TECHNICAL REPORT ON A FIXED WING AEROMAGNETIC SURVEY

North Stevenson Ridge Block,

Yukon

for

Geological Survey of Canada
and the
Yukon Geological Survey

by

GOLDAK AIRBORNE SURVEYS

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GOLDAK AIRBORNE
SURVEYS

Goldak Airborne Surveys
2 Hangar Rd.
Saskatoon, Saskatchewan
Tel: (306) 249-4474
Fax: (306) 249-4475
Cell: (306) 222-5104

Email: info@goldak.ca
URL: www.goldak.ca

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1. INTRODUCTION

This report describes an aeromagnetic survey conducted over the North Stevenson Ridge area in west central Yukon. This high sensitivity aeromagnetic survey was carried out by Goldak Airborne Surveys (Goldak) on behalf of the Geological Survey of Canada (GSC) and the Yukon Geological Survey (YGS) between May 10th, 2009 and July1st, 2009.

Aircraft equipment operated included three cesium vapour magnetometers, a GPS real-time and post-corrected differential positioning system, a flight path recovery camera, VHS titling and recording system, as well as radar and barometric altimeters. All data was recorded digitally in GEDAS binary file format.

Reference ground equipment included two GEM Systems GSM-19W Overhauser magnetometers and a Novatel 12 channel GPS base station which was set up at the base of operations for differential post-flight corrections.

All installations are described in more detail in Section 4 of this report. Equipment specifications can be found in Section 6.

Thirty four production flights were required to complete the survey block. A total of 25,358 line kilometres of high resolution magnetic data were collected, processed and plotted.

The traverse lines were flown at a spacing of 400 metres with control lines flown at a separation of 2400 metres. Nominal terrain clearance was specified at 100 metres above ground. Dawson City, YK was used as the base of operations throughout the entire survey.

2. SURVEY AREA LOCATION

The North Stevenson Ridge Survey block is centered approximately 150 kilometers south of Dawson City, YK with the midpoint roughly at 62° 42' N, 139° 34' W. This block contained 25,358 line kilometers of data (21,626 km of traverse lines and 3,731 of control lines).

Coordinates of the block are posted in Appendix A.

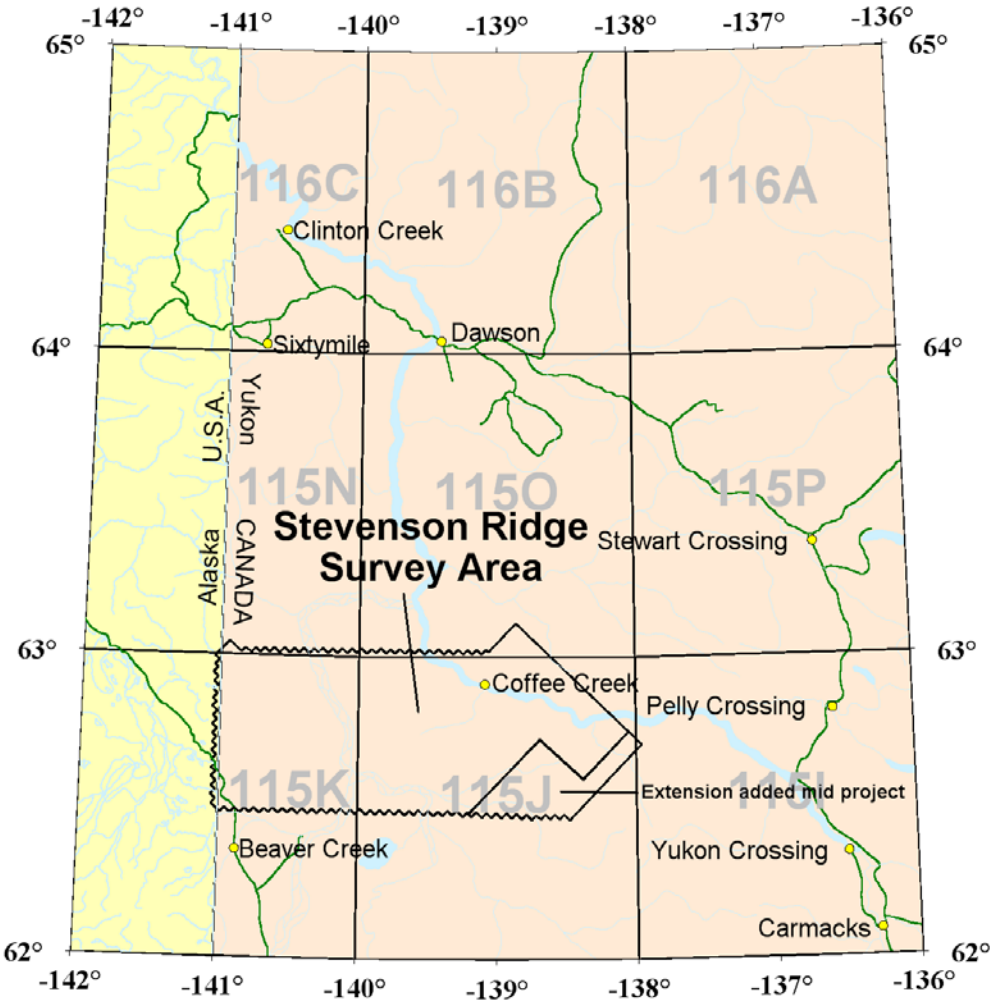

Figure 1 - Location of the Stevenson Ridge Survey Block

3. CONTRACT SPECIFICATIONS

3.1 Line Spacing

Traverse Lines	bearing:	N 41.75°E UTM
	spacing:	400 metres
	allowed min separation:	300 metres
	allowed max separation	500 metres
Control Lines	bearing	N131.75°W UTM
	nominal spacing:	2400 metres

3.2 Altitude

Altitude control was accomplished via a smooth drape, calculated using topographic data digitized from publically available government topographic maps.

> nominal altitude: 100 m MTC (mean terrain clearance)
> tolerance: a maximum 30m difference between traverse lines and control lines. To accomplish this, actual height deviations from the drape surface were not to exceed an envelope of +/- 15 metres at all times.

3.3 Diurnal

A maximum tolerance of 3 nT (peak to peak) deviation from a long chord equivalent to a period of 60 seconds was not to be exceeded. Additionally, the diurnal was not to exceed a 0.5 nT deviation over 15 seconds.

3.4 Magnetic Noise

The magnetic noise was not to exceed 0.1 nT in the 4^{th} digital difference.

All data was fully examined in the field and was deemed to have met the above specifications.

4. AIRCRAFT AND EQUIPMENT

4.1 Aircraft

Two aircraft were used on this survey. Each was a Piper PA-31 Navajo, registrations C-GJBB and C-GJBG, owned and operated by Goldak Airborne Surveys. Each aircraft is fitted with a 3-meter stinger attached to the rear fuselage on the centerline of the aircraft. The attitude sensing fluxgate magnetometer is positioned at the midpoint of the stinger. The aircraft also has magnetometers installed in composite pods on each wingtip. The pods mount the sensors 1.2 metres outboard of the aircraft wingtip. The three magnetometers form a two-axis gradiometer with following dimensions:

Lateral separation	14.865m
Longitudinal separation	9.754 m

The aircraft have been extensively modified, both mechanically and electrically, to minimize the effects of maneuvering on the measured magnetic field. Both aircraft have demonstrated a Figure of Merit of less than 0.7 nT as measured to Geological Survey of Canada (GSC) specification. Typical FOMs under less than ideal calibration environments are 0.9 nT for the tail magnetometer. This low level of magnetic noise is considered to be exceptional by experts at the National Research Council.

Figure 2 - Aircraft C-GJBB at Dawson City

4.2 Magnetometer and Compensation

The airborne magnetometers used are a matched set of Geometrics G-822A optically pumped cesium vapor types with sensitivity of 0.005 nT. The magnetometer's Larmor signal is decoupled and counted by an RMS Instruments AADCII compensator, and data are produced at a rate of 10 Hz with a resolution of 0.001 nT. The data bandwidth is from 0 to 0.9 Hz with an internal noise level of less than 0.002 nT.

The AADCII compensates for magnetic noise due to aircraft motion and heading. Prior to the survey, the aircraft is taken to an area of low magnetic gradient at a high altitude (7000' AGL +) and put through a series of rolls, pitches and yaws on each of the survey's cardinal headings. This is done so that the AADCII can form a model of the aircraft's magnetic characteristics without the near influence of the local geology. The remaining magnetic distortion is quantified by a term known as the Figure of Merit, or FOM. The Geological Survey of Canada uses a figure of merit of 1.5 or less as standard survey criteria. As stated above, this aircraft has an exceptional typical FOM of approximately 0.9 nT.

Several compensation flights were flown prior to the survey in an attempt to isolate some low magnitude noise that was polluting the data. The results of the two compensation flights that pertain to survey data are posted in Appendix B.

4.3 Magnetic Base Station

For this survey two magnetic base stations were installed. Dual stations are useful both as a hardware back up and to discern any cultural effects from either unit. In both installations the base station employed was a GEM Systems GSM19W Overhauser type proton precession magnetometer with GPS time base. Each setup was configured to log data both internally and externally to a DAP 9800 handheld computer with a compact flash memory card. The station closest to the base of operations (Basemag1) was also equipped with a VHF radio link to the processing office so that diurnal conditions could be monitored in real time.

Technical problems were experienced with Basemag2 from June 23 to June 29. Data from the CARISMA station were substituted in the Basemag2 channel for these flights.

Name	Latitude	Longitude	Reference Value	Comment
Basemag1	64° 3' 29.04"	-139° 25' 6.72"	57852 nT	1 km east of operations base, 200 m up on a hill
Basemag2	64° 2' 54.03"	-139° 6' 37.91"	57263 nT	On airport grounds, 500 m E of aircraft parking area.
CARISMA	64° 3' 0.00"	-139° 6' 36"	57694 nT	110 m east of the gateway to the firefighting base.

Table 1 - Magnetic base station details

4.4 GPS Positioning System

The GPS receiver in the survey aircraft was a Novatel OEM4 Propak 12 channel dual-frequency differential unit that communicates directly with the GEDAS system. This unit is used for navigation purposes and also logs data for post-flight differential corrections. The base station GPS was also a Novatel OEM4 dual-frequency Propak whose data were logged by a battery-powered, industrial portable computer. A survey-grade GPS base antenna designed to minimize multi-path errors was used.

GPS signals can be affected by atmospheric and ionospheric effects which typically reduce the accuracy of the non-differential positioning to approximately 10 metres RMS. If a suitable stationary GPS receiver, on a known or assumed position, is used to record the apparent errors in the satellite range data, those errors can be used to correct the moving receiver in the aircraft to an accuracy of 1 meter RMS. This compensation process is called differential correction and can be applied to the moving receiver in real time for higher dynamic accuracy, or applied later to find out where the aircraft *was* with high accuracy. These are called real-time and post-corrected differential positioning respectively.

The base GPS antenna used for post flight differential corrections was set up on the roof of the Yukon Hotel in Dawson City. The precise position of the antenna was determined by collecting 6.5 hours of data then submitting the data to the NRCan's online Precise Point Positioning (PPP) service. The following coordinate was delivered:

Latitude	64° 03' 32.9402" N
Longitude	139° 26' 18.4006" W
Ellipsoidal height	340.661 m

Table 2 – GPS Base Location

Figure 3 - Base GPS Location

4.5 Attitude Correction System

Three GPS antennas, connected to OEM 4 Power Pak receivers, are installed at the front, right wing and the tail of each aircraft to collect precise attitude data at 10 Hz. By determining the relative positions of the front-right and front-tail antenna pairs and comparing to the reference geometry of the aircraft, the pitch, roll, azimuth and yaw of the aircraft can be determined to within 1° +/- 0.2°. A correction matrix is derived, which when applied to the measured gradients, 'rotates' the measured gradients to maintain a consistent gradient orientation in three dimensions.

4.6 Radar Altimeter

Each aircraft had two radar altimeters installed. The primary unit was a Thompson ERT-160 with a range of 0 – 8000 feet, one meter resolution and an accuracy of 2%. A Terra TRA-30 with an accuracy of 5-7% over a range of 40 to 2500 feet was the secondary altimeter.

4.7 Barometric Altimeter

C-GJBB & C-GJBG were both equipped with a Setra model 270 barometric altimeter. This instrument has an accuracy of ±1 meter.

4.8 Flight Path Camera

The flight path was captured by a Panasonic GP-KR222 SV hi-resolution color video camera located in the lower rear fuselage of each aircraft. The video was recorded to a removable hard drive by a Toronto Micro Systems MDVR digital recorder, and then burned to dual layer DVD post flight.

4.9 GEDAS Digital Recorder

All magnetic and positioning data are processed and recorded digitally by our GEDAS system. The GEDAS is an industrial rack-mount Intel Pentium based PC computer with multiple hard-drives, IO ports and ADAC devices.

The GEDAS system records GPS navigation records at 1Hz and magnetic data at 10 Hz. Data files are organized on a flight-by-flight basis in a proprietary binary format. The data is then imported directly into Geosoft via a custom gx.

5. DATA PROCESSING AND PRESENTATION

All latitude/longitude positions in the databases are represented in the original WGS84 datum. All projected positions are expressed in the NAD83 datum. UTM coordinates are calculated in Zone 7 N.

5.1 Positioning Data

All position GPS position data was post processed in the field using Novatel Grafnav software. This step, depending on baseline distance and ionospheric activity, improves the accuracy of the data to the sub meter level.

5.2 Total Field Processing

The first steps in verifying the magnetic data took place in the field. The base station data was monitored to ensure compliance with the contract specification. The fourth difference was also monitored carefully to find any sudden offsets or other problems in the data.

The intention of tie line leveling is to apply a smoothly varying function to the measured data which results in near identical values at the intersections of traverse and control lines. The most significant component of the correction is to accommodate the diurnal variation of the magnetic field. Other sources of error are altitude errors, GPS positioning errors, and system drift.

Two processes were performed on the magnetometer data prior to tie line levelling. The first process, designed to remove undesired effects introduced to the data by the RMS AADCII compensator, and strongly correlation to turbulence, and involved the following steps:

1. Subtract the compensated mag (MAGCOM) from the uncompensated mag (MAGUNCOM).
2. Apply a 2 second low pass filter to the difference obtained from the above step.
3. Add the filtered difference to the uncompensated mag into a new channel named MAG

This step proved unnecessary on data collected from flights 45 to 50. For these flights MAGCOM values were used in the MAG channel.

A second process, designed to remove altitude related incongruities was performed on the MAG channel. This process involved the following steps:

1. Calculate the IGRF value using the drape surface (SURFACE) as the height reference.
2. Calculate the IGRF value using the actual aircraft height (GPSALT) as the height reference.
3. Subtract the DGPS IGRF value from the SURFALT IGRF value.
4. Subtract the difference of the above operation from the MAG channel to create MAGRAWED

Leveling of the total field magnetic data consists of the following steps:

1. Iterative application of best fit, zero, first and second order trends (with outliers removed) on traverse and control lines, recursively, until resulting correction approaches zero.

2. The final levelling step involves manual inspection of the remaining intersection mismatches and reducing it to zero where appropriate by applying the necessary amounts to either the survey or tie lines. Special attention is paid to ensuring that the overall correction profiles are as smooth as possible and that there is no line to line correlation in the correction profiles, which implies a misapplied correction. The correction channel (MAGTLCOR), when applied to the unleveled raw magnetic total field magnetic channel (MAGRAW_ED) produces the final levelled total field magnetic channel (SRVMGLEV).

3. The second vertical derivative of the total field grid is analyzed to ensure that the corrections are sufficient and appropriate. Features which appear along the survey lines in the second vertical

derivative may be the result of overcorrection or undercorrection. In either case the solution is to revise the correction profile at those intersections.

4. The International Geomagnetic Reference Field was subtracted from the final leveled total field channel. A fixed date of 2009.43 and a fixed altitude of 1219 metres ASL were used as input for this calculation.
   SRVMAGLEV – IGRF = SRVMGRES

5.3 Altitude Data

Part of the GPS positioning processing involves calculation of the aircraft height above sea level. This component of the position is the least reliable, however with suitable care should be accurate to within 2-3 metres.

The barometric altimeter is calibrated for the air pressure at the beginning of each flight. Barometric drift, which is very similar to the magnetic diurnal in that it varies both in time and in space, is corrected for by periodically synchronizing the barometric altimeter with GPS altitude.

The derived topography was generated by subtracting the radar altitude from the post-processed GPSZ, gridding the result and comparing it with the known topography. Some striations that showed in the resultant gridded data were removed from the profile data by means of the tie line leveling method described above.

5.4 Gridded Data

The residual total field and digital elevation grids were created using the minimum curvature method. Grid cell size for all grids is 100 m. The first vertical derivative grid was calculated directly from the residual total field grid.

5.5 Digital Data Files

Digital data has been provided on DVD-ROM in Geosoft .GDB format. One database was provided for each survey area. The fields included are as follows:

Contractor Channel Name	GSC Channel Name	Description	Format	Units	Sample Rate
Contractor	**GSC Channel**	**Description**	**Format**	**Units**	**Sample**
Line	LINE	Line number	I10	-	0.1
GTime	TIME	GPS Time (seconds of the day, dbl prec.& rounded)	F10.2	sec	0.1
fiducial	FIDUCIAL	Acquisition System time increment	F10.2	sec	0.1
DLon	LONG	Longitude [NAD83]	F13.6	deg	0.1
DLat	LAT	Latitude [NAD83]	F13.6	deg	0.1
X	EASTING	UTM Easting (NAD83, zone 8N)	F10.2	m	0.1
Y	NORTHING	UTM Northing (NAD83, zone 8N)	F10.2	m	0.1
RAlt1a	RALTRAW	Raw Primary Radar Altimeter	F10.2	m	0.1
Radar_Alt	RALT	Lagged Radar Altimeter - final	F10.2	m	0.1
CBaro	BALT	Barometric altimeter corrected for drift and lag	F10.2	m	0.1
SurfAlt	SURFACE	Ideal Surface altitude (drape)	F10.2	m	0.1
GPSZ0	GPSALTR	Uncorrected GPS Altitude (real-time)	F10.2	m	0.1
DGPSZ	GPSALT	Differentially Corrected GPS Altitude	F10.2	m	0.1
RadarTopo	DEMRAW	Raw digital Topography [GPSALT - RALT]	F10.2	m	0.1
demcorr	DEMCOR	Correction applied to digital Topography	F10.2	m	0.1
radartopo_Final	DEMLEV	Levelled digital Topography [GPSALT - RALT]	F10.2	m	0.1
MBU	MAGUNCOM	Raw uncompensated, unlagged Lower Tail Mag	F10.2	nT	0.1
MBC	MAGCOM	Raw compensated, unlagged Lower Tail Mag	F10.2	nT	0.1
MBc_Lag	MAGRAW	Raw compensated, lagged Lower Tail Mag	F10.2	nT	0.1
MBC_ed_lag	MAGRAWED	Compensated, lagged, HF_Filter corr. applied L.Tail	F10.2	nT	0.1
~~Mag_cor~~	~~MAGIGRF~~	~~MAGRAWED – Digrf/DHt => input for levelling~~	~~F10.2~~	~~nT~~	~~0.1~~

BaseMag1R	DIURNRAW	Raw Basemag1	F10.2	nT	0.1
BaseMag2R	DIUR2RAW	Raw Basemag2	F10.2	nT	0.1
BaseMag1	DIURNAL	Basemag 1	F10.2	nT	0.1
BaseMag2	DIURNAL2	Basemag2	F10.2	nT	0.1
tlcorr	MAGTLCOR	Tie-line levelling corrections to mag	F10.2	nT	0.1
Mag_level	SRVMGLEV	Final tie-line levelled mag	F10.2	nT	0.1
Igrf	IGRF	IGRF correction calculated at altitude of 1219 m	F10.2	nT	0.1
Magres	SRVMGRES	Levelled residual magnetic field	F10.2	nT	0.1
VMl	FLUXLONG	Longitudinal Vector Mag (fluxgate)	F10.2	nT	0.1
VMt	FLUXTRAN	Transverse Vector Mag (fluxgate)	F10.2	nT	0.1
VMv	FLUXVERT	Vertical Vector Mag (fluxgate)	F10.2	nT	0.1
Gsc_date	DATE	Local date **(YYYYMMDD)**	I10	-	0.1
Flight	FLIGHT	Flight number	I10	-	0.1

Table 3 - Final Database Channels

5.6 Final Maps

Maps were delivered in hard copy (7 copies of each) and digitally in both Geosoft .Map and .PDF format. The products delivered are as follows:

GSC Open File	YGS Open File	Description
6254	2009-28	Residual total magnetic field NTS 115 J/9 and 115 J/10
6255	2009-29	First vertical derivative NTS 115 J/9 and 115 J/10
6256	2009-30	Residual total magnetic field NTS 115J/11 and 115 J/12
6257	2009-31	First vertical derivative MF NTS 115J/11 and 115 J/12
6258	2009-32	Residual total magnetic field NTS 115 J/13 and115 J/14
6259	2009-33	First vertical derivative MF NTS 115 J/13 and 115J/14
6260	2009-34	Residual total magnetic field NTS 115 J/15 and 115 J/16
6261	2009-35	First vertical derivative MF NTS 115 J/15 and 115 J/16
6262	2009-36	Residual total magnetic field NTS 115 K/9 and 115 K/10
6263	2009-37	First vertical derivative MF NTS 115 K/9 and 115 K/10
6264	2009-38	Residual total magnetic field NTS 115 K/15 and 115 K/16
6265	2009-39	First vertical derivative MF NTS 115 K/15 and 115 K/16
6266	2009-40	Residual total magnetic field NTS 115-O/1, 115-O/2 and part of 115-O/3
6267	2009-41	First vertical derivative MF NTS 115 P/3 & 115 P4115-O/1, 115-O/2 and part of 115-O/3

Table 4 - Final Maps

5.7 Flight Path Video

Flight path video for this survey is supplied on dual layered DVD, one per flight in a proprietary format. Software required to view the video is included on each disk. Times, positions, direction and speed are overlain on the tape for detailed flight path recovery if required.

6. DETAILED EQUIPMENT SPECIFICATIONS

Our detailed equipment technical specifications are as follows:

Aircraft

C-GJBB	Piper PA-31 Navajo	
4m composite tail stinger		
Demonstrated Figure of Merit	0.9nT	
Sensor Separation		
Lateral	584"	14.865 m
Longitudinal	384"	9.754 m

Aircraft Magnetometers:

Manufacturer:	Geometrics
Type and Model Number:	Cesium G-822A
Range in nT:	20,000 to 90,000
Sensitivity in nT:	0.005
Sampling Rate:	10Hz

Base Station Magnetometers:

Manufacturer:	GEM Systems
Type and Model Number:	Overhauser GSM-19W
Range in nT:	20,000 to 120,000
Sensitivity in nT:	0.01
Sampling Rate:	5Hz maximum (0.5Hz typical)
Solar Power Supply:	1 - Solarex MSX50

Base Station Data Loggers:

Manufacturer:	DAP Technologies
Type and Model Number:	Microflex PC9800
Media Type:	Flash RAM (32 Mb)

Real-time Magnetic Compensator:

Manufacturer:	RMS Instruments
Type and Model Number:	AADCII
Range in nT:	20,000 to 100,000
Resolution in nT:	0.001
Sampling Rate:	20Hz

Radiometric System:

Manufacturer:	Radiation Solutions Inc.
Type and Model:	RS-500 Advanced Digital Gamma Ray Spectrometer
Detector Volume:	36 litres downward, 4 litres upward
Channels:	1024

Digital Acquisition System:

Manufacturer:	Goldak Exploration Technology
Type and Model Number:	GEDAS
Sampling Rate:	10Hz
Data Format:	GEDAS binary

Positioning Cameras:

Manufacturer:	Panasonic
Model:	GPKR402 HRSV
Lens:	WV-LR4R5 4.5mm
	FOV at 1000 feet AGL is 1040 x 1300 feet

Barometric Altimeter:

Manufacturer:	Setra
Type and Model Number:	270
Range:	-1000 to 10,000 feet
Resolution:	1 meter

Radar Altimeter 1:

Manufacturer	Thompson
Type and Model Number:	CFS 530A
Range:	0-8000 feet
Resolution:	1 meter
Accuracy:	2%

Radar Altimeter 2:

Manufacturer	Terra
Type and Model Number:	TRA3000 – TRI40
Range:	40-2500 feet
Resolution:	3 metres
Accuracy:	5-7%

Positioning System:

Manufacturer:	Goldak Exploration Technology Ltd.
Type and Model Number:	GEDAS
Displays:	10” color LCD graphical display
	Graphic LCD pilot indicator

GPS Subsystem:

Manufacturer	Novatel
Type and Model Number:	OEM4 dual-frequency Pro-paks (x3)
System Resolution:	1 meter
Overall accuracy:	3 m in real-time, <1m post-corrected

Software

Manufacturer:	Geosoft
Function:	Geophysical data processing
Type and Model Number:	Oasis Montaj v 6.2
Manufacturer:	Waypoint Consulting
Function:	GPS post-processing
Type and Model Number:	GrafNav 8.10, GrafMov 8.10
Manufacturer:	Handmade Software Inc.
Function:	converting map files to PDF
Type and Model Number:	Image Alchemy 1.13

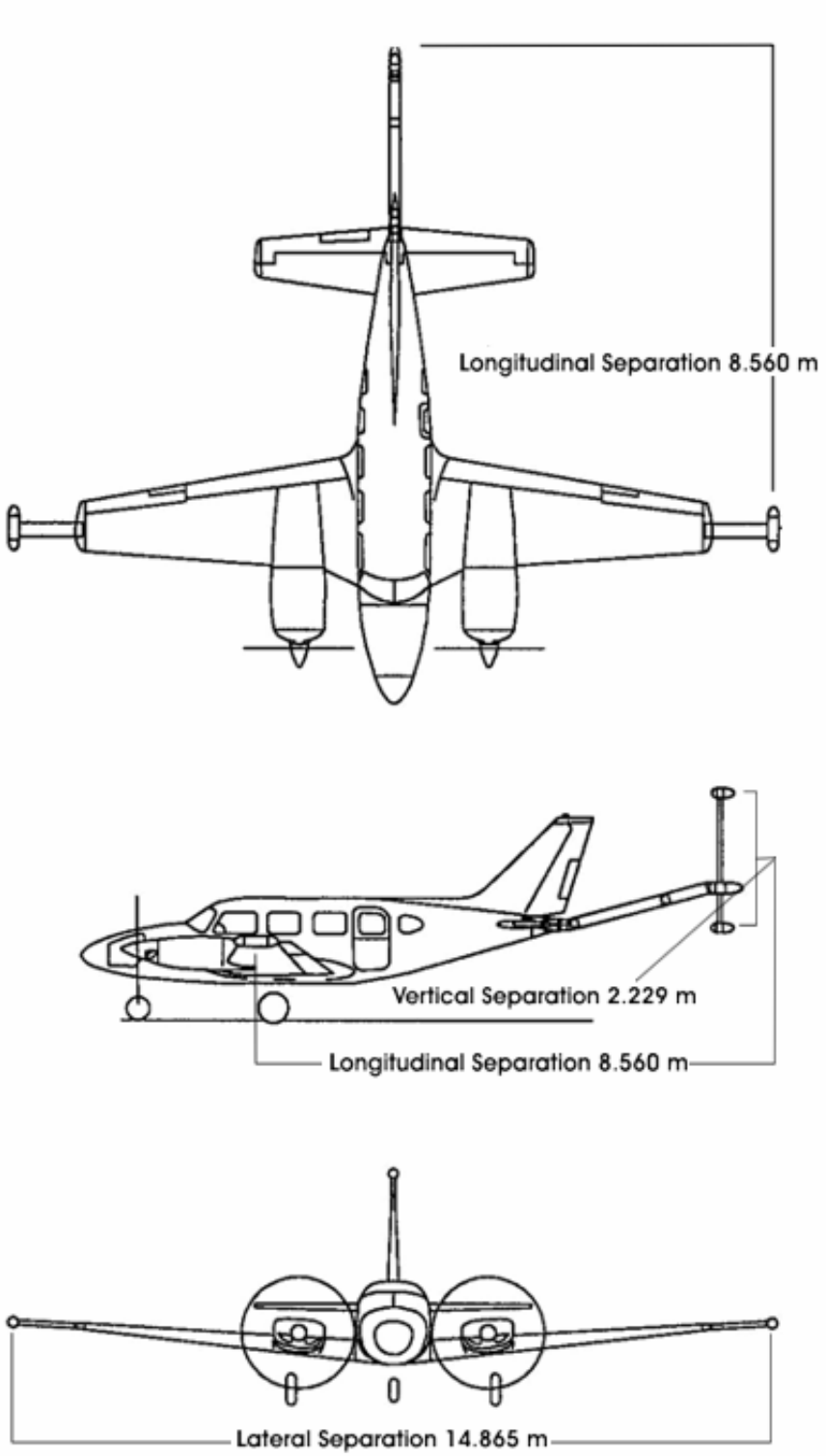

Figure 4 - Survey Aircraft Layout

7. STATEMENT OF QUALIFICATIONS

I, Marc Pelletier of the city of Saskatoon, Saskatchewan, certify that:

I am a member in good standing of the Association of Professional Engineers and Geoscientists of Saskatchewan (member number 10037).

I hold a B.Sc. Adv. in Geophysics from the University of Saskatchewan.

I have been practicing geophysics since 1986.

I am presently employed by Goldak Airborne Surveys as chief geophysicist.

I have supervised or performed all of the work in this report and find that it was performed with regards to normal best practices in the industry. Furthermore I feel it to be suitable for geologic interpretation.

Marc Pelletier, P.Geo September, 2009

APPENDIX A: SURVEY AREA COORDINATES

The Stevenson Ridge area was defined by the following NAD83 coordinates:

Stevenson Ridge Area Boundaries	
Latitude	**Longitude**
N62° 45’ 10”	W138 ° 04’ 56”
N62 ° 36’ 36”	W138 ° 23’ 04”
N62 ° 44’ 33“	W138 ° 41’ 43”
N62 ° 30’ 00“	W139 ° 11’ 37”
N62 ° 30’ 00“	W141 ° 00’ 00”
N63 ° 00’ 00”	W141 ° 00’ 00”
N63 ° 00’ 00”	W139 ° 03’ 35”
N63 ° 06’ 05”	W138 ° 51’ 48”

Table 5 – Original Survey Area Coordinates

On June 1st, 2009 GSC requested that the following area be added to the block:

Stevenson Ridge Area Extension Boundaries	
Latitude	**Longitude**
N62° 30’ 00”	W139 ° 11’ 37”
N62 ° 44’ 33”	W138 ° 41’ 43”
N62 ° 36’ 36“	W138 ° 22’ 04”
N62 ° 45’ 10“	W138 ° 04’ 56”
N62 ° 42’ 50“	W138 ° 00’ 00”
N63 ° 30’ 00”	W138 ° 29’ 04”

Table 6 - Extension Boundaries

APPENDIX B: CALIBRATION FLIGHTS

Compensation Flight #1

Aircraft	Piper PA-31 Navajo
Registration	C-GJBB
Date	May 18, 2009
Crew	Robinson / Luten
Reason for Compensation	Start of Survey

RMS AADCII Compensator Statistics

	UnComp Std Dev	Comp Std Dev	IR	Solution Norm
Right Wing M1	1.51E+00	3.32E-02	45.6	37.2
Left Wing M2	9.71E-01	4.51E-02	21.5	35.1
Tail Lower M4	1.65E-01	2.43E-02	6.8	14.6
Lateral Grad G1	2.59E+00	2.58E-01	9.9	42.4
Long Grad G2	3.17E-01	1.36E-01	23.4	37.1

Fom Analysis: Tail

	North	East	South	West	Sum
Pitch	0.07	0.14	0.10	0.12	0.43
Roll	0.01	0.03	0.02	0.04	0.10
Yaw	0.05	0.05	0.03	0.02	0.15
Sum	0.13	0.22	0.15	0.18	0.68

Table 7 - Figure of Merit 1 Results

Compensation Flight #2

Aircraft	Piper PA-31 Navajo
Registration	C-GJBB
Date	June 16, 2009
Crew	Robinson / Kiesman
Reason for Compensation	Monthy comp

RMS AADCII Compensator Statistics

	UnComp Std Dev	Comp Std Dev	IR	Solution Norm
Right Wing M1	8.84E-01	3.66E-02	24.2	28.8
Left Wing M2	1.99E+00	6.10E-02	32.6	49.2
Tail Lower M4	1.61E-01	2.62E-02	6.1	14.0
Lateral Grad G1	5.74E+00	1.47E-01	39.1	49.1
Long Grad G2	3.77E+00	8.08E-02	46.6	38.9

Fom Analysis: Tail

	North	East	South	West	Sum
Pitch	0.12	0.08	0.06	0.06	0.32
Roll	0.02	0.01	0.02	0.01	0.06
Yaw	0.07	0.07	0.01	0.09	0.24
Sum	0.21	0.16	0.09	0.16	0.62

Table 8 - Figure of Merit 2 Results

Radar Altimeter Calibration

Test Location	Saskatoon Airport (YXE)
Test Date	May 7, 2009
Aircraft	C-GJBB
Radar1 Type	Thompson CFS530 A
Radar2 Type	Terra TRA-30
Avg Runway height	502.1

Pass	GPS Alt	Baro Alt	Height above Runway	Radar1	Radar 1 Scale Factor	Radar2	Radar 2 Scale Factor
0	505.0	502.3	-0.6	0			
200	565.2	563.6	59.6	60.8	0.980	58.2	1.024
400	625.1	623.3	119.5	120.9	0.988	115.9	1.031
600	689.2	687.2	183.6	186.0	0.987	178.2	1.030
800	742.3	740.7	236.7	237.6	0.996	229.3	1.032
1000	803.5	801.2	297.9	299.1	0.996	288.9	1.031
				Linear Est	**0.990**		**1.030**

Table 9 - Radar Altimeter Scaling Factors

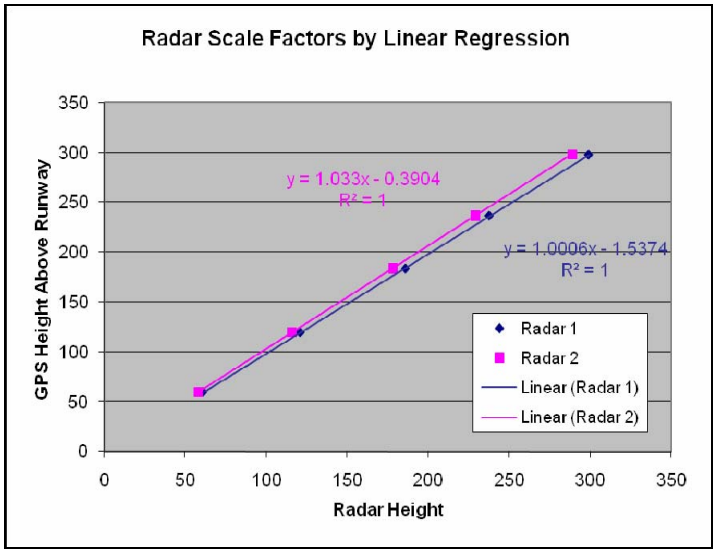

Figure 5 – C-GJBB Radar Altimeter Scaling Factors

Lag Test

A test to verify the system lag on the survey aircraft was conducted on over a radio tower located 22 km southwest of Saskatoon. This test involved flying two passes in each of the four cardinal headings over the tower and comparing the position of the observed magnetic peaks with the know position of the target.

Aircraft	C-GJBB
Date	September 8, 2008
Location	22 km SW of YXE

Pass	Direction	X	Y	Velocity	Distance from Target	Lag
1	W	370575	5767244	72.9	25.9033	0.36
2	N	370606	5767261	70.8	27.03883	0.38
3	E	370630	5767232	72.5	31.45888	0.43
4	S	370596	5767207	76.5	28.28801	0.37
5	W	370570	5767242	75.3	29.77815	0.40
6	N	370605	5767266	72.2	31.58403	0.44
7	E	370632	5767232	78.3	32.7239	0.42
8	S	370594	5767202	78.7	33.78107	0.43
					AVERAGE	**0.403**

Table 10 – C-GJBB Lag Test Results

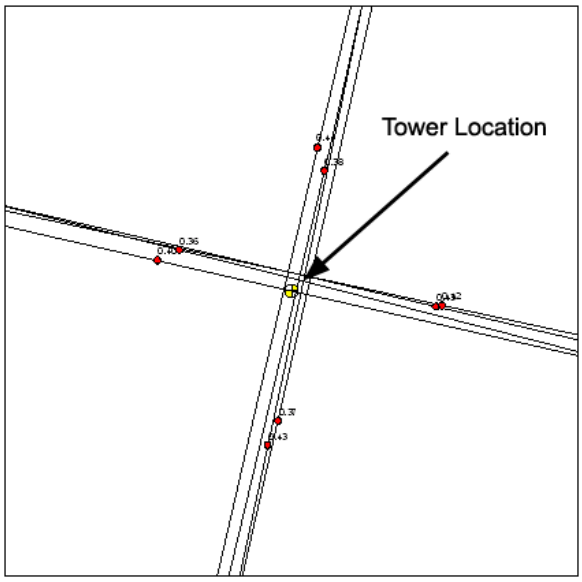

Figure 6 – C-GJBB Lag Test Flight Path

Meanook Heading Test

The aircraft conducted a heading test both pre and post survey. The results follow:

Aircraft	Piper Navajo
Registration	C-GJBB
Date	May 8, 2009
Crew	Robinson / Luten
Location	Meanook

Pass	Direction	Time	Meas TF	Base TF	Error (nT)	Heading Err
1	N	72978.4	58073.74	58076.1	-2.36	-1.25
2	S	73399.9	58071.89	58073.0	-1.11	
3	N	73825.5	58071.06	58073.0	-1.94	0.86
4	S	74233.0	58069.80	58072.6	-2.80	
5	E	73165.5	58071.32	58073.7	-2.38	-0.11
6	W	73616.4	58068.63	58070.9	-2.27	
7	N	74006.8	58076.17	58078.2	-2.03	0.00
8	S	74448.3	58076.17	58078.2	-2.03	

Mean Offset	**-2.11**
Mean N/S Err	0.00
Mean E/W Err	-0.17
Mean Err	**-0.13**

Table 11 – Pre Survey Meanook results

Aircraft	Piper Navajo
Registration	C-GJBB
Date	July 3, 2009
Crew	Luten
Location	Meanook

Pass	Direction	Time	Meas TF	Base TF	Error* (nT)	Heading Err
1	N	61791.3	58037.75	58037.7	0.05	0.24
2	S	62267.9	58038.39	58038.6	-0.19	
3	N	62699.4	58034.75	58034.6	0.14	0.32
4	S	63147.1	58033.75	58033.9	-0.18	
5	W	62026.6	58039.14	58039.5	-0.32	0.05
6	E	62485.6	58035.90	58036.3	-0.37	
7	W	62905.2	58033.46	58034.0	-0.56	-0.42
8	E	63399.4	58031.96	58032.10	-0.14	

Mean Offset	**-0.20**
Mean N/S Err	0.28
Mean E/W Err	-0.19
Mean Err	**0.05**

Table 12 - Post Survey Meanook Results

Goldak Airborne Surveys

WEEK BEGINNING
May 3, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Luten
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun									25209					
May 03														
DOY :123														
Mon														Truck Departs
May 04														
DOY :124														
Tues														
May 05														
DOY :125														
Wed														Truck Arrives in Dawson
May 06														
DOY :126														
Thurs	1	JBB												Stack and Lag Flown at YXE
May 07														
DOY :127														
Fri	2	JBB												Meanook
May 08														
DOY :128														
Sat														JBB in Dawson
May 09														
DOY :129														
TOTAL FOR WEEK			0	0	0	0	0	0						
CARRIED OVER			0	0	0	0	0	0	25209					
TOTAL FOR JOB			0	0	0	0	0	0	25209					

Goldak Airborne Surveys

WEEK BEGINNING
May 10, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Luten
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun	3	JBB		1.2		1.2			25209				80	Rain, cloud => Comp flown late in day
May 10														Comp rejected
DOY :130														
Mon													100	
May 11														
DOY :131														
Tues	4		0.3			0.3								Testing fluxgate for spiking - none observed
May 12	5		1.1			1.1								Comp - fluxgate spikes at end
DOY :132														
Wed	6	JBB	0.8		0.3	1.1	40	0	25209					two lines flown to evaluate comp => not good
May 13														
DOY :133														
Thurs	7			1.1		1.1								Fluxgate replaced
May 14	8			0.7		0.7								attempted comp with new flux => poor Wx
DOY :134														
Fri	9			1.1		1.1								COMP => short and long maneuvers
May 15														
DOY :135														
Sat	10		0.9		3.1	4.0	807	807	24402					noisy = > Status pending
May 16	11		1.0			1.0								Comp => failed
DOY :136														
TOTAL FOR WEEK			4.1	4.1	3.4	11.6	847	807						
CARRIED OVER			0.0	0.0	0.0	0.0	0	0	25209					
TOTAL FOR JOB			4.1	4.1	3.4	11.6	847	807	24402					

Goldak Airborne Surveys

WEEK BEGINNING
May 17, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Luten
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun	12	JBB		1.0		1.0			24402					Comp => Looks good
May 17														
DOY :137														
Mon	13	JBB	1.1		4.0	5.1	1135	1135	23267					Status Pending
May 18	14	JBB		1.1		1.1								Compensator Changed
DOY :138	15	JBB		0.9		0.9								L Alternator Changed
	16	JBB		0.9		0.9								Fluxgate Cable Changed; Changed back
Tues	17	JBB	0.7			0.7								Aborted, Turbulence
May 19														
DOY :139														
Wed	18	JBB	1.1		4.1	5.2	1085	1085	22182					
May 20														
DOY :140														
Thurs	19		1.1		3.4	4.5	665	665	21517					
May 21	20			1.1		1.1								Test comp with breakers pulled
DOY :141														
Fri	21	JBB	1.0		4.3	5.3	1052	1052	20465					
May 22														
DOY :142														
Sat	22	JBB	1.1		4.2	5.3	1050	1050	19415					
May 23														
DOY :143														
TOTAL FOR WEEK			6.1	5.0	20.0	31.1	4987	4987						
CARRIED OVER			4.1	4.1	3.4	11.6	847	807	24402					
TOTAL FOR JOB			10.2	9.1	23.4	42.7	5834	5794	19415					

Goldak Airborne Surveys

WEEK BEGINNING
May 24, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Luten
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun	23	JBB	1.0		5.1	6.1	1312	1312	18103					
May 24														
DOY :144														
Mon	24	JBB	0.9		5.0	5.9	1287	1287	16816					
May 25														
DOY :145														
Tues	25	JBB	1.0		4.3	5.3	1130	1130	15686					
May 26														
DOY :146														
Wed	26	JBB	0.9		2.7	3.6	647	647	15039					Windy. Flight cut short. Streches of > .1 nT
May 27														noise throughout the data
DOY :147														
Thurs											10		100	some diurnal activity early am. Low cloud all day
May 28														Luten Out/ Kiesman In
DOY :148														
Fri													100	Low Cloud all day
May 29														
DOY :149														
Sat													100	Low Cloud all day
May 30														
DOY :150														
TOTAL FOR WEEK			3.8	0.0	17.1	20.9	4376	4376						
CARRIED OVER			10.2	9.1	23.4	42.7	5834	5794	19415					
TOTAL FOR JOB			14.0	9.1	40.5	63.6	10210	10170	15039					

Goldak Airborne Surveys

WEEK BEGINNING
May 31, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Kiesman
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun	27	JBB	1.0		3.3	4.3	808	808	14231				30	early am fog; bumpy late am
May 31														
DOY :151														
Mon	28	JBB	1.1		5.0	6.1	1292	1292	12939					
Jun 01														
DOY :152														
Tues	29	JBB	0.8		5.3	6.1	1299	1299	11640					
Jun 02														
DOY :153														
Wed	30	JBB	1.0		1.9	2.9	502	502	11138	75				Lost De-icing boot
Jun 03														
DOY :154														
Thurs										100				Aircraft maintanence. Awaiting a part
Jun 04														
DOY :155														
Fri										100				Aircraft maintanence
Jun 05														
DOY :156														
Sat	31	JBB	0.2			0.2								Wind and extreme turbulence
Jun 06														
DOY :157														
TOTAL FOR WEEK			4.1	0.0	15.5	19.6	3901	3901						
CARRIED OVER			14.0	9.1	40.5	63.6	10210	10170	15039					
TOTAL FOR JOB			18.1	9.1	56.0	83.2	14111	14071	11138					

Goldak Airborne Surveys

WEEK BEGINNING
June 7, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Kiesman
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun	32	JBB	0.9		5.1	6.0	1300	1300	9838					
Jun 07														
DOY :158														
Mon	33	JBB	0.9		4.9	5.8	1234	1234	8604					
Jun 08														
DOY :159														
Tues	34	JBB	0.9		0.0	0.9							100	Smoke covering block
Jun 09														
DOY :160														
Wed	35	JBB	0.9		4.5	5.4	1159	1159	7445					
Jun 10														
DOY :161														
Thurs													100	High winds, T-Storms
Jun 11														
DOY :162														
Fri	36	JBB	0.9		3.5	4.6	806	790	6655				50	Cut short, storm cells in block
Jun 12														
DOY :163														
Sat													100	Rain, low cloud
Jun 13														
DOY :164														
TOTAL FOR WEEK			4.5	0.0	18.0	22.7	4499	4483						
CARRIED OVER			18.1	9.1	56.0	83.2	14111	14071	11138					
TOTAL FOR JOB			22.6	9.1	74.0	105.9	18610	18554	6655					

Goldak Airborne Surveys

WEEK BEGINNING
June 14, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Kiesman
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun									6655				100	Rain, low cloud
Jun 14														
DOY :165														
Mon	37	JBB	0.9		0.8	1.7	146	146	6509				85	
Jun 15														
DOY :166														
Tues	38	JBB	1.1		4.9	6.0	1067	1060	5449					
Jun 16	39	JBB		1.1										Monthly comp as per contract
DOY :167														
Wed													100	Rain, low cloud
Jun 17														
DOY :168														
Thurs	40	JBB	0.8			0.8								RTB => Rain, low cloud
Jun 18														
DOY :169														
Fri	41	JBB	1.2		0.1	1.3								RTB =>No visibility
Jun 19														
DOY :170														
Sat														Rain, Rain, low cloud
Jun 20														
DOY :171														
TOTAL FOR WEEK			4.0	1.1	5.8	9.8	1213	1206						
CARRIED OVER			22.6	9.1	74.0	105.9	18610	18554	6655					
TOTAL FOR JOB			26.6	10.2	79.8	115.7	19823	19760	5449					

Goldak Airborne Surveys

WEEK BEGINNING
June 21, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Kiesman
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun	42	JBB	0.8		1.4	2.2	312	312	5137				75	Low cloud in AM. Heavy turbulence cut flight short
Jun 21														
DOY :172														
Mon	43	JBB	1.0		4.2	5.2	1048	1040	4097					Started 23:00 local
Jun 22														
DOY :173														
Tues	44	JBB	1.1		0.6	1.7	144	140	3957				90	Cut short => winds, turbulence
Jun 23														
DOY :174														
Wed	45	JBB	1.0		4.8	5.8	1229	1229	2728					
Jun 24														
DOY :175														
Thurs	46	JBB	0.9		1.5	2.4	370	326	2402					landed in Pelly mid flight, minor medical issue
Jun 25	47	JBB	1.0		2.0	3.0	507	507	2221					
DOY :176														
Fri													100	Rain, low cloud
Jun 26														
DOY :177														
Sat	48	JBB	1.2		4.9	6.1	1232	1232	989					
Jun 27														
DOY :178														
TOTAL FOR WEEK			7.0	0.0	19.4	26.4	4842	4786						
CARRIED OVER			26.6	10.2	79.8	115.7	19823	19760	5449					
TOTAL FOR JOB			33.6	10.2	99.2	142.1	24665	24546	663					

Goldak Airborne Surveys

WEEK BEGINNING
June 28, 2009

WEEKLY OPERATIONS REPORT

Aircraft: C-GJBB
Pilot: Robinson
Co Pilot: Kiesman
Data Processor: Heath
Project total 25209

GSC - Northern Stevens Ridge

Project #: 2009-05

Base: Yukon Hotel, Dawson City
Phone: 867-993-5451 Ext 296

			Flight Times				Kilometers			Unservicability				
Date	Flt	Aircraft	Ferry	Test	Prod	Total	Flown	Accept	Remain	A/C	Eqt	Diur	Wx	Comments
Sun									663			20	100	Rain Low Cloud. Active Diumal 15 to 17z
Jun 28														
DOY :179														
Mon													100	Low Cloud
Jun 29														
DOY :180														
Tues	49	JBB	1.0		5.1	6.1	1152	1152	-489					
Jun 30														
DOY :181														
Wed	50	JBB	1.2		1.5	2.7	258	258	-747					
Jul 01														
DOY :182														
Thurs														
Jul 02														
DOY :183														
Fri														
Jul 03														
DOY :184														
Sat														
Jul 04														
DOY :185														
TOTAL FOR WEEK			2.2	0.0	6.6	8.8	1410	1410						
CARRIED OVER			33.6	10.2	99.2	142.1	24665	24546	663					
TOTAL FOR JOB			35.8	10.2	105.8	150.9	26075	25956	-747					