SANDER GEOPHYSICS LTD.

AERIAL SURVEY PLAN

AND

RISK ANALYSIS

FIXED WING

AngloG16.MN PROJECT

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INTRODUCTION

PREAMBLE

This document captures the aviation planning aspect of the aerial project and examines the associated risks. It contains information, policies and procedures that shall be followed in order to ensure the safety of flight operations. Additional policies and procedures related to safe, efficient and compliant operations can be found in the Flight Operations Manual, Pilot Policies Procedures and Reference Manual and other Company documents and manuals.

This document is designed as a tool to help identify the risks and hazards associated with this aerial survey project. The purpose is to enhance pilot awareness of the risks. It is designed to be as comprehensive as possible however it does not and could not cover all possible scenarios. **Final evaluation of risk, judgement and daily decision making still rests in the hands of the pilots.**

Only aspects of the project associated with aviation operations are considered in this document. The Personnel Risk Assessment documents the risk to personnel on the ground.

Suggestions for amendment to the format of this Aerial Survey Plan and Risk Analysis can be made via e-mail to the Flight Operations Manager.

Where reference in this document is made to the “Air Operator”, the “Company” and/or the “Operator”, it shall be taken to mean Sander Geophysics Ltd.

This document is gender neutral. For brevity, the pronoun “he” is used throughout; any references to “he” shall infer both “he” and/or “she” as appropriate.

AMENDMENT PROCEDURES

This document shall be completed prior to mobilizing the crew. Sections marked with **<<text>>** are designed to be modified with information appropriate to the project being examined. Once edited, the characters **<<>>** shall be removed and this information shall remain in bold type. Details which vary from project to project and highlighted in **bold black type.**

Changes to procedures to enhance safety and critical information related to the risks associated with the project are highlighted in red bold type and may also include a black border surrounding the text.

Upon arrival at the survey location, flight crew are to verify the accuracy of the details presented in this document. Once a reconnaissance flight has been completed, the lead pilot or his designate shall review and update the document as required.

All flight crews are required to review this document prior to accepting an assignment as a flight crew member. Any pilot can update this document at any point during the survey.

When making changes to the contents of this document, a vertical bar will be used in the right hand margin to indicate the amended area and the Author and Amendment Record table shall be updated. The revised document shall be sent to the Chief Pilot and Flight Operations Manager. Once changes have been reviewed by either the Flight Operations Manager or Chief Pilot, he shall save as .pdf and post on the Company internal file transfer site.

Each page of this document will show the amendment number, the amendment date, and page number on the bottom of the page.

AMENDMENT RECORD

Amendment No	Amendment Date	Author	Summary of Revisions
Original	Aug 26, 2016	Steven Hyde	Initial Draft
1	Aug 30, 2016	Steven Hyde	Added info on hunting season, bird activity. Added the pull up height. Changed the target ground speed. Made various minor corrections
2	Aug 30, 2016	Steven	Corrected the maximum number of flight hours during a 7 day period. Added comments on the client's community outreach program

Amendment No	Amendment Date	Author	Summary of Revisions

DISTRIBUTION AND CONTROL

Electronic copies of this document in .pdf form will be accessible online by all operations personnel from the Company internal file transfer site. Once the aerial survey is complete, the Aerial Survey Plan and Risk Analysis shall be kept in the project directory on the Company internal network.

COPYRIGHT ACKNOWLEDGEMENT

Portions of the risk analysis section of this document have been adapted from the Basic Aviation Risk Standard - Resource Sector created by the Flight Safety Foundation.

1 AERIAL SURVEY PLAN

1.1 INTRODUCTION TO THE PROJECT

Sander Geophysics Ltd has recently been awarded a contract for a **magnetic and radiometric** survey with **AngloGold Ashanti** that would involve low level survey in **Grand Rapids Minnesota.** The purpose of the survey is to **<<survey purpose if relevant>>**.

1.2 CONFIDENTIALITY

Although this project is a government project and is therefore public, we are not permitted to disclose any information that isn't already in the public domain or isn't required to be disclosed under Law. The safest thing is to treat this project like most of our other surveys and keep survey details confidential and not divulge them to anyone outside the company, except to ensure safety or as required by law or government regulation.

1.3 GENERAL SURVEY DETAILS

The proposed survey consists of **66,307 line km** of survey flying in **1 block** over **relatively flat terrain with some rolling hills** in **northern Minnesota**. These blocks are primarily over rural areas **but there are several sites with towns, unincorporated villages, clusters of houses, cottages and other structures.** In wooded or jungle areas, tree or canopy height is expected to be **up to 100ft (White Spruce, Red Pine).** A .kmz file of the survey areas and operations area can be provided upon request.

1.4 PROPOSED PROJECT START DATE AND PROJECT DURATION

The aerial survey portion of this project is proposed to start on **October 1, 2016** or as soon as operating permission is granted and any required pre-survey inspections and audits are completed. **It is expected to last for up to 8 weeks** The **actual number of flying days** will likely only be about **35 and the number of flying hours to complete the project** will likely be about **340** but the length of the project will depend on weather and equipment serviceability, permitting and any other restrictions imposed by the operating conditions.

1.5 PROPOSED AIRCRAFT SELECTION

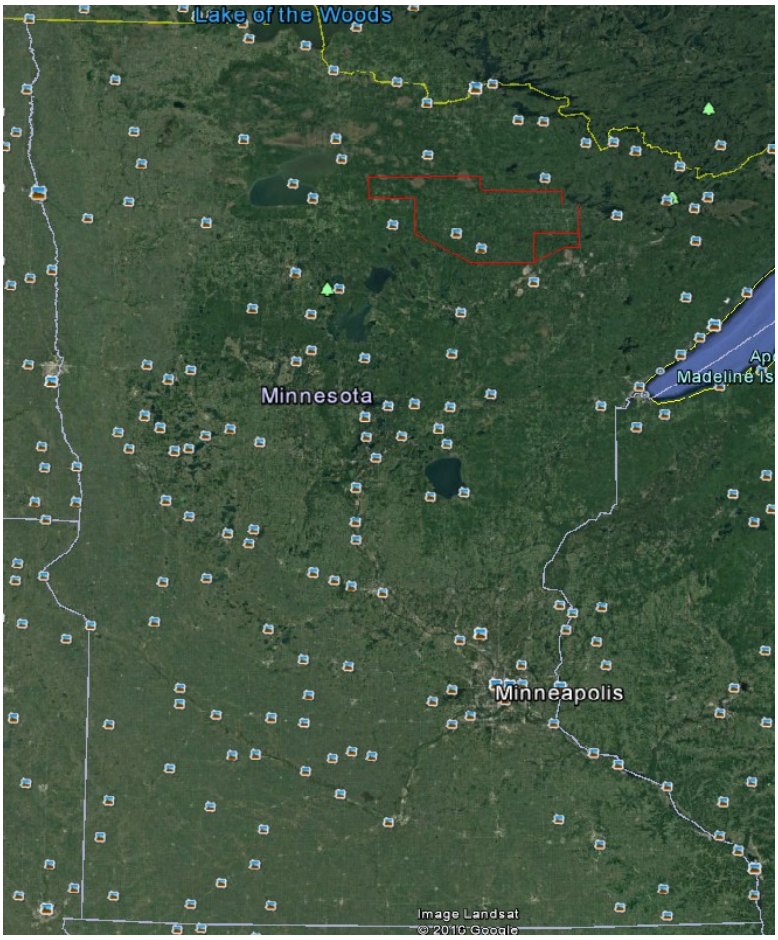
1.5.1 AIRCRAFT SELECTION

This project will be flown with **2** of our fleet of specially modified **C-208** aircraft, **C-GSGW and C-GSGL.**

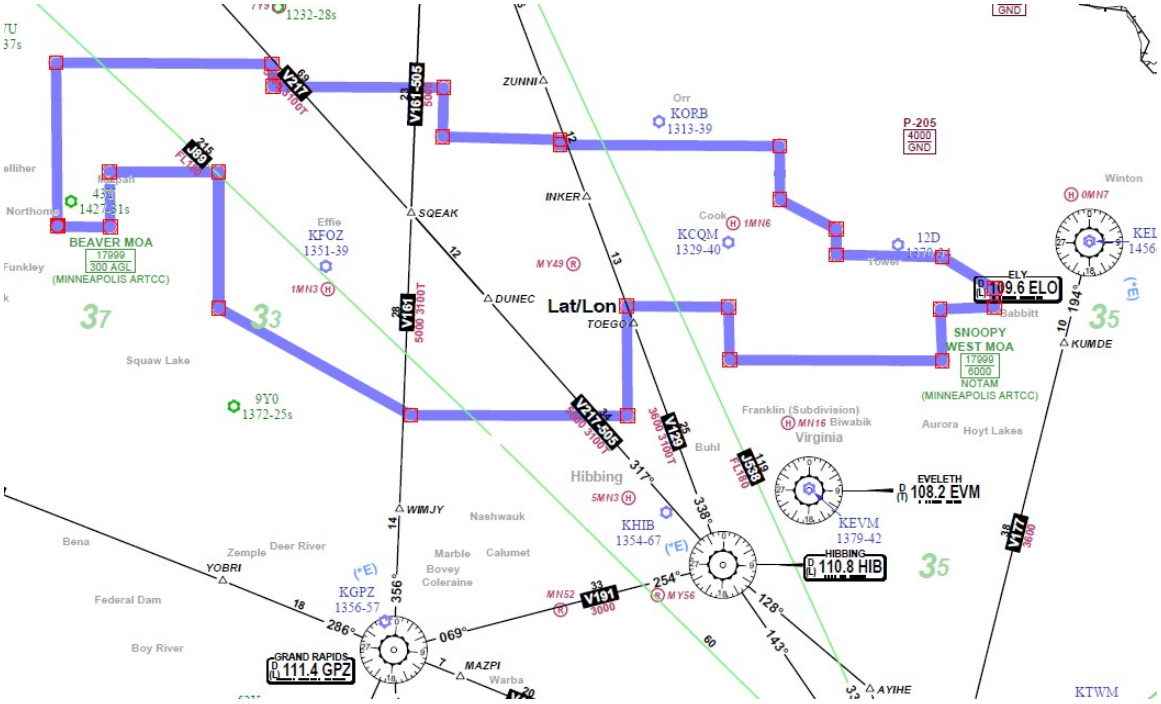
1.5.2 ALTERNATE AIRCRAFT PROPOSED

No alternate aircraft have been proposed.

1.6 MAPS OF THE SURVEY AREA



Google Earth



1.7 SURVEY HEIGHT AND FLIGHT LINE SPACING

For the purpose of the scientific mission the aircraft will fly at **60m (197ft) above ground**. The aircraft will follow survey lines oriented approximately **N to S (360/180)** and spaced at **100m** intervals. There are additional control survey lines oriented in an approximately **E to W (090/270)** direction that the aircraft will follow which are spaced at **1000m intervals**. Unless problems with the data are discovered after the flight, the aircraft will follow each survey line once only.

The aircraft will maintain a nominal height of **197ft** AGL using GPS for guidance. When approaching rising terrain, the aircraft will climb to plan to clear the top of the highest terrain at **197ft** AGL and therefore will be higher than **197ft AGL** for most areas of rising terrain. In cases where the terrain gradient is greater than the aircraft climb performance, the aircraft will climb well in advance to ensure that adequate terrain separation is ensured for all portions of the climb. The aircraft radar altimeter will be set to alert the pilots with an aural warning in the highly unlikely event that the aircraft gets lower than **164ft** AGL. In addition to the aircraft radar altimeter alert for low clearances, at any time that the terrain clearance is less than or equal to **164ft** a warning signal on the survey navigation computer is triggered along with an indication on the pilot navigation display to pull-up.

When flying from the base of operation to the survey area, the aircraft will be flown at 1000ft above ground or higher if required for air traffic or weather avoidance. Additional survey equipment testing will be conducted at 10,000ft above ground.

1.8 CONTRACT TOLERANCES

The contract requirements are that the aircraft remain within the following tolerances:

1.8.1 HORIZONTAL DEVIATION

Not greater than **20m** for **1km** and in no case greater than **50m.**

Horizontal deviation displayed on pilot display is shown in meters (m).

Pilots shall climb or deviate from flight path as necessary to prevent collision with towers or other obstacles. A comment <Cntrl c> stating the reason for deviation shall be inputted into the survey computer for every deviation.

1.8.2 VERTICAL DEVIATION

Not greater than **10m** for **2km** and in no case greater than **30m**.

Not greater than **33ft** for **1nm** and in no case greater than **98ft.**

Vertical deviation displayed on pilot display is shown in feet (ft).

Pull-up height in the survey system computer shall be set to 50m or **164ft.** If the pilot feels that the drape guidance system will take the aircraft below **50m or 164ft** or if a pull-up indication appears on the pilot navigation display, the pilot shall pull up to avoid low ground clearance as per SGL Standard Operating Procedures (SOP). A comment <Cntrl c> stating the reason for deviation shall be inputted into the survey computer for every deviation.

1.8.3 TARGET GROUNDSPEED

Target groundspeed for the project is **110kts.** Minimum safe survey speed shall be **82kts** and in no case lower than IAGSA minimum recommended safe survey speed which is the greater of 130% Vs or 110% Vyse or Vsse. Maximum survey groundspeed shall be <**<XX>>kts.**

1.8.4 EXCEPTIONS FOR CONTRACT TOLERANCES

These conditions may be exceeded without re-flight where such constraints would breach air regulations, or in the opinion of the pilot, put the aircraft and crew at risk. All such exceptions shall be logged. All re-flights of flightline segments must traverse at least two tie-lines of the overlapping portion.

1.8.5 AIRCRAFT MANOEUVRING

Maximum angle of bank for the entire flight is **10 degrees for AIRGRav** and **30 degrees for all other low level operations.**

1.8.6 ADDITIONAL CONTRACT SPECIFICATIONS

Survey flight lines must be flown in alternating directions

1.9 AIRCRAFT PERFORMANCE

1.9.1 FUEL BURN AND TIME ON SURVEY

Transit times from the proposed base of operations, **KGPZ (Grand Rapids/Itasca Co-Gordon Newstrom Field),** to the survey area are expected to be as follows :

Fuel Load	Distance (nm one way)	Transit Time 140 kts 350 pph	Time on Survey 105 kts 320 pph	Endurance to Landing Reserve <<XXX>>lbs	Endurance to Dry Tanks	Including <<30 min>>Contingency	
2524 lbs						Time on Survey	Endurance to Landing Reserve
Nearest	21	:09	6.4	6.7	7.8	5.4	5.7
Middle	37	:16	6.0	6.6	7.7	5.1	5.7
Furthest	61	:26	5.7	6.6	7.7	4.7	5.6

** Actual times and fuel burn may vary with conditions.

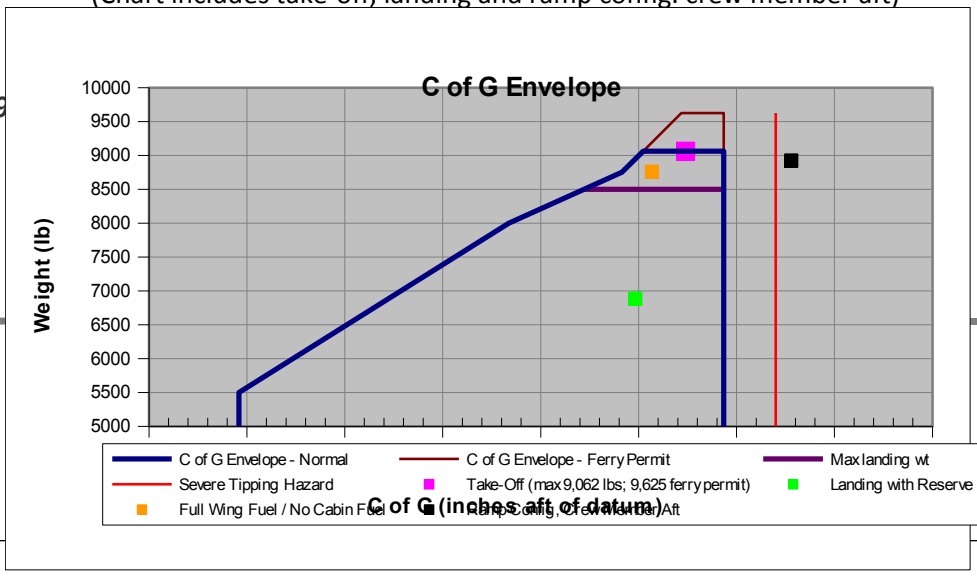
1.9.2 AIRCRAFT PERFORMANCE PLANNING WEIGHTS*

Operating Weight	Max Take-off Weight	Fuel Load	Actual Take-off Weight	Fuel Reserve	Mid-Survey Weight	Landing Weight
9061 lbs	9062 lbs	2524 lbs	9061 lbs	700 lbs	8261 lbs	7272 lbs

* Use approved SGL W&B form to complete calculations

1.9.3 AIRCRAFT PERFORMANCE PLANNING CENTER OF GRAVITY

(Chart includes take-off, landing and ramp config. crew member aft)

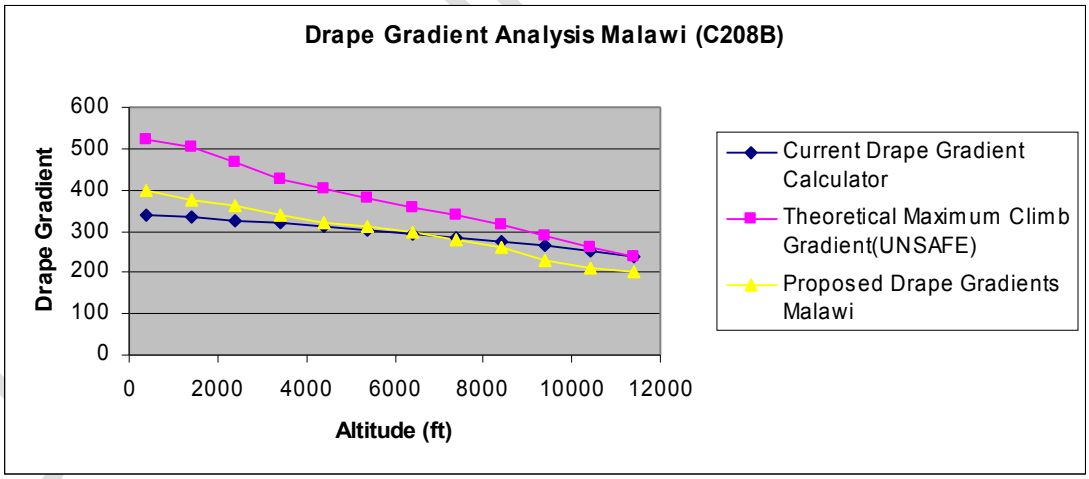


Terrain Height	Temperature	Density Altitude	Groundspeed	Max Aircraft Theoretical Climb Rate	Drape Climb Gradient	Max Aircraft Theoretical Climb Gradient
Min	25	1322	105	734	275	509
Max	24	2149	105	715	271	488

*** Values are for Flaps 20**

1.9.5 CHART OF THEORETICAL AIRCRAFT PERFORMANCE VERSUS PLANNED DRAPE

<<insert chart here>><<chart to be obtained once final planning is complete>>



1.9.6 ANALYSIS OF THEORETICAL MAXIMUM AIRCRAFT PERFORMANCE VERSUS PLANNED DRAPE

<<insert relevant comments here>>

Sample analysis with sample comments below

				Proposed Gradient for XXX Drape	
Elevation (ft)	Gradient Calculator	Theoretical Max	OEI Max	Gradient (ft/nm)	Elevation (m)
0	381	941	120	390	0
500	376	923	107	386	152
1000	371	904	95	382	305
1500	365	886	82	378	457
2000	358	858	70	374	610
2500	351	830	57	370	762
3000	343	812	44	366	914
3500	333	775	31	362	1067
4000	322	756	18	358	1219

4500	310	738	4	354	1372
5000	295	701	-10	343	1524

Aircraft theoretical twin engine performance should provide plenty of margin however, max theoretical performance is based on speeds much lower that can be flown safely at low altitude. In addition, pilot experience has shown that aircraft actual performance can vary significantly from theoretical max, particularly in hot temperatures. One Engine Inoperative (OEI) climb performance is positive up to the maximum terrain elevation but just barely.

1.10 DRAPE QC

This project will be flown using **a drape**.

Additional survey planning specifications can be found in the Drape QC report Rev **<<#>>**

1.10.1 KNOWN OR SUSPECTED PROBLEMS WITH DRAPE

During an analysis of the drape qc report and associated DIM charts for **plan <<#>>**, **surf <<#>>**, the following known or suspected problems and proposed solutions were noted:

<<detail problems here>>

1.10.2 IN FLIGHT DRAPE QC

A drape qc check was performed by **<<pilot names>>** in **<<aircraft ident>>** on **<<date>>.** The pilots reported that **<<there are no problems with the drape/detail problems>>**.

When pilots are reporting problems with the drape, it is important to include as many details as possible including: outside air temperature (OAT), altitude, airspeed, groundspeed, winds, aircraft weight, power setting etc.

1.11 BASE(S) OF OPERATIONS

1.11.1 MAIN SURVEY BASE BASIC INFO

The following base will be used for **survey operations and as a maintenance base**

City	Grand Rapids MN	**Fuel Available**	Yes (Jet-A)
Airport	Grand Rapids/Itasca Co-Gordon Newstrom Field	**Storage/delivery**	By Truck
Ident	KGPZ	**Variation**	2 Degrees East
Dist from Town	4 km	**Approaches**	ILS, RNAV, VOR
Dist fr Block Center	37 nm	**Open 24 Hrs**	Yes
Surface	Asphalt	**Airport Hrs**	24 (Attended 0700 – 2100 lcl)
Elevation	1356'	**Handling**	Not Required
Runway Direction	16-34 / 23-05	**Hangar**	Yes: 100X150'
Max runway (ft)	5747'	**Sunrise**	11:24z
Aircraft T.O Dist.	3032' @ 10 Celcius	**Sunset**	01:08z
Aircraft Land Dist.	1900' @ 10 Celcius	**Light Intensity**	High
NOTAMs	https://www.notams.faa.gov/dinsQueryWeb/		
Restrictions	Attended April – October 1300Z – 0300Z Runway 05-23 and Runway 10-28 closed to wheel aircraft during winter months		
Remarks	Airport manager +1-218-326-8337 FBO: Airways Aviation Center 0700-2100 Daily +1-218-326-1226 Deer and Birds on and in the vicinity of the airport		

1.11.2 AIRPORT RESTRICTIONS, PROCEDURES AND INFORMATION

- ***The airport is uncontrolled but UNICOM advisories are available on the CTAF 122.8. Arrival and departure control is provided by Minneapolis Center on 127.9.***
- ***AWOS Frequency: 118.42***

- ***Firefighting and crash rescue services are provided by the Grand Rapids Fire Department.***

1.11.3 REFUELING

1.11.4 FACILITIES AVAILABLE (HANGAR)

Parking is **<<adequate/ideal/tight>>** and the ramp area is **<<busy/quiet>>**. Hangar facilities are **available with prior notice**.

Parking Ramp

1.11.5 RETRIEVAL OF NOTAMS

NOTAMS can be retrieved from https://www.notams.faa.gov/dinsQueryWeb/.

1.12 POSSIBLE WEATHER / PRECAUTIONARY LANDING ALTERNATES

1.12.1 AIRPORTS

Airport/City	Ident	Dist fr main base	Dist from center of survey area	Suitability
Bigfork Municipal Airport/Bigfork	KFOZ	35nm	15nm	Good
Remarks	NDB and GPS approaches are available. Jet fuel is not listed as available.			

Airport/City	Ident	Dist fr main base	Dist from center of survey area	Suitability
Duluth International Airport/Duluth	KDLH	59nm	74nm	Excellent
Remarks	Multiple precision and non precision approaches available. Full service FBO on site.			

1.12.2 OFF STRIP LANDING AREAS

There general terrain in the survey area and en-route to the survey area is **flat with some gently rolling hills. The land is heavily treed but there are several large clearings and lakes.** There are **some** areas that would be suitable for an off strip precautionary landing.

1.13 CREW ACCOMMODATIONS

The flight crew shall be provided with suitable accommodation to obtain adequate rest according to flight and duty regulations. *Suitable accommodation* is defined as a single-occupancy bedroom that is subject to a minimal level of noise, is well ventilated and has facilities to control the levels of temperature and light or, where such a bedroom is not available, an accommodation that is suitable for the site and season, is subject to a minimal level of noise and provides adequate comfort and protection from the elements. *Reference CAR 101.01*

The flight crew will stay in a **climate controlled <<hotel/crew house>>** that is located in **Grand Rapids, (pop 11097)** which is **2km** or a **5 minute drive** to the airport. There have been **<<no>>** problems with the flight crew accommodations reported to date.

1.14 FLIGHT AND DUTY RESTRICTIONS

Flight crews will follow **the client's** flight and duty time restrictions which are as follows:

1.14.1 FLIGHT AND DUTY TIME

Interval	Flight Time		Duty Time	
	Flight Time	Extended To	Duty Time	Extended To
24 hours	7 (on survey)	--	12	--
7 days	40	--	60	--
28 days	120	--	--	--
42 days	--	--	--	--
90 days	300	--	--	--
180 days	--	--	--	--
12 months	1200	--	--	--

1.14.2 REST PERIODS

The required rest period(s) are:

Minimum rest immediately before duty: 10 Hours (CFR 91.1059)

Minimum rest during any consecutive 7 day period: 36 consecutive hours (Client). Compliance with this requirement will ensure compliance with the two regulations listed below. They are included for reference only:

Minimum number of days off per 30 day period: 3 (24 consecutive hours each) (CARS 720)

Note: 5 consecutive periods of 24 consecutive hours free from duty are required following any assignment that exceeds 27 consecutive days (CARS 720)

1.14.3 REGULATIONS

The regulations cited include AngloGold Ashanti Group Aviation Guideline, CFR 91.1059 (Flight time limitations and rest requirements) and CARS 720.15/720.20. The project flight and duty time limits incorporate the most conservative of the client, FAA and TC regulations.

1.15 CREW SELECTION

1.15.1 RESOURCE LEVELS

Each aircraft shall be flown by two qualified and experienced pilots using Transport Canada approved Standard Operating Procedures (SOP) or one experienced pilot and one trained equipment operator for limited flights. Flight crew have completed extensive ground and flight training and testing on the aircraft. In addition to having extensive flying experience, the flight crew has extensive low level and

towing experience and have completed countless safe and successful missions in a variety of operating environments all over the world.

Factoring in the number of daylight hours, possible weather and mechanical delays and flight and duty time restrictions, the project will be staffed with **<<2>>** pilots per aircraft, **<<2>>** ground support geophysicists, **<<1>>** survey equipment technician and **<<2>>** aircraft mechanics.

1.15.2 CREW EXPERIENCE AND TRAINING

In addition to the standard training and experience required, the following mission specific training and experience is required prior to accepting flight crew duties on this project:

1. **Underwater Egress Training**
2. **Additional Line Check: Pilot Competency Checks are required at 6 month intervals for all flight crew members. Flight crew members must comply with this requirement before commencing survey operations.**
3. **Aerial Reconnaissance Flight: This shall be flown in day VMC at a safe height and of sufficient duration to ensure that all known and potential unknown hazards are identified. Where risk assessment or the client deem necessary, an additional reconnaissance flight will be conducted when pilots are changed. The reconnaissance flight shall be completed prior to the start of the production and the information obtained will be subject to a formal review by the client before commencing survey operations.**
4. **Helmets: All pilots are required to wear helmets unless doing so is impractical. If helmets are not worn approval must be obtained from the client**
5. **60 Minute Flight Following Call Interval: Flight following calls shall be made every 60 minutes**
6. **Clothing: All flight crew members shall wear non-synthetic long trousers and shirts, cotton undergarments and robust shoes**
7. **Captains' Flight Experience:**

   2000 Hours Total Time

   300 Hours Gas Turbine

   100 Hours Low Level Survey Experience

   10 Hours in the Previous 90 Days
8. **First Officer's Flight Experience:**

   10 Hours in the Previous 90 Days

50 Hours Low Level Survey Experience

1.16 GENERAL WEATHER ANALYSIS

1.16.1 GENERAL WEATHER SUMMARY

The weather between October and December will be cool to cold, with lows reaching the negative mid-teens by December. Each month will average approximately10 days of precipitation and there will be a risk of freezing rain starting in late October/early November.

1.16.2 GENERAL WEATHER CHARTS

Climate data for Grand Rapids, Minnesota (1981–2010) [hide]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high °F (°C)	51 (11)	61 (16)	80 (27)	93 (34)	101 (38)	100 (38)	104 (40)	100 (38)	99 (37)	89 (32)	71 (22)	59 (15)	104 (40)
Average high °F (°C)	19.4 (−7)	26.3 (−3.2)	38.5 (3.6)	54.3 (12.4)	67.0 (19.4)	75.5 (24.2)	80.2 (26.8)	78.2 (25.7)	67.9 (19.9)	53.8 (12.1)	36.6 (2.6)	22.5 (−5.3)	51.7 (10.9)
Average low °F (°C)	−2.7 (−19.3)	2.3 (−16.5)	16.1 (−8.8)	29.7 (−1.3)	41.4 (5.2)	51.1 (10.6)	56.0 (13.3)	54.1 (12.3)	44.9 (7.2)	33.3 (0.7)	20.1 (−6.6)	4.2 (−15.4)	29.2 (−1.6)
Record low °F (°C)	−51 (−46)	−45 (−43)	−39 (−39)	−10 (−23)	11 (−12)	24 (−4)	33 (1)	27 (−3)	15 (−9)	−3 (−19)	−25 (−32)	−45 (−43)	−51 (−46)
Average precipitation inches (mm)	0.92 (23.4)	0.64 (16.3)	1.31 (33.3)	2.06 (52.3)	3.07 (78)	4.37 (111)	4.29 (109)	3.41 (86.6)	3.31 (84.1)	2.81 (71.4)	1.61 (40.9)	1.07 (27.2)	28.87 (733.3)
Average snowfall inches (cm)	12.3 (31.2)	7.2 (18.3)	7.7 (19.6)	3.8 (9.7)	0.2 (0.5)	0 (0)	0 (0)	0 (0)	Trace	1.5 (3.8)	9.4 (23.9)	11.7 (29.7)	54.4 (138.2)
Average precipitation days (≥ 0.01 in)	10	9	9	9	12	13	12	10	12	11	10	11	128
Average snowy days (≥ 0.1 in)	11	8	6	3	0	0	0	0	0	1	7	11	48

Source: NOAA (extremes 1915–present)[8]

1.16.3 SOURCES OF WEATHER INFORMATION

Some sources of weather information for this project are:

https://www.aviationweather.gov/

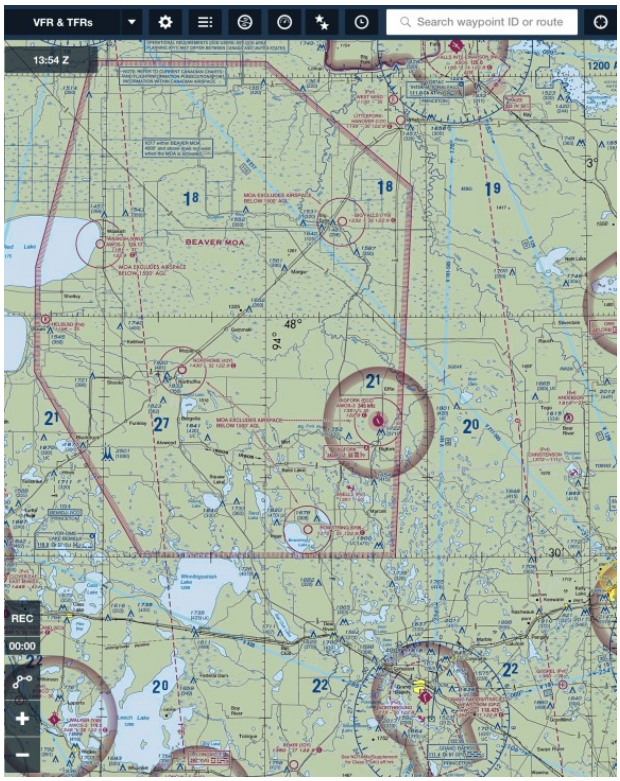
ForeFlight (satellite imagery, radar imagery, etc)

A weather office **is not** available at the base of operations but automated METARS are published for KGPZ.

1.17 BORDER, FIR BOUNDARY AND EEZ

The planned survey is **within 25 nautical miles of the US/Canada border.** The countries in question **do** have diplomatic relations. We **do** have permission to cross this **border in accordance with standard ATC procedures (i.e. establish radio contact with Canadian ATC prior to crossing the border.**

1.18 RESTRICTED, PROHIBITED AND DANGER AREAS



Area	Height Restriction	Permission to Enter	Block Location	Size	Notes
Beaver MOA	300' AGL to 17,999' MSL	Not when active	The MOA encompasses the western portion of the block	64 nm by 45 nm	0800-2200 M-F By NOTAM 0800-1600 S-S By NOTAM

1.19 OTHER NO FLY ZONES

Several populated areas have been identified inside the block. The drape has been raised to 1000' AGL for each of these. There are many 'cottage' areas located along the shores of most of the lakes in the survey area. These areas have not been raised but they will be identified on the portable GPS units

used by the pilots. As required by FAA regulations, the pilots will overfly these areas at a minimum height of 500' AGL.

1.20 IDENTIFICATION OF HAZARDS INSIDE THE AREA OF OPERATIONS

1.20.1 COMMUNITIES AND SETTLEMENTS

There are numerous towns, unincorporated communities, airports and other inhabited areas located within the survey block. These include (but are not limited to) the following:

1. Bigfork Municipal Airport

2. Cook Municipal Airport

3. Anderson Airport

4. The town of Bigfork

5. The town of Cook

6. Gheen

7. Celina

8. Gemmell

9. Forest Grove

10. Side Lake

The survey will take place during hunting season. A full schedule of the various seasons is published here: http://www.dnr.state.mn.us/hunting/seasons.html **Note that the earliest seasons begin during the first week of September (snipe and rail, bear, mounring dove, crow, Canada geese). Turkey season begins October 1st and deer season on October 29th.**

1.20.2 SPARSELY POPULATED AREAS

As noted above, there are cottages along the shores of most lakes within the block. Farms and other sparsely populated areas have been identified.

1.20.3 STADIUMS AND/OR COMMON GATHERING PLACES

Bigfork, Cook and Side Lake will contain sports fields, parks and other common gathering places. Gathering places may be found elsewhere in the block.

1.20.4 PARKS

1. McCarthy Beach State Park

2. Scenic State Park

3. Big Fork State Forest

4. George Washington State Forest

5. Sturgeon State River

1.20.5 BIRD HAZARD

A significant bird risk shall be deemed to exist for all coastal areas and for other areas of known bird concentration. Use of historical bird strike data for an area should be used where available.

As per the Airport and Facilities Directory, birds can be found at and in the vicinity of KGPZ. The most recent reported bird strike was in 2010 and involved a Canada Goose. Bird strikes involving gulls and unknown small birds were reported a handful of times during the 1990's.

Birds will be found inside the survey block. Many Canada geese remain in Minnesota throughout the winter (Reference: http://www.dnr.state.mn.us/birds/canadagoose.html). Additionally, the National Audubon Society as identified several 'Important Bird Areas' within Minnesota:

http://mn.audubon.org/conservation/minnesota-important-bird-areas. Note that Areas 4 and 9 overlap the survey block.

1.20.6 AIRPORTS AND AIRSPACE

1. Bigfork Municipal (KFOZ): A small uncontrolled airport

2. Anderson (MY49): A small private airstrip

3. Cook Municipal (KQCM): A small uncontrolled airport

4. Orr Regional (KORB): Located just outside the northeast corner of the block, this is a small uncontrolled airport

Given the number of airports, crews should be alert for GA aircraft operating within the block. Crews must also monitor the status of the Beaver MOA and regularly check for TFRs (Temporary Flight Restrictions).

5. Lily Lake (adjacent to the airport) is a PPR seaplane base.

1.20.7 POWERLINES, TOWERS, WINDFARMS AND OBSTACLES

There are power lines and towers inside the block and in the vicinity of Grand Rapids airport. Refer to the VFR navigation chart as well as the AFD or details. The highest MEF (Maximum Elevation Figure) is 2400'.

1.20.8 OTHER HAZARDS

<<details here>>

1.21 MAINTENANCE AND AIRCRAFT SERVICEABILITY PLANNING

The total airframe hours at the start of the project are **<<#>>**. There are **<<#>> hours remaining on the aircraft engine(s)**. Major components that are on time extensions or are expected to expire during survey are **<<list components>>**. Projected maintenance expected to occur during the course of the survey are **<<standard inspections every XX days / hours / months.>>**

1.22 CONDITIONAL MINIMUM EQUIPMENT LIST

The unserviceability or unavailability of aircraft instruments and equipment may affect the risk profile of the project although not all defects will effect the airworthiness or serviceability of the aircraft. Instruments, equipment and systems listed on the conditional minimum equipment list have been identified as having an affect on the risk profile of the project.

Reporting Defects to Items Listed on Conditional Minimum Equipment List

In addition to the aircraft maintenance discrepancy reporting procedures established in the Maintenance Control Manual, the pilot in command shall immediately report defects to instruments, equipment or systems listed in the conditional minimum equipment list to the Flight Operations Manager or Chief Pilot via e-mail.

Defect Control for Items Listed on Conditional Minimum Equipment List

All aircraft defects shall be handled in accordance with the Maintenance Control Manual. For items listed on the conditional minimum equipment list, pilots may continue operations for up to **<<10>>** days from midnight on the day the defect was recorded and reported to the Flight Operations Manager and Chief Pilot. Should the equipment require greater than **<<10>>** days to be returned to service, the risk analysis shall be re-evaluated and permission is required from the Flight Operations Manager prior to operating.

Project Conditional Minimum Equipment List

In addition to the minimum instruments and equipment required for day VFR, the following shall be considered to be equipment that affects the risk profile of the project:

See Section 2.1 of the client contract for full details. Some client-mandated items are listed below:

Radar or Laser Altimeter

TSO C126 Airframe Mounted ELT (TSO C91 may be acceptable in conjunction with a satellite based flight following system)

GPS Flight Following Equipment capable of reporting at a one minute interval

4 or 5 point seat belt harness of all occupants

2 X Attitude Indicator

2 X Heading Indicator

2 X Turn Coordinator

A clear, unscratched and serviceable canopy (wind screen)

Fuel totalizer

Note: if flight in IMC or at night is to be conducted (when ferrying to/from the block for example), the aircraft shall be equipped in accordance with the AFM.

1.23 OPERATING PERMISSIONS

<<The following operating permission are required to be in place for this survey:

The FSDO shall be contacted prior to the start of the survey.

Letter of no objection from civil aviation authority

Military operating permission

Border crossing permission

NAFTA

Aircraft decal

Copies of these operating permits are required to be in the aircraft for all survey flights. The pilot in command is responsible to ensure that all required permits are in place and are current.

The **<<flight operations department / field crew chief / lead field pilot>>** is responsible to renew these permits as required.

1.24 ATC CO-ORDINATION

An initial meeting with ATC shall be held at the beginning of the project as required by the lead field pilot. A checklist is provided in the annex of this document for the lead field pilot to use when co-ordinating this meeting.

As the base of operations is uncontrolled, a face to face meeting with ATC will not be possible. At a minimum, local flying clubs, schools, EAA and AOPA chapters, etc should be made aware of the project. Minneapolis Center and Princeton FSS may be contacted. An attempt should be made to publish a NOTAM regarding the survey.

<< Record details of any special procedures here.>>

1.25 MILITARY CO-ORDINATION

No military co-ordination is required for this survey project.

There are no special procedures other than what is outlined in standard aviation publications.

1.26 NOTIFICATION OF LOCAL AUTHORITIES

The FSDO was contacted and has no objection to our operation.

There are no special procedures other than what is outlined in standard aviation publications.

1.27 COMMUNITY OUTREACH

The client has established a community outreach program for this project. It is expected to be finished by September 15, 2016.

1.28 SIMULTANEOUS AIRCRAFT OPERATIONS (SIMOPS)

1.28.1 SIMOPS POLICY

Prior to conducting survey operations, a SIMOPS plan will be co-ordinated by the lead field pilot. A checklist is provided in the annex of this document for the lead field pilot to use when co-ordinating this meeting with local operators.

Flight crew will use local reporting procedures to notify other aircraft of our operations. SGL's **C-208 Caravans** are equipped with TCAS which will assist the pilots in maintaining awareness of other low level traffic.

1.28.2 KNOWN AIRCRAFT OPERATORS

<<Details of known aircraft operators in the area. Particular attention should be paid to researching

- **aerial spray areas**
- **Aerial fire fighting**
- **Low level helicopter operations including but not limited to police, military and medevac**
- **Sport and experimental aviation**
- **Drones>>**

1.28.3 SIMOPS DETAILS

<<Details of SIMOPS procedures here.>>

1.29 FLIGHT FOLLOWING AND EMERGENCY RESPONSE

1.29.1 FLIGHT FOLLOWING PROCEDURES

Complete flight following procedures shall be documented in the Emergency Response Plan (ERP). Flight following frequency method shall be **30 minute <<ops normal position reports / position text messages / automatically generated position messages.>>**

1.29.2 SEARCH AND RESCUE (SAR)

Search and rescue services will be provided by the United States Air Force Rescue Coordination Center with support from the Civil Air Patrol and various local and state agencies.

Contact information for SAR can be found in the project Emergency Response Plan (ERP).

2 PROJECT HAZARD IDENTIFICATION

2.0 HAZARD ID

Aviation related project hazards are identified in this section. Under each category, a variety of hazards are listed that have the potential to affect the safe, efficient and compliant operation of the survey. Basic hazards in different categories are considered as well as *"risk multipliers"* or factors that could exacerbate the significance of the hazard identified. In addition, *"risk reduction factors"* or factors that could reduce the significance of the hazard identified are considered when appropriate. The cumulative affect of these hazards are taken into consideration in the Risk Analysis section of this document.

<<In this section, delete any hazards that are highly improbable.>>

2.1 WEATHER

Anticipated Weather Related Hazards		
X if Yes	**Hazard**	**Details**
X	Fog	Associated with cool, wet weather
X	Low Cloud	
	Hills Obscured By Cloud	
X	Moderate or Heavy Rain	
X	Low Visibility	In conjunction with rain/snow and fog
	High Winds	
	Windshear	
	Thunderstorms	
X	Cold<-17C	Possible during the latter part of the project
X	Snow / Freezing Rain	Expected during the mid to latter part of the project
X	Icing	Icing in cloud or in freezing precipitation
	Rapidly varying weather conditions in the block	Likely only associated with frontal passage during days when we are not flying due to weather
	Rapidly varying weather conditions at the base	Likely only associated with frontal passage during days when we are not flying due to weather

Anticipated Weather Related Hazards		
X if Yes	**Hazard**	**Details**
	Other	

Hazardous Weather Conditions Risk Multipliers		
X if Yes	**Risk Multiplier**	**Details**
	Aircraft operating long distance from suitable landing area	
	Less than 2 suitable landing areas within post survey fuel range	
	Greater than 50% of block with >50m/km (300ft/nm) terrain relief	
	Reduced flying hours due to delays (temptation to push weather)	
	Rapidly changing weather conditions	
	Large percentage of survey over water	
	Other	

Weather Related Hazard Risk Reduction Factors		
X if Yes	**Risk Reduction Factor**	**Details**
X	Access to at least one reliable and comprehensive weather website	www.aviationweather.gov
X	Access to close up and real time weather radar or satellite shots	Satellite and Radar imagery are available
X	Trained personnel on ground monitoring weather	
X	Aircraft operating near suitable landing area ferry time 30 minutes or less	
	Other	

2.2 TERRAIN AND OBSTACLES

Terrain and Obstacle Hazards		
X if Yes	**Hazard**	**Details**
	Steep mountainous terrain	
	Ridge crossings at sharp angles	
	%age of block with high elevation (above 8000ft)	
X	Obstacles, towers or man-made obstructions	

Terrain and Obstacle Hazards		
X if Yes	**Hazard**	**Details**
X	Tall power lines	There are charted towers and power lines in the survey block
	Other	

Terrain and Obstacle Hazard Risk Multipliers		
X if Yes	**Risk Multiplier**	**Details**
	Rapidly varying weather conditions in mountainous areas	
	Reduced visibility in mountainous areas	
	Frequent low visibility in mountainous areas	
	Frequent winds >20 kts in mountainous areas	
X	Short line with frequent turns	In the western portion of the block
	Heat > than 25°C	
	Density altitude >7000 ft at peaks	
	Survey planning near aircraft max performance capabilities	

Terrain and Obstacle Hazard Risk Multipliers		
X if Yes	**Risk Multiplier**	**Details**
X	Obstacles likely to blend in with background	Towers and power lines may not contrast well against trees
	Other	

Terrain and Obstacle hazard Risk Reduction Factors		
X if Yes	**Risk Reduction Factor**	**Details**
	One crew member has >200 hrs mountain flying experience	
X	Clear and calm weather	
	Survey lines pass over ridges at >125m	
	Gentle survey drape gradient (150ft/nm or less)	
	Survey lines are higher than majority of obstacles	
	Aircraft to be flown at reduced weight to increase available climb performance	
X	Aircraft equipped with EGPWS or other terrain awareness system	

Terrain and Obstacle hazard Risk Reduction Factors		
X if Yes	**Risk Reduction Factor**	**Details**
	Other	

2.3 AIRSPACE RELATED HAZARDS

Airspace Related Hazards		
X if Yes	**Hazard**	**Details**
X	Restricted or Prohibited Areas	Beaver MOA (By NOTAM)
X	Military Airspace	Beaver MOA
	Special Use Airspace	
	Politically Sensitive Areas	
	Other No-Fly Areas	
	ATC Routing Restrictions	
	Danger/Blasting Areas	
X	Wildlife or Refuge Parks	
X	Communities and Settlements	Towns, villages, cottages etc will be flown above normal survey height
X	Stadiums or Gathering Places	
	Political Borders	

Airspace Related Hazards		
X if Yes	**Hazard**	**Details**
	Survey Lines Planned with Minimal Distance to No-fly zones	
	Other	

Airspace Related Hazard Risk Multiplier		
X if Yes	**Risk Multiplier**	**Details**
	Frequent weather problems	
	Other	

Airspace Related Hazard Risk Reduction Factors		
X if Yes	**Risk Reduction Factor**	**Details**
X	Frequently good weather	
X	Gentle terrain gradient (<50m/km or 300ft/nm)	
N/A	No fly areas depicted on moving map	
	Other	

2.4 AIR TRAFFIC HAZARDS

Air Traffic Related Hazards		
X if Yes	**Hazard**	**Details**
	Busy Air Traffic Environment	
	English Language Problems with ATC	
	ATC Uses non-standard practices and/or phraseology	
	ATC makes errors or shows indications of lack of situational awareness	
X	Other low level aircraft activity in survey area	To be determined – Recreational aircraft are a possibility
X	Airstrips or landing areas in use inside survey area	
	Other low level operators	To be determined
	Gliders or ultralights in work area	To be determined
	Privately operated or training aircraft in work area	To be determined
	Helicopters servicing facilities in the work area	To be determined
	Crop dusters	
X	Float operators in the work area	Possibly during the start of the project

Air Traffic Related Hazards		
X if Yes	**Hazard**	**Details**
	Military or special ops aircraft operating on private frequency	
	Other operators not speaking clear and readable English	
	Other operators following expected procedures	
X	Other operators using locally known reporting points that are unfamiliar to crew	Possibly
X	Known Bird Activity (qty, size)	Canada Geese

Air Traffic Related Hazard Risk Multipliers		
X if Yes	**Risk Multiplier**	**Details**
	Frequent weather problems	
	Mountainous terrain	
	No fly boundary is not a straight line	
	Other	

Air Traffic Related Hazard Risk Reduction Factors		
X if Yes	**Risk Reduction Factor**	**Details**
X	Frequently good weather	
X	Gentle terrain gradient (<50m/km or 300ft/nm)	
	Airspace requires special authorization for entry	
X	ATC radar equipped	Minneapolis Center is radar equipped but the aircraft will likely be too low for coverage while surveying
	Other operators have TCAS	Likely not – but many private operators will have ADS-B traffic info via ForeFlight and similar systems
	Other	

2.5 HAZARDS AT THE BASE OF OPERATIONS

Hazards At The Base Of Operations		
X if Yes	**Hazard**	**Details**
X	Lack of emergency services at airfield	The Grand Rapids Fire Department is based in town, a short distance from the airport
	Unimproved runway	
	Runway or ramp surface not in good condition	

Hazards At The Base Of Operations		
X if Yes	**Hazard**	**Details**
X	Icy or slippery runway	Possibly during the late fall/winter months but the standard of runway maintenance is expected to be high.
X	Wildlife or people sometimes on runway	Deer and birds have been reported
X	Obstacles on or near approach	Trees in the vicinity of the runways (see the AFD)
	Frequent FOD	Watch for broken asphalt on some sections of the ramp
	Extremely busy ramp	
	Tight parking	Not likely but to be confirmed
	Frequent large aircraft in vicinity of SGL aircraft (jetwash)	
	Other	

2.6 NATURAL DISASTERS OR EXTREME EVENTS

Hazards Related to Natural Disasters or Extreme Events		
X if Yes	**Hazard**	**Details**
	Volcano	
	Earthquake	

Hazards Related to Natural Disasters or Extreme Events		
X if Yes	**Hazard**	**Details**
	Forest Fire or Other Large Fire	
	Flooding	
	Tsunami	
	Cyclone	
X	Hail, Blizzard or Severe Winter Storm	Crews may encounter heavy snowfall
	Avalanche	
	Epidemic	
	Nuclear Disaster	
	Violent Political Unrest or War	
	Violent Crime	
	Other	

2.7 HEALTH AND SECURITY

Anticipated Hazards At The Base of Operations		
X if Yes	**Hazard**	**Details**
	Dangerous animals or insects near accommodations area	

Anticipated Hazards At The Base of Operations		
X if Yes	**Hazard**	**Details**
	Dangerous animals or insects on the ramp or other work area	
	Hostile Inhabitant on the Ground	
	Security concerns while airborne	
X	Security concerns after a forced landing	Bears, wolves, bobcats, lynx and cougars can be found in Minnesota
	Security concerns after a precautionary landing	
	Operating near hostile territories	
	Poor accommodation to obtain suitable rest	
	Limited available diet	
	Significant local health risks	
	Poor security on the ground	
	Limited local SAR Capability	
	Extreme heat (>35C)	
X	Extreme cold (<-17C)	Possible during the latter part of the survey

2.8 MISCELLANEOUS HAZARDS

Miscellaneous Hazards		
X if Yes	**Hazard**	**Details**
	Requirement to Carry Local Co-Pilot	
	Requirement to Carry Local Observer	

3 RISK ANALYSIS POLICY AND PROCEDURE

3.1 SANDER GEOPHYSICS RISK ACCEPTABILITY POLICY

		Highly Probable	Probable	Possible	Improbable	Highly Improbable
		5	4	3	2	1
Catastrophic	5	25	20	15	10	5
Hazardous	4	20	16	12	8	4
Major	3	15	12	9	6	3
Minor	2	10	8	6	4	2
Negligible	1	5	4	3	2	1

- All risks shall be reduced to the lowest, reasonably practicable level.
- Sander Geophysics will strive for on-going reduction of risk.
- When and where risk is present and a decision regarding acceptability is made, the following policy shall be observed by management and staff:
    - A risk rating which is "6 or less" (Green Zone) is the company objective whenever reasonably practicable. Survey may proceed as planned.
    - A risk rating of "7 to 12" (Amber Zone) shall be acceptable only when a lower Risk Rating is not reasonably practicable. Survey may proceed upon approval by Flight Operations Manager and/or Chief Pilot.
    - A risk rating of between "13 and 25" (Red Zone) is unacceptable regardless of circumstances. Survey not to proceed as currently planned. Consultation between Flight Operations Manager, Field Operations Manager and Chief Pilot/Senior Field Pilot required to significantly amend plans.
    - High risk ratings (7 to 25) are deemed unacceptable and mitigation is sought to reduce the risk to an acceptable level.

3.2 SANDER GEOPHYSICS RISK ASSESSMENT PROCEDURE

In this document, different aspects of the aerial survey project are assessed for risk as far as they relate to flight operations for the purpose of ensuring that no hazard is created to persons or property on the surface including locations of forced landing areas in the event of an emergency. Where relevant, risk is evaluated separately for the different aircraft types being considered. Other aspects of risk to the project personnel such as car accidents are assessed in different documents.

The severity and probability of each risk is evaluated using the information gathered in the Aerial Survey Planning section of this document. The severity and probability are then multiplied to determine a risk rating. A risk mitigation factor or M-Factor is then applied based on the number and quality of risk mitigating factors. The final risk rating is considered to be the risk rating minus the M-factor.

The assessment of risk will always contain elements of subjectivity and personal judgement. The diverse experience and background of the Sander Geophysics crew members is sufficient to ensure balanced identification and evaluation leading to implementation of proper mitigation and control actions.

3.3 EXPLANATION OF PROBABILITY AND SEVERITY INDICES

Probability Indices	
1 - Highly Improbable	Almost unthinkable that the event occurs
2 - Improbable	Very unlikely to occur
3 - Possible	Could occur
4 - Probable	Has occurred in the industry
5 - Highly Probable	Has occurred in the company and in the industry
Severity Indices	
1 - Negligible	No injury or affect on persons or property
2 - Minor	Superficial or minor affect on persons or property
3 - Major	Serious injuries or major effect on environment
4 - Hazardous	Fatality and major effect on environment
5 - Catastrophic	Multiple fatalities and serious effect on environment

4 COMMON CONTROLS

4.1 OVERVIEW

Safety is taken very seriously at SGL and is always a primary factor in any decision. Many of the Company's basic policies and procedures are effective risk mitigation strategies that act as common controls applicable against all threats outlined in this risk analysis.

The following sections provide an overview of procedures and policies drawn from the company's Air Operator Certificate, Flight Operations Manual, Standard Operating Procedures (SOP) Manual, Maintenance Control Manual, Emergency Response Plan, Health, Safety and Environment Policy Manual and the IAGSA Safety Policy Manual. IAGSA is the International Airborne Geophysics Safety Association, of which SGL is a founding and an accredited member in good standing.

4.2 HEALTH AND SAFETY

The following presents the standard SGL H&S policy statement:

Sander Geophysics is a founding and active executive member of the International Airborne Geophysics Safety Association (IAGSA), which promotes the safe operation of helicopters and fixed-wing aircraft on airborne geophysical surveys.

SGL has developed and implemented a Safety Management System (SMS) and comprehensive Health, Safety and Environment (HSE) policies that govern all aspects of company operations. Safety initiatives include:

- Project-specific Aviation Risk Analysis (ARA) and Personnel Risk Analysis (PRA) for all surveys
- Real-time satellite tracking of SGL aircraft
- HSE and first aid training for all field personnel
- Low-level flight and aircraft simulator training for pilots
- Advanced safety training appropriate to the survey location, such as water-egress, wilderness survival, etc.

4.3 OPERATING CREW

Each aircraft shall be flown by one experienced pilot and one trained equipment operator or two qualified and experienced pilots using Transport Canada approved Standard Operating Procedures (SOP). Flight crew have completed extensive ground and flight training and testing on the aircraft. In addition to having extensive flying experience, the flight crew has extensive low level experience and have completed countless safe and successful missions in a variety of operating environments all over the world.

The operation will be supported on the ground by one to three experienced and qualified geophysicists who will monitor the progress of the flight using a satellite tracking system. The number of geophysicists on site will depend on the size and complexity of the operation. They will also be available to answer flight following calls from the aircraft satellite telephone and to relay to the pilots any urgent requests to divert from their flight plan in the event of an emergency. The ground crew are trained to implement the SGL Emergency Response Plan in the unlikely event that the aircraft is suspected to be in distress. The ground crew are trained to monitor weather conditions in the survey area and at the base of operations and will notify the air crew of any unexpected changes in observed or forecast weather.

A qualified and experienced aircraft maintenance engineer (AME) will be available at the base of operations at all times to ensure the aircraft is kept airworthy and that any maintenance related issues are rectified immediately. The aircraft maintenance engineer has had aircraft specific training. In addition to scheduled maintenance, the AME will assist the pilots with their daily airworthiness pre-flight checks. Details of all maintenance performed are monitored by the Ottawa maintenance department managers.

All field crew are supported 24-7 by experienced and qualified personnel in Ottawa. In the unlikely event that any unfamiliar maintenance issue should arise, the aircraft maintenance engineer will have the support and guidance of an entire team of experienced aircraft maintenance engineers, parts specialists, fabricators, avionics technicians and aeronautical engineers. The aircraft survey system includes provisions for monitoring all aspects of pilot flying including aircraft speed and distance from ground. Pilots are questioned about any unusual recording. In addition, pilots are supported by the Ottawa management such that any decision made in the interest of safety with regard to delaying a flight or cutting a flight short is accepted without question. The Ottawa flight operations and maintenance department undergo regular internal and independent audits to ensure safety and compliance with governing regulations. A Health and Safety committee including an aviation representative meet regularly to discuss and resolve any reported hazards, incidents or safety related issues.

4.4 FLIGHT OPERATIONS

The lines that are to be flown are built into a database which is used by the aircraft navigation system to provide the pilots with horizontal and vertical guidance. The pilot navigation system is comprised of a navigation computer and pilot navigation display but it is not an autopilot. The pilot navigation screen is situated in the cockpit in a heads-up manner that allows the pilot to easily monitor the navigation screen and maintain a look-out outside. The vertical guidance is provided by a combination of GPS and a radar altimeter that has been accurately calibrated. The guidance is presented on a screen in a simple and intuitive way. The height above ground is presented in large, clear numbers along with an altitude (above ground) tape with a colour bar that is red at unsafe altitude. If the clearance suddenly drops

below a specified altitude above ground, a warning signal is triggered along with an indication to pull-up. In addition to the radar altimeter, a laser profiler provides an alternate source of clearance information for the pilots. Along with altitude, the pilot navigation display shows aircraft speed in large clear digital format with an additional speed tape that is coloured to indicate unsafe airspeeds.

In preparation for the survey, a set of maps are made available to the pilots so they can visualize and plan for obstacles or potential hazards within the survey area. A topographical map showing the terrain and the location of all lines will also help pilots to know what to expect. In addition, the aircraft is equipped with a GPS system displaying the aircraft location in real-time on a digital map including the above mentioned elements.

The aircraft will be hand flown at all times such that a failure of any aspect of the survey system would not adversely affect the flight in any way.

4.5 AIR TO GROUND COMMUNICATIONS

The aircraft is equipped with a satellite telephone which is wired through the intercom system. Pilots will make routine flight following calls or automated text messages to check in with the ground support crew at regular intervals. The telephone is capable of receiving calls at any time, and if there are any known problems or changes in the operations area the ground support crew will convey them to the aircraft crew. In addition, ground crew will provide weather updates to the flight crew via satellite telephone if requested.

4.6 MANAGING INCIDENTS ON THE GROUND

The Sander Geophysics Emergency Response Plan (presented upon request) sets out the plan for dealing with an emergency involving a political incident, an aircraft accident, a vehicle accident or injury or illness to personnel while operating in the field.

4.7 SATELLITE TRACKING

The aircraft is also equipped with a satellite tracking system which updates position reports every two minutes. Aircraft position is updated in real time and displayed on a website which will be monitored by the ground support crew.

4.8 SIMULTANEOUS AIRCRAFT OPERATIONS (SIMOPS)

Prior to conducting survey operations, a SIMOPS plan will be co-ordinated with local operators. Flight crew will use local reporting procedures to notify other aircraft of our operations. SGL's Cessna Caravans are equipped with TCAS which will assist the pilots in maintaining awareness of other low level traffic.

4.9 PROJECT PLANNING AND RISK ANALYSIS

Prior to commencement of flight operations, a detailed risk analysis modeled on that described in the IAGSA Safety Policy Manual is conducted to determine the suitability of the aircraft type chosen given

the survey technical specifications and location. The flight crews are provided with the results of the risk analysis after its approval by management and are expected to provide feedback. Project planning also includes the provisions of the company Health, Safety and Environment Policy Manual.

4.10 AIR REGULATIONS

Before commencing operations, it is the pilot´s responsibility to become familiar with the local Aeronautical Information Publication (AIP) and all other relevant information (i.e. NOTAMS). The flight crew is to visit the local Air Traffic Services (ATS) and Meteorological Offices in order to establish personal contact with the local airport staff and to review local regulations and Search and Rescue (SAR) procedures. The flight crew also provides the ATS with a map of the survey area, a description of the aircraft, the intended flight altitudes and the operational procedures. Where possible, any other airports in and around the survey block are notified. Particular attention is given to military flight personnel and operations, landowners with livestock, and affected municipalities.

4.11 PILOT QUALIFICATIONS

Before undertaking any duties as a flight crew member, all the requirements of the company´s approved ground and flight training program as described in the Flight Operations Manual shall have been satisfied. Before flying company aircraft, the pilot has the responsibility of ensuring that all required licenses, certificates and ratings are in force. A flight crew member annually undergoes a pilot competency check conducted by the chief pilot or his designate, in each type of aircraft to be flown.

4.12 CREW OPERATING PROCEDURES AND RESPONSIBILITIES

Each flight crew consists of two pilots using Transport Canada approved Standard Operating Procedures (SOP). Pilots shall use an aircraft checklist, standard calls, and procedures as described in the SOP Manual during all flight operations. When there are two pilots, they share handling duties in flight to mitigate the onset of fatigue. The aircraft shall be flown at all times within the limitations of the aircraft's flight manual and supplements along with any additional requirements imposed by the civil aviation authority. The aircraft may also be flown by one experienced pilot and one equipment operator upon special approval by the Flight Operations Manager of Chief Pilot.

4.13 FLIGHT RULES

Low level survey operations on the company aircraft are to be conducted under Visual Flight Rules (VFR) during daylight hours only. Certain flights or portions thereof may be conducted at night and or under Instrument Flight Rules (IFR) under conditions described in the Flight Operations Manual. No survey flights will be undertaken at night.

4.14 FLIGHT AND DUTY TIME LIMITATIONS

The flight crews will observe Flight Time and Duty Limitations provisions as set out in Canadian Flight Regulations or the country where the aircraft is being operated if applicable. In addition, if at any time a crew member finds themselves to be fatigued, they will either not take off or if already in flight will return for landing without question.

4.15 FLIGHT PLANNING AND FLIGHT FOLLOWING

Prior to the first flight in a new area, the flight crew will develop a protocol for flight following including search and rescue specific to the operating base and survey area. For each flight, the flight crew is required to file a company Operational Flight Plan with a person assigned flight following duties prior to departure. In addition, a Flight Plan must normally be lodged with the local ATS agency. The aircraft crew is required to report to the flight follower at intervals not exceeding one hour. These calls shall include the current line number, position, aircraft status and the expected time of the next call. The details of the report are noted by the flight follower in a flight following log. If the aircraft is overdue or has missed two consecutive calls, the flight follower initiates the search and rescue procedures and proceeds in accordance with the Emergency Response Plan.

4.16 ESSENTIAL CREW

There are no passengers permitted in the aircraft during flight. Only the flight crew and any personnel directly involved with the survey operation are allowed to fly and be designated as essential crew. Any crew members in addition to the pilots are thoroughly briefed on all flight safety procedures before the aircraft is moved. Essential crew may include observers mandated by a civil aviation or military authority.

4.17 SAFETY EQUIPMENT

The aircraft will conform to the required equipment list as described in the aircraft's flight manual and applicable supplements, in addition to equipment required for VFR and over water flights, as applicable. This includes flight instruments, communication, and navigation equipment. The pilot in-command shall also ensure that equipment is carried sufficient for the survival of each person on board, given the geographical area, the season of the year and anticipated seasonal climatic variations. Each crew member is also provided with a personal PLB (personal locator beacon). When operating over water or offshore (IAGSA Safety Policy Manual definitions) the aircraft shall be equipped with a life raft of sufficient capacity to accommodate all persons on board and equipped with a sea survival kit; a personal floatation device for each person on board; and a functional radio capable of two way communication with flight watch and/or ATS. During operations over cold water, a hypothermia protection suit is provided for each person on board.

4.18 DANGEROUS GOODS

Dangerous goods, as defined by IATA, shall not be carried on board company aircraft.

4.19 AIRCRAFT MODIFICATIONS

All aircraft modifications relating to the survey equipment are documented, installed, and maintained in accordance with airworthiness approvals granted by the civil aviation authority.

4.20 MAINTENANCE PLANNING

The Aircraft Maintenance Engineer (AME) is responsible for ensuring that all maintenance is performed in a timely manner in accordance with the aircraft and engine manufacturer's recommendations and the company´s Maintenance Control Manual under the authority of the company´s Approved Maintenance Organization. In addition to the regular aircraft inspections, special inspections on the installed survey equipment and any other relevant stress areas are carried out bearing in mind that survey aircraft operate at low altitudes for extended periods of time. Major maintenance tasks are carried out in an appropriately equipped hangar. Weekly reports are submitted to company headquarters to facilitate maintenance tracking and planning.

4.21 TECHNICAL PUBLICATIONS

All technical publications are kept up-to-date with the latest Airworthiness Directives, and Service Bulletins incorporated. The airframe, engine and propeller log books are kept up-to-date at the operations base. An aircraft Journey Log is used to record the daily serviceability state and will also provide a record of daily flying totals.

4.22 AIRCRAFT SPARE PARTS

Sufficient running spares are kept on hand to ensure continued aircraft serviceability. Any other items required are ordered from approved suppliers who are required to attach a manufacturer´s release note to substantiate the authenticity of the part in accordance with the procedures described in the Maintenance Control Manual.

4.23 AIRPORT SECURITY

Every effort is made to provide a safe parking or storage area for the aircraft. Chocks, tie down facilities, and hangars are utilized as required. In high risk areas, tamper-proof, self adhesive, uniquely numbered seals are used on all doors and access panels.

4.24 FUEL

All fuel is obtained from reputable sources. The AME on site is responsible for ensuring quality control of the fuel and its issue. Proper testing and filtering of the fuel for water and other contaminants prior to delivery to the aircraft tanks is checked and approved by the AME and the captain. Fuel system anti-icing inhibitor is added as required.

5 RISK ANALYSIS

5.1 AIRCRAFT CRASH ON CONGESTED AREA

The aircraft experiences a crash on a congested area

Severity	Probability	Rating	M/Factor	Final Rating
5	1	5	-2	3

5.2 AIRCRAFT CRASH IN NON-CONGESTED AREA

The aircraft experiences a crash on a non-congested area

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-2	2

Note on probability of crash on congested area in Cessna Grand Caravan

Operation Within Safe Gliding Distance

The aircraft shall be operated such that if a power unit fails, an emergency landing can be made without undue hazard to persons or property on the surface.

Turbine Engine

Transport Canada continually monitors the continuing airworthiness of the PT6A engine which is installed in the Cessna Caravan. According to the latest P&WC data (1Q/2007), the 12 months in-flight shut down (IFSD) rate for the PT6A series engines is 0.004 per 1000 hours which is well within the acceptable certification requirement of 10E-5. 10E-5 is an industry target for reliability (one failure for every 100,000 hours, which roughly translates to one failure every 20 years, if an engine is utilized 5000 hours per year, or every 40 years if the engine is operated 2500 hours per year).

Glide Distance

According to the Maximum Glide chart from Section III of the AFM, the aircraft could glide approximately **<<>>**nm if it experienced an engine failure at the proposed survey altitude.

Mathematical Probability of a Crash

The aircraft travels approximately 1.7nm every minute. Given the IFSD of the PT-6 and the limited amount of time that the aircraft will be over any congested area, the worst case mathematical probability of the aircraft having an engine failure and crashing over a town is calculated to be 10E-9 for each survey line that passes over the community. This is assuming that the aircraft would be incapable of turning away from a congested area.

Mitigation Factors Applicable to Both Congested and Non-Congested Areas

Pilot Experience and Training

Aircraft shall be piloted by two experienced and qualified pilots. Both captains have extensive flying experience, including extensive low level flying experience over a variety of terrain. Aircraft captains have completed extensive ground and inflight training to deal with emergencies. Pilots have additional classroom and simulator training from Flight Safety.

Emergency Standard Operating Procedures (SOP)

If any abnormal situation with the aircraft or survey equipment is detected the aircraft flight crews are instructed to climb to a safe altitude to deal with the situation. In addition, in event of an abnormal situation, the pilot will fly the aircraft in a direction to minimize or eliminate risk to any persons, vehicles, vessels or structures on the ground.

Heads-Up Pilot Navigation Display

The pilot navigation screen is situated in the cockpit in a heads-up manner that allows the pilot to easily monitor the navigation screen and maintain a look-out outside.

Aircraft Maintenance and Airworthiness

Aircraft shall be maintained according to Transport Canada guidelines and a trained and experienced Aircraft Maintenance Engineer will be on site to ensure aircraft airworthiness.

Hourly "Operations Normal" Reports

Flight crew will make hourly “operations normal” flight following call via satellite telephone.

Hourly Fuel Calculations and Minimum Fuel Requirement

Pilots are required to do fuel calculations every hour and report the fuel remaining, time to depart the survey location and the fuel on landing every hour. SGL policy requires the aircraft to land with a minimum of one hour fuel reserve which is double the VFR minimum fuel requirement.

Fuel Quality Audits

The airport fuel supplier will be audited and the fuel is checked for contaminants by an Aircraft Maintenance Engineer. The pilots are required to sample the fuel prior to going flying for contaminants. The sampled fuel will be stored for the duration of the survey flight.

Satellite Tracking System

The aircraft is equipped with a satellite tracking system which updates the aircraft's position and groundspeed in real time to a website. The satellite tracking website will be monitored by the ground crew every 15 minutes.

Emergency Response Plan

An Emergency Response Plan has been completed explaining in detail the procedure to follow in the event that the ground crew suspects that the aircraft is in distress or is unable to locate the aircraft.

Emergency Locator Transmitters

In addition to the aircraft 406 MHz ELT, all crew members have a personal 406 ELT which can be manually activated sending a distress signal with position.

Survey System Design

Aircraft survey system can be easily isolated from the basic electrical system so that an electrical failure or fire need not affect the basic aircraft electrical system. In the event of any electrical abnormality associated with the survey system, the crew will isolate and shut down the survey system.

Aeronautical Engineering Approvals and Testing

All aircraft modifications have been designed and approved by a team of qualified and experienced aeronautical engineers. The aircraft has undergone extensive in-flight testing to confirm the airworthiness of the aircraft with modifications.

Mitigation Factors for Twin Engine Aircraft

One Engine Inoperative (OEI) Climb Rate

OEI climb performance is adequate for the aircraft to maintain level flight in the event of an engine failure.

5.3 AIRCRAFT CRASH OVER WATER

The aircraft experiences a crash over water

Severity	Probability	Rating	M/Factor	Final Rating
3	1	3	-2	1

Standard Risk Controls

Overwater Emergency Equipment

A life raft with sufficient capacity to accommodate all persons on board and equipped with a sea survival kit shall be carried. Each person on board shall have a personal floatation device with a personal locator beacon, whistle, light and hook knife in the pocket.

Survival Suits

Where necessary for water temperature, survival suits suitable for the climactic conditions shall be worn.

Underwater Egress Training

Crew members on flights conducted over water shall have completed underwater egress training.

Helmets

Pilots will wear approved aviation safety helmets if deemed appropriate upon evaluation based on a helmet risk analysis. These helmets are fitted with different visors for different light conditions.

5.4 ENGINE FAILURE

The aircraft suffers an engine failure which results in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
3	1	3	-2	1

Standard Risk Controls

Aircraft Selection

The aircraft selected shall match the survey requirements to influence crash survivability. Consideration of survey terrain shall be made when making this selection as well as "crash-worthy" characteristics such as low stalling and landing speeds and energy absorbing structure to protect the crew.

Engine Trend Monitoring

The aircraft shall use engine trend monitoring in order to enhance early detection of any possible engine-related problems.

Fuel Quality Control

Fuel quality control procedures shall be in effect. These procedures are documented in the Maintenance Control Manual.

Four or Five Point Harness

The aircraft shall be equipped with a four or five point seat belt which shall be worn during survey operations.

Survival Suits

Where necessary for water temperature, survival suits suitable for the climactic conditions shall be worn.

Underwater Egress Training

Crew members on flights conducted over water shall have completed underwater egress training.

Helmets

Pilots will wear approved aviation safety helmets if deemed appropriate upon evaluation based on a helmet risk analysis. Helmet visors shall be worn. These helmets are fitted with different visors for different light conditions.

Temperature Considerations

Seasonal and daily temperature variations can also affect the performance of an aircraft significantly. Planning of the survey for the coolest periods may be necessary to optimize performance.

Aircraft Payload

Fuel loading of the aircraft may be reduced in order to reduce the landing inertia of the aircraft. This may require closer positioning of the aircraft to the survey site to minimize transit time or reduce the time on survey requirements.

Height of Survey and Drape Parameters

Increasing the height of the survey can improve the probability of selecting an suitable location to execute a forced landing after experiencing an engine failure. Generally an increase in the survey height will afford a pilot greater reaction time to configure the aircraft, attempt a re-start, and consider all options available in the event of

such an occurrence. A similar result may be achieved by reducing the maximum allowable gradients used for the drape.

5.5 FORCED LANDING - TWIN ENGINE AIRCRAFT

A twin engine aircraft suffers and engine failure and may be required to execute a forced landing

Severity	Probability	Rating	M/Factor	Final Rating
3	1	3	-2	1

Severity

5 Assigned when there is no forced landing or ditching area available. Survey site is completely wooded or over jungle. Any attempt to conduct a forced landing will probably not be survivable.

4 Assigned when the aircraft is considered to be able to execute a survivable forced landing or ditching for some (25%) of the survey area.

3 Assigned when the aircraft is considered to be able to execute a survivable forced landing or ditching for about half of the survey area.

2 Assigned when the aircraft is considered to be able to execute a survivable forced landing or ditching for most (75%) of the survey area.

1 Assigned when the complete survey area is suitable for survivable forced landing or ditching scenario.

Likelihood

5 Assigned when the gradient of the terrain or drape exceeds the maximum climb gradient of the aircraft in normal two engine operation and precludes a controlled descent to lower altitudes at which sustained OEI flight can be achieved.

4 Assigned when the gradient of the terrain or drape exceeds the maximum climb gradient of the aircraft in single engine climb configuration for the complete survey area and precludes a controlled descent to lower altitudes at which sustained OEI flight can be achieved.

3 Assigned when the gradient of the terrain or drape exceeds the maximum climb gradient of the aircraft in single engine climb configuration and descent to altitudes at which sustained OEI flight can be achieved is not possible for more than 50% of the survey area.

2 Assigned when the maximum gradient of the terrain or drape is less than the maximum climb gradient of the aircraft in single engine operation calculated at the mean survey weight and temperature or it is possible to descend to altitudes at which sustained OEI flight is achievable.

1 Assigned when the maximum gradient of the terrain is less than the maximum climb gradient of the aircraft in single engine operation calculated at the start survey weight and maximum projected temperature.

Continued next page

Standard Risk Controls - Likelihood

Aircraft Selection

The easiest way to influence performance considerations against terrain is to correctly match the aircraft to the survey requirements. It may be necessary to consider other aircraft types or categories (i.e. helicopter) if the performance characteristics are not suitable for the survey.

Aircraft Payload

By reducing the weight (i.e. fuel loading) of an aircraft the performance can be optimised. This may require closer positioning of the aircraft to the survey site to minimise transit time, or reduce the time-on-survey requirements. Alternatively, higher areas may be flown during later stages of flights when fuel has been consumed.

Temperature Considerations

Seasonal and daily temperature variations can also affect the performance of an aircraft significantly. Planning of the survey for the coolest periods may be necessary to optimise performance.

Maintenance Considerations

Engine Trend Monitoring, Fuel Quality Control and S.O.A.P. Sampling.

Standard Risk Controls - Severity

Aircraft Selection

The forced landing characteristics of single engine aircraft and helicopters are such that they do not require areas as large as twin engine, fixed wing aircraft for successful forced landing and the landing speeds are lower. In some cases it may be more appropriate to consider the use of a helicopter rather than aeroplane given the terrain to be flown.

Height of Survey and Drape Parameters.

Increasing the height of the survey can improve the probability of maintaining flight after experiencing an engine failure. Generally an increase in the survey height will afford a pilot greater reaction time to configure the aircraft, climb away from the ground, or turn towards lower ground, and consider all options available in the event of such an occurrence. A similar result may be achieved by reducing the maximum allowable gradients used for the drape.

Protective Equipment.

More protective gear for crew members (helmet, 4-5 point harness, ditching and survival gear, etc.).

5.6 COLLISION WITH OBSTACLE

Aircraft and object collide in air resulting in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-2	2

Standard Risk Controls

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. Both pilots will maintain a lookout for obstacles and will point out any obstacles verbally. When obstacles are encountered, PF will state intention to climb or go around the obstacles in order to maintain good CRM. In the case where one pilot and one equipment operator are flying together, the Pilot-in-Command shall brief the equipment operator on maintaining a look-out for obstacles.

Heads-Up Pilot Navigation Display

The pilot navigation screen is situated in the cockpit in a heads-up manner that allows the pilot to easily monitor the navigation screen and maintain a look-out outside.

Established Weather Minimums

VFR weather minima have been established and are documented in the Flight Operations Manual. Flight into reduced visibility is not authorized. In the case where the actual weather conditions are better than the established weather minima yet there is still a possibility that the combination of lack of terrain and obstacle contrast and flight visibility are such that the pilot might not see an obstacle, the flight shall be terminated until better flight conditions prevail.

Crew Experience and Training

Aircraft shall be flown by experienced pilots with training in avoiding adverse weather conditions as well as training in the hazards of continuing flight into reduced visibility or areas with a lack of discernible horizon regardless of reported flight visibility.

Crew Remuneration

To remove unnecessary pressure to fly and potentially compromise minimum standards, flight crews shall not be paid on the basis of hours or distance flown.

Established Flying Height

The aircraft will be flying higher than most obstacles. Obstacles higher than the proposed flying height shall be depicted on detailed planning maps.

Detailed Planning Maps

Prior to conducting low level operations, the pilot shall review detailed maps that depict the survey lines over the terrain. Where possible, the location of known objects shall be depicted on these maps.

Pre-Survey Reconnaissance Flight

Prior to conducting low level operations, the aircraft will perform a reconnaissance flight of the area at high level to ensure the pilot is aware of any obstacles that may pose a safety risk to the aircraft.

Helmets

Pilots will wear approved aviation safety helmets if deemed appropriate upon evaluation based on a helmet risk analysis. These helmets are fitted with different visors for different light conditions.

Flight and Duty Limitations

Pilot flight and duty hours shall be restricted by applicable regulations. Pilots shall not fly when they are fatigued regardless of maximum flight and duty hour limitations.

Company HSE Culture

The culture of the Company at all levels and in all positions is such that conservative decisions with respect to weather and monitoring fatigue levels are encouraged.

5.7 CONTROLLED FLIGHT INTO TERRAIN (CFIT)

An airworthy aircraft under the control of crew is flown into the ground (or water) resulting in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-2	2

Standard Risk Controls

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. During operations using two flight crew, both pilots shall shall maintain a look-out for unexpected areas of high terrain.

Crew Experience and Training

Aircraft shall be flown by experienced pilots with training in low level flying, particularly with respect to avoiding adverse weather conditions as well as training in the hazards of continuing flight into reduced visibility or areas with a lack of discernible horizon regardless of reported flight visibility. Specific crew experience and training is required for flying in mountainous areas.

Heads-Up Pilot Navigation Display

The pilot navigation screen is situated in the cockpit in a heads-up manner that allows the pilot to easily monitor the navigation screen and maintain a look-out outside.

Digital Display of Terrain Clearance

Pilot guidance display include large, clear digital readout of current altitude AGL along with an altitude display tape with color bars for unsafe altitude.

Visual and Aural Pull-Up Warning

The survey equipment includes a calibrated radar altimeter and has a visual pull up warning to notify the pilots when getting too close to the ground . If this radar altimeter fails, a back-up radar altimeter will automatically take over and give warning to the pilots. The aircraft is equipped with a radar altimeter which will provide an additional aural alert when the pilots are too close to the ground.

Terrain Awareness and EGPWS

The aircraft is also equipped with two Garmin 696 GPS systems which have a terrain awareness feature. Most aircraft are also equipped with EGPWS.

Established Weather Minimums

VFR weather minima have been established and are documented in the Flight Operations Manual. Flight into reduced visibility is not authorized. In addition to the established ceiling and visibility restrictions, flight into mountainous or rough terrain will be terminated in high wind, excessively turbulent conditions and whenever windshear is encountered.

Low Clearance SOP

If any of the aircraft systems indicate that the aircraft is too close to the ground, pilots will conduct an overshoot procedure as per company SOP.

Crew Remuneration

To remove unnecessary pressure to fly and potentially compromise minimum standards, flight crews shall not be paid on the basis of hours or distance flown.

Survey Planning and Aircraft Performance Analysis

During the pre-flight planning, a detailed analysis of the proposed flying surface with respect to the aircraft performance is completed to ensure adequate theoretical aircraft performance exceeds planned flying surface in all cases.

Detailed Topographic Maps

Prior to conducting low level operations, the pilot shall review detailed topographic maps that depict the survey lines over the terrain. These detailed topographic maps depict terrain gradient to a much greater detail than shown on ordinary VFR aeronautical charts.

Pre-Survey Reconnaissance Flight

Prior to conducting low level operations, the helicopter will perform a reconnaissance flight of the area at high level to ensure the pilot is aware of any areas where the terrain may pose a safety risk to the aircraft.

Pre-Survey Flying Surface Quality Control Check

The lead Pilot-in-Command at a new survey location shall complete an inflight flying surface quality control check where a few survey lines shall be flown to ensure that there are no problems with the planned flying surface with respect to aircraft performance being inadequate or actual terrain being significantly different from the pre-survey planning.

In-Flight Modification of Flight Path

In situations where it is possible that the terrain gradient exceeds the aircraft climb gradient, the pilot will initiate a climb well in advance to ensure adequate terrain clearance at all times during the climb. At all times, safety of the aircraft will take precedence over the survey objective to maintain the specified terrain clearance.

Survey Speed

The survey speed selected shall be low enough to allow good quality data collection but in all cases high enough to provide an adequate margin of safety.

Helmets

Pilots will wear approved aviation safety helmets if deemed appropriate upon evaluation based on a helmet risk analysis. These helmets are fitted with different visors for different light conditions.

Flight and Duty Limitations

Pilot flight and duty hours shall be restricted by applicable regulations. Pilots shall not fly when they are fatigued regardless of maximum flight and duty hour limitations.

5.8 INADVERTENT ENCOUNTER WITH INSTRUMENT METEOROLOGICAL CONDITIONS (IMC)

An aircraft unexpectedly enters an area where IMC exists

Severity	Probability	Rating	M/Factor	Final Rating
1	2	2	-1	1

Standard Risk Controls

Two Crew Operation

The aircraft will be flown by two qualified and experienced pilots. Both pilots are current and qualified for IFR operations. Aircraft is equipped for flight into IMC.

Established Weather Minimums

VFR weather minima have been established and are documented in the Flight Operations Manual. Flight into reduced visibility is not authorized. In addition to the established ceiling and visibility restrictions, flight into mountainous or rough terrain will be terminated in high wind, excessively turbulent conditions and whenever windshear is encountered.

Flight Following Support

Ground crew providing flight following support via satellite telephone are trained to monitor weather conditions and alert the pilots if weather conditions are deteriorating unexpectedly.

Satellite Telephone Contact With AIS

The flight crew can call AIS directly via the satellite phone in the aircraft if there is any question about deteriorating weather conditions.

Minimum Fuel Reserves

SGL policy requires the aircraft to land with a minimum of one hour fuel reserve which is double the VFR minimum fuel requirement. The flight crew will return to base with additional fuel when the weather conditions are marginal.

Crew Remuneration

To remove unnecessary pressure to fly and potentially compromise minimum standards, flight crews shall not be paid on the basis of hours or distance flown.

5.9 LOSS OF SEPARATION OR COLLISION WITH ANOTHER AIRCRAFT - UNCONTROLLED AIRSPACE

Aircraft experiences a loss of separation or collision with another aircraft resulting in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
5	1	5	-2	3

Standard Risk Controls

Simultaneous Operations (SIMOPS) Co-Ordination Meeting

Prior to commencing survey operations, the flight crew shall meet with the local operators to ensure they are fully informed of our operations and the crew is fully informed of local procedures. Air crew shall be familiar with known local, float operator bases, heliports or other Special Air Service (SAS) bases.

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. During operations using two flight crew, both pilots shall maintain a look-out for other traffic. In the case where one pilot and one equipment operator are flying together, the Pilot-in-Command shall brief the equipment operator on maintaining a look-out for other traffic.

T-CAS

The aircraft is equipped with a Traffic Collision Avoidance System (TCAS)

Heads-Up Pilot Navigation Display

The pilot navigation screen is situated in the cockpit in a heads-up manner that allows the pilot to easily monitor the navigation screen and maintain a look-out outside.

Pulse Lights

The aircraft is equipped with a flashing "Pulse Light" system that increases the aircraft's visibility. The pulse lights are used only for enroute potions of the flight.

VHF Position Reports

Aircraft is equipped with two VHF radios. Pilots will monitor appropriate frequencies and make position reports as required.

Established Weather Minimums

VFR weather minima have been established and are documented in the Flight Operations Manual. Flight into reduced visibility is not authorized.

5.10 LOSS OF SEPARATION OR COLLISION WITH ANOTHER AIRCRAFT - CONTROLLED AIRSPACE

Aircraft experiences a loss of separation or collision with another aircraft resulting in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
5	1	5	-2	3

Standard Risk Controls

Air Traffic Control (ATC) Co-Ordination Meeting

Prior to commencing survey operations, the flight crew shall meet with the local ATC to ensure they are fully informed of our operations and the crew is fully informed of local procedures.

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. During operations using two flight crew, both pilots shall maintain a look-out for any possible other traffic. In the case where one pilot and one equipment operator are flying together, the Pilot-in-Command shall brief the equipment operator on maintaining a look-out for other traffic.

Heads-Up Pilot Navigation Display

The pilot navigation screen is situated in the cockpit in a heads-up manner that allows the pilot to easily monitor the navigation screen and maintain a look-out outside.

Pulse Lights

The aircraft is equipped with a flashing "Pulse Light" system that increases the aircraft's visibility. The pulse lights are used only for enroute potions of the flight.

VHF Position Reports

Aircraft is equipped with two VHF radios. Pilots will monitor appropriate frequencies and make position reports as required.

Satellite Telephone

In addition to the VHF radios, the aircraft is equipped with a satellite telephone. The aircraft satellite telephone number will be given to the local AIS Units.

5.11 STRUCTURAL OR MECHANICAL FAILURE

A structural or mechanical failure of the aircraft result in loss of control and crash

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-2	2

Standard Risk Controls

Daily Inspection (DI)

A daily inspection shall be performed by the Pilot-in-Command to ensure the aircraft is airworthy. An AME will present to address and concerns that the pilot may have.

Certified Aeronautical Engineering

All aircraft modifications relating to the survey equipment are documented, installed, and maintained in accordance with airworthiness approvals granted by the civil aviation authority.

Isolation of Survey Equipment

The survey equipment shall be installed so that any failure related to the survey equipment would not adversely affect any aspect of the aircraft.

Supply of Spares

The Company shall maintain a list of Approved Suppliers to ensure that parts received conform to civil aviation approved design data and are in a condition for safe operation. Sufficient running spares are kept on hand to ensure continued aircraft serviceability. Any other items required are ordered from approved suppliers who are required to attach a manufacturer´s release note to substantiate the authenticity of the part in accordance with the procedures described in the Maintenance Control Manual.

Technical Publications

All technical publications are kept up-to-date with the latest Airworthiness Directives, and Service Bulletins incorporated. The airframe, engine and propeller log books are kept up-to-date at the operations base. An aircraft Journey Log is used to record the daily serviceability state and will also provide a record of daily flying totals.

Hangar Facilities

Hangar facilities suitable for the level of activity performed are to be accessible for major maintenance work.

Engine Trend Monitoring

Most aircraft have Engine Trend Monitoring (ETM) equipment installed. In aircraft that do not have automated ETM capability, engine power checks shall be completed as a means of engine trend monitoring.

5.12 AIRCRAFT ELECTRICAL FAILURE

An aircraft experiences an electrical failure that results in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-2	2

Standard Risk Controls

Certified Aeronautical Engineering

All aircraft modifications relating to the survey equipment are documented, installed, and maintained in accordance with airworthiness approvals granted by the civil aviation authority.

Isolation of Survey Equipment Power

The survey equipment shall be installed so that all electrical power to the survey equipment can be quickly and easily shut off from the pilot's seat without affecting the ship's electrical power.

VFR Operations

Aircraft is operated under Visual Flying Rules (VMC) so electrical failure is unlikely to result in serious consequences for the aircraft.

Alternate Navigating Device

An alternate navigating device such as an iPad with moving map or hand held GPS unit that is capable of operating without the use of ship's power shall be available for the crew to navigate in the event of a total electrical failure.

Aircraft System Redundancy

Redundancy is built into the aircraft electrical system such that a total electrical failure is highly unlikely.

5.13 AIRCRAFT ELECTRICAL FIRE

An aircraft experiences an electrical or cabin fire that results in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
4	2	6	-3	3

Standard Risk Controls

Certified Aeronautical Engineering

All aircraft modifications relating to the survey equipment are documented, installed, and maintained in accordance with airworthiness approvals granted by the civil aviation authority.

Isolation of Survey Equipment Power

The survey equipment shall be installed so that all electrical power to the survey equipment can be quickly and easily shut off from the pilot's seat without affecting the ship's electrical power.

Fire Extinguisher Training

All crew members have had fire extinguisher training.

Cabin Smoke Clearing Procedures

Standard aircraft emergency procedures includes procedure for smoke in the cabin.

5.14 FUEL EXHAUSTION

The aircraft conducts a forced landing or ditching as a result of fuel exhaustion and leads to an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-1	3

Standard Risk Controls

Fuel Check

Prior to the flight, the Pilot-in-Command shall check to ensure that the actual fuel quantity loaded reflects that in the flight plan.

Flight Plan and Weather Data

Aircrew shall have access to weather information when determining planned duration of flight. Unless a reduced fuel load is required to reduce aircraft weight and improve performance capabilities, the aircraft will depart with full fuel.

Fuel Reserve

The aircraft shall land with a minimum 60 minute fuel reserve at all time. In the case where weather information or other variables could adversely affect the flight, the aircraft shall land with an additional contingency reserve.

In-Flight Fuel Calculations

The Pilot-in-Command shall complete fuel reserve calculations every hour.

Low Fuel Indication System

The aircraft is fitted with a low fuel indication system in addition to the regular fuel gauges.

5.15 FUEL CONTAMINATION

An aircraft is forced to put down at an unprepared site with minimal warning as a result of contaminated fuel causing loss of engine power and results in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
4	2	8	-4	4

Standard Risk Controls

Fuel Testing

Testing of the fuel supplied shall include use of water detector capsules or any equivalent that is able to test for water in suspension. The Pilot-in-Command will ensure that the quality of the fuel being uplifted is acceptable for operation of the aircraft.

Fuel Filtration

Fuel delivery systems including portable systems are to be fitted with water blocking filtration of the Go No-Go types. Filter canisters are to be marked with the next date of change or inspection cycle. All filters must be replaced at nominated pressure differentials as annotated on the filter housing or as recommended by the manufacturer, but as a minimum will be replaced annually.

Fuel Sampling

Fuel samples from the aircraft shall be taken prior to the first flight after the aircraft has been refueled as per the Aircraft Flight Manual (AFM). The sample shall be retained in a clear jar with screw-top type lid and shall be retained until completion of the daily flying activities.

Fuel Supplier Audit

The onsite Aircraft Maintenance Engineer (AME) shall perform an audit of the fuel supplier prior to refueling Company aircraft.

Refueling Procedures

Refueling shall be supervised by trained Company personnel. Refueling shall not be carried out during heavy rain or severe weather.

Drummed Fuel

Special precautions as outline in Company manuals shall be taken prior to using fuel from drummed fuel.

Aircraft Selection

Turbine powered aircraft are less susceptible to power loss as a result of fuel contamination as compared to a piston engine.

5.16 WEATHER

Weather conditions force the aircraft to deviate from original flight path and causes an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
4	2	8	-4	4

Standard Risk Controls

Established Weather Minimums

VFR weather minima have been established and are documented in the Flight Operations Manual. Flight into reduced visibility is not authorized.

Crew Experience and Training

Aircraft shall be flown by experienced pilots with training in avoiding adverse weather conditions as well as training in the hazards of continuing flight into reduced visibility.

Crew Remuneration

To remove unnecessary pressure to fly and potentially compromise minimum standards, flight crews shall not be paid on the basis of hours or distance flown.

Company HSE Culture

The culture of the Company at all levels and in all positions is such that conservative decisions with respect to weather are encouraged.

Pre-Survey Recon Flight

During the pre-survey reconnaissance flight, safe poor weather escape routes that lack terrain or obstacle hazards shall be noted by the Pilot-in-Command. These routes can be used to return to a safe landing area in the event that the weather deteriorates unexpectedly.

Pre-Flight Planning

Alternate landing sites shall be established during the pre-flight planning phase of the day's operations.

Flight Following

The aircraft is equipped with a satellite telephone which is wired through the intercom system. Flight operations are supported on the ground by a flight follower who is trained to monitor the weather conditions at the base of operations and if necessary also in the survey operations area. If an adverse trend in weather conditions is predicted, the flight crew shall be alerted via satellite telephone call.

5.17 INCORRECT LOADING

Incorrect loading of the aircraft results in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
3	1	3	-1	2

Standard Risk Controls

Installed Survey Equipment

All survey equipment shall be installed in the aircraft by trained technicians and licensed Aircraft Maintenance Engineers (AME). This equipment shall be included on the aircraft empty weight and balance report created by the AME. Any change of equipment shall require that a new aircraft weight and balance report be generated by the AME. Any aircraft weight and balance report created by an AME in the field shall be reviewed by an Ottawa maintenance manager.

Basic Operational Weight and Balance

A basic operational weight and balance (W&B) report that includes any additional equipment (eg. survival equipment), crew and operating fuel shall be completed by the Pilot-in-Command or his designate. The W&B report shall demonstrate that the movement of the Center of Gravity (CG) as the aircraft burns fuel throughout the flight will not adversely affect the correct loading off the aircraft. The W&B report shall be reviewed by the Pilot-in-Command and an Ottawa flight operations manager. The Pilot-in-Command shall ensure that the actual aircraft loading reflects the loading on the W&B report.

Ground Crew Training

On personnel that have completed ramp safety training specific to that aircraft type shall be allowed to approach the aircraft on the ground. This ramp safety training shall include training on relevant factors associated with aircraft weight and balance.

Ramp Access

If ramp access is not controlled at the airport of operations, all ground crew shall be responsible to ensure that non-Company personnel do not approach the Company aircraft. This includes any client or local representatives.

5.18 BIRD STRIKE

The aircraft hits a bird during flight resulting in aircraft damage

Severity	Probability	Rating	M/Factor	Final Rating
2	3	6	-3	3

Standard Risk Controls

Pre-Survey Planning

During the pre-survey planning, the location of any areas where birds may be prevalent shall be established.

Altitude Selection

For all flight in and around coastal areas and for other areas of known bird concentrations, flight below 1000' AGL is to be avoided if possible, other than for landing and take-off and transit altitudes shall be at the highest practicable altitude. Where flight is required below 1000' AGL in this area due to the operational task additional mitigation measures outlined below shall be implemented.

Departure and Arrival Procedures

Any local departure and arrival procedures shall be designed to minimize the time below 1000' AGL to the greatest extent practicable and in consideration with other ATC requirements.

Survey Speed

Consideration should be given to a reduction in airspeed to ≤100kts when below 1000', which would significantly reduce the impact force of a bird strike. In no case shall airspeed be reduced to below the minimum IAGSA specific airspeed.

Helmets

Pilots will wear approved aviation safety helmets with visors if deemed appropriate upon evaluation based on a helmet risk analysis. (See section 7 this document)

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. Both pilots shall maintain a lookout for any possible bird encounters. In the case where one pilot and one equipment operator are flying together, the Pilot-in-Command shall brief the equipment operator on maintaining a look-out for birds.

Heads-Up Pilot Navigation Display

The pilot navigation screen is situated in the cockpit in a heads-up manner that allows the pilot to easily monitor the navigation screen and maintain a look-out outside.

Pulse Lights

The aircraft is equipped with a flashing "Pulse Light" system that increases the aircraft's visibility to birds. Pulse lights shall be kept on for the duration of flight.

Continued next page

Bird Encounter SOP

In the case where the aircraft encounters a large flock of birds, the crew will maneuver the aircraft as necessary to avoid a strike.

Bird Strike Awareness Training

Pilots shall have bird strike awareness training using the Transport Canada publication *"Sharing the Skies"* TP13549E.

5.19 AIRSPACE OR BORDER VIOLATION

The aircraft flies over a border or into unauthorized airspace

Severity	Probability	Rating	M/Factor	Final Rating
2	2	4	-2	2

Standard Risk Controls

Pre-Survey Planning

During the pre-survey planning, the location of the border shall be established using a reputable source.

Overflight Permissions

The status of any overflight permissions shall be documented in the Aerial Survey Plan. Pilots shall remain aware of the current status of any overflight permissions.

Safe Zone

The case where the Company does not have permission to enter airspace or cross a border, a no-fly "safe zone" shall be established to provide a safety buffer.

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. During operations using two flight crew, the pilots shall use good Crew Resource Management (CRM) so that at least one pilot is always aware of the location of the border or no-fly area with respect to the aircraft. The the case where one pilot and one equipment operator are flying together, the Pilot-in-Command shall brief the equipment operator on how to identify and maintain awareness of the border or no-fly zone using the aircraft GPS. Sterline cockpit shall be maintain whenever the aircraft is operating within 4nm of a border.

Pre-Flight Planning and Briefing

During the daily pre-flight planning, the pilots shall note the location of the border or no-fly zone with respect to the location of the day's planned flight. Any change of operating plans made in the air shall include a cockpit briefing of the location of the revised planned area of operations with respect to the border or no-fly area.

Cockpit GPS Units

Pilots shall ensure that the location of the border or no-fly zone is displayed on the aircraft moving mapGPS unit with sufficient zoom level to be able to visually identify the distance of the aircraft from the no-fly zone.

Flight Following and Satellite Tracking

In the case where the aircraft is planned to fly near to a no-fly zone, the flight follower shall check periodically to ensure that the aircraft has not crossed into the no-fly zone.

5.20 DAMAGE OR DISTURBANCE OF ANIMALS DUE TO OVERFLIGHT OF AIRCRAFT

Nervous animals on the ground are frightened by the aircraft and are injured while running away

Severity	Probability	Rating	M/Factor	Final Rating
2	3	6	-2	4

Standard Risk Controls

Pre-Survey Planning

During the pre-survey planning, consideration of the likelihood of overflying nervous animals and the potential consequences shall be made.

Planned Survey Altitude

In the cases where the survey may go over nervous animals on the ground, consideration of the number and type of animals who may be affected shall be made when selecting survey altitude.

Community Outreach

Local officials shall be notified of the survey so that the community may be aware of the survey operations.

Pre-Survey Recon

In the case where nervous animals may be prevalent on the ground, a pre-survey reconnaissance flight will be completed so that pilots are aware of the location of these animals.

Minimal Overflight

In the case where nervous animals may be adversely affected by the survey, flight over the affected areas shall be minimized as much as possible.

No Overflight of Herds of Animals

In the case where herds of nervous and vulnerable animals are encountered who may be adversely affected by the low flying aircraft, the aircraft shall depart the immediate survey area until the animals have left the area. In the case where the animals are found inside a wildlife park or wildlife reserve, pilots shall avoid herding the animals out of the park or reserve area.

Flight Following

The aircraft is equipped with a satellite telephone which is wired through the intercom system. Pilots will make routine flight following calls to check in with the ground support crew at regular intervals. The telephone is capable of receiving calls at any time, and if there are any known problems or changes in the operations area the ground support crew will convey them to the aircraft crew.

Minimal Exposure

As a fixed wing aircraft, the time spent over one area would be extremely minimal. In addition, the aircraft will climb to 800ft AGL in the turns at the end of each line to minimize and disturbance to people or animals on the ground.

5.21 PERSONS ON THE GROUND ARE FRIGHTENED OR IRRITATED BY LOW FLYING AIRCRAFT

Severity	Probability	Rating	M/Factor	Final Rating
1	3	3	-2	1

Standard Risk Controls

Planned Survey Altitude

In the cases where the survey may go over persons on the ground, consideration of the number of people who may be affected shall be made when selecting survey altitude.

Community Outreach

Local officials shall be notified of the survey so that the community may be aware of the survey operations.

Flight Following

The aircraft is equipped with a satellite telephone which is wired through the intercom system. Pilots will make routine flight following calls to check in with the ground support crew at regular intervals. The telephone is capable of receiving calls at any time, and if there are any known problems or changes in the operations area the ground support crew will convey them to the aircraft crew.

Minimal Exposure

As a fixed wing aircraft, the time spent over one area would be extremely minimal. In addition, the aircraft will climb to 800ft AGL in the turns at the end of each line to minimize and disturbance to people or animals on the ground.

5.22 VEHICLE ACCIDENT AS A RESULT OF BEING DISTRACTED BY LOW FLYING AIRCRAFT

A vehicle driver is distracted by the low flying aircraft and causes a car accident

Severity	Probability	Rating	M/Factor	Final Rating
2	2	4	-2	2

Standard Risk Controls

Planned Survey Altitude

In the cases where the survey goes over a roads, consideration of the amount of traffic shall be made when selecting survey altitude.

Minimal Overflight

In the case where drivers on the road may be adversely affected by the survey, flight over the affected areas shall be minimized as much as possible.

Flight Following

The aircraft is equipped with a satellite telephone which is wired through the intercom system. Pilots will make routine flight following calls to check in with the ground support crew at regular intervals. The telephone is capable of receiving calls at any time, and if there are any known problems or changes in the operations area the ground support crew will convey them to the aircraft crew.

Minimal Exposure

As a fixed wing aircraft, the time spent over one area would be extremely minimal. In addition, the aircraft will climb to 800ft AGL in the turns at the end of each line to minimize and disturbance to people or animals on the ground.

5.23 RUNWAY EXCURSION

The aircraft departs the runway during take-off or on landing and results in an aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
3	1	3	-2	1

Standard Risk Controls

Pilot Experience

Only experienced pilots will be allowed to act as Pilot-in-Command of SGL aircraft. Performance capabilities of the aircraft shall be considered with respect to prevailing wind conditions and pilot ability and experience.

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator.

5.24 COLLISION ON GROUND

The aircraft and object collide on ground resulting in aircraft accident

Severity	Probability	Rating	M/Factor	Final Rating
2	2	4	-2	2

Standard Risk Controls

Aircraft Ground Crew

A trained ground crew member shall be available when the aircraft is departing or returning. These ground crew members shall maintain a lookout for objects that could collide with the aircraft. If the ground crew member notices an object that could collide with the aircraft, he shall alert the pilot using hand signals.

Pilot Experience and Training

Pilot shall have extensive experience and training in avoiding collisions with objects on the ground.

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. The equipment operator shall be trained and briefed to keep a lookout for objects on the ground that could collide with the aircraft.

Ramp Inspection

All crew that have ramp access shall be trained to maintain a lookout for any objects that could collide with the aircraft. A ramp inspection shall be completed prior to aircraft departure and before aircraft arrival.

Ramp Access

If ramp access is not controlled at the airport of operations, all ground crew shall be responsible to ensure that non-Company personnel maintain a safe distance from Company aircraft. This includes any client or local representatives.

Ground Crew Training

On personnel that have completed ramp safety training specific to that aircraft type shall be allowed to approach the aircraft on the ground.

5.25 DAMAGE OF PROPERTY DUE TO PROPWASH OF AIRCRAFT

Property on the ground is damaged by the rotor wash of the aircraft

Severity	Probability	Rating	M/Factor	Final Rating
2	2	4	-2	2

Standard Risk Controls

Aircraft Ground Crew

A trained ground crew member shall be available when the aircraft is departing or returning. These ground crew members shall maintain a lookout for objects that could be blown away by the propwash of the aircraft. If the ground crew member notices an object that could collide with the aircraft, he shall alert the pilot using hand signals.

Pilot Experience and Training

Pilot shall have extensive experience and training in avoiding damage to objects on the ground from propwash during taxi operations as well as take-off and landing.

Two Crew Operation

Aircraft shall be piloted either by two trained flight crew members or an experienced flight crew member and equipment operator. The equipment operator shall be trained and briefed to keep a lookout for objects on the ground that could be blown away or damaged by the propwash of the aircraft.

Ramp Inspection

All crew that have ramp access shall be trained to maintain a lookout for any objects that could be damaged from the propwash of the aircraft. A ramp inspection shall be completed prior to aircraft departure and before aircraft arrival.

5.26 A PERSON IS INJURED WORKING ON THE RAMP

A person is injured or killed as a result of performing duties on the ramp

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-2	2

Standard Risk Controls

Ramp Access

If ramp access is not controlled at the airport of operations, all ground crew shall be responsible to ensure that non-Company personnel maintain a safe distance from Company aircraft. This includes any client or local representatives.

Ground Crew Training

On personnel that have completed ramp safety training specific to that aircraft type shall be allowed to approach the aircraft on the ground.

Climate Controlled Rest Area

In the case where the climate is extremely hot (>27°C) or extremely cold (<-10°C) a climate controlled rest area shall be provided for persons working on the ramp. Additional policies on working in extreme heat or cold can be found in the Company manuals. In addition, crew shall not work outside during thunderstorms or during severe weather.

Buddy System

Ground crews shall avoid working alone on the ramp. In the case where this is not possible, a check-in system with another ground crew member shall be implemented so that somebody is keeping track of the location and safety of the person working on the ramp periodically.

Hangar Facilities

Hangar facilities suitable for the level of activity performed are to be accessible for major maintenance work.

5.27 AIRCRAFT FOD

An aircraft is damaged due to an encounter with FOD

Severity	Probability	Rating	M/Factor	Final Rating
2	2	4	-2	2

Standard Risk Controls

Ramp Inspection

All crew that have ramp access shall be trained to maintain a lookout for any FOD that has the potential to damage the aircraft. A FOD inspection shall be completed prior to aircraft departure and before aircraft arrival.

Aircraft Marshallers

Aircraft marshallers shall be used when the aircraft is departing or returning. These marshallers shall maintain a lookout for FOD.

5.28 AIRCRAFT GROUND HANDLING DAMAGE

An aircraft is damaged during ground handling

Severity	Probability	Rating	M/Factor	Final Rating
2	2	4	-2	2

Standard Risk Controls

Ground Crew Training

On personnel that have completed ramp safety training specific to that aircraft type shall be allowed to move the aircraft on the ground.

Look-out Support

While the aircraft is being moved on the ramp, additional crew shall be present to provide a look-out and alert all ground handling personnel it if appears the aircraft is in danger of being damaged.

5.29 AIRCRAFT DAMAGED ON RAMP

An aircraft is damaged due to an unspecified event on the ground

Severity	Probability	Rating	M/Factor	Final Rating
2	2	4	-2	2

Standard Risk Controls

Selection of Parking Area

The parking area selected will minimize exposure to damage from other aircraft moving around the ramp.

Airport Security

In the case where it is suspected that the airport grounds may not be secure, additional security officers will be hired to protect the aircraft.

Aircraft Control Locks and Tie Downs

In addition to standard control locks, the aircraft will be tied down when on the ground.

Daily Inspection (DI)

A daily inspection shall be performed by the Pilot in Command to ensure the aircraft has not been damaged.

5.30 AIRCRAFT UNDER THREAT FROM HOSTILE INHABITANTS ON THE GROUND

An aircraft is shot at or shot down by hostile inhabitants on the ground

Severity	Probability	Rating	M/Factor	Final Rating
4	1	4	-3	1

Standard Risk Controls

Altitude Selection

Where threats from hostile inhabitant on the ground are possible, the survey altitude selected will minimize the exposure to that threat.

Military Contact

Where threats from hostile inhabitant on the ground are possible, the local military or diplomatic officials will be contacted in order to determine the nature and extent of the threat as well as to determine the capabilities of hostile forces.

Safe Zone

The case where the hostile inhabitants are near to but not directly under the survey area, a no-fly "safe zone" shall be established to provide a safety buffer.

5.31 AIRCRAFT OR CREW UNDER THREAT FROM NATURAL DISASTER OR EXTREME EVENT

An aircraft is damaged due to a natural disaster or extreme event

Severity	Probability	Rating	M/Factor	Final Rating
3	1	3	-2	1

Standard Risk Controls

Base Selection

Where natural disasters or extreme events are possible, the operating bases selected will minimize exposure to those events.

Hangar Availability

Where natural disasters or extreme events are possible, a hangar will be sourced if appropriate minimize exposure to those events.

Emergency Response Plan (ERP)

An ERP shall be created which includes a plan of action should a natural disaster or extreme event occur.

6 AIRCRAFT ACCIDENT

In this section, different aspects of the aerial survey project are assessed for risk as far as they relate to their affect on an aircraft accident scenario.

6.1 POST CRASH SURVIVABILITY OVER LAND

Post Crash Survivability Over Land		
X if Yes	**Hazard**	**Details**
X	Fuselage unlikely to remain intact following crash	A crash into trees will likely cause the fuselage to break apart
	30% or more of survey in mountainous area	
X	Water temperature	Lake water will be extremely cold
X	Airspeed likely to be >65kts at moment of impact	
X	Aircraft likely difficult to locate at crash site	Visual identification may be difficult if the aircraft crashes in a forested area.
	50% or more of survey area above 8000 ft	
	Aircraft operating in jungle area	
	Extreme heat or cold	
X	Dangerous animals in the area	Bears, lynx, cougars and wolves can be found in Minnesota
	Significant number of disease carrying insects in the area	
	Difficult to extract survivors in the crash area	
X	No towns or villages near crash area	Portions of the block are located far from settlements

Post Crash Survivability Over Land		
X if Yes	**Hazard**	**Details**
	Hostile inhabitants on the ground	
	Other	

6.2 POST CRASH SURVIVABILITY OVER WATER

Post Crash Survivability Over Water		
X if Yes	**Hazard**	**Details**
X	Low water temperature	
X	Low air temperature	
	Wave height	
	High average wind speed	
	Fog likely	
	Other	

6.3 MITIGATING DEFENCES IN THE EVENT OF AN AIRCRAFT ACCIDENT

Mitigating Defences in The Event of an Aircraft Accident		
X if Yes	**Defence**	**Details**
X	Helicopter available to extract survivors	Duluth Air National Guard base.
X	Second serviceable SGL aircraft on site	
X	3rd party aircraft available on site to assist search	The Civil Air Patrol, private operators

Mitigating Defences in The Event of an Aircraft Accident		
X if Yes	**Defence**	**Details**
X	SGL satellite tracking system functioning correctly	
X	Crew on location monitoring SATS at least hourly	
X	Highly trained and experiences SAR technicians	
	Other	

6.4 MITIGATING DEFENCES IN THE EVENT OF AN AIRCRAFT ACCIDENT - OVER WATER

Mitigating Defences in the Event of an Aircraft Accident Over Water		
X if Yes	**Defence**	**Details**
	Crew has access to marine forecasts and dispatch limits set	N/A
X	Crew has underwater egress training	
	Pilots able to wear helmets without adverse physiological effects	
	Crew has suitable survival suits	
	Other	

6.5 SAR ASSESSMENT

SAR Assessment		
X if Yes	**Hazard**	**Details**
	Limited local SAR capability	

SAR Assessment		
X if Yes	**Hazard**	**Details**
	Frequent weather systems that could slow down SAR	
	Problems with communication systems in the area	
	Long time before SAR could arrive on site	
	Lack of means to transport survivors to medical facility	
	Long time to transport survivors to medical facility	
	Limited medical facilities in area	

7 HELMET USE RISK ANALYSIS

There is a significant body of evidence which indicates that the use of a certified aviation crash helmet can increase the likelihood of survival in the event of an aircraft crash. This helmet usage analysis has been developed as a tool to help identify, evaluate and highlight the risks and hazards that may be associated with the use of aviation helmets on survey projects. The purpose is to enhance pilot awareness of the risks, and to use that awareness as a decision making tool for the usage of helmets.

7.1 RISKS AND HAZARDS FOR HELMET USAGE

Factor	Details
Flight Duration	
General Flight Conditions (turbulence)	
Operating Temperatures	
Aircraft Heating and Cooling	
Helmet Usage is Client Requirement	The contract indicates that helmets are necessary unless it is not practical to wear them in the type of aircraft being flown. The BT-67 (Balser DC-3) and PA-31 (Piper Navajo) are give as examples of aircraft in which helmets cannot practically be worn.
Other	

7.2 HELMET USAGE DECISION ANALYSIS

Factoring in the risks and hazards associated with additional fatigue or heat stress that could be caused by wearing a helmet, the use of helmets is **<<required / recommended / optional>>** for this project.

APPENDIX A: PILOT PRE-SURVEY PROJECT START-UP CHECKLIST

Some items have been completed by the first crew however all crews should familiarize themselves with the project using this checklist.

ADMINISTRATIVE ITEMS

- Obtain copy of local AIP/AIS, AIC, and/or Civil Aviation Regulations (digital copies are best):
    1. Identify any special in-country flight procedures
    2. Identify VFR weather minima and local definition of day and night
    3. Identify local flight & duty time limitations
    4. Create a tentative flight schedule that complies with duty times and operational limitations
- Set up pilot office:
    1. Identify a workspace and obtain stationary for pre/post-flight paperwork
    2. Post maps in the office
- Obtain maps of local area and survey maps
- Identify appropriate alternate landing areas
- Complete paperwork:

1. Complete Operational Weight & Balance **(ensure actual loading is reflected in BOFP)**
2. Complete Basic Operational Flight Plan
3. Fill our CAA flight plan
4. Emergency Response Plan (ERP)
5. Review, revise and edit Aviation Risk Analysis (ARA)

- Create pilot binders. Binders for different aircraft should be identical and should include:
    1. Operational W&B
    2. BOFP
    3. CAA flight plan
    4. Copy of the Emergency Response Plan
    5. Copies of charts and approach plates
    6. Flight permits (if any)
    7. Contents of the aircraft and office binders should be identical
- Complete aircraft inventory (or obtain a copy of the most recent one)
- Review drape QC report
- Create survey system checklist
- Get project briefing from previous crew members

REQUIRED CO-ORDINATION WITH SGL FIELD CREW

Coordination with other SGL departments is essential to a successful survey. Crew members from other departments may need to perform certain tasks pre- and post-flight that can alter the typical day's work flow. It is important to identify these limitations are the beginning of the project.

- Liaise frequently with Field Crew Chief and other crew members to find out if they need any help with project set-up. Be sure they are also aware of the tasks you need to complete
- Review aircraft logbook with on-site AME and **BE SURE** there are no snags. Discuss plan for completing inspections that will come due during the survey.
- Review with the Field Crew Chief the following:
    1. Required test flights (be sure you understand what is required
    2. Configuring Garmin 696/796 to show survey lines. Discuss procedures for updating the GPS as lines are flown.
    3. How to operate and monitor the survey system (review survey checklist)
- Discuss a typical day's schedule with the entire crew and identify any operational restrictions than may mean departing or returning at a certain time.

REQUIRED CO-ORDINATION WITH LOCALS

Local knowledge is invaluable. Airport operations vary widely between locations and discussing procedures with local operators and ATC is essential to a successful survey.

Talk to ATC regarding:

1. ATC contacts / contact info
2. Local ground and flight procedures
3. Local operators (including flight school training areas)
4. Co-ordination of survey , survey test line and survey calibration / test areas
5. Capability of aviation services (radar, weather forecasting, etc.)
6. Operating hours (including hours of fuel service)
7. Provide ATC with a map of our survey area
8. Be sure to show concern about making **our** use of **their** airport go smoothly

- Talk to airport management regarding:
    1. Parking arrangements
    2. Fueling arrangements
    3. Requirements for airside passes
- Talk to local pilots and operators about:
    1. Local weather
    2. Local area and any non-published procedures they may use
- Obtain charts, maps, and approach plates that can be used for navigation

    1. Approach plates can be printed from Flitestar
    2. Enroute and VFR charts are best obtained in a trip kit or locally.
- Conduct fuel audit (if no AME present or if delegated by AME)
- Coordinate SIMOPS

1. Flight operations contact info
2. Provided with SGL survey map
3. Base of operation
4. Nature of operations
5. Area of operation
6. Typical operating altitude
7. # and type of aircraft
8. Company frequencies used
9. Aircraft are TCAS equipped?
10. Record details of co-ordination plan

FINAL PRE-SURVEY FLIGHT CHECKLIST

Ensure these items are complete before going flying

1. Required paperwork is complete and sent to Ottawa
2. You have reviewed the project ARA
3. Aircraft inventory / survival equipment is on board and functional
4. Survey checklist is complete
5. You now how to operate the survey system and what to look for
6. Charts and approach plates are on board
7. You know where your alternates are
8. The correct sequence file is loaded
9. You are aware of any restricted airspace or no-fly zones
10. You are aware of local frequencies
11. You are aware of local weather patterns
12. Survey permissions are in place, up to date and on board the aircraft
13. Flight following procedures have been established
14. Ensure pull-up height is set to **<< 60>>**m. Do not fly closer than **<<60>>**m to the ground. In the event that the planned drape appears that it will take the aircraft closer to the ground, pull up and maintain adequate clearance.
15. Set radar pull-up height to **<<60>>**m

APPENDIX B: RAMP SAFETY BRIEFING

The lead field pilot shall ensure that all SGL personnel are given an aircraft and site specific safety briefing prior to working on the ramp. A checklist is provided for guidance however the briefing should be adjusted as necessary for the field location and experience level of the person receiving the briefing.

SITE SPECIFIC SAFETY BRIEFING

Airport Access, Regulations, Hazards	
	Security access procedures, consequences of violations
	Airside passes, expiry dates, procedure for renewal, person responsible for renewal
	Prohibited items (possibly cameras, knives, some tools, GPS, radios, other)
	Hazards (people, animals, snakes, scorpions, other operators, trip hazards etc)
Normal Operating Procedures	
	Where ground crew will stand, # of people allowed on ramp
	Hand signals to be used, normal and emergency
	Approaching the aircraft with engine running
	Connecting/unconnecting ground power incl associate aircraft specific hazards
	Ground heating/cooling systems
	Laser altimeters and hazards
	Tool control procedures
	Refueling procedures incl use of PPE, quantity; allowance for thermal expansion
Abnormal Operating Procedures	
	Fuel spills
Handling Emergencies	
	Emergency services available at the airport
	Electrocution - what to do, how to remove power sources
	Fire, including engine fire or smoke on start-up or shut-down; location of extinguishers and/or fire blankets if avail
	Contact with hazardous materials (fuel, oil, other); location of eye wash, clean-up materials
	Emergency contacts (incl where list is posted)
Other	

AIRCRAFT SPECIFIC SAFETY BRIEFING

General Items	
	Operation of doors, securing, consideration for wind, jetblast / rotorwash from other aircraft
	Boarding and exiting aircraft, tripping and slipping hazards
	Danger and hazard areas (incl diagram from internal website)
	Visibility (lack of) from cockpit: if you cannot see pilots eye, he cannot see you
	Feather signal (if appropriate)
	Use of battery power to power up aircraft instruments required for survey equipment (on ground)
	Use of external power (to power aircraft instruments required for survey equipment)
	Location of fuel drains (avoid getting dripped on, fire risk)
	Emergency equipment in aircraft (fire extinguisher, first aid kit, water - ground crew not to use unless emergency)
	Areas not to push, lean or move
	Reminder of dangers to controls if items left near rudder pedals or dropped on floor
Safe Entry and Exit Points - Running Aircraft	
C208B Cessna Caravan	
SAFE	Left side pilot door, rear left cargo door, rear right air stairs door (may be unsafe for some - requires 4 ft climb)
DANGEROUS	You must not enter through the right pilot door - hot exhaust may burn you. Never enter the back of the Caravan without installing the tail stand.
BN2B Islander	
SAFE	Rear left side door
DANGEROUS	Pilot door - too close to the propeller
C404	
SAFE	Rear left side door
DANGEROUS	Do not approach the pilot window
DA42 Diamond Twin Star	
SAFE	Main canopy or rear left door accessed from behind the wing
DANGEROUS	Approaching the canopy forward of the wing
DHC-6 Twin Otter	
SAFE	Rear left side door **if left engine is shut down**
DANGEROUS	Either pilot door - they are too close to the propellers Rear left side door if left engine is running

GENERAL RAMP SAFETY BRIEFING

The lead field pilot shall ensure than all SGL personnel have received general ramp safety training. This training is normally provided in Ottawa however the following checklist is provided as guidance for briefing personnel who may benefit from recurrent training.

Major Hazards	
	Propeller - running (invisible, debris, prop wash, noise)
	Propeller - not running (sharp edges - people have been killed hitting their heads on propellers that aren't running!)
	Exhaust - running engine (high volumes of hot exhaust 600C, exhaust danger areas, blast on ground power connection)
	Exhaust - after shut down (still hot for a while)
	Approaching running aircraft
	Anticipating engine start (pilot in cockpit - assume start is imminent, aircraft tail light on - start imminent)
Taxiing Aircraft and Ramp Vehicles	
	Visibility (see and be seen, safety vests, be aware of blind spots in aircraft and ramp vehicles, awareness of other operators)
	Dangers of brake failures (specially in turns), slippery surfaces
	Wide fast sweep of tail boom in turns
	Danger of loose items on ramp to aircraft (FOD, chocks, ladders etc)
Dangers From Refueling	
	Fire (fuel fumes - specially AVGAS, bonding, fire procedures)
	Spills, overflow, splashback into eyes (PPE requirement) - eye, skin protection
Situations That May Cause Damage to Aircraft on the Ground	
	Serious damage may occur that you cannot see
	Storms, high wind, exposure to volcanic ash, blast and rotorwash from other aircraft, other aircraft or objects hitting aircraft
	Incorrect towing procedure, overstressing nose gear, brakes on, towing with rudder lock on, scissor link connected (DHC-6)
	Leaving doors open, control locks off, improper tie down, no pogo
	Speak up! Safety is everybody's business
Working in Aircraft on the Ground	
	Do not move levers or switches or pull CB
	Dangers of water bottles, pens, tools, loose screws etc in cockpit
	If you cause any damage, notice any damage, disrupt any cockpit controls or notice any irregularities, you must notify a flight crew member. You will not be reprimanded (as per SGL policy), as long as you report the occurrence immediately. Hiding what seems to be an insignificant amount of damage could lead to a serious accident.
General	
	PPE requirement
	No smoking
	Ramp safety documents available on the company internal website