	0.0038	-0.0145	0.438	36.1	0.0122
A780 to A782 (3)	-0.0005	-0.0010	-0.0031	0.084	38.9	0.0097
A781 to 81U454 (1)	0.0055	-0.0046	0.0074	0.914	11.3	0.0122
A781 to A782 (1)	-0.0013	0.0030	0.0071	1.620	4.8	0.0051
A781 to A782 (4)	-0.0018	0.0054	0.0064	1.784	4.8	0.0045
A783 to A781 (1)	-0.0054	0.0007	-0.0090	0.271	38.7	0.0150
A783 to A781 (3)	-0.0052	0.0034	0.0170	0.468	38.7	0.0129
A781 to A784 (2)	0.0073	-0.0043	-0.0142	0.320	51.8	0.0073
A782 to 81U454 (1)	-0.0033	0.0020	-0.0038	0.753	7.1	0.0094
A782 to 81U454 (2)	-0.0003	0.0011	-0.0053	0.761	7.1	0.0082
A783 to A782 (2)	0.0058	0.0018	0.0045	0.209	36.1	0.0190
A783 to A782 (3)	-0.0064	0.0027	-0.0075	0.285	36.1	0.0119
A782 to A784 (1)	-0.0036	-0.0004	0.0204	0.427	48.5	0.0072
A782 to A784 (3)	-0.0040	0.0014	-0.0007	0.089	48.5	0.0049
A782 to A785 (1)	-0.0010	-0.0006	-0.0004	0.013	90.3	0.0052
A782 to A786 (1)	-0.0038	-0.0000	0.0010	0.042	94.4	0.0052
A783 to 81U454 (2)	0.0035	0.0035	-0.0081	0.320	29.5	0.0188
A783 to 81U454 (1)	0.0016	-0.0044	0.0152	0.539	29.5	0.0165
A783 to A784 (1)	-0.0045	0.0008	0.0161	1.079	15.5	0.0204
A783 to A784 (3)	0.0049	0.0004	-0.0055	0.472	15.5	0.0117
A783 to A786 (1)	0.0156	-0.0009	-0.0091	0.303	59.6	0.0084
A783 to A786 (2)	0.0156	-0.0009	-0.0091	0.303	59.6	0.0084
A784 to A785 (1)	0.0006	-0.0000	0.0006	0.020	42.7	0.0047

A784 to A785 (2)	0.0004	0.0001	-0.0007	0.020	42.7	0.0048
A784 to A786 (1)	-0.0022	0.0001	0.0003	0.048	45.9	0.0048
A784 to A786 (2)	-0.0022	0.0001	0.0003	0.048	45.9	0.0048
A785 to A786 (1)	-0.0007	-0.0016	0.0003	0.155	11.4	0.0067
A785 to A786 (3)	-0.0012	0.0009	-0.0004	0.133	11.4	0.0066
IROQ to A776 (1)	-0.0009	-0.0011	-0.0011	0.039	45.9	0.0098
IROQ to A775 (1)	0.0024	-0.0028	0.0034	0.107	47.2	0.0075
IROQ to A775 (2)	0.0013	-0.0005	0.0021	0.054	47.2	0.0096
IROQ to A775 (3)	0.0024	-0.0028	0.0034	0.107	47.2	0.0075
IROQ to A776 (2)	0.0002	0.0034	0.0015	0.081	45.9	0.0090
IROQ to A777 (2)	-0.0052	0.0019	-0.0048	0.113	64.5	0.0108
IROQ to A777 (3)	-0.0052	0.0019	-0.0048	0.113	64.5	0.0108

RMS	0.0048	0.0032	0.0082			

\$ - This session is flagged as a 3-sigma outlier

CHECK POINT RESIDUALS (East, North, Height - Local Level)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
723007	0.0027	-0.0069	-0.0161
81U454	-0.0106	0.0029	0.0101
93U829	0.0018	0.0049	0.0559

RMS	0.0064	0.0052	0.0341

CONTROL POINT RESIDUALS (ADJUSTMENT MADE)

STA. NAME	-- RE -- (m)	-- RN -- (m)	-- RH -- (m)
963012	-0.0050	0.0055	-0.0002
IROQ	0.0048	-0.0057	0.0004

RMS	0.0049	0.0056	0.0003

OUTPUT STATION COORDINATES (LAT/LONG/HT)

STA_ID	-- LATITUDE --	-- LONGITUDE --	- ELLHGT -	ORTHOHGT
723007	49 33 15.33943	-83 00 34.95583	216.3858	254.0392
81U454	49 26 57.99253	-82 33 16.33061	193.3902	230.5290
93U829	49 16 33.80333	-81 40 04.82107	203.1009	240.4383
963012	49 40 02.76908	-83 30 39.73565	229.3038	267.3724
A775	49 07 25.84093	-81 00 42.23818	237.6360	275.2920
A776	49 03 25.99507	-81 07 06.28407	232.2307	269.7780
A777	49 05 56.72039	-81 24 02.09752	229.4286	266.8451
A778	49 13 39.64102	-81 33 10.44807	221.9256	259.3089
A779	49 14 17.02615	-82 02 09.29256	197.1612	234.4133
A780	49 18 31.63116	-81 57 35.96766	194.5410	231.8041
A781	49 22 37.33803	-82 26 44.10843	191.2631	228.2979
A782	49 25 02.47845	-82 28 09.43141	189.2499	226.3262
A783	49 27 53.48513	-82 57 39.62027	203.8096	241.2898
A784	49 34 27.94645	-83 05 36.33442	209.7961	247.5317
A785	49 36 25.74770	-83 40 52.34236	228.3105	266.3354
A786	49 42 32.09742	-83 41 40.11632	212.1153	250.3207
IROQ	48 45 20.87943	-80 41 29.64321	247.2724	284.4779

 OUTPUT STATION COORDINATES (GRID)

STA_ID	- EASTING - (m)	- NORTHING - (m)	- ELLHGT - (m)	ORTHOHGT (m)
723007	354647.4158	5491013.6737	216.3858	254.0392
81U454	387325.9931	5478581.6654	193.3902	230.5290
93U829	451411.1241	5458359.0744	203.1009	240.4383
963012	318812.3175	5504683.2655	229.3038	267.3724
A775	499143.9611	5441223.2244	237.6360	275.2920
A776	491348.9565	5433823.5368	232.2307	269.7780
A777	470758.5744	5438548.3936	229.4286	266.8451
A778	459744.0767	5452913.2709	221.9256	259.3089
A779	424592.9622	5454436.9978	197.1612	234.4133
A780	430219.4070	5462226.3003	194.5410	231.8041
A781	395068.2963	5470375.5410	191.2631	228.2979
A782	393435.2462	5474890.6741	189.2499	226.3262
A783	357910.9475	5480982.1630	203.8096	241.2898
A784	348655.4173	5493420.7572	209.7961	247.5317
A785	306295.8450	5498406.6044	228.3105	266.3354
A786	305742.9892	5509752.7566	212.1153	250.3207
IROQ	522669.5953	5400355.6660	247.2724	284.4779

 OUTPUT VARIANCE/COVARIANCE

STA_ID	SE/SN/SUP (95.00 %) (m)	----- CX matrix (m)----- (not scaled by confidence level) (ECEF, XYZ cartesian)			
723007	0.0104	1.8430e-005			
	0.0105	-1.3550e-006	2.5557e-005		
	0.0139	1.1914e-006	-6.9907e-006	2.5148e-005	
81U454	0.0104	1.8493e-005			
	0.0110	-1.6549e-006	2.5958e-005		
	0.0143	1.0134e-006	-6.9209e-006	2.7883e-005	
93U829	0.0099	1.6383e-005			
	0.0094	-5.6416e-007	1.8091e-005		
	0.0111	4.7319e-007	-2.9372e-006	1.7266e-005	
963012	0.0096	1.5389e-005			
	0.0093	-2.4159e-007	1.5977e-005		
	0.0102	2.1709e-007	-1.4636e-006	1.5553e-005	
A775	0.0099	1.6398e-005			
	0.0095	-4.6667e-007	1.7903e-005		
	0.0110	4.5311e-007	-2.6358e-006	1.6975e-005	
A776	0.0102	1.7413e-005			
	0.0100	-8.0136e-007	2.1164e-005		
	0.0122	6.3055e-007	-4.1030e-006	1.9936e-005	
A777	0.0099	1.6514e-005			
	0.0096	-5.9583e-007	1.8470e-005		
	0.0113	4.5423e-007	-3.0836e-006	1.8100e-005	
A778	0.0105	1.8765e-005			
	0.0104	-1.2332e-006	2.4479e-005		
	0.0133	9.2321e-007	-5.8442e-006	2.2943e-005	
A779	0.0102	1.7506e-005			
	0.0102	-1.1307e-006	2.2928e-005		
	0.0130	1.0669e-006	-5.6002e-006	2.2465e-005	
A780	0.0101	1.7374e-005			
	0.0103	-1.2398e-006	2.3213e-005		

	0.0133	9.3724e-007	-5.8156e-006	2.3721e-005
A781	0.0099	1.6429e-005		
	0.0096	-6.5502e-007	1.8950e-005	
	0.0114	5.2617e-007	-3.3242e-006	1.8154e-005
A782	0.0098	1.6105e-005		
	0.0094	-4.6586e-007	1.7644e-005	
	0.0109	4.0287e-007	-2.6088e-006	1.6895e-005
A783	0.0101	1.7140e-005		
	0.0097	-8.0702e-007	1.9878e-005	
	0.0117	5.2891e-007	-3.6724e-006	1.8419e-005
A784	0.0099	1.6414e-005		
	0.0094	-4.0940e-007	1.7923e-005	
	0.0110	4.1488e-007	-2.7154e-006	1.7062e-005
A785	0.0099	1.6363e-005		
	0.0095	-4.3353e-007	1.8422e-005	
	0.0112	4.0977e-007	-3.0255e-006	1.7704e-005
A786	0.0098	1.6086e-005		
	0.0094	-4.4733e-007	1.7691e-005	
	0.0109	3.6458e-007	-2.5280e-006	1.6924e-005
IROQ	0.0096	1.5389e-005		
	0.0093	-2.4159e-007	1.5977e-005	
	0.0102	2.1709e-007	-1.4636e-006	1.5553e-005

VARIANCE FACTOR = 1.0048

Note: Values < 1.0 indicate statistics are pessimistic, while
 values > 1.0 indicate optimistic statistics. Entering this
 value as the network adjustment scale factor will bring
 variance factor to one.
