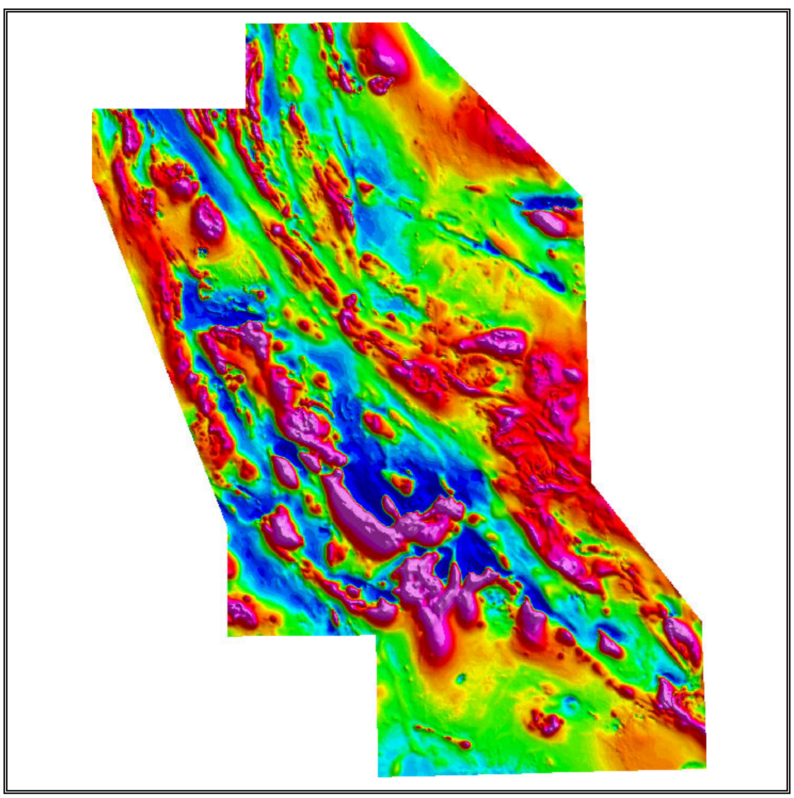
NATURAL RESOURCES CANADA (NRCan)

AEROMAGNETIC SURVEY
over MARSH LAKE AREA, YUKON

FINAL TECHNICAL REPORT

Contract # 3000656158

July 2018



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FINAL TECHNICAL REPORT

By

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1.0 INTRODUCTION

On November 23th, 2017 **Géo Solutions Données GDS / Geo Data Solutions GDS Inc.** was awarded contract number 3000656158 by Natural Resources Canada. The contract required the execution and compilation of digitally-recorded high sensitivity fixed-wing airborne total magnetic field survey consisting of 59,653 l-km over Marsh Lake area in Yukon (Figure 1).

The data were recorded using split-beam cesium vapour magnetometers mounted in each of the tail booms of a Beechcraft King Air A100 (C-FLRB) and a Piper Navajo PA-31(C-GPTB) flying at a nominal terrain clearance of 150 m. The survey was flown on a pre-determined flight surface to minimize differences in magnetic values at the intersections of control and traverse lines. These differences were computer-analysed to obtain a mutually levelled set of flight-line magnetic data.

This report describes the survey procedures and data verification, which were carried out in the field, and data processing, which followed at the office.

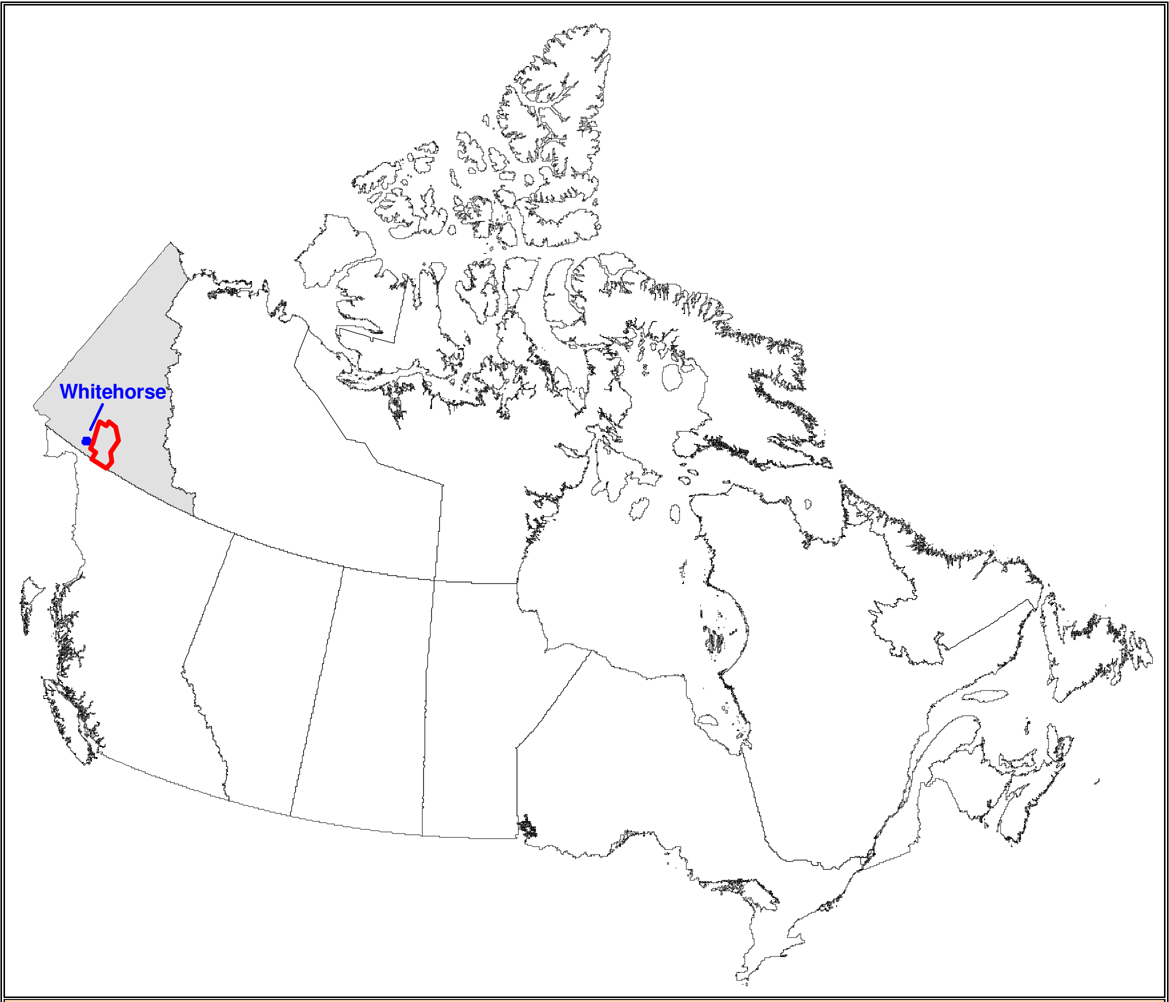

Figure 1: Survey area (red) and base of operations (blue)

2.0 RECONNAISSANCE OF PROJECT

Mobilization started on January 4th, 2018 and the first aircraft arrived in Whitehorse, YT two days later. Data acquisition flights occurred between January 12th and March 16th. Weather conditions were relatively unstable throughout the survey. There were 13 days that the weather prevented production flying.

During data acquisition period, daylight hours gradually increased from 6 to 12 hours.

In terms of topography, the terrain may be classified as moderate to rugged for most of the area (Figure 3). **GDS** used a 3D navigation system to fly a smooth drape surface with a rate of climb of 5%. The use of this technique minimizes the high height intersection differences between control lines and traverses in order to control and achieve optimal ground clearance in some areas of steep topography. The drape surface was created using Shuttle Radar Topography Mission (SRTM) 1 arc second data (source data in Canada originating from NRCan) along with drape software from the Geological Survey of Canada (Drape_dtm).

There were no restricted or danger zones within the survey area but local wildlife (Caribou and migratory birds) were avoided and reported if observed.

GDS set up its base of operations in Whitehorse, which is located 10 km west of the survey area. As such, the range capability of the aircraft to fly the survey was suitable to collect large volumes of data on each flight.

Two magnetic base stations were set up at magnetic noise-free locations, away from magnetic objects, vehicles and DC electrical power lines (Figure 2). A GPS base station was also installed in a safe place.

Figure 2: Magnetic and GPS Base station locations (Whitehorse)

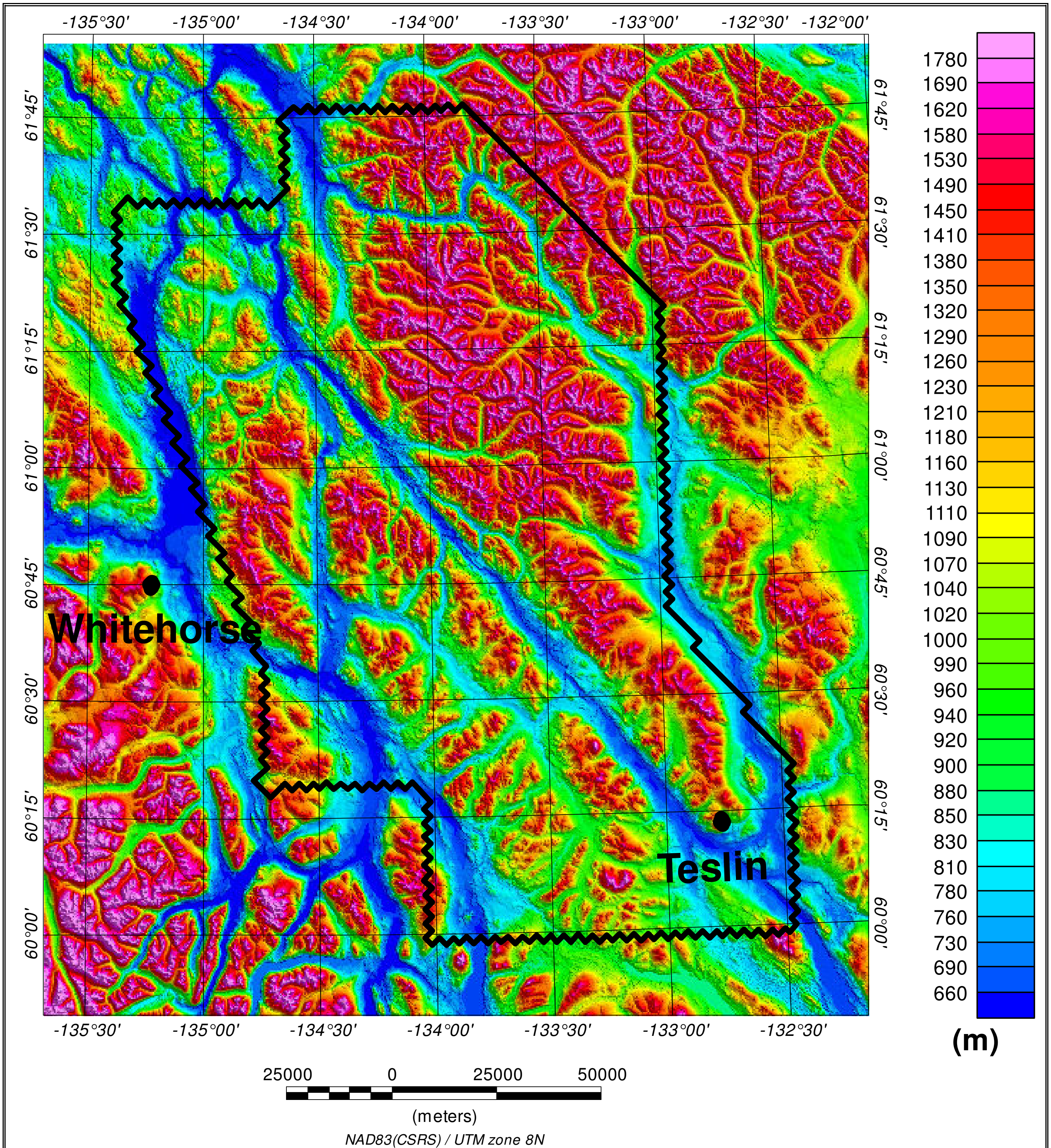

Figure 3: Survey area topographic relief

The survey area consisted of a single block flown with a nominal terrain clearance of 150m and having a line spacing and orientation, relative to UTM zone 8, as shown in the following table.

Table 1: Flight line bearing and spacing			
Area	**Line type**	**Bearing**	**Spacing**
Marsh Lake	Traverse	N045° E	400 m
	Control	N135° E	2 400 m

The survey block location is shown on Figure 3 while table 2 defines its co-ordinates in NAD83 UTM zone 8.

Table 2: Survey area coordinates					
	Easting	**Northing**		**Easting**	**Northing**
1	515 569.2	6 687 562.0	**8**	608 012.0	6 801 983.5
2	515 438.7	6 716 228.0	**9**	610 280.9	6 727 699.5
3	480 307.5	6 807 209.0	**10**	639 003.7	6 691 516.0
4	480 403.5	6 825 101.0	**11**	640 459.6	6 653 076.0
5	520 253.0	6 825 116.0	**12**	554 789.4	6 650 806.5
6	520 116.2	6 847 382.5	**13**	554 234.2	6 687 943.0
7	562 013.6	6 847 887.5			

3.0 TESTS AND CALIBRATIONS

The following is a summary of the tests performed before, during or after survey production. Results are presented in appendices A and B.

Table 3: Tests and calibrations				
Aircraft	**Morewood**	**Altimeters**	**Lag**	**FOM**
C-FLRB	2017-12-21	2018-01-18	2018-01-09	2017-12-21 2018-01-12
C-GPTB	2018-02-02	2018-02-02	2018-03-13	2018-02-02 2018-02-14

3.1 Magnetometer Tests

The aircraft proceeded to Morewood, ON test site for the calibration of the magnetometers. This calibration included a measurement of the heading error. Two passes in each of four directions were flown to obtain sufficient statistical data to complete the standard form. Test results were submitted to the Technical Inspector.

Also, the effects of aircraft manoeuvres (roll, pitch and yaw) were determined and the results of this test submitted to the Technical Inspector. The test was performed over a magnetically quiet zone, at a high altitude. It consisted of flying ±10^o rolls, ±5^o pitches and ±5^o yaws peak to peak parallel to survey lines headings (N45ºE, N135ºE, N225ºE and N315ºE) over periods of 4-5 seconds. A compensation Figure of Merit (FOM) for the aircraft was calculated by summing up the peak-to-peak amplitudes of the 12 magnetic signatures. The FOM did not exceed 1.5 nT.

3.2 Altimeter Tests

Calibrations were performed by flying a range of altitudes representative of the survey area conditions, above and below the designated survey altitude. These altitudes covered the minimum and maximum range at different altitudes. Typically, these levels were determined by the real time GPS-Z and radar altimeter above an airstrip of known elevation.

3.3 Lag Tests

Prior to the initial commencement of survey production and with any major survey equipment alteration or replacement on the aircraft, each aircraft performed a lag test to ascertain the time difference between the magnetometer readings and the positioning devices. The tests were carried out by flying in opposite directions at the normal survey height over a distinct anomaly to determine any lag in the digitally recorded navigational data. These test results were submitted to the Technical Inspector.

4.0 TIMING

The two aircraft (C-FLRB and C-GPTB) and their respective field crews progressively arrived in Whitehorse starting on January 6th, 2018. The first production flight began on January 12th and the last flight ended on March 16th.

Excluding calibration and test flights, a total of 63 flights were needed to cover the survey area. C-FLRB flew 34,735 km (58%) and C-GPTB flew 25,052 km (42%). Preliminary results were sent to the Technical Inspector progressively during the flying phase while final maps and data were submitted in June 2018. Tables 4 and 5 show the production statistics of each aircraft.

Table 4: Production summary

	2018		
	January	**February**	**March**
C-FLRB			
C-GPTB			

Table 5: Aircraft statistics

		C-FLRB	**C-GPTB**	**Project**
Flight number range		001 - 041	201 - 236	
Number of production flights		35	28	63
Production days		27	21	42
Non-production days (weather, test,..)		22	9	27
Aircraft on-site		2018-01-06	2018-02-14	2018-01-06
First production flight		2018-01-12	2018-02-18	2018-01-12
Last production flight		2018-02-24	2018-03-16	2018-03-16
Demobilization		2018-02-25	2018-03-17	2018-03-17
Flight time	Production	133:33	109:46	243:19
	Ferry and tests	18:01	21:09	39:10
	Total	**151:34**	**130:55**	**282:29**
L-km flown	Traverses	29,835	21,223	51,058
	Tie lines	4,900	3,829	8.729
	Total	**34,735**	**25,052**	**59.787**
Participation		58%	42%	

5.0 FIELD AND OFFICE CREW

The general management of the project was monitored offsite by Ms. Isabelle D'Amours. Mr. Saleh Elmoussaoui was responsible for data quality control while Mr. Mouhamed Moussaoui did the final data processing, consulting with Mr. Frank Kiss, Technical Inspector from the Geological Surveys of Canada, to ensure that the work was carried out according to contractual specifications.

Field and office personnel are listed in table 6.

Table 6: Field and Office Crew

Function	Name
Project Manager	Ms. Isabelle D'Amours, P.Eng.
Data Quality Control	Mr. Saleh Elmoussaoui
Field Manager	Mr. Saleh Elmoussaoui Mr. Kenneth Bernier
Field Instrument Operators	Mr. Francois Godin Mr. Pierre Filion Mr. Kenneth Bernier Mr. Alireza Kasraei
Professional Pilots/co-pilots	Mr. Manuel Gagné Mr. Sacha Labrie Mr. Sébastien Proulx Mr. Alan Brown
Final Processing	Mr. Mouhamed Moussaoui, P.Eng.
CAD Specialist (Drawing Products)	Ms. Isabelle D'Amours, P.Eng.
Survey Technical Report	Ms. Isabelle D'Amours, P.Eng.

6.0 AIRCRAFT AND EQUIPMENT

6.1 Aircraft

A Beechcraft King Air (C-FLRB) and a Piper Navajo PA-31 aircraft (C-GPTB) flew the geophysical survey (Figure 4). All aircraft were Transport Canada approved to carry out this particular type of survey.

The main characteristics of the aircraft are presented below:

Beechcraft
King Air A100

C-FLRB

Piper
Navajo PA-31

C-GPTB

Figure 4: Piper Navajo PA-31 and Beechcraft King Air twin-engine aircraft

Aircraft Characteristics	C-FLRB	C-GPTB
Type	Beechcraft KingAir 100	Piper Navajo PA-31
Empty Weight	3 100 kg	1 710 kg
Max charge	5 200 kg	2 950 kg
Ceiling	10 000 m	8 320 m
Rate of climb	13.2 m/s	7.1 m/s
Survey Speed	75 m/s (146 knots)	75 m/s (146 knots)
Fuel Type	Jet fuel	AVGAS 100LL
Fuel consumption (2 engines)	270 litres/hr	130 litres/hr
Survey / Maximum range	5.0 / 6.0 hours	5.0 / 6.0 hours

6.2 Magnetometer and digital acquisition systems

6.2.1 Airborne magnetometer

The following table describes the airborne magnetometer. The sensor was mounted in a stinger rigidly attached to each aircraft tail.

Magnetometer	C-FLRB	C-GPTB
Manufacturer	Geometrics	Geometrics
Type and Model	Cesium G-822A	Cesium G-822A
Ambient Range	20 000 - 100 000 nT	20 000 - 100 000 nT
Sensitivity	± 0.003 nT	± 0.003 nT
Absolute Accuracy	± 10 nT	± 10 nT
Noise Envelope	0.10 nT	0.10 nT
Sampling Rate	10 Hz	10 Hz
Heading effect	<2.0 nT	<2.0 nT

The cesium CS-3 sensor is a versatile and highly sensitive means of accurately measuring the Earth's total magnetic field intensity. Based upon the principle of optical pumping and monitoring, the cesium sensor is capable of resolving millisecond variations as small as 0.005 nT (gamma) or 1 part of 10,000,000 of the Earth's magnetic field. This unique process involves the interaction of the magnetic moment and angular momentum of the valence electron of cesium with the ambient magnetic field to produce an oscillation whose frequency is dependent on the magnetic field intensity. The sensor, operating on an atomic process, contains no moving parts and is inherently simple, rugged, and accurate.

6.2.2 Magnetic Compensator and Data Acquisition system

The magnetic field generated by the aircraft was compensated using a DAARC500, an Automatic Aeromagnetic Digital Compensator system manufactured by RMS Instruments. The DAARC500 incorporates a sophisticated and flexible data acquisition system.

The DAARC500 is an instrument used to compensate or correct in real time for the magnetic interference caused by the aircraft itself and aircraft maneuvering in the Earth's magnetic field, when using inboard-mounted high sensitivity magnetometers. The compensation accounts for the effects of permanent magnetism, induced magnetism, Eddy currents and also removes the heading errors caused by the sensors themselves. It provides a frequency bandwidth of DC to 0.9 Hz, the frequencies of most interest to the geophysicist. Other bandwidths are optionally available. The signal(s) from the magnetometer(s) are digitized faithfully without aliasing or phase distortion.

The DAARC500 is based on many years of research and development on automatic aeromagnetic compensation by the National Aeronautical Establishment (NAE), a division of the National Research Council of Canada. Following the transfer of technology, RMS Instruments continued with the development resulting in an instrument which is extremely reliable, capable of accepting the Larmor frequencies of up to four high sensitivity magnetometers, and is based on a sophisticated compensation algorithm which is extremely robust.

Figure 5: The RMS DAARC500 unit and its Graphical User Interface

Data acquisition system	C-FLRB	C-GPTB
Manufacturer	RMS Instruments	RMS Instruments
Model	DAARC500	DAARC500
GPS synchronization	PPS signal	PPS signal
Magnetic compensator	integrated	integrated

Geophysical instruments and sensors may be directly connected to the DAARC500, via 8 Outputs and Inputs high speed RS232 digital ports and 16 analogic Inputs ports as well as an ethernet port. Incoming data are real time processed via serial ports. All acquired data are synchronized through a GPS receiver pulse-per-second (PPS).

6.3 Ground base station magnetometer

Two GEM System inc. Overhauser type ground magnetometers with combined GPS system were used as ground base stations. They provided synchronized GPS time and recorded the total intensity of the earth's magnetic field with a resolution of 0.01 nT.

The primary and secondary magnetic base stations were set up at a magnetic noise-free location, away from magnetic objects, vehicles and DC electrical power lines (Figure 2). Both magnetometers sampled at a rate of one per second. Records, including GPS time, were dumped digitally on a computer, merged with airborne data and displayed daily.

The following table describes the base station magnetometers:

Mag base station	Magnetic Base A	Magnetic Base B
Manufacturer	GEM System inc	GEM System inc
Type	Overhauser	Overhauser
Model	GSM-19 w/ GPS	GSM-19 w/ GPS
Dynamic Range	20 000 - 120 000 nT	20 000 - 120 000 nT
Sensitivity	± 0.01 nT	± 0.01 nT
Sampling Rate	1 Hz	1 Hz
Noise Level	0.10 nT	0.10 nT

Figure 6: The base station magnetometer and console

6.4 Positioning Cameras, Navigation and Flight Path Systems

6.4.1 Video system

The vertically-mounted, continuous-recording video camera, with a wide angle lens to maximize ground coverage at survey altitude, operated at all times while aircraft was surveying. Data, which were displayed alphanumerically in the top portion of each frame, included time after midnight, date and GPS generated lat,lon,Z co-ordinates. Data and video were available for review immediately after each flight with no further processing.

The following tables describe the video system installed in the aircraft:

Video camera	C-FLRB	C-GPTB
Manufacturer	Samsung	Samsung
Model	SNB-7002	SNB-7002
Mounting	Vertical	Vertical
Video Format	Full HD	Full HD
Iris Exposure	Automatic	Automatic

Video recorder	C-FLRB	C-GPTB
Manufacturer	Samsung	Samsung
Model	SRN-470DN	SRN-470DN

Figure 7: Video camera and digital recorder

6.4.2 Differential GPS and Navigation System

A dual frequency GPS antenna was mounted on each aircraft over the cockpit. The following table describes the airborne GPS system, which obtained a complete coverage and provided both real-time navigation and flight-path recovery:

Figure 8: GPS receivers and Navigation System

GPS receiver	C-FLRB	C-GPTB
GPS Manufacturer	Novatel	Novatel
Model	DL-V3 L1/L2	DL-V3 L1/L2
Number of Channels	12	12
Sampling Interval	1 Hz	1 Hz
Differential System	SBAS Real time	SBAS Real time
Recording media	Compact Flash card	Compact Flash card

Navigation system	C-FLRB	C-GPTB
Manufacturer	Agnav	Agnav
Model	Guia LiNav 3D	Guia LiNav 3D

A dual frequency Novatel DL-V3 GPS Receiver sampling once every second was also used as a base station for post-flight differential correction of each aircraft's raw GPS data of all flights.

6.4.3 Radar altimeter

On each aircraft, a radar altimeter was used for measuring the distance between aircraft and ground accurately. The following table presents the technical characteristics of the altimeter:

Equipment	C-FLRB	C-GPTB
Manufacturer	Honeywell	Honeywell
Model	HG8505DA01	HG8505DA01
Minimum Range	0 to 2400 m	0 to 2400 m
Accuracy	±3 ft + 1%	±3 ft + 1%
Resolution	0.03 m	0.03 m
Sampling rate	2 Hz	2 Hz

6.4.4 Barometric altimeter

The following table describes the barometric altimeter with digital output, which was installed in each aircraft:

Equipment	C-FLRB	C-GPTB
Manufacturer	Honeywell	Honeywell
Model	PPT0020AWN2VA	PPT0020AWN2VA
Pressure Ranges	0 to 20 psi	0 to 20 psi
Accuracy	0.10 %	0.10 %
Sensitivity	3 mV/m	3 mV/m
Recording Interval	1 Hz	1 Hz

While the barometric altimeter data were recorded in flight and used as backup for the GPS height measurements, the output was not archived in the final data set since the differentially corrected GPS height data in comparison were much more precise.

7.0 QUALITY CONTROL - FIELD

All work was performed to the satisfaction and subject to the acceptance of the Technical Inspector. A copy of the Technical Specifications was available to **GDS**'s personnel responsible in the execution of the contract.

After each production day, instrument operators were bringing the acquired data to the field office in order to achieve quality control. The processing system consisted of a computer equipped with commercial and custom software including that for GPS processing (Novatel WayPoint), profile and flight path plots and all processing software necessary to calculate intersections, and to carry out preliminary levelling and gridding (Geosoft Montaj).

Digital data were verified daily to ensure the recorded parameters met the contract specifications. Positional data were analyzed to verify for the accuracy of the differentially corrected flight path.

7.1 GPS Data

Navigation and positioning were achieved through differential GPS. All aircraft were equipped with a Novatel DL-V3 GPS receiver. After each production day, data including GPS positions were transferred to the field computer systems and merged into the database. GPS data were differentially processed, using NovAtel Waypoint software. The actual surveyed flight path digital data were displayed and compared to the planned flight path. Errors were noted and re-flights called where necessary.

Latitude	Longitude	Altitude (ellips)
60° 42' 33.126" N	135° 04' 19.46" W	716.31

Verification on the positioning included a calculation of a digital elevation model (DEM), using the differentially corrected GPS altitude and altimeter data. The DEM was gridded and displayed. GPS receivers generated latitudes and longitudes which were then projected to UTM Northing and Easting, with respect to the WGS 84 datum.

7.2 Flight Path Specifications

The survey height was controlled according to a pre-defined smooth drape surface. The nominal terrain clearance was 150 metres except in areas where Transport Canada regulations prevent flying at this height. In areas where obstacles or topography conflicted with the drape surface, the pilot's judgement prevailed within reason. Traverse lines and control lines were flown at the same altitude at points of intersection. The altitude tolerance was limited to no more than +/-15 metres difference between traverse lines and control lines.

All traverse lines intersected a minimum of two control lines. Outside survey boundaries, all traverse lines started or ended by intersecting a control line. In order to provide valid information beyond the map boundaries, traverse and control lines had to be extended over a minimum distance of 1000 meters. No gaps were accepted in the final products.

For each survey flight, adjacent lines were flown consecutively and in opposite directions. Race track flying pattern was not permitted.

Lines flown outside the following positioning tolerances were re-flown at GDS' own cost.

Table 7: Flight plan specifications

Area	Line type	Bearing	Spacing	Min/Max separation	Min. overfly distance
Marsh Lake	Traverse	N045° E	400 m	300 / 500 m	1 000 m
	Control	N135° E	2 400 m	-	1 000 m

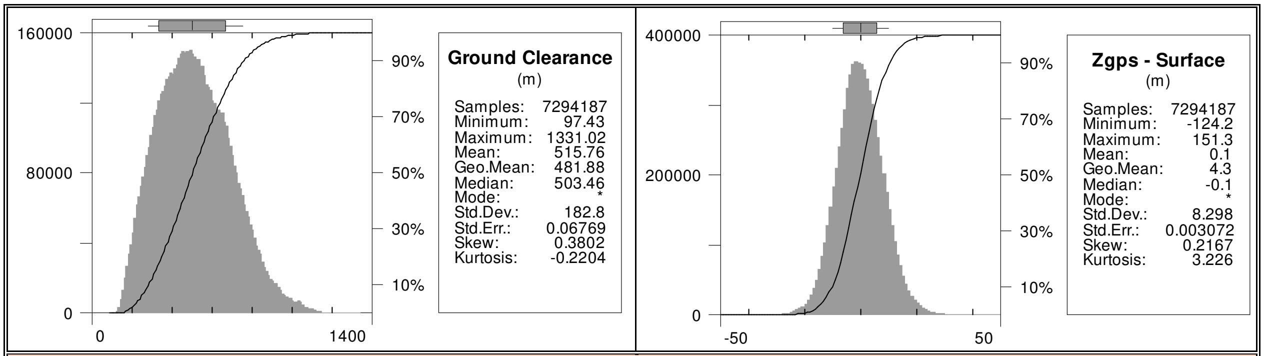

Figure 9: Ground clearance (left) and deviation from flight surface (right)

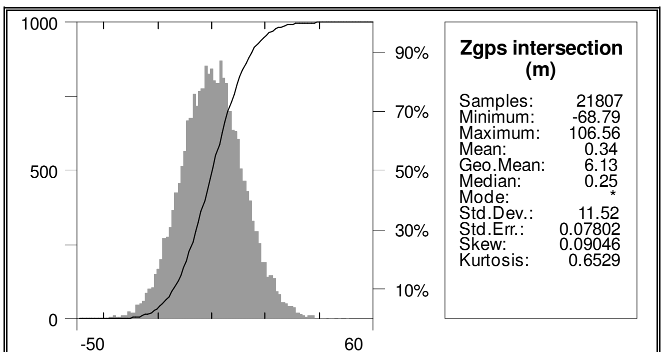

Figure 10: Traverse/Tie Altitude difference

7.3 Diurnal Specifications

Diurnal magnetic variations were monitored and recorded using two base stations. Base station and aircraft acquisition time were synchronized via GPS time.

For each base station, a maximum tolerance of 3.0 nT (peak to peak) deviation from a long chord equivalent to a period of one minute was requested. An additional maximum tolerance of 0.50 nT (peak to peak) deviation from a long chord equivalent to a period of 15 seconds for each station was also requested.
The base station magnetometers were located at the following coordinates in WGS84 (figure 2):

	Installation date	Latitude	Longitude
Magnetic base A	January 7, 2018	60° 44' 51.45" N	135° 04' 05.71" W
Magnetic base B	January 7, 2018	60° 44' 07.65" N	135° 04' 55.90" W
	January 15, 2018	60° 44' 08.43" N	135° 05' 00.71" W

7.4 Maintenance of speed and sampling

The pilot flew this survey with an average ground speed of 299 kilometres per hour. As the data is recorded at a rate of 10 Hz, the density is equivalent to one sample data every 8.3 meters on the ground.

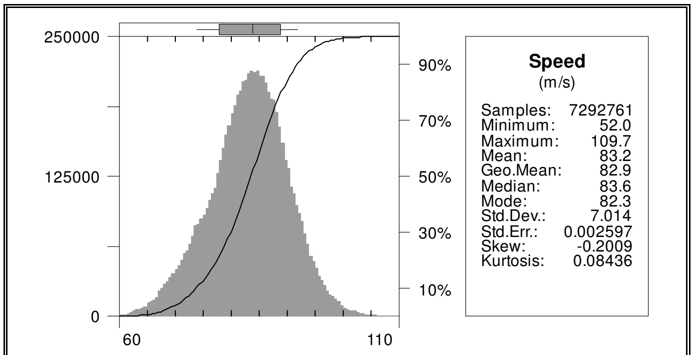

Figure 11: Aircraft speed statistics

7.5 Magnetic data

All magnetic data recorded in flight were checked for noise by an inspection of the fourth difference trace.

When enough and adequate data were accumulated, magnetic values for traverse/tie line intersections were calculated and preliminary magnetic levelling were carried out. Finally, preliminary magnetic grids were produced to ensure data veracity and completeness.

8.0 FINAL DATA PROCESSING

Since the data had been edited and processed throughout the data acquisition phase, it was not expected that additional serious problems would be encountered. Nevertheless, further editing and compilation procedures were carried out to detect and correct for any remaining isolated errors. The processing stages, such as refining the positioning, levelling and gridding through to final contours, are shown in figures 12 and 13. The processing was monitored closely by the Project Leader. The digital data, as well as the preliminary and final products were submitted to the Technical Inspector for checking according to the contract specifications.

8.1 Positioning Data (GPS and altimeters)

The raw GPS data from the aircraft and the base stations were recovered. Waypoint's GrafNav software was used for post-processing and for verifying the raw GPS data. The latitudes and longitudes were converted from the WGS84 spheroid to the local map projection and datum in UTM coordinates. A point to point speed calculation was then done from the final X, Y, Z coordinates and reviewed as part of the quality control. The flight data was then cut back to the proper survey line limits and a preliminary plot of the actual flight path was done and compared to the planned flight path to verify the navigation.

The positional data, which includes the radar altimeter and post-processed corrected GPS elevation values were checked and corrected for spikes using a fourth difference editing routine. The raw radar altimeter data was adjusted using the calibrations determined from the altimeter flight test. Some subtle noise filters, such as a non-linear of 0.3sec and a low-pass of 0.5sec, were then applied to the data. The filtered radar altimeter data were also lagged to account for system parallax.

A digital elevation model (DEM) was then computed by subtracting the altimeter values from the differentially corrected GPS elevation values.

8.2 Magnetic base station data

The recorded magnetic diurnal base station data were loaded into the flight database based on common GPS time stamps. After initial verification of its integrity, the data were checked and corrected for small DC shifts and cultural events.

8.3 Airborne Magnetic Data

The RMS DAARC500 binary raw data (mag, analog and serial inputs) were reformatted and loaded into the Oasis Montaj database.

A detail check of the magnetic data was done along each flight. The magnetic data were corrected for spikes followed by lag correction. After that, a filter was applied to remove some small noise detected on the data. The noise removed had a wavelength cut-off of 0.9sec.

The airborne magnetic data weren’t corrected for diurnal drift. Tests showed that subtraction of ground from airborne magnetometer data didn’t enhance the overall quality.

Prior to levelling, the magnetic data was corrected for small height departures from the intended drape surface as the datum in order to bring magnetic total filed levelling traverse line and control line intersections values to the same altitude. The Taylor series expansion consisting of continuations using the grid of the First and Second Vertical Derivative of the pre-levelled magnetic data, and the differences between Zgps and drape surface were applied for this purpose.

Tie line levelling process was then applied to the corrected magnetic data. This consists of calculating the positions of the control points (intersections of traverses and tie lines), calculating the magnetic differences at the control points and analyzing to produce a smooth pattern of adjustments to the levelling network in order to reduce the misclosures to zero. In areas of steep magnetic gradient and/or of rugged topographic relief, the intersection adjustments have been deleted or an appropriate adjustment assigned to a traverse line. Due to the nature of the magnetic field in the area and the diurnal variation along the survey, pseudo-tie lines were created between actual flown control lines and introduced to help and improve the levelling of the total magnetic field data.

No micro-levelling has been applied to the magnetic data.

To produce the Residual Magnetic Field, the International Geomagnetic Reference Field (IGRF), defined at the average GPS altitude of 1606 m for the current mid-survey date of 2018/02/13, was first calculated from the year 2015 model, and then removed from the levelled magnetic data.

8.4 Gridding of the Residual Magnetic Field and First Vertical Derivative

The grid of the Residual Magnetic Field and its First Vertical Derivative were calculated by using the minimum curvature algorithm with software developed by the Geological Survey of Canada and gridded with a cell size of 100 metres. Minimum curvature gridding provides the smoothest possible grid surface that also honours the profile line data.

The First Vertical Derivative of the magnetic field is the rate of change of the magnetic field in the vertical direction. Computation of the first vertical derivative removes long-wavelength features of the magnetic field and significantly improves the resolution of closely spaced and superposed anomalies. The grid of the First Vertical Derivative was computed from the gridded Residual Magnetic Field data using a fast Fourier transform.

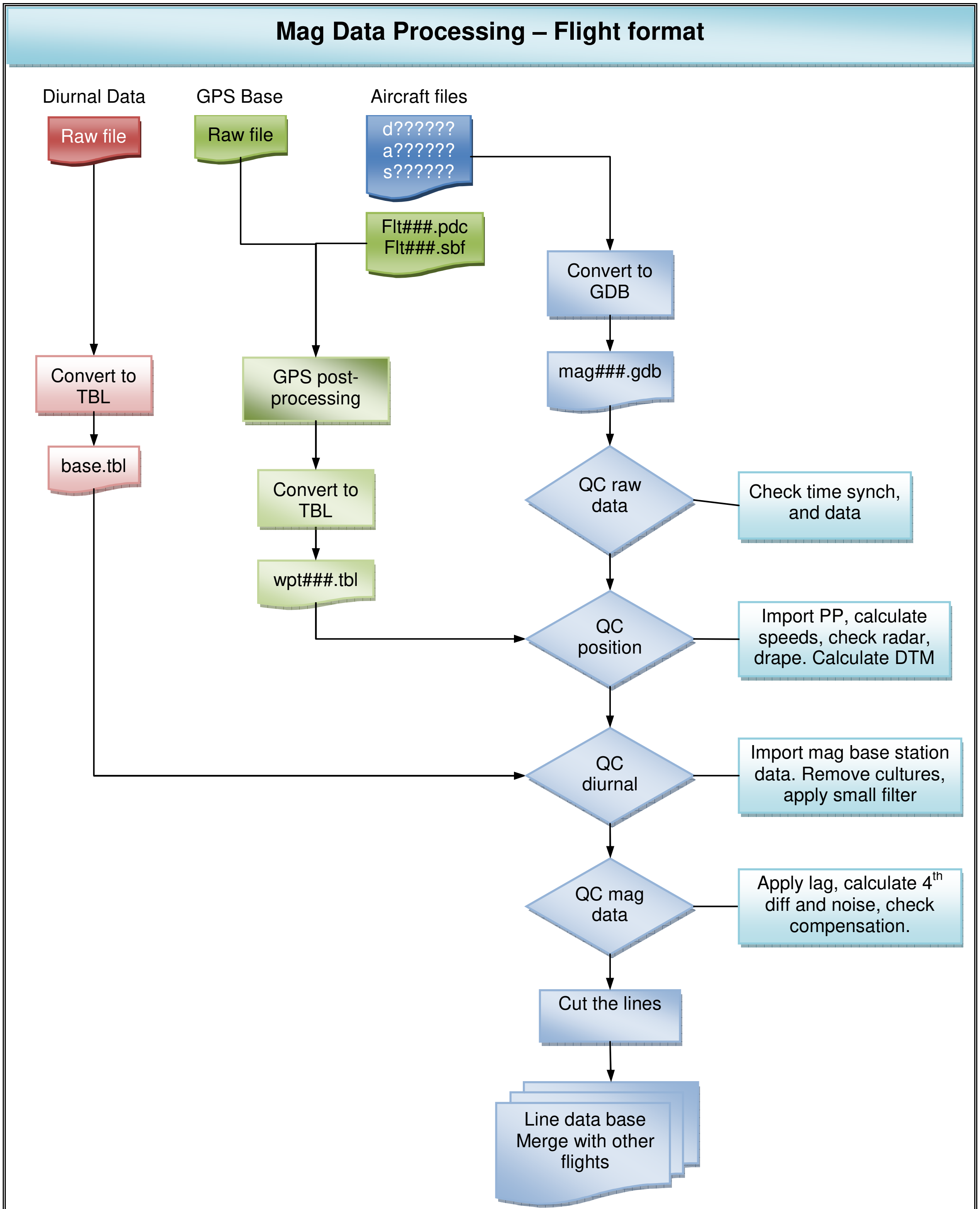

Figure 12: Magnetic data processing flowchart – Flight format

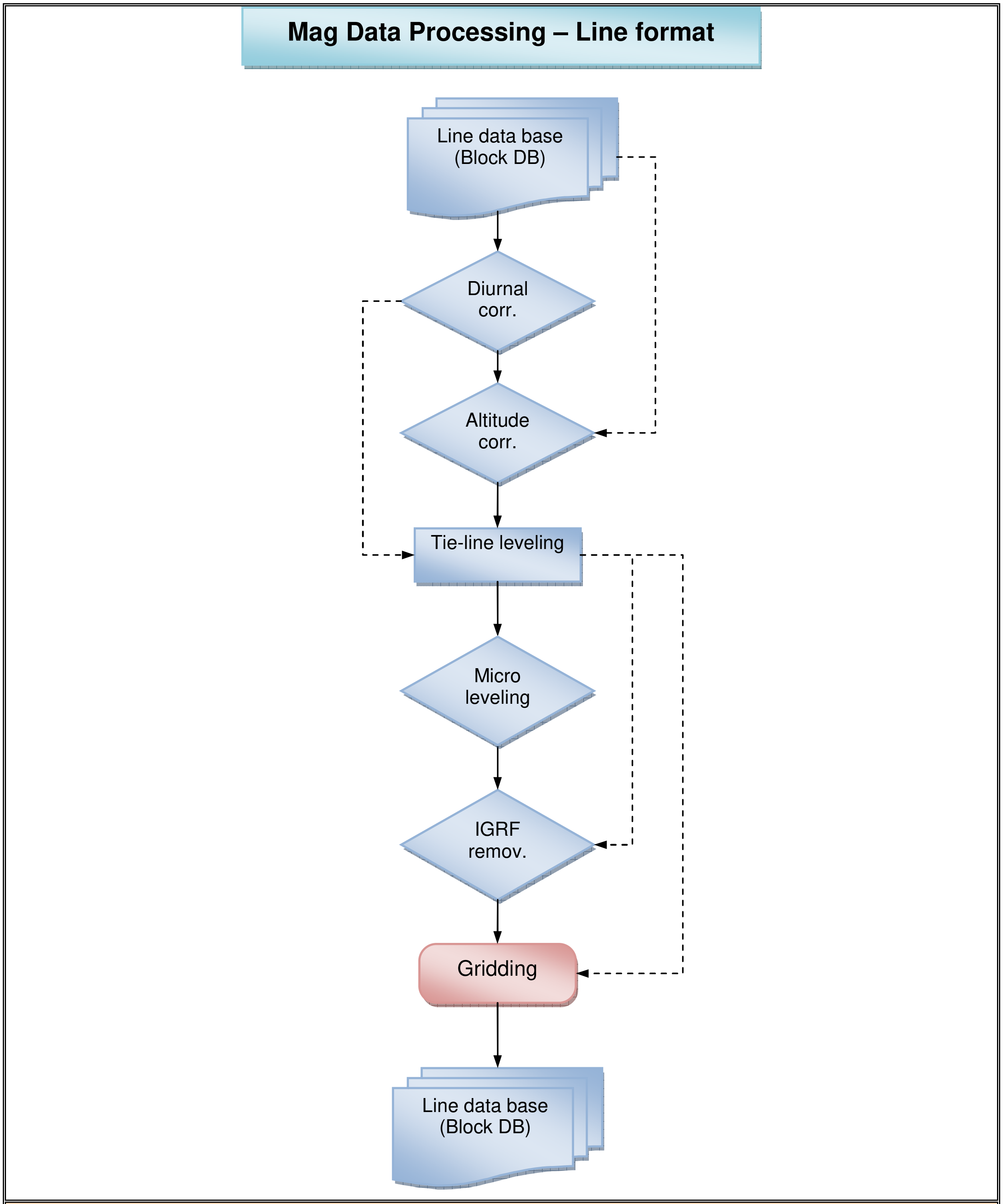

Figure 13: Magnetic data processing flowchart – Line format

9.0 FINAL PRODUCTS

9.1 Compilation Specifics

Map Scale and projection: 1:100 000 WGS84 UTM Zone 8
Grid cell size: 100 meters

The following parameters were processed:

- Magnetic Total Field
- Residual Total Magnetic Field
- Magnetic First Vertical Derivative
- Magnetic Second Vertical Derivative
- Digital Elevation Model

9.2 Final Products

Maps

All final maps were delivered in both Geosoft MAP and Adobe PDF/X formats.

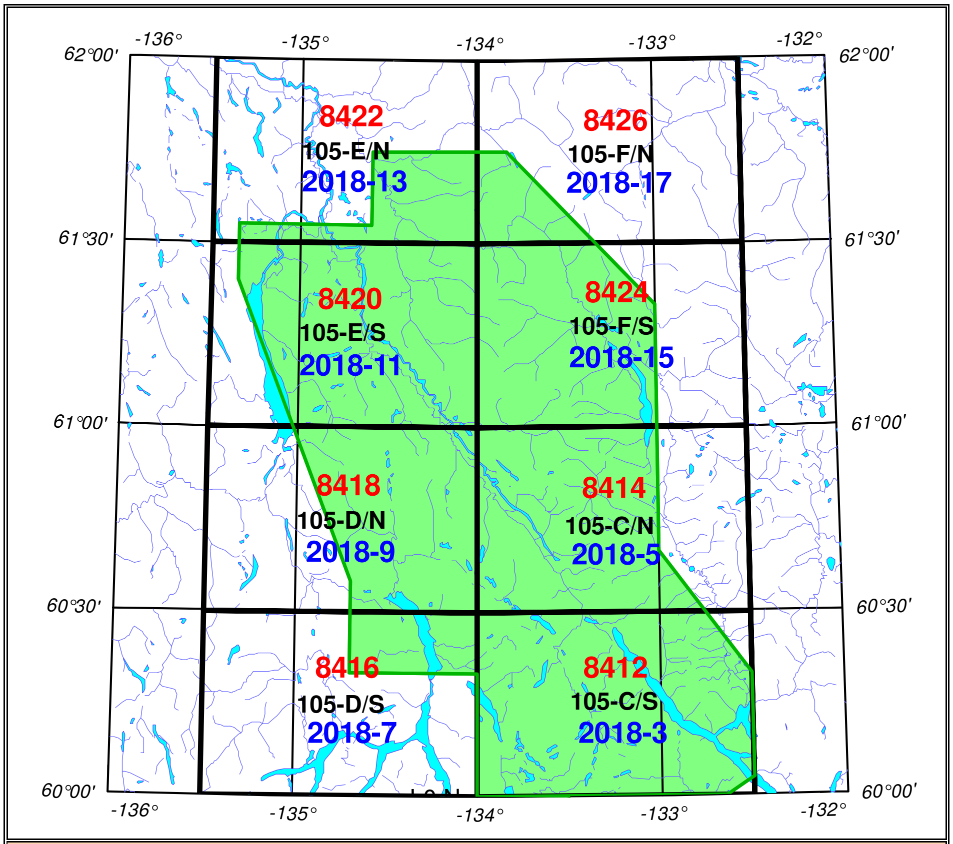

Figure 14: Final Map index

NTS sheet (1:100,000)	GSC Open File		YGS Open File	
	Residual Total Magnetic field	Magnetic first vertical derivative	Residual Total Magnetic field	Magnetic first vertical derivative
Part of NTS 105-C / South	OF8412	OF8413	2018-3	2018-4
Part of NTS 105-C / North	OF8414	OF8415	2018-5	2018-6
Part of NTS 105-D / South	OF8416	OF8417	2018-7	2018-8
Part of NTS 105-D / North	OF8418	OF8419	2018-9	2018-10
Part of NTS 105-E / South	OF8420	OF8421	2018-11	2018-12
Part of NTS 105-E / North	OF8422	OF8423	2018-13	2018-14
Part of NTS 105-F / South	OF8424	OF8425	2018-15	2018-16
Part of NTS 105-F / North	OF8426	OF8427	2018-17	2018-18

Final Report

- Final technical report (3 paper copies) accompanied by digital files in PDF format.

Video archive

- Flight path videos on external USB hard drive

Data archives on DVD (2 copies) (table 9)

- One Geosoft format digital archive of the final line data.
- One Geosoft format grid file for each of the processed parameters for the entire survey.

Profile Data

- Magnetic line archive profiles are provided in Geosoft Montaj binary database (GDB) sampled at 10Hz. The content of the database is summarized in table 8.

Table 8: Final database channel listing		
Channel Name	**Description**	**Units**
FIDCOUNT	Fiducial counter	-
FLIGHT	Flight number	-
LINE	Line number	-
AIRCRAFT	Aircraft registration name	-
DATE	Date of flight line (YYYYMMDD)	-
UTCTIME	Time, UTC (Universal Time Clock) -- second of day	sec
LONG	Longitude (NAD83)	deg
LAT	Latitude (NAD83)	deg
EASTING	Easting (NAD83, UTM zone 8N)	m
NORTHING	Northing (NAD83, UTM zone 8N)	m
GPSALTR	Uncorrected GPS altitude (real-time)	m
GPSALT	Differentially Corrected GPS Altitude	m
SURFACE	Drape Surface	m
RALT	Final radar altitude (Terrain clearance)	m
DEMRAW	Raw Digital Elevation Model (GPSALT – RALT)	m
DEMLEV	Levelled Digital Elevation Model	m
DIURNRAW	Raw Diurnal, main base station	nT
DIURNAL	Edited Diurnal / ground magnetics (main base)	nT
DIUR2RAW	Raw Diurnal, base station 2	nT
DIURNAL2	Edited Diurnal / ground magnetics (base 2)	nT
FLUXLONG	Longitudinal Vector of Magnetic field (fluxgate)	nT
FLUXTRAN	Transverse Vector of Magnetic field (fluxgate)	nT
FLUXVERT	Vertical Vector of Magnetic field (fluxgate)	nT
MAGUNCOM	Raw uncompensated, unlagged mag	nT
MAGCOM	Raw compensated, unlagged mag	nT
MAGRAW	Raw compensated, lagged mag	nT
MAGHFCOR	High-Frequency correction to mag	nT
ALTCOR	Taylor series correction factor for height variations	nT
MAGTLCOR	Tie-line levelling corrections to mag	nT
SRVMGLEV	Final tie-line leveled mag (SRVMGLEV = MAGRAW + MAGHFCOR + ALTCOR + MAGTLCOR)	nT
IGRF	IGRF correction calculated at altitude 1606 m, date 2018/02/13	nT
SRVMGRES	Leveled residual magnetic field	nT
LINENAME	Line type (L=traverse Line, T=Tie)	-
LINETYPE	Line name (Line type + Line number)	-

Table 9: DVD archive content	
File	**Description**
****	
File list & description.pdf	DVD archive content
\Marsh_Lake_Technical_Report	
MarshLake-Technical_Report.pdf	Technical Report
\Marsh_Lake_PROFILE	
Marsh_Lake_channel_list.pdf	Database channel list and description
Marsh_Lake.gdb	Magnetic database (Geosoft GDB)
\Marsh_Lake_GRIDS (Geosoft GRD and GeoTIFF, NAD83 UTM zone 8N, Cell size: 100 m)	
Marsh_Lake_SRVMGLEV.grd / .tif	Magnetic Total field
Marsh_Lake_SRVMGRES.grd / .tif	Residual Magnetic Total field
Marsh_Lake_FVD.grd / .tif	Magnetic First vertical derivative
Marsh_Lake_SVD.grd / .tif	Magnetic Second vertical derivative
Marsh_Lake_DEM.grd / .tif	Digital Elevation Model
\Marsh_Lake_MAPS\RMF (All maps are provided in Geosoft MAP and PDF, NAD83 UTM zone 8, Scale 1:100,000)	
OF8412_105C-S-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105C South)
OF8414_105C-N-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105C North)
OF8416_105D-S-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105D South)
OF8418_105D-N-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105D North)
OF8420_105E-S-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105E South)
OF8422_105E-N-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105E North)
OF8424_105F-S-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105F South)
OF8426_105F-N-RMF.map / .pdf	Shaded Residual Magnetic Total field (NTS 105F North)
\Marsh_Lake_MAPS\VD1 (All maps are provided in Geosoft MAP and PDF, NAD83 UTM zone 8, Scale 1:100,000)	
OF8413_105C-S-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105C South)
OF8415_105C-N-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105C North)
OF8417_105D-S-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105D South)
OF8419_105D-N-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105D North)
OF8421_105E-S-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105E South)
OF8423_105E-N-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105E North)
OF8425_105F-S-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105F South)
OF8427_105F-N-VD1.map / .pdf	Shaded Magnetic First vertical derivative (NTS 105F North)

10.0 CONCLUSION

Flown from January 12th to March 16th, 2018, the aeromagnetic survey was completed within the time frame allowed by the contract.

All airborne and ground-based records were of excellent quality. Determined from the fourth difference of the lagged and edited airborne magnetic data, the noise level for the measured Total Magnetic Field was well within the accepted limits.

GPS results proved to be of high quality. The flight path was surveyed accurately according to the digital elevation model available. The speed checks showed no abnormal jumps in the data.

It is hoped that the information presented in this report, and the accompanying digital products, will be useful both in planning subsequent exploration efforts and in the interpretation of related exploration data.

Respectfully Submitted,

Isabelle D'Amours, P.Eng.
Geo Data Solutions GDS inc.

July 04, 2018
Date

APPENDIX A

CALIBRATION AND TESTS

BEECHCRAFT KING AIR A100

C-FLRB

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES
AT MOREWOOD, ONTARIO; MEANOOK, ALBERTA and BAKER LAKE, NUNAVUT

AIRCRAFT TYPE AND REGISTRATION: KingAir 100 C-FLRB
ORGANIZATION (COMPANY): Geo Data Solutions GDS Inc.
MAGNETOMETER TYPE: Geometrics, Cs G-822A
MAGNETOMETER SERIAL NUMBER:
COMPILED BY: SALEH

SITE AND DATE: Morewood 21-Dec-17
HEIGHT FLOWN: 1500 feet
SAMPLING RATE: 10.0 /sec
DATA ACQUISITION SYSTEM: RMS DAARC500
GSC 12/2015

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point Greenwich Mean Time	Total Field Value Recorded in Survey Aircraft over intersection point **T1 (nT)**	Observatory Diurnal Reading at Previous Minute i.e. Hours + Minutes **T2 (nT)**	Observatory Diurnal Reading at Subsequent Minute i.e. H hours + (M + 1) mins. **T3 (nT)**	Interpolated Observatory Diurnal Reading at Time H hours + M mins + S sec **T4 (nT)**	Calculated Observatory Value C = 640.1 **T5=T4-C* (nT)**	Error Value **T6=T1-T5 (nT)**
North	21:20:03.8	53596.8	54234.1	54234.2	54234.1	53594.0	2.7
South	21:16:38.5	53600.1	54233.9	54234.0	54234.0	53593.9	6.1
East	21:01:06.2	53596.8	54234.0	54234.0	54234.0	53594.0	2.8
West	21:04:53.8	53599.7	54234.1	54234.1	54234.1	53594.0	5.7
North	21:27:55.7	53596.4	54234.0	54234.0	54234.0	53593.9	2.5
South	21:24:07.4	53599.8	54233.8	54233.8	54233.8	53593.8	6.1
East	21:08:38.7	53597.3	54233.9	54234.0	54234.0	53593.9	3.4
West	21:11:49.9	53599.1	54233.8	54233.8	54233.8	53593.8	5.3

*C is the difference in the total field between the Blackburn, Meanook or Baker L. observatories (O) and the value (B) at the test site intersection point above the designated height

Ottawa(O)/Morewood(B), Ontario: 1500 Feet, C = (O-B) = 640.1 nT
Meanook(O)/Meanook(B), Alberta: 1000 Feet, C = (O-B) = 0 nT
Baker Lake(O)/ Baker Lake(B), Nunavut: 1000 Feet, C = (O-B) = 75 nT

Total: 34.6565 nT

Average North-South Heading Error (T6 North - T6 South): -3.4618 nT
Average East-West Heading Error (T6 East - T6 West): -2.4082 nT

Number of Passes for Average: 8

Ave: 4.3321 nT

The completed document must be forwarded to the GSC Project Leader prior to the start of field operations and a copy must be attached to the next weekly report.

FOM Test

Geo Data Solutions GDS Inc.

Location: Mont-Laurier, QC
Pilot: Manuel Gagnon
Operator: Francois Godin
Compiled by: Saleh

Date: 21-Dec-17
Aircraft: C-FLRB
Configuration: Stinger
Altitude: 3000m

Sensor3 - Tail Stinger

North (360º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	73395.7 to 73401.3	0.627	0.087	7.207
ROLL	73412.4 to 73418.1	0.993	0.073	13.603
YAW	73428.8 to 73434.7	0.165	0.068	2.426
	TOTAL	**1.785**	**0.228**	**7.829**

East (90º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	73499.0 to 73503.4	0.298	0.089	3.348
ROLL	73510.7 to 73516.8	1.319	0.111	11.883
YAW	73528.6 to 73534.1	0.184	0.163	1.129
	TOTAL	**1.801**	**0.363**	**4.961**

South (180º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	73591.3 to 73596.5	0.678	0.152	4.461
ROLL	73609.2 to 73616.9	0.712	0.242	2.942
YAW	73622.3 to 73630.4	0.136	0.157	0.866
	TOTAL	**1.526**	**0.551**	**2.770**

West (270º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	73686.2 to 73693.0	0.303	0.091	3.330
ROLL	73701.4 to 73707.7	0.328	0.032	10.250
YAW	73719.7 to 73729.7	0.189	0.106	1.783
	TOTAL	**0.820**	**0.229**	**3.581**

Uncomp. mag (nT)	**Comp. Mag (nT)**	**Improv. Ratio**
5.932	**1.371**	**4.327**

FOM Test

Geo Data Solutions GDS Inc.

Location:	Whitehorse,YK	**Date:**	12-Jan-18
Pilot:	Manuel Gagnon	**Aircraft:**	C-FLRB
Operator:	Francois Godin	**Configuration:**	Stinger
Compiled by:	Saleh	**Altitude:**	3000m

Sensor3 - Tail Stinger

North-East (45º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	75962.1 to 75966.9	0.655	0.053	12.358
ROLL	75978.5 to 75985	1.626	0.033	49.273
YAW	75995.4 to 76002.3	0.183	0.059	3.102
	TOTAL	**2.464**	**0.145**	**16.993**

South-East (135º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	76063.9 to 76069.5	0.821	0.045	18.244
ROLL	76079.9 to 76087.8	1.658	0.057	29.088
YAW	76099.9 to 76105	0.203	0.156	1.301
	TOTAL	**2.682**	**0.258**	**10.395**

South-West (225º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	76156.7 to 76163.5	1.033	0.039	26.487
ROLL	76173.6 to 76180.3	0.908	0.048	18.917
YAW	76193.6 to 76203.9	0.178	0.127	1.402
	TOTAL	**2.119**	**0.214**	**9.902**

North-West (315º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	76252.3 to 76261.4	0.532	0.084	6.333
ROLL	76270.3 to 76277.2	0.516	0.042	12.286
YAW	76289.5 to 76296.9	0.215	0.091	2.363
	TOTAL	**1.263**	**0.217**	**5.820**

Uncomp. mag (nT)	Comp. Mag (nT)	Improv. Ratio
8.528	**0.834**	**10.225**

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ALTIMETER CALIBRATION

Geo Data Solutions GDS Inc.

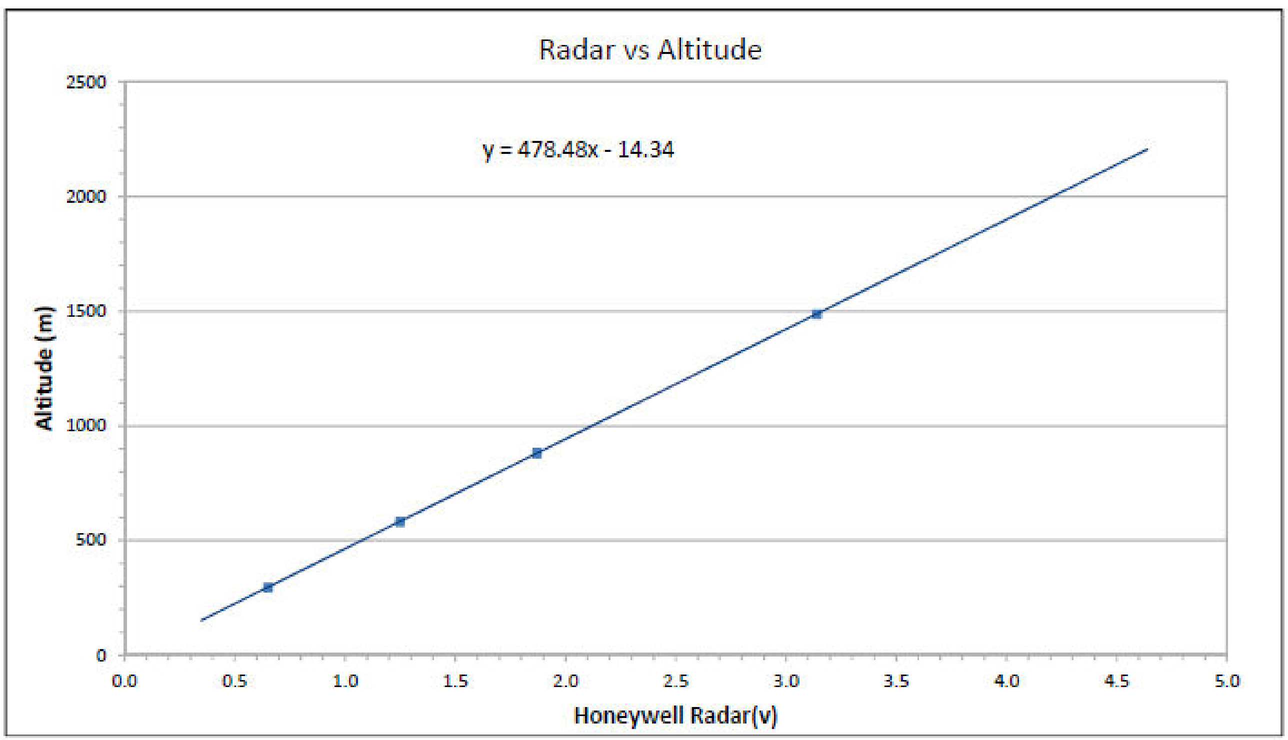
Location: Whitehorse, YK
Pilot: Emanuel Gagné, Sacha
Operator: Francois G.

Date: 18-janv-18
Aircraft: C-FLRB
Compiled by: SALEH

Antenna Height (m): 2.0

Terrain clearance (ft)	Honeywell (v)	Zgps (m)	Topo (m)	Altitude (m)
980	0.65	983.09	685.04	296.05
1310	1.25	1280.91	696.49	582.42
1640	1.87	1581.14	695.51	883.63
2300	3.14	2182.11	693.27	1486.84

radar(m)= 478.48 x (volt) - 14.34

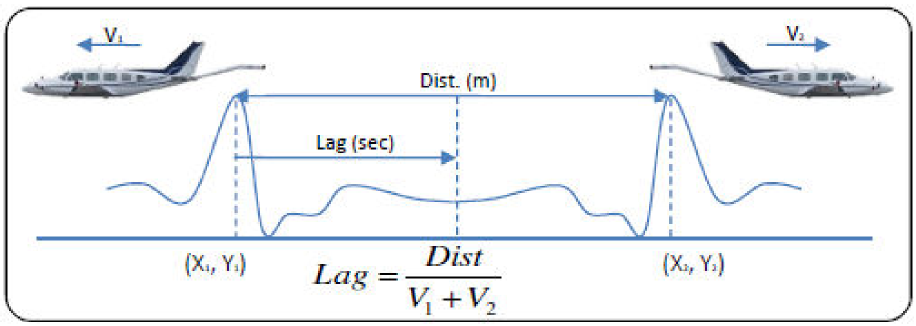


Lag Test

Geo Data Solutions GDS Inc.

Location: Marsh Lake. YK
Date: 9-Jan-18
Compile: Saleh

Aircraft: C-FLRB
Configuration: Stinger
Apply Tail Lag: +0.6



	Line Dir	Fiducial (sec)	X (m)	Y (m)	Z (m)	Mag Field (nT)	Vx (m/s)	Vy (m/s)	Speed (m/s)
A)	N 045	71136.80	546102.86	6834325.53	1869.35	57307.228	-63.73	-64.67	90.79
B)	N 225	71795.50	546028.70	6834234.74	1866.44	57296.775	63.38	64.42	90.37

Ave Speed = **90.58 m/s**

Passes dist.= **0.00 m** **Distance =** **117.23 m**

Tail Lag = **+0.65 sec**

APPENDIX B

CALIBRATION AND TESTS

PIPER NAVAJO PA-31

C-GPTB

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES
AT MOREWOOD, ONTARIO; MEANOOK, ALBERTA and BAKER LAKE, NUNAVUT

AIRCRAFT TYPE AND REGISTRATION: Piper Navajo C-GPTB
ORGANIZATION (COMPANY): Geo Data Solutions GDS Inc.
MAGNETOMETER TYPE: Geometrics, Cs G-822A
MAGNETOMETER SERIAL NUMBER:
COMPILED BY: Carlos Cortada

SITE AND DATE: Morewood 2-Feb-18
HEIGHT FLOWN: 1500 feet
SAMPLING RATE: 10.0 /sec
DATA ACQUISITION SYSTEM: RMS DAARC500
GSC 12/2015

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point Greenwich Mean Time	Total Field Value Recorded in Survey Aircraft over intersection point **T1 (nT)**	Observatory Diurnal Reading at Previous Minute i.e. Hours + Minutes **T2 (nT)**	Observatory Diurnal Reading at Subsequent Minute i.e. H hours + (M + 1) mins. **T3 (nT)**	Interpolated Observatory Diurnal Reading at Time H hours + M mins + S sec **T4 (nT)**	Calculated Observatory Value C = 640.1 **T5=T4-C* (nT)**	Error Value **T6=T1-T5 (nT)**
North	18:21:43.6	53579.3	54214.6	54214.6	54214.6	53574.5	4.8
South	18:18:31.0	53577.8	54213.8	54213.8	54213.8	53573.8	4.1
East	18:34:47.7	53578.4	54213.9	54213.9	54213.9	53573.8	4.5
West	18:31:54.5	53577.8	54213.8	54213.8	54213.8	53573.8	4.0
North	18:28:04.0	53578.7	54214.1	54214.1	54214.1	53574.0	4.6
South	18:24:40.7	53577.3	54213.2	54213.2	54213.2	53573.1	4.2
East	18:41:44.3	53578.5	54214.2	54214.2	54214.2	53574.1	4.4
West	18:38:18.0	53578.0	54213.7	54213.7	54213.7	53573.7	4.3

*C is the difference in the total field between the Blackburn, Meanook or Baker L. observatories (O) and the value (B) at the test site intersection point above the designated height

Ottawa(O)/Morewood(B), Ontario: 1500 Feet, C = (O-B) = 640.1 nT
Meanook(O)/Meanook(B), Alberta: 1000 Feet, C = (O-B) = 0 nT
Baker Lake(O)/ Baker Lake(B), Nunavut: 1000 Feet, C = (O-B) = 75 nT

Total: **34.9413 nT**

Average North-South Heading Error (T6 North - T6 South): **0.562 nT**
Average East-West Heading Error (T6 East - T6 West): **0.319 nT**

Number of Passes for Average: 8 Ave: **4.3677 nT**

The completed document must be forwarded to the GSC Project Leader prior to the start of field operations and a copy must be attached to the next weekly report.

FOM Test

Geo Data Solutions GDS Inc.

Location: Mont Laurier, QC
Pilot:
Operator: Francois G.
Compiled by: Carlos Cortada

Date: 2-Feb-18
Aircraft: C-GPTB
Configuration: Stinger
Altitude: 3000m

Sensor3 - Tail Stinger

North (360º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	63476.1 to 63480	0.495	0.040	12.375
ROLL	63493.6 to 63499	0.702	0.046	15.261
YAW	63514 to 63519.7	0.203	0.115	1.765
	TOTAL	**1.400**	**0.201**	**6.965**

East (90º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	63591.8 to 63596.5	1.076	0.093	11.570
ROLL	63609.7 to 63615.2	0.358	0.040	8.950
YAW	63623.5 to 63628.3	0.759	0.058	13.086
	TOTAL	**2.193**	**0.191**	**11.482**

South (180º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	63680.6 to 63684.3	2.440	0.043	56.744
ROLL	63693.8 to 63699.5	0.921	0.024	38.375
YAW	63710.1 to 63715.3	0.406	0.049	8.286
	TOTAL	**3.767**	**0.116**	**32.474**

West (270º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	63779.2 to 63783.8	0.573	0.075	7.640
ROLL	63792.2 to 63796.2	1.413	0.041	34.463
YAW	63812.5 to 63818.1	0.213	0.058	3.672
	TOTAL	**2.199**	**0.174**	**12.638**

Uncomp. mag (nT)	Comp. Mag (nT)	Improv. Ratio
9.559	**0.682**	**14.016**

FOM Test

Geo Data Solutions GDS Inc.

Location: Whitehorse,YK
Pilot: Sébastien Proulx
Operator: Kenneth Bernier
Compiled by: Saleh

Date: 14-Feb-18
Aircraft: C-GPTB
Configuration: Stinger
Altitude: 3000m

Sensor3 - Tail Stinger

SE (135º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	2615.8 to 2623	1.525	0.046	33.152
ROLL	2633.6 to 2640.4	0.210	0.030	7.000
YAW	2650.1 to 2659.3	0.565	0.069	8.188
	TOTAL	**2.300**	**0.145**	**15.862**

NE (45º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	2718.2 to 2724.1	0.309	0.037	8.351
ROLL	2734.2 to 2741.2	0.283	0.046	6.152
YAW	2751.7 to 2757.6	0.118	0.068	1.735
	TOTAL	**0.710**	**0.151**	**4.702**

NW (315º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	2811.3 to 2819.4	0.626	0.038	16.474
ROLL	2825.8 to 2833.2	0.956	0.018	53.111
YAW	2842.6 to 2852.5	0.399	0.035	11.400
	TOTAL	**1.981**	**0.091**	**21.769**

SW (225º)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	2896.9 to 2905.5	2.057	0.066	31.167
ROLL	2915.3 to 2923.3	0.917	0.021	43.667
YAW	2931.6 to 2941.1	0.624	0.024	26.000
	TOTAL	**3.598**	**0.111**	**32.414**

Uncomp. mag (nT)	Comp. Mag (nT)	Improv. Ratio
8.589	**0.498**	**17.247**

ALTIMETER CALIBRATION

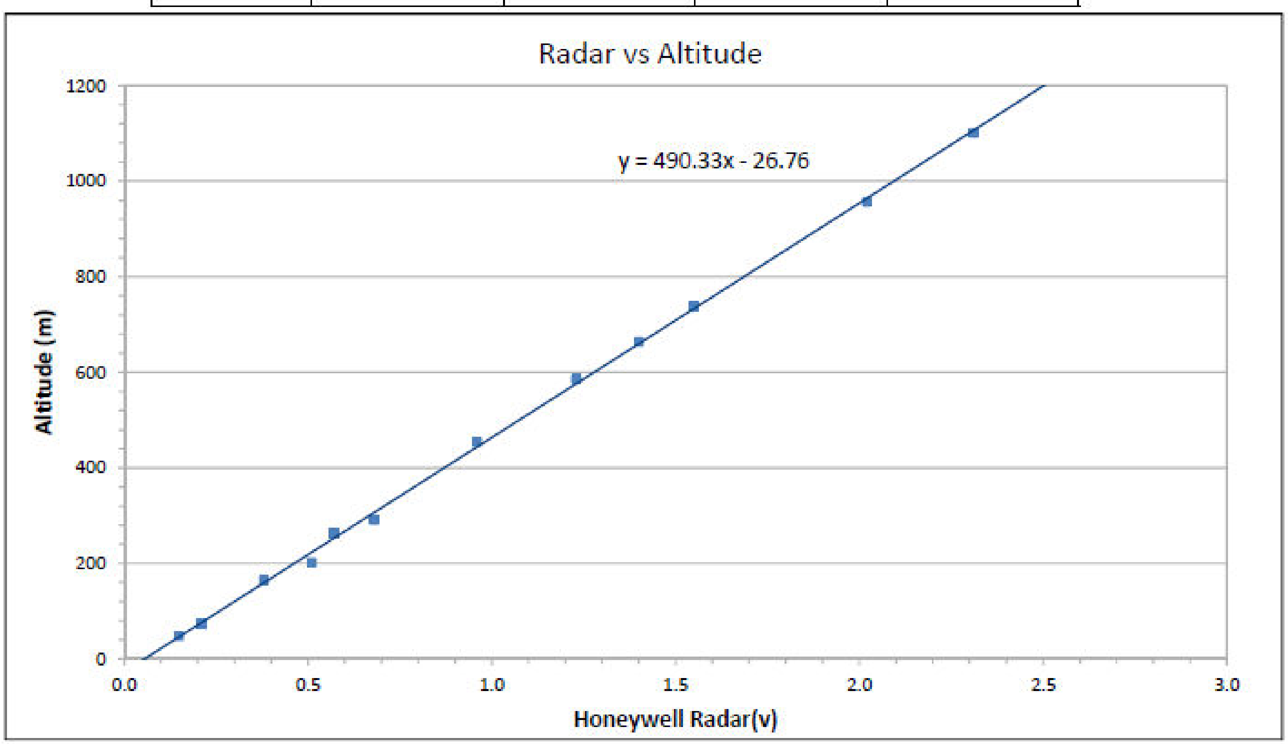
Geo Data Solutions GDS Inc.

Location: Ottawa and Whitehorse
Pilot: Sebastien Proulx
Operator: Alireza Kasraei

Date: 2018-02-02 & 2018-02-10
Aircraft: C-GPTB
Compiled by: SALEH

Antenna Height (m): 2.0

Terrain clearance (ft)	Honeywell (v)	Zgps (m)	Topo (m)	Altitude (m)
180	0.15	762.40	711.80	48.60
290	0.21	788.08	711.70	74.38
550	0.38	866.86	711.84	165.05
660	0.51	882.84	678.24	202.60
866	0.57	947.10	680.95	264.15
1025	0.68	972.77	679.25	291.52
1460	0.96	540.00	83.80	454.20
1900	1.23	656.88	68.24	586.64
2150	1.40	733.82	67.15	664.67
2400	1.55	810.66	70.18	738.48
3100	2.02	1039.56	80.73	956.83
3600	2.31	1165.47	62.43	1101.04



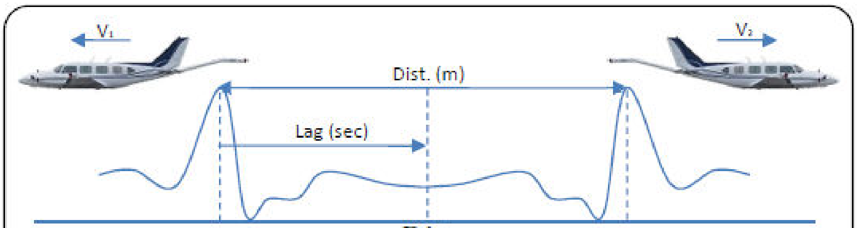
Lag Test

Geo Data Solutions GDS Inc.

Location: Marsh Lake. YK
Date: 13-Mar-18
Compile: Saleh

Aircraft: C-GPTB
Configuration: Stinger
Apply Tail Lag: +0.7

Ties: 50260-50261



$$Lag = \frac{Dist}{V_1 + V_2}$$

	Line Dir	Fiducial (sec)	X (m)	Y (m)	Z (m)	Mag Field (nT)	Vx (m/s)	Vy (m/s)	Speed (m/s)
A)	N 135	92943.00	524106.49	6761505.75	1741.50	57524.925	-66.32	67.50	94.63
B)	N 315	90137.60	524005.24	6761591.49	1747.19	57509.723	67.45	-67.14	95.17

Ave Speed = 94.90 m/s
Passes dist.= 0.00 m **Distance =** 132.68 m
Tail Lag = +0.70 sec

APPENDIX C

DAILY REPORT

Daily Report

Date	Flying Time			Production (Km)				Flights	Comments
	Flown	Survey	Ferry	Total	Accepted	Extra	Rejected		
18-Dec-17									Preparation
19-Dec-17									Preparation
20-Dec-17	01:25	00:00	01:25					101.1	FERRY TO LACHUTE C-FVTL
21-Dec-17	06:48	00:00	06:48					1.1 001 101 101.2	FOM and MOREWOOD CALIBRATION TESTS C-FLRB, C-FVTL
22-Dec-17	01:13	00:00	01:13					002	FERRY BACK ST H C-FLRB RADAR CHECK
23-Dec-17									**HOLIDAYS PERIOD**
24-Dec-17									
25-Dec-17									
26-Dec-17									
27-Dec-17									
28-Dec-17									
29-Dec-17									
30-Dec-17									
31-Dec-17									
1-Jan-18									
2-Jan-18									
3-Jan-18									PREPARE FOR MOB
4-Jan-18									WEATHER
5-Jan-18									MOBILIZATION (Emanuel , Sacha, Francois)
6-Jan-18									MOBILIZATION (Emanuel , Sacha, Francois),arrived to Whitehorse
7-Jan-18									START SETUP , Saleh and Alireza (E. Tech) arrived to Whitehorse
8-Jan-18									FLIGHT ABORTED DUE TO WEATHER CONDITIONS
9-Jan-18									COLD weather, havey rugged terrain Radar loose signal
10-Jan-18									COLD weather, havey rugged terrain Radar loose signal
11-Jan-18									flight aborted due to weather
12-Jan-18	03:09	01:50	01:19	515.2	513.0			005	small flight and FOM calibration
13-Jan-18	03:23	03:05	00:18	834.5	826.8			006	
14-Jan-18									no production due to weather
15-Jan-18	04:59	04:42	00:17	1 277.4	1 272.6			007	
16-Jan-18	00:44	00:01	00:43					8.1	no production due to weather
17-Jan-18	04:59	04:46	00:13	1 305.9	1 298.8			009	
18-Jan-18	00:21	00:19	00:02					10.1	no production due to weather
19-Jan-18									no production due to weather
20-Jan-18									no production due to weather
21-Jan-18	03:02	02:44	00:18	733.5	725.2	0.5	2.6	011	
22-Jan-18	01:56	01:38	00:18	395.4	376.6	0.2	15.0	012	flight aborted due to weather
23-Jan-18	06:20	05:54	00:26	1 581.8	1 554.0	0.5	23.6	013 014	
24-Jan-18									
25-Jan-18	04:28	04:04	00:24	1 119.5	1 104.4			015	
26-Jan-18									Avionic Maintenance
27-Jan-18									Avionic Maintenance
28-Jan-18	06:47	06:20	00:27	1 688.7	1 687.6	2.8		016 017	
29-Jan-18	05:44	05:20	00:24	1 481.8	1 471.2		8.3	018	
30-Jan-18	01:55	01:37	00:18	450.7	448.0			019	late flight due to weather
31-Jan-18	05:50	05:36	00:14	1 480.9	1 462.2	0.2	13.9	020	
1-Feb-18	05:57	05:41	00:16	1 490.7	1 483.7			021	
2-Feb-18	09:46	06:16	03:30	1 748.1	1 741.9			022 023 201	
3-Feb-18	06:55	06:28	00:27	1 804.4	1 796.4			024 025	
4-Feb-18	06:50	06:35	00:15	1 852.9	1 843.2			026 027	
5-Feb-18	07:04	06:49	00:15	1 899.9	1 891.2			028 029	
6-Feb-18	02:34	02:31	00:03	724.7	722.4			030	
7-Feb-18									aircraft mechanical inspection
8-Feb-18									aircraft mechanical inspection
9-Feb-18									aircraft mechanical inspection
10-Feb-18	05:18	05:11	00:07	1 466.9	1 461.9			031	
11-Feb-18	09:14	08:51	00:23	2 503.3	2 495.0			032 033	
12-Feb-18	01:07	00:50	00:17	238.8	229.1	1.5	7.8	034	FLIGHT ABORTED DUE TO WEATHER CONDITIONS
13-Feb-18									WEATHER
14-Feb-18	01:07	00:00	01:07					202	C-FPTB arrives and FOM
15-Feb-18									WEATHER
16-Feb-18									WEATHER
17-Feb-18									WEATHER
18-Feb-18	16:16	14:11	02:05	3 785.5	3 762.8	1.5	2.5	035 203 036 204	
19-Feb-18	09:24	08:24	01:00	2 127.7	2 119.4			205 037	
20-Feb-18	10:11	08:57	01:14	2 375.3	2 301.2	3.2	57.1	038 206	
21-Feb-18	14:12	12:16	01:56	3 093.0	3 060.0	3.7	9.9	039 207 208	
22-Feb-18	11:14	10:08	01:06	2 548.1	2 537.2	0.4		209 040	
23-Feb-18									WEATHER
24-Feb-18	04:25	03:09	01:16	857.2	853.6			041 210	FLIGHT ABORTED DUE TO WEATHER CONDITIONS
25-Feb-18	05:47	04:51	00:56	1 092.1	1 054.0	3.3	8.6	211	
26-Feb-18									WEATHER
27-Feb-18	01:43	01:17	00:26	270.6	255.0	0.1	13.4	212	
28-Feb-18									WEATHER
1-Mar-18	05:24	04:58	00:26	1 125.1	1 104.7	0.8	3.8	213	
2-Mar-18	09:44	09:05	00:39	2 294.2	2 235.3	3.3	31.9	214 215	
3-Mar-18	09:08	08:06	01:02	2 072.1	2 054.8	0.9		216 217	
4-Mar-18									WEATHER
5-Mar-18	05:29	05:01	00:28	865.0	846.9		1.2	218	
6-Mar-18	05:29	05:18	00:11	1 313.8	1 311.6			219	
7-Mar-18	02:04	01:39	00:25	373.0	327.9	2.0	41.5	220	
8-Mar-18									inspection 100 h
9-Mar-18	04:22	03:56	00:26	914.6	894.3	2.6	11.0	221	
10-Mar-18	04:51	03:35	01:16	851.6	844.2			222	
11-Mar-18									
12-Mar-18	03:42	03:10	00:32	819.6	812.7			223	
13-Mar-18	10:37	09:52	00:45	2 554.8	2 482.6	2.0	57.2	224 225	
14-Mar-18	09:34	08:41	00:53	2 188.5	2 166.7	2.4		226 227	
15-Mar-18	10:19	09:03	01:16	2 115.4	2 083.3			228 229	
16-Mar-18	05:29	04:06	01:23	776.7	273.4	4.8	478.7	230 231	include reflown lines
17-Mar-18									survey completed and crew demob

FLIGHT SUMMARY - C-FLRB

Flight	Date	Pilot / Co-pilot	Operator	Processor	Flight time			Kilometers	
					Survey	Ferry	Total	Accepted	Rejected
001	21-Dec-17	Emanuel,Sacha	Francois,Alireza	saleh	00:00	01:10	01:10	0.0	0.0
001	21-Dec-17	Emanuel,Sacha	Francois,Alireza	saleh	00:00	01:57	01:57	0.0	0.0
002	22-Dec-17	Emanuel,Sacha	Francois,Alireza	saleh	00:00	01:13	01:13	0.0	0.0
003	8-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	**00:00**	**00:42**	**00:42**	**0.0**	**0.0**
003	9-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	03:21	00:18	03:39	0.0	0.0
004	10-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	03:07	00:24	03:31	0.0	0.0
004	10-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	00:00	01:24	01:24	0.0	0.0
005	12-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	01:50	01:19	03:09	513.0	0.0
006	13-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	03:05	00:18	03:23	826.8	0.0
007	15-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	04:42	00:17	04:59	1 272.6	0.0
008	16-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	00:01	00:43	00:44	0.0	0.0
009	17-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	04:46	00:13	04:59	1 298.8	0.0
010	18-Jan-18	Emanuel,Sacha	Francois,Alireza	saleh	00:19	00:02	00:21	0.0	0.0
011	21-Jan-18	Emanuel,Sacha	Alireza	saleh	02:44	00:18	03:02	725.2	2.6
012	22-Jan-18	Emanuel,Sacha	Alireza	saleh	01:38	00:18	01:56	376.6	15.0
013	23-Jan-18	Emanuel,Sacha	Alireza	saleh	04:21	00:13	04:34	1 110.7	23.6
014	23-Jan-18	Emanuel,Sacha	Alireza,Kenneth	saleh	01:33	00:13	01:46	443.2	0.0
015	25-Jan-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:04	00:24	04:28	1 104.4	0.0
016	28-Jan-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:47	00:14	05:01	1 244.4	-5.6
017	28-Jan-18	Emanuel,Sacha	Alireza,Kenneth	saleh	01:33	00:13	01:46	443.2	0.0
018	29-Jan-18	Emanuel,Sacha	Alireza,Kenneth	saleh	05:20	00:24	05:44	1 471.2	8.3
019	30-Jan-18	Emanuel,Sacha	Alireza,Kenneth	saleh	01:37	00:18	01:55	448.0	0.0
020	31-Jan-18	Emanuel,Sacha	Alireza,Kenneth	saleh	05:36	00:14	05:50	1 462.2	13.9
021	1-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	05:41	00:16	05:57	1 483.7	0.0
022	2-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:42	00:17	04:59	1 289.1	0.0
023	2-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	01:33	00:17	01:50	452.8	0.0
024	3-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:39	00:14	04:53	1 288.3	0.0
025	3-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	01:49	00:13	02:02	508.2	0.0
026	4-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:06	00:08	04:14	1 149.1	0.0
027	4-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	02:29	00:07	02:36	694.1	0.0
028	5-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:19	00:06	04:25	1 178.2	0.0
029	5-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	02:30	00:09	02:39	713.0	0.0
030	6-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	02:31	00:03	02:34	722.4	0.0
031	10-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	05:11	00:07	05:18	1 461.9	0.0
032	11-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:25	00:11	04:36	1 235.6	0.0
033	11-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:26	00:12	04:38	1 259.4	0.0
034	12-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	00:50	00:17	01:07	229.1	7.8
035	18-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	05:00	00:18	05:18	1 372.0	2.5
036	18-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	03:41	00:22	04:03	1 073.8	0.0
037	19-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:00	00:19	04:19	1 074.1	0.0
038	20-Feb-18	Emanuel,Sacha	Alireza,Kenneth	saleh	04:34	00:20	04:54	1 270.2	10.3
039	21-Feb-18	Emanuel,Sacha	Kenneth,Pierre	saleh	04:56	00:18	05:14	1 355.6	0.0
040	22-Feb-18	Emanuel,Sacha	Kenneth,Pierre	saleh	05:19	00:32	05:51	1 499.3	0.0
041	24-Feb-18	Emanuel,Sacha	Kenneth,Pierre	saleh	02:28	00:26	02:54	684.6	0.0

FLIGHT SUMMARY - C-GPTB

Flight	Date	Pilot / Co-pilot	Operator	Processor	Flight time			Kilometers	
					Survey	Ferry	Total	Accepted	Rejected
201	2-Feb-18	Sebastien , George	Alireza,Kenneth	saleh	00:01	02:56	02:57	0.0	0.0
202	14-Feb-18	Sebastien , Alan	Alireza,Kenneth	saleh	00:00	01:07	01:07	0.0	0.0
203	18-Feb-18	Sebastien , Alan	Alireza,Kenneth	saleh	03:28	00:44	04:12	815.3	0.0
204	18-Feb-18	Sebastien , Alan	Alireza,Kenneth	saleh	02:02	00:41	02:43	501.7	0.0
205	19-Feb-18	Sebastien , Alan	Alireza,Kenneth	saleh	04:24	00:41	05:05	1 045.3	0.0
206	20-Feb-18	Sebastien , Alan	Alireza,Kenneth	saleh	04:23	00:54	05:17	1 030.9	46.8
207	21-Feb-18	Sebastien , Alan	Kenneth,Pierre	saleh	04:36	00:46	05:22	1 114.3	0.0
208	21-Feb-18	Sebastien , Alan	Kenneth,Pierre	saleh	02:44	00:52	03:36	590.1	9.9
209	22-Feb-18	Sebastien , Alan	Kenneth,Pierre	saleh	04:49	00:34	05:23	1 037.9	-4.8
210	24-Feb-18	Sebastien , Alan	Kenneth,Pierre	saleh	00:41	00:50	01:31	169.0	0.0
211	25-Feb-18	Sebastien , Alan	Kenneth	saleh	04:51	00:56	05:47	1 054.0	8.6
212	27-Feb-18	Sebastien , Alan	Kenneth	saleh	01:17	00:26	01:43	255.0	13.4
213	1-Mar-18	Sebastien , Alan	Kenneth	saleh	04:58	00:26	05:24	1 104.7	3.8
214	2-Mar-18	Sebastien , Alan	Kenneth	saleh	05:12	00:16	05:28	1 259.5	31.9
215	2-Mar-18	Sebastien , Alan	Kenneth	saleh	03:53	00:23	04:16	975.8	0.0
216	3-Mar-18	Sebastien , Alan	Kenneth	saleh	04:54	00:23	05:17	1 240.4	0.0
217	3-Mar-18	Sebastien , Alan	Kenneth	saleh	03:12	00:39	03:51	814.4	0.0
218	5-Mar-18	Sebastien , Alan	Kenneth	saleh	05:01	00:28	05:29	846.9	1.2
219	6-Mar-18	Sebastien , Alan	Kenneth	saleh	05:18	00:11	05:29	1 311.6	-9.2
220	7-Mar-18	Sebastien , Alan	Kenneth	saleh	01:39	00:25	02:04	327.9	41.5
221	9-Mar-18	Sebastien , Alan	Kenneth	saleh	03:56	00:26	04:22	894.3	11.0
222	10-Mar-18	Sebastien , Alan	Kenneth	saleh	03:35	01:16	04:51	844.2	0.0
223	12-Mar-18	Sebastien , Alan	Kenneth	saleh	03:10	00:32	03:42	812.7	0.0
224	13-Mar-18	Sebastien , Alan	Kenneth	saleh	05:19	00:11	05:30	1 415.0	0.0
225	13-Mar-18	Sebastien , Alan	Kenneth	saleh	04:33	00:34	05:07	1 067.6	57.2
226	14-Mar-18	Sebastien , Alan	Kenneth	saleh	05:20	00:16	05:36	1 329.5	0.0
227	14-Mar-18	Sebastien , Alan	Kenneth	saleh	03:21	00:37	03:58	837.3	-0.6
228	15-Mar-18	Sebastien , Alan	Kenneth	saleh	04:50	00:15	05:05	1 106.7	0.0
229	15-Mar-18	Sebastien , Alan	Kenneth	saleh	04:13	01:01	05:14	976.6	0.0
230	16-Mar-18	Sebastien , Alan	Kenneth	saleh	04:06	00:27	04:33	273.4	478.7