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Request for Supply Arrangement (RFSA)

REFRESH

Canada, as represented by the Minister of Natural Resources Canada, hereby requests a Supply Arrangement on behalf of the client identified herein.

Comments – Commentaires

Issuing Office – Bureau de distribution

Finance and Procurement Management Branch
Natural Resources Canada
580 Booth Street, 5th Floor
Ottawa, Ontario
K1A 0E4

Title – Sujet
Airborne Geophysical Surveys - REFRESH

Solicitation No. – No de l'invitation	Date
NRCan-5000041793B	May 12, 2023

Client Reference No. - N° de reference du client
5000041793

Requisition Reference No. - N° de la demande
149768

Solicitation Closes – L'invitation prend fin
at – à 02:00 PM EDT
on – le May 30, 2023

Address Enquiries to: - Adresse toutes questions à:	Buyer ID – Id de l'acheteur
Kaeli.McCarthy@nrcan-rncan.gc.ca	**B38**
Telephone No. – No de telephone	**Fax No. – No. de Fax**
343-571-9878	N/A

If marked "X" please see the box to the left
S'il ya un "X" ici, s.v.p. voir la boite à la gauche
☒ **Acknowledgement copy required**
Accusé de réception requis

Destination – of Goods, Services and Construction:
Destination – des biens, services et construction:

Natural Resources Canada
615 Booth Street
Ottawa, Ontario
K1A 0E8

Security – Sécurité

This Request for Supply Arrangement does not include provisions for security.

Vendor/Firm Name and Address
Raison sociale et adresse du fournisseur/de l'entrepreneur

Telephone No.:- No. de téléphone:
Facsimile No.: - No. de télécopieur:
Email – Courriel :

Name and Title of person authorized to sign on behalf of Vendor/Firm (type or print)
Nom et titre de la personne autorisée à signer au nom du fournisseur/de l'entrepreneur (taper ou écrire en caractères d'imprimerie)

Signature **Date**

REFRESH

FOR

REQUEST FOR SUPPLY ARRANGEMENT (RFSA)

FOR

AIRBORNE GEOPHYSICAL SURVEYS

NRCAN REQUEST FOR SUPPLY ARRANGEMENT NUMBER: NRCan-5000041793

REFRESH:

This is a solicitation to refresh the existing Supply Arrangement NRCan-5000041793; for the provision of Airborne Geophysical Surveys to Natural Resources Canada (NRCan). All potential suppliers capable of meeting the requirements of this solicitation are invited to reply to this solicitation to provide the Services under the framework of the resulting Supply Arrangement. Only suppliers that are pre- qualified at the time individual RFPs are issued against this Supply Arrangement will be eligible to bid for the requested Services.

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PART 1 – GENERAL INFORMATION

1.1 Introduction

The Request for Supply Arrangement (RFSA) is divided into six (6) parts plus attachments and annexes, as follows:

Part 1: **General Information:** provides a general description of the requirement;

Part 2: **Supplier Instructions:** provides the instructions applicable to the clauses and conditions of the RFSA;

Part 3: **Arrangement Preparation Instructions:** provides suppliers with instructions on how to prepare the arrangement to address the evaluation criteria specified;

Part 4: **Evaluation Procedures and Basis of Selection:** indicates how the evaluation will be conducted, the evaluation criteria which must be addressed in the arrangement, the security requirement and the basis of selection;

Part 5: **Certifications:** includes the certifications to be provided; and

Part 6: **6A – Supply Arrangement:** includes the Supply Arrangement (SA) with the applicable clauses and conditions;
6B – Bid Solicitation: includes the instructions for the bid solicitation process within the scope of the SA;
6C – Resulting Contract Clauses: includes general information for the conditions that will apply to any contract entered into pursuant to the SA.

The Annexes include:

Annex "A" – Statements of Work
Annex "B" – Evaluation Criteria (at the RFP stage)
Annex "C" – Insurance Requirements (RFSA and RFP stage)
Annex "D" – Financial Proposal (RFP stage)
Annex "E" – Socio-Economic Benefits
Annex "F" – Quarterly Reporting Spreadsheet

1.2 Summary

By means of this RFSA, Natural Resources Canada (NRCan) wishes to qualify a number of firms that shall provide Airborne Geophysical Survey services with either Fixed Wing Plane and/or Rotary Wing Helicopter, on an 'as and when required' basis that would include the following streams:

- WORKSTREAM 1: Aeromagnetic Survey
- WORKSTREAM 2: Radiometric (Gamma Ray Spectrometric) Survey
- WORKSTREAM 3: Airborne Gravity Survey
- WORKSTREAM 4: Time Domain Electromagnetic (TDEM) Survey
- WORKSTREAM 5: Airborne Gravity Gradiometry

It is requested that the Bidders clearly identify which Workstreams they are bidding on.

1.2.1 Trade Agreements

The requirement is subject to the provisions of the Canada-Korea Free Trade Agreement (CKFTA), the Canadian Free Trade Agreement (CFTA), the Canada-Chile Free Trade Agreement (CCFTA), the Canada-Columbia Free Trade Agreement (CColFTA), The Canada-Honduras Free Trade Agreement (CHFTA), the Canada-Panama Free Trade Agreement (CPanFTA), the Canada-Peru Free Trade Agreement (CPFTA), the Canada-Ukraine Free Trade Agreement (CUFTA), the Comprehensive and Progressive Agreement for Trans-Pacific Partnerships (CPTPP), the Canada-European Union Comprehensive Economic and Trade Agreement (CETA), and the World Trade Organization – Agreement on Government Procurement (WTO-AGP).

1.2.2 Comprehensive Land Claims Agreements

The Request for Supply Arrangements (RFSA) is to establish supply arrangements for the delivery of the requirement detailed in the RFSA to the Identified Users across Canada, including areas subject to Comprehensive Land Claims Agreements (CLCAs), including locations within Yukon, Northwest Territories, Nunavut, Quebec, and Labrador.

1.3 Security Requirement

There is no security requirement associated with this request, or any subsequent Supply Arrangements and/or resulting Contracts.

1.4 Debriefings

After issuance of a Supply Arrangement, suppliers may request a debriefing on the results of the Request for Supply Arrangement process. Suppliers should make the request to the Supply Arrangement Authority within 15 working days of receipt of the results of the Request for Supply Arrangement process. The debriefing may be in writing, by email.

PART 2 – SUPPLIER INSTRUCTIONS

2.1 Standard Instructions, Clauses and Conditions

All instructions, clauses and conditions identified in the Request for Supply Arrangement (RFSA) by number, date and title are set out in the *Standard Acquisition Clauses and Conditions Manual* issued by Public Works and Government Services Canada (PWGSC).

Suppliers who submit an arrangement agree to be bound by the instructions, clauses and conditions of the RFSA and accept the clauses and conditions of the Supply Arrangement and resulting contract(s).

The 2008 (2022-03-29) Standard Instructions - Request for Standing Offers - Goods or Services - Competitive Requirements, are incorporated by reference into and form part of the RFSO.

In the complete content (**Except Section 1.4f, Section 3) of 2008 (2022-03-29):**

DELETE: Public Works and Government Services Canada (PWGSC)
INSERT: Natural Resources Canada (NRCan)

Sub-Section 5.4 - Submission of Offers of 2008 (**2022-03-29**) is amended as follows:

DELETE: 60 days
INSERT: 120 days

Subsection 8.1 – Transmission by Facsimile of 2008 (**2022-03-29**) is amended as follows:

DELETE: in its entirety

Subsection 19 – Further Information of 2008 (2022-03-29) – Not Applicable

2.2 Submission of Arrangements

Bidders must submit all proposals using the Canada Post Canada (CPC) Connect service. Given the current constraints on NRCan's networks, the electronic mail system has a limit of 1GB per single message received and a limit of 20GB per conversation.

Bids must be submitted no later than the date and time indicated on page 1 of the bid solicitation.

Only bids submitted using CPC Connect service will be accepted.

At least five (5) business days before the bid solicitation closing date, it is necessary for the Bidder to send an email requesting to open CPC Connect conversation to the following address:

procurement-approvisionnement@NRCan-RNCan.gc.ca

IMPORTANT: It is requested that you write the bid solicitation number in "Subject" of the email:

NRCan will not assume responsibility for proposals directed to any other location.

The onus is on the Bidder to ensure that the bid is submitted correctly using epost Connect service. Not complying with the instructions may result in NRCan's inability to ascertain reception date and/or to consider the bid prior to contract award. Therefore, NRCan reserves the right to reject any proposal not complying with these instructions.

Due to the nature of the bid solicitation, bids transmitted by mail or facsimile to NRCan will not be accepted.

The onus is on the Bidder to ensure that the proposal is delivered to the location above. Not complying with the above instructions may result in NRCan's inability to ascertain reception date and/or to consider the bid prior to contract award. Therefore, NRCan reserves the right to reject any proposal not complying with these instructions.

2.3 Former Public Servant – Notification

Service contracts awarded to former public servants in receipt of a pension or a lump sum payment must bear the closest public scrutiny and reflect fairness in the spending of public funds. Therefore, the bid solicitation will require that you provide information that, were you to be the successful bidder, your status with respect to being a former public servant in receipt of a pension or a lump sum payment, will be required to report this information on the departmental websites as part of the published proactive disclosure reports generated in accordance with Treasury Board policies and directives on contracts with former public servants, Contracting Policy Notice 2012-2 and the Guidelines on the Proactive Disclosure of Contracts

2.4 Federal Contractors Program for Employment Equity – Notification

The Federal Contractors Program (FCP) for employment equity requires that some Contractors make a formal commitment to Employment and Social Development Canadas (ESDC) – Labour to implement employment equity. In the event that this Supply Arrangement would lead to a contract subject to the Federal Contractors Program (FCP) for employment equity, the bid solicitation and resulting contract templates would include such specific requirements. Further information on the Federal Contractors Program (FCP) for employment equity can be found on Employment and Social Development Canada (ESDC) - Labour's website.

2.5 Enquiries – Request for Supply Arrangements

All enquiries must be submitted in writing to the Supply Arrangement Authority no later than **five (5)** calendar days before the Request for Supply Arrangements (RFSA) closing date. Enquiries received after that time may not be answered.

Suppliers should reference as accurately as possible the numbered item of the RFSA to which the enquiry relates. Care should be taken by Suppliers to explain each question in sufficient detail in order to enable Canada to provide an accurate answer. Technical enquiries that are of a proprietary nature must be clearly marked "proprietary" at each relevant item. Items identified as "proprietary" will be treated as such except where Canada determines that the enquiry is not of a proprietary nature. Canada may edit the questions or may request that Suppliers do so, so that the proprietary nature of the question is eliminated, and the enquiry can be answered with copies to all Suppliers. Enquiries not submitted in a form that can be distributed to all Suppliers may not be answered by Canada.

2.6 Applicable Laws

The Supply Arrangement and any contract resulting from the Supply Arrangement must be interpreted and governed, and the relations between the parties determined, by the laws in force in Ontario.

Suppliers may, at their discretion, substitute the applicable laws of a Canadian province or territory of their choice without affecting the validity of their offer, by deleting the name of the Canadian province or territory specified and inserting the name of the Canadian province or territory of their choice. If no change is made, it acknowledges that the applicable laws specified are acceptable to the Suppliers.

2.7 Bid Challenge and Recourse Mechanisms

a) Several mechanisms are available to potential suppliers to challenge aspects of the procurement process up to and including contract award.

b) Canada encourages suppliers to first bring their concerns to the attention of the Contracting Authority. Canada's Buy and Sell website, under the heading "Bid Challenge and Recourse Mechanisms" contains information on potential complaint bodies such as:

- Office of the Procurement Ombudsman (OPO)
- Canadian International Trade Tribunal (CITT)

c) Suppliers should note that there are **strict deadlines** for filing complaints, and the time periods vary depending on the complaint body in question. Suppliers should therefore act quickly when they want to challenge any aspect of the procurement process.

PART 3 – ARRANGEMENT PREPARATION INSTRUCTIONS

3.1 Arrangement Preparation Instructions

Natural Resources Canada encourages the use of recycled paper and **two-sided printing**. Reduction in the size of Due to the outbreak of COVID-19, NRCan is foregoing the need to have people outside delivering packages to our Bid Receipt Unit. Therefore, given this pandemic, you must submit your bids as follows:

Your Company Name – Section I – Technical /Section II – Financial /III – Certifications

Section I: **Technical Bid:** One (1) PDF copy - labelled as per the above

Section II: **Financial Bid:** One (1) PDF copy – labelled as per the above

Section III: **Certifications:** One (1) PDF copy - labelled as per the above

Prices must appear in the financial bid only. No prices must be indicated in any other section of the bid.

Canada requests that Offerors follow the format instructions described below in the preparation of their offer.

- Use a numbering system that corresponds to that of the Request for Standing Offers.

Section I – Technical Arrangement

In their technical arrangement, Suppliers should explain and demonstrate how they propose to meet the requirements and how they will carry out the Work.

Section II – Certifications

Suppliers must submit the certifications required under Part 5.

PART 4 – EVALUATION PROCEDURES AND BASIS OF SELECTION

The following are the Evaluation Criterion that the Bidders must comply with to be awarded a Supply Arrangement.

4.1 Evaluation Procedures

a) Arrangements will be assessed in accordance with the entire requirement of the Request for Supply Arrangements including the technical evaluation criteria.

b) An evaluation team composed of representatives of Canada will evaluate the arrangements.

4.1.1 Technical Evaluation

The evaluation process of this procurement will be conducted in three (3) phases:

Phase 1: The Offer(s) will be evaluated against the Mandatory Requirements below. Should a Bidder be fully compliant with **ALL** Mandatory Requirements for any Workstream(s) they are bidding on they will be awarded a Supply Arrangement for that (those) Workstream(s).

Phase 2: If an Offer(s) does not comply with **ALL** of the Mandatory Requirements, for any particular Workstream they are bidding on, the Bidder notified in writing of the inadequacy in their proposal related to any such "unmet" mandatory criteria. They will then be provided an additional fifteen (15) calendar days, after this evaluation to correct the problem and resubmit their revised data. If the revised data are acceptable, in accordance with the aforementioned mandatory requirements, the Bidder will be awarded a Supply Arrangement upon acceptance of the revised data for that (those) particular Workstreams.

Phase 3: If, after the fifteen (15) calendar days the revised data is still not acceptable, the Offer(s) will be considered non-compliant and no further consideration will be given for that (or those) Workstream(s). However, this does not preclude the disqualified Bidder from responding to the RFSA refresh, which will occur once per year.

Proposals must clearly detailed the following elements in their proposal to be considered compliant:

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
M1	The Bidder **MUST** be able to provide the following for each Workstream they are bidding on: Drape flying capability is mandatory for the following Workstreams: **Fixed Wing:** a) Workstream 1: Aeromagnetic Survey b) Workstream 2: Radiometric (Gamma-ray Spectrometric) Survey c) Workstream 3: Airborne Gravity Survey d) Workstream 4: Time Domain Electromagnetic (TDEM) Survey e) Workstream 5: Airborne Gravity Gradiometry **Rotary Wing:** a) Workstream 3: Airborne Gravity Survey	☐ Yes ☐ No	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	b) Workstream 5: Airborne Gravity Gradiometry Survey Drape flying capability is optional for the following Workstreams: **Rotary Wing:** a) Workstream 1: Aeromagnetic Survey b) Workstream 2: Radiometric (Gamma-ray Spectrometric) Survey c) Workstream 4: Time Domain Electromagnetic (TDEM) Survey		
M2	Note: The Bidder must submit a digital dataset for evaluation. **Data must be submitted for each Workstream that the bidder is bidding on.** For aeromagnetic and radiometric surveys the dataset must be no less than 10,000 line kilometers for fixed-wing surveys and no less than 2,500 line kilometers for helicopter-borne surveys. A fixed-wing time-domain electromagnetic, airborne gravity or airborne gravity gradient dataset must be at least 2,500 line kilometers. Data must be submitted for each Workstream being bid on to be considered compliant. This dataset must include: • gamma-ray spectrometry for Workstream 2 • electromagnetic for Workstream 4, • gravity, or gravity gradient data for Workstream 3 and 5 respectively. **For Fixed Wing**: Workstream 1: Aeromagnetic Survey and Workstream 2: Radiometric (Gamma Ray Spectrometric) Survey: • the dataset must be no less than 10,000 lkms Workstream 3: Airborne Gravity Survey Workstream 4: Time-Domain Electromagnetic Survey Workstream 5: Airborne Gravity Gradiometry Survey • dataset must be at less 2,500 lkms **For Rotary Wing:** Workstream 1: Aeromagnetic Survey and Workstream 2: Radiometric (Gamma Ray Spectrometric) Survey: • the dataset must be no less than 2,500 lkms Datasets must include the following: a) Calibration Data (as required per workstream) b) Line data c) Gridded data	☐ Yes ☐ No	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	d) Supporting maps and documentation to portray and demonstrate compilation.		
Workstream 1: Aeromagnetic Data			
M3	The Bidder **must** provide the following information for their magnetic data: a) **Line Data:** Line data must be sampled at 10 Hz or more and in Geosoft (.gdb) format. The following data channels must be provided: • Line channel (integer number) • Time (fiducial) channel • Differentially corrected latitude, longitude channels (in decimal degrees, six (6) decimal place accuracy) or equivalent easting, northing (m) • Flight number channel (integer number) • Orthometrically corrected GPS height (m) • Drape surface (m) used to fly survey (where applicable) • Radar Altimeter (m) • Uncompensated and compensated raw magnetic data (where applicable) • Fluxgate magnetometer (XYZ) data • Raw edited and lagged magnetic data • All intermediate adjustments to the magnetic channel (nT), (filters, additional adjustments applied in leveling steps to achieve the final leveled magnetic channel) • Levelled magnetic channel • Magnetic base station diurnal channel(s) b) **Gridded Data:** Gridded data must be supplied with a grid interval of approximately ¼ of the traverse line spacing and in Geosoft (.gdb) file format. The following grid types must be provided: • Grid of the magnetic field produced from the leveled magnetic channel • Grid of the first vertical derivative of the magnetic field c) **Maps and support documentation:** the following maps and support documentation must be provided: • Map of gridded magnetic total field data • Map of gridded first vertical derivative of the magnetic field • Profile map of magnetic leveling adjustments (i.e. compensated raw magnetic channel minus leveled magnetic channel, each line zeroed to its average) plotted on the flight plan. The map of the first vertical derivative of the magnetic field grid and the profile of	☐ Yes ☐ No	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	the magnetic level adjustment may be combined on one map. • Support documentation describing complete details on the leveling steps used to achieve the final leveled magnetic channel. d) **Specific Equipment Requirements:** ***Aircraft:*** The Bidder must provide the appropriate aircraft (as per M1) capable of following the drape surface of the digital elevation model at a sustained rate of climb/descent of 5% for fixed-wing aircraft and 15% for rotary wing aircraft. ***Magnetometer:*** The sensor(s) must be mounted in a stinger attached to the aircraft. ***Compensator:*** An on-board compensator system is required (active or post-processing) ***Radar Altimeter:*** Minimum range: 0 – 800 m Accuracy (minimal) 5% ***GNSS:*** Complete GNSS coverage must be obtained. A GNSS ground base station is required. Raw dual-frequency positional GPS data must be supplied* *Post flight differential correction of the raw GPS data is **mandatory** using ground GPS base station data for all flights. ***Video Camera:*** The video image overlay must show, at the minimum, GPS time to a precision of tenths of seconds and image centre cross-hair. GPS positional information is optional. ***Ground Magnetometer Stations:*** At least one (1) base station is required in proximity to each survey area. The base station must record data at a rate of 1 sample per second and record GPS time with each magnetic base station reading. Bidder must identify which base station is used.		
Workstream 2: Radiometric (Gamma-Ray Spectrometric) Data (qualification for this stream must include qualification under Workstream 1: Aeromagnetic):			
M4	The Bidder must provide the following information:	☐ Yes	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	a) Calibration Data: Gamma-ray spectrometer data recorded for calibration tests must be provided in Geosoft (.gdb) format with the same channels as listed below for Line Data. The calibration data must include data recorded using spectrometry calibration pads available in Ottawa or Toronto, data recorded for cosmic calibration flights at altitudes greater than 3000m above the ground and data recorded during a sensitivity / attenuation calibration test flight, for example at Breckinridge, Quebec. The bidder is to provide all correction constants used to achieve the conversion of raw gamma-ray spectrometry data to the final corrected data, including cosmic corrections, radon corrections, stripping correction, attenuation constants and factors used to do the conversion to concentration or dose rate. a) **Line Data:** Line data must be sampled at 1 Hz or more and in Geosoft (.gdb) format. The following data channels must be provided: • Line channel (integer number) • Time (fiducial) channel • Differentially corrected latitude, longitude channels (in decimal degrees, six (6) decimal place accuracy) or equivalent easting, northing (m) • Flight number channel (integer number) • Orthometrically corrected GPS height (m) • Drape surface (m) used to fly survey (where applicable) • Radar Altimeter (m) • Temperature (°C) • Barometric pressure (kPa) • Effective altitude (m) • Live time (ms) • Cosmic count (cps) • Upward detector spectrum (1024 channels) • Main detector spectrum (1024 channels) • Upward crystal count (cps) • Raw total count (cps) • Raw potassium count (cps) • Raw uranium count (cps) • Raw thorium count (cps) • Total air absorbed dose rate (nGy/h) • Corrected potassium (pct) • Corrected equivalent uranium (ppm) • Corrected equivalent thorium (ppm) • Ratio: equivalent uranium/equivalent thorium (ppm/ppm) • Ratio: equivalent uranium/potassium (ppm/pct)	☐ No	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	• Ratio: equivalent thorium/potassium (ppm/pct) b) **Gridded Data:** Gridded data must be supplied with grid interval of approximately ¼ of the traverse line spacing and in Geosoft (.gdb) file format. The following grid types must be provide: • Grids of the total air absorbed dose rate, corrected potassium, equivalent uranium, equivalent thorium, and of the three (3) ratios. • Maps of previous gridded data. c) The bidder is to provide sample gamma-ray spectrometer data recorded for calibration tests This includes data recorded using spectrometry calibration pads available in Ottawa or Toronto, data recorded for cosmic calibration flights at altitudes greater than 3000 m above the ground and data recorded during a sensitivity/attenuation calibration test flight, for example at Breckinridge, Quebec. d) The bidder is to provide all correction constants used to achieve the conversion of raw gamma-ray spectrometry data to the final corrected data, including cosmic corrections, radon corrections, stripping correction, attenuation constants and factors used to do the conversion to concentration or dose rate. e) **Maps and support documentation:** The following maps and support documentation must be provided: • Map of previous gridded data • Support documentation describing all correction constants used to achieve the conversion of raw gamma-ray spectrometry data to the final corrected data, including cosmic corrections, radon corrections, stripping correction, attenuation constants and factors used to do the conversion to concentration or dose rate. **f) Specific Equipment Requirements:** ***Aircraft:*** The Bidder must provide the appropriate aircraft (as per M1) of flying at 30 m intervals for 100 to 200 seconds each between 60 m and 300 m above the surface and capable of flying at 500 m intervals for 600 seconds each between 1500 and 3500 m ASL. The Bidder must provide suitable aircraft capable of following the drape surface of the digital elevation		

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	model at a sustained rate of climb/descent of 5% for fixed-wing aircraft and 15% for rotary wing aircraft. ***Gamma-ray Spectrometer:*** The gamma-ray detectors must be positioned in the aircraft such that shielding of the detectors by the fuel tanks is minimal. Systems must use multiple detectors (minimum 36L) independently digitized and combined to a single output spectrum and preserve the Poisson distribution in all output spectrum channels. ***Radar Altimeter:*** Minimum range: 0 – 800 m Accuracy (minimal) 5% ***Barometer:*** Absolute air pressure to 0.1 kPa ***Thermometer:*** External ambient temperature to: 1°C		
Workstream 3: Gravity Data (qualification for this stream must include qualification under Workstream 1: Aeromagnetic with magnetic data of (2,500 km)):			
M5	The Bidder must provide the following information for this workstream: a) **Calibration Data:** All calibration data must be provided in Geosoft (.gdb) format with the same channels as listed below for Line Data. The calibration data must include airborne gravity comparison measurements with suitable upward continued ground gravity measurements. The bidder is to provide all correction constants used to achieve the conversion of raw gravity data to the final corrected data. a) **Line data:** Line data must be sampled at 4 Hz or more and in Geosoft (.gdb) file format. The following data channels must be provided: • Line channel (integer number) • Time (fiducial) channel • Differentially corrected latitude, longitude channels (in decimal degrees, six (6) decimal place accuracy) or equivalent easting, northing (m) • Flight number channel (integer number) • Orthometrically corrected GPS height (m) • Drape surface (m) used to fly survey (where applicable)	☐ Yes ☐ No	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	• Radar Altimeter (m) • Raw accelerometer channels of X, Y and Z • Eotvos correction • Raw gravity • Free air gravity (unleveled and leveled filtered gravity) • Bouguer correction (2.67 g/cc) • Earth curvature correction • Terrain correction • Bouguer gravity anomaly, unleveled • Levelling correction • Bouguer gravity anomally b) **Gridded Data:** Gridded data must be supplied with a grid interval of approximately ¼ of the traverse line spacing and in Geosoft (.gdb) file format. The following grid types must be provided: • Grids of the free air and Bouguer gravity anomalies c) **Maps and support documentation:** The following maps and support documentation must be provided: • Maps of the previous gridded data d) **Specific Equipment Requirements:** ***Aircraft:*** The Bidder must provide suitable aircraft capable of following the drape surface of the digital elevation model at a sustained rate of climb/descent of 5% for fixed-wing aircraft and 15% for rotary wing aircraft. ***Gravimeter:*** The gravimeter must have an accuracy of at least 0.5 mGal measuring the vertical component of gravity. The final data must have a half-sine wave resolution of at least 3.0 km. ***Radar Altimeter:*** Minimum range: 0 – 800 m Accuracy (minimal) 5% ***Laser Altimeter:*** Minimum range: 0 – 300 m Accuracy (minimal) 10 cm ***GNSS:*** Complete GNSS coverage must be obtained. A GNSS ground base station is required. Raw dual-frequency positional GNSS data must be supplied. Post flight differential correction of the raw		

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	GNSS data is **mandatory** using ground GNSS base station data for all flights.		
Workstream 4: Time Domain Electromagnetic Data (TDEM)			
M6	The Bidder must provide the following information for this Workstream: a) **Calibration Data:**. A pre-flight and post-flight measurement of the TDEM background response and assessment of noise level. All calibration data must be provided in Geosoft (.gdb) format with the same channels as listed below for Line Data. a) **Line Data:** Line data must be sampled at 5 Hz or more and in Geosoft (.gdb) format. The following data channels must be provided: • Line channel (integer number) • Time (fiducial) channel • Differentially corrected latitude, longitude channels (in decimal degrees, six (6) decimal place accuracy) or equivalent easting, northing (m) • Flight number channel (integer number) • Orthometrically corrected GPS height (m) • Drape surface (m) used to fly survey (where applicable) • Radar Altimeter (m) • Digital Elevation model (m) • Transmitter height (m) • Receiver height (m) • Raw channels of X, Y and Z components of dB/dt* and calculated or measured B* field • Power line monitor • All intermediate adjustments to the magnetic channels (filters, additional adjustments applied in leveling steps to achieve the final leveled magnetic channel) • Leveled channels of the X, Y and Z components of dB/dt* and B* field • Decay time constant from dB/dt* (X component) • Calculated apparent conductivity • EM anomalies and calculated conductance The Bidder must provide the stream data at full resolution of all measured components and primary field for a production flight having a minimum duration of one (1) hour. *Note: * Units of dB/dt and B must be in physical units (SI) or in ppm relative to the primary field.*	☐ Yes ☐ No	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	b) **Gridded Data:** Gridded data must be supplied with a grid interval of approximately ¼ of the traverse line spacing and in Geosoft (.gdb) file format. The following grid types must be provided: • Grid of the apparent conductivity, grids of the decay time constraints: x and z components. c) **Maps and Support documentation:** The following maps and support documentation must be provided: • Maps of previous gridded data • EM anomaly map including anomaly conductance. d) Results from the EM system flown over the Reid-Mahaffy test site. A complete description of the test site and the test survey is provided in: Ontario Geological Survey, 2000; Airborne magnetic and electromagnetic surveys. Reid-Mahaffy Airborne Geophysical Test Site Survey; Ontario Geological Survey, Miscellaneous Release – Data (MRD)-55. f) Provide a sample flight line that includes magnetic and EM data **or** include magnetic data in the TDEM database demonstrating the magnetic sensor integration with the TDEM system. g) **Specific Equipment Requirements**: ***EM System – Helicopter:*** The electromagnetic system can either be a rigid system (loop-loop configuration) or have its EM receiver above the transmitter loop. The system must have a proven depth of penetration of 250 m. The electromagnetic receiver is comprised of a multi-channel computer for data processing and reduction, and sensors in a towed-bird. The electromagnetic system is capable of providing the dB/dt (the horizontal X, Y and vertical Z components). The maximum operating waveform frequency will be **90** Hz. ***EM System – Fixed Wing:*** The electromagnetic system must have a primary minimum dipole moment of 14.85 x 10^5 Am^2. The electromagnetic receiver is comprised of a multi-channel computer for data processing and reduction, and sensors in a towed-bird. The electromagnetic system is capable of providing the dB/dt and B-field responses in three (3) orthogonal directions (the horizontal X, the transverse Y and vertical Z components). The operating waveform frequency will be **90** Hz and the pulse width 2 ms. ***Aircraft:***		

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	The Bidder must provide an aircraft capable of following the drape surface of the digital elevation model at a sustained rate f climb/descent of 5% for fixed-wing and 15% for rotary wing aircraft. ***Radar Altimeter:*** Minimum range: 0 – 800 m Accuracy (minimal) 2% ***GNSS:*** Complete GNSS coverage must be obtained. A GNSS ground base station is required. Raw dual-frequency positional GPS data must be supplied* *Post flight differential correction of the raw GPS data is **mandatory** using ground GPS base station data for all flights. ***Video Camera:*** Images must be clear and each frame must overlap. Image overlay must show time in seconds. **Note to Bidders:** **For EM helicopter:** Please provide the following for each of your EM time domain systems and also include a description of a typical utilization in different environment such as a capability to acquire data in moderate to extreme topography versus capability to detect deep structures: • For each EM system with a transmitter Tx flying at 35 m above the ground, please provide a nomogram for a homogeneous half space varying from 0.01 mS/m to 10000 mS/m and showing a log-log representation of dB/dt in nT/s versus the conductivity in mS/m (Name of the system, base frequency, pulse width, Tx and Rx heights, and dipole moment are indicated in the title of the nomogram). Noise level will be plotted on this nomogram • A table for each EM system specification available containing the following information: ○ Name of the system, ○ Tx-Rx configuration, ○ Tx coil surface (m^2), ○ Base frequency range (Hz), ○ Pulse shape, ○ Transmitter pulse width range (ms), ○ Transmitter off-time range (ms), ○ Peak dipole moment range (NIA), ○ Transmitter turns, ○ Peak current (A), ○ Components (X,Y,Z), ○ System (rigid or flexible),		

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	○ Noise level estimation (nT/s), ○ Maximum depth of investigation in a resistive environment (m) **For EM fixed wing:** Please provide the following for each of your EM time domain systems and also include a description of a typical utilization in different environment such as a capability to acquire data in moderate to extreme topography versus capability to detect deep structures: • For each EM system with a transmitter Tx flying at 120 m above the ground, please provide a nomogram for a homogeneous half space varying from 0.01 mS/m to 10000 mS/m and showing a log-log representation of dB/dt in nT/s versus the conductivity in mS/m (Name of the system, base frequency, pulse width, Tx and Rx heights, and dipole moment are indicated in the title of the nomogram). Noise level will be plotted on this nomogram • A table for each EM system specification available containing the following information: ○ Name of the system, ○ Tx-Rx configuration, ○ Tx coil surface (m^2), ○ Base frequency range (Hz), ○ Pulse shape, ○ Transmitter pulse width range (ms), ○ Transmitter off-time range (ms), ○ Peak dipole moment range (NIA), ○ Transmitter turns, ○ Peak current (A), ○ Components (X,Y,Z), ○ System (rigid or flexible), ○ Noise level estimation (nT/s), ○ Maximum depth of investigation in a resistive environment (m)		
Workstream 5: Gravity Gradiometry Gradiometric Data			
M7	The Bidder must provide the following information for this Workstream: a) **Line Data:** Line data must be sampled at 1 Hz or better and in Geosoft (.gdb) file format. The following data channels or similar, depending on features of the gravity gradiometer system, should be provided : • Line Channel (integer number) • Time (Fiducial) channel • Differentially corrected latitude, longitude channels (in decimal degrees, six (6) decimal place accuracy) or equivalent easting, northing (m) • Flight number channel (integer number)	☐ Yes ☐ No	

Item	Mandatory Criteria	Compliant/Non-Compliant	Cross Reference to Proposal, including Page Number
	• Orthometrically corrected GPS height (m) • Drape surface (m) used to fly survey (where applicable) • Radar Altimeter (m) • Raw gravity gradients (Gij) • Levelled gravity gradients (Gij) • Eötvös correction • Free air gravity Bouguer correction (2.67 g/cc) • Terrain correction • Bouguer gravity anomaly c) **Gridded Data:** Gridded data must be supplied with a grid interval of approximately ¼ of the traverse line spacing and in Geosoft (.gdb) file format. The following grid types must be provided: • Grids of the vertical gravity gradient and Bouguer gravity anomalies d) **Maps and Support Documentation:** The following maps and support documentation must be provided: • Maps of the previous gridded data e) **Specific Equipment Requirements:** ***Aircraft***: The Bidder must provide suitable aircraft capable of following the drape surface of the digital elevation model at a sustained rate of climb/descent of 5% for fixed-wing aircraft and 15% for rotary wing aircraft. ***Gravity Gradiometer***: The gradiometer must have an accuracy of 5 Eötvös, or better, measuring the gravity gradient. The final data must have an along line full wave resolution of 500 m, or better. ***Radar Altimeter***: Minimum Range: 0 – 800 m Accuracy (Minimal) 5% ***Laser Altimeter***: Minimum Range: 0 – 300 m Accuracy (Minimal) 10 cm ***GNSS:*** Complete GNSS coverage must be obtained. A GNSS ground base station is required. Raw dual-frequency positional GPS data must be supplied* *Post flight differential correction of the raw GPS data is **mandatory** using ground GPS base station data for all flights.		

4.2 Basis of Selection

Supply Arrangements (SAs) will be issued to Offerors who meet all the Mandatory Requirements detailed above for the Workstream(s) they bid on. Only these SA Holders will be deemed to be qualified firms for the purposes of performing the services. Qualification will be based on the Workstream with which the Bidder qualified under. The Bidder can qualify under all streams or on some of the streams. **It is requested that the Bidders clearly identify which Workstream(s) they are bidding on.**

4.2.1 RFP Evaluation Process:

This RFSA, coupled with the resulting Supply Arrangements (SAs), comprise the first stage of a **two-stage** procurement process. At Stage 1, the procurement framework for subsequent contracts will be detailed. Suppliers will be evaluated against all criteria contained herein as described at Part 4 of this RFSA and SAs will be issued to those suppliers who meet all the criteria. At Stage 2, contracts will be issued based on the framework as requirements are known according to the process described at Annex "A". For further details please refer to page 34 of this document.

At time of issuance of any RFP against this Supply Arrangement, the RFP will have separate evaluation criteria applicable to their performance on a contract issued as a result of the previous RFP against the SA. Bidders will be rated on a +/- scale on each criterion. Bidders who obtain less than a -2 rating applicable to their performance on a contract for the previous RFP will be will deemed ineligible to bid in response to an RFP for the subsequent requirement at the sole discretion of NRCan. See below.

Exclusion of Contractors from Bidding Process due to Poor Performance:

NRCan reserves the right to penalize suppliers who have obtained 2 or more negative criteria ratings on the evaluation of a past requirement; as detailed in the RFP rated evaluation criteria (Annex B, 2.1.1 – Recent Past Performance).

Technical Criteria		**Rating**
Surpass Requirements Satisfactory Substandard and Inadequate	2 points (2 points added) 0 points (no points added) -2 points (2 points deducted)	
Recent Past Performance		
Past performance will be evaluated on the following sub-categories: a) **Quality of Data Acquisition with Respect to Specifications:** • Completeness of data set and gaps in coverage • Noise levels on geophysical data • Altimeter data • Navigational data • Diurnal monitoring (if magnetic Workstream required)		**2**
b) **Timing:** • Start of data acquisition • Conduct and efficiency of operations • Delivery of acquisition data • Delivery of final products		**2**
c) **Compilation and Final Products:**		**2**

• Number of re-submissions • Qualify of final products	
d) **Adherence to Recent Contracts:** • Mobilization on time and as proposed • Milestones delivered on time • No performance-related amendments required	**2**

At NRCan's discretion, a supplier can be omitted from consideration for a bid solicitation opportunity (RFP) issued under this RFSA if they received a negative score in two or more point rated criteria on their contract evaluation criteria (as detailed above). Should the Supplier obtain a second such negative rating, they will be deemed ineligible to bid the following three requirements. Should the Supplier obtain a third such negative rating, NRCan reserves the right to withdraw the Supply Arrangement Agreement from that provider. The bidder will then not be one of the invited bidders under this SA.

Receipt of a Supply Arrangement does **NOT** mean that an Offeror will receive subsequent Contracts.

Note: Should an Aboriginal firm be considered fully compliant – NRCan is willing to set-aside a Supply Arrangement for an Aboriginal Business.

PART 5 – CERTIFICATIONS

Offerors must provide the required certifications and associated information to be issued a standing offer. Canada will declare an offer non-responsive if the required certifications are not completed and submitted as requested.

The certifications provided by Offerors to Canada is subject to verification by Canada at all times. Canada will declare an offer non-responsive, will have the right to set-aside a standing offer, or will declare a Contractor in default in carrying out any of its obligations under any resulting contracts, if any certification made by the Offeror is found to be untrue whether made knowingly or unknowingly during the offer evaluation period, during the Standing Offer period, or during the contract period.

The Standing Offer Authority will have the right to ask for additional information to verify the Offeror's certifications. Failure to comply and to cooperate with any request or requirement imposed by the Standing Offer Authority may render the Offer non-responsive, may result in the setting aside of the Standing Offer or constitute a default under the Contract.

5.1 Certifications Required with the Offer

Offerors must submit the following duly completed certifications as part of their offer.

5.1.1 Integrity Provisions – Declaration of Convicted Offences

In accordance with the Integrity Provisions of the Standard Instructions, all Offerors must provide with their offer, **if applicable**, the declaration form available on the Forms for the Integrity Regime website (http://www.tpsgc-pwgsc.gc.ca/ci-if/declaration-eng.html), to be given further consideration in the procurement process.

5.2 Certifications Precedent to the Issuance of a Standing Offer and Additional Information

The certifications and additional information listed below should be submitted with the offer, but may be submitted afterwards. If any of these required certifications or additional information is not completed and submitted as requested, the Standing Offer Authority will inform the Offeror of a time frame within which to provide the information. Failure to provide the certifications or the additional information listed below within the time frame provided will render the offer non-responsive.

5.2.1 Integrity Provisions – Required Documentation

In accordance with the section titled Information to be provided when bidding, contracting or entering into a real property agreement of the Ineligibility and Suspension Policy (http://www.tpsgc-pwgsc.gc.ca/ci-if/politique-policy-eng.html), the Offeror must provide the required documentation, as applicable, to be given further consideration in the procurement process.

5.2.2 Federal Contractors Program for Employment Equity – Standing Offer Certification

By submitting an offer, the Offeror certifies that the Offeror, and any of the Offeror's members if the Offeror is a Joint Venture, is not named on the Federal Contractors Program (FCP) for employment equity "FCP Limited Eligibility to Bid" list (http://www.labour.gc.ca/eng/standards_equity/eq/emp/fcp/list/inelig.shtml) available from Employment and Social Development Canada-Labour's website.

Canada will have the right to declare an offer non-responsive, or to set-aside a Standing Offer, if the Offeror, or any member of the Offeror if the Offeror is a Joint Venture, appears on the "FCP Limited Eligibility to Bid" list at the time of issuing of a Standing Offer or during the period of the Standing Offer.

5.2.3 Additional Certifications Precedent to Issuance of Standing Offer

5.2.3.1 Status and Availability of Resource

The Offeror certifies that, should it be issued a standing offer as a result of the Request for Standing Offer, every individual proposed in its offer will be available to perform the Work resulting from a call-up against the Standing Offer as required by Canada's representatives and at the time specified in a call-up or agreed to with Canada's representatives. If for reasons beyond its control, the Offeror is unable to provide the services of an individual named in its offer, the Offeror may propose a substitute with similar qualifications and experience. The Offeror must advise the Standing Offer Authority of the reason for the substitution and provide the name, qualifications and experience of the proposed replacement. For the purposes of this clause, only the following reasons will be considered as beyond the control of the Offeror: death, sickness, maternity and parental leave, retirement, resignation, dismissal for cause or termination of an agreement for default.

If the Offeror has proposed any individual who is not an employee of the Offeror, the Offeror certifies that it has the permission from that individual to propose his/her services in relation to the Work to be performed and to submit his/her résumé to Canada. The Offeror must, upon request from the Standing Offer Authority, provide a written confirmation, signed by the individual, of the permission given to the Offeror and of his/her availability. Failure to comply with the request may result in the offer being declared non-responsive.

5.2.3.2 Education and Experience Certification

The Offeror certifies that all the information provided in the résumés and supporting material submitted with its offer, particularly the information pertaining to education, achievements, experience and work history, has been verified by the Offeror to be true and accurate. Furthermore, the Offeror warrants that every individual offered by the Offeror for the requirement is capable of performing the Work resulting from a call-up against the Standing Offer.

5.2.3.3 Aboriginal Designation

Who is eligible?

a. An Aboriginal business, which can be:

i. a band as defined by the Indian Act
ii. a sole proprietorship
iii. a limited company
iv. a co-operative
v. a partnership
vi. a not-for-profit organization

in which Aboriginal persons have at least 51 percent ownership and control,

OR

b. A joint venture consisting of two or more Aboriginal businesses or an Aboriginal business and a non-Aboriginal business(es), provided that the Aboriginal business(es) has at least 51 percent ownership and control of the joint venture.

When an Aboriginal business has six or more full-time employees at the date of submitting the bid, at least thirty-three percent of them must be Aboriginal persons, and this ratio must be maintained throughout the duration of the contract.

The supplier must certify in its submitted bid that it is an Aboriginal business or a joint venture constituted as described above.

☐ Our Company is NOT an Aboriginal Firm
☐ Our Company is an Aboriginal Firm, as identified above. The bidder must complete the certificate from the appropriate clause below:

5.2.3.4 Integrity Provisions – List of Names Required

In accordance with the *Ineligibility and Suspension Policy* (http://www.tpsgc-pwgsc.gc.ca/ci-if/politique-policy-eng.html), the Bidder must provide with its bid the required documentation, as applicable, to be given further consideration in the procurement process.

- Suppliers that are corporate entities, including those bidding as joint ventures, must provide a complete list of the names of all current directors or, for a privately owned corporation, the names of the owners of the corporation;

- Suppliers bidding as sole proprietors, including sole proprietors bidding as joint ventures, must provide a complete list of the names of all owners;

- Suppliers bidding as a general partnership do not have to submit a list of names

Name of Supplier: _____

OR

Name of each member of the joint venture:

Member 1: _____
Member 2: _____
Member 3: _____
Member 4: _____

Identification of the directors / owners:

NAME	FIRST NAME	TITLE

NAME	FIRST NAME	TITLE

_____ _____

Signature of Authorized Company Official Date

PART 6 – SUPPLY ARRANGEMENT AND RESULTING CONTRACT CLAUSES

A) SUPPLY ARRANGEMENT

A1. Arrangement

The Supply Arrangement covers the Work described in Annex "A" – Statements of Work.

A2. Security Requirement

There is no security requirement associated with this request or any subsequent Supply Arrangements and/or Contracts.

A3. Standard Clauses and Conditions

All clauses and conditions identified in the Supply Arrangement and resulting contract(s) by number, date and title are set out in the Standard Acquisition Clauses and Conditions Manual issued by Public Works and Government Services Canada.

A3.1 General Conditions

2020 (*insert date*) - General Conditions – Supply Arrangements - Goods or Services, apply to and form part of the Supply Arrangement.

Section 1 – Interpretation of 2020 (*insert date*), should be amended as follows:

DELETE: Public Works and Government Services Canada
INSERT: Natural Resources Canada

A4. Dispute Resolution

Mediation

If a dispute arising from this contract cannot be settled amicably through negotiation, then the parties agree in good faith to submit the dispute to mediation as administered by the Arbitration and Mediation Institute of Canada Inc. (AMIC). The parties acknowledge receipt of the rules of AMIC. The cost of mediation shall be borne equally by the parties.

Arbitration

If the parties cannot resolve the dispute through mediation within sixty (60) days, the parties agree to submit the dispute to arbitration pursuant to the Commercial Arbitration Act (Canada). The party requesting such arbitration shall do so by written notice to the other party/parties. The cost of the arbitration and fees of the arbitrator shall be borne equally by the parties. The arbitration shall take place in the city where the contractor carries on business before a single arbitrator to be chosen jointly by the parties. If the parties cannot agree on the choice of arbitrator within thirty (30) days of written notice to submit the dispute to arbitration, each party will choose a representative who will select the arbitrator.

The parties may determine the procedure to be followed by the arbitrator in conducting the proceedings, or may ask the arbitrator to do so. The arbitrator shall issue a written award within thirty (30) days of hearing the parties. The award may be entered in any court having jurisdiction and enforced as a judgment of that court.

Meaning of "Dispute"

The parties agree that the word "dispute" in this clause refers to a dispute of fact or of law, other than a dispute of public law.

The parties understand that the Procurement Ombudsman appointed pursuant to Subsection 22.1(1) of the *Department of Public Works and Government Services Act* will, on request or consent of the parties to participate in an alternative dispute resolution process to resolve any dispute between the parties respecting the interpretation or application of a term and condition of this contract and their consent to bear the cost of such process, provide to the parties a proposal for an alternative dispute resolution process to resolve their dispute. The Office of the Procurement Ombudsman may be contacted by telephone at 1-866-734-5169 or by e-mail at boa.opo@boa.opo.gc.ca.

A5. Other SACC Manual Clauses

A5.1 Foreign Nationals

SACC Manual clause A2000C (2006-06-16) (Canadian Contractor) OR
SACC Manual clause A2001C (2006-06-16) (Foreign Contractor)

A6. Supply Arrangement Reporting

The Supplier must compile and maintain records on its provision of goods, services or both to the federal government under contracts resulting from the Supply Arrangement. This data must include all purchases, including those paid for by a Government of Canada Acquisition Card.

The Supplier must provide this data in accordance with the reporting requirements detailed in Annex "F". If some data is not available, the reason must be indicated. If no goods or services are provided during a given period, the Supplier must still provide a "NIL" report.

The data must be submitted on a quarterly basis to the Supply Arrangement Authority.

The quarterly reporting periods are defined as follows:

1st quarter: April 1 to June 30;
2nd quarter: July 1 to September 30;
3rd quarter: October 1 to December 31;
4th quarter: January 1 to March 31.

The data must be submitted to the Supply Arrangement Authority no later than ten (10) calendar days after the end of the reporting period.

A7. Term of Supply Arrangement

A7.1 Term of Supply Arrangement Refresh

The period of the Supply Arrangement refresh shall be from **date of award** to **August 31, 2022**.

A7.2 Option to Extend the Supply Arrangement Period

The Contractor grants to NRCan the irrevocable option to extend the period of the Arrangement for up to **two (2)** additional **twelve (12)** month periods, under the same terms and conditions stated in the Supply Arrangement.

The option may only be exercised by the Supply Arrangement Authority, at the request of the Project Authority, and will be evidenced, for administrative purposes only, through a contract amendment. NRCan may exercise the option, or any extension thereof, at any time by written notice to the Contractor at least 30 calendar days prior to the contract expiry date.

A8. Comprehensive Land Claims Agreements (CLCAs)

The Request for Supply Arrangements (RFSA) is to establish supply arrangements for the delivery of the requirement detailed in the RFSA to the Identified Users across Canada, including areas subject to Comprehensive Land Claims Agreements (CLCAs), including locations within Yukon, Northwest Territories, Nunavut, Quebec, and Labrador.

A9. Authorities

A9.1 Supply Arrangement Authority

The Supply Arrangement Authority is:

Kaeli McCarthy
Procurement Specialist
Natural Resources Canada
580 Booth Street, 5th Floor
Ottawa, Ontario
K1A 0E4
Tel: 343-571-9878
Email: kaeli.mccarthy@nrcan-rncan.gc.ca

The Supply Arrangement Authority is responsible for the issuance of the Supply Arrangement, it administration and its revision, if applicable.

A9.2 Supplier's Representative

The Supplier's Representative is:

Name:
Title:
Tel:
Email:

A10. Identified Users

The Identified User is **Natural Resources Canada (NRCan)**

A11. On-going Opportunity for Qualification

A Notice will be posted once a year on the Government Electronic Tendering Service (GETS) (Buy and Sell) to allow new Suppliers to become qualified. **Existing qualified Suppliers, who have been issued a supply arrangement, will not be required to submit a new arrangement.**

A12. Notification of Withdrawal from the Supply Arrangement

In the event that an SA Holder wishes to withdraw from this SA, the SA Holder shall advise the NRCan SA Authority, in writing of its desire to be removed from the SA Holders list and withdraw the SA. After receipt of such notice, the SA Authority will remove the SA Holder from the SA Holders list and consider the SA arrangement no longer valid. The SA Holder acknowledges that its withdrawal from the SA Holders list and SA will not affect any Contracts entered into prior to the receipt by the NRCan SA Authority of such notice.

If during the course of the SA the NRCan SA Authority becomes aware that the contractor is in violation of the terms and conditions of this SA or any resulting Contract, NRCan may withdraw the SA Holder from the SA Holders list and remove authorization to use the SA, in the manner set-out below or take other appropriate action.

NRCan may, by giving thirty (30) days written notice to the SA Holder, withdraw the SA Holder from the SA Holders list and remove authorization from the project authority to use the SA. NRCan acknowledges that withdrawal of the SA Holder from the SA Holders list and removal of authorization to use the SA will not, through this action alone, affect any contracts made prior to the issuance of such notice.

Conditions which may result in withdrawal of authorization to use the SA include:

A Documented history of chronic poor contract performance.

The NRCan SA Authority will meet directly or via teleconferencing with the Contractor and the designated Contracting Authority within thirty (30) days after reported instances of poor service performance. If, after meeting with the Contractor, the situation is not improved within the next thirty (30) days, the SA Holder may be withdrawn from the SA Holders list, and authorization to the Project Authority/SA authority to use the SA will be withdrawn; or,

B Documented history of chronic late contract performance.

The NRCan SA Authority will meet directly or via teleconferencing with the contractor and the designated SA Authority within thirty (30) days after reported instances of late contract performance. If, after meeting with the contractor the performance is not improved within the next thirty (30) days, the SA Holder may be withdrawn from the SA Holders list, and authorization to the Project Authority/SA Authority to use the SA will be withdrawn; or,

C Documented history of chronic violation of any of the specific terms and conditions detailed in this SA.

The NRCan SA Authority will meet directly or via teleconferencing with the contractor and the designated contracting authority within thirty (30) days after reported instances of any such violation. If, after meeting with the contractor, the situation is not improved within thirty (30) days, the SA Holder may be withdrawn from the SA Holders list, and authorization to the Project Authority/SA Authority to use the SA will be withdrawn;

Each reported instance of violation will be investigated by the NRCan SA Authority to confirm that the contractor is indeed in violation of the terms and conditions of the SA, or contract(s).

Withdrawal of authorization to use the SA, for whatever reason, does not remove the right of the NRCan SA Authority or the Project Authority/ SA Authority to pursue other measures that may be available.

A13. Priority of Documents

If there is a discrepancy between the wording of any documents that appear on the list, the wording of the document that first appears on the list has priority over the wording of any document that subsequently appears on the list.

a) The Articles of the Supply Arrangement
b) The General Conditions 2020 (2017-09-21) – General Conditions – Supply Arrangement – Goods or Services;
c) The supplemental general conditions identified herein;
d) Annex "A" – Statement of Work;
e) Annex "B" – Evaluation Criteria
f) Annex "C" – Insurance Requirements;
g) Annex "D" – Financial Proposal;
h) Annex "E" – Socio-Economic Benefits;
i) Annex "F" – Quarterly Reporting Spreadsheet
j) The Supplier's Arrangement dated _____.

A14. Certifications and Additional Information

A14.1 Compliance

Compliance with the certifications provided by the Supplier in the arrangement is a condition of the Supply Arrangement (SA) and subject to verification by Canada during the term of the SA and of any resulting contract that would continue beyond the period of the SA. If the Supplier does not comply with any certification or it is determined that any certification made by the Supplier in the arrangement is untrue, whether made knowingly or unknowingly, Canada has the right to terminate any resulting contract for default and suspend or cancel the SA.

A15. Applicable Laws

The Supply Arrangement (SA) and any contract resulting from the Supply Arrangement must be interpreted and governed, and the relations between the parties determined, by the laws in force in Ontario.

B) BID SOLICITATION

B1. Bid Solicitation Documents

Canada will use the following bid solicitation templates based on the estimated dollar value and complexity of the requirement:

- High Complexity (HC) for more complex requirements.

A copy of the standard procurement templates(s) can be requested by suppliers from the Supply Arrangement Authority or the Contracting Authority, as applicable.

Note: References to the HC templates in PWGSC's Request for Supply Arrangements are provided as examples only. The latest versions of the templates and terms and conditions will be used at time of bid solicitation.

The bid solicitation will contain, as a minimum, the following:

a) Security Requirement (if applicable);
b) A complete description of the Work to be performed;
c) 2003 (2020-05-28) – Standard Instructions – Goods or Services – Competitive Requirements;
d) Bid Preparation Instructions
e) Instructions for the submission of bids (address for submission of bids, bid closing date and time);
f) Evaluation procedures and Basis of Selection;
g) Financial Capability (if applicable)
h) Certifications:
    - **Federal Contactors Program (FCP) for Employment Equity – Notification**
    - **Integrity Provisions – Declaration of Convicted Offenses**
i) Conditions of the Resulting Contract

B2. Bid Solicitation Process

B2.1 Bids will be solicited for specific requirements within the scope of the Supply Arrangement (SA) from suppliers who have been issued a SA.

B2.2 The bid solicitation will be sent directly to suppliers.

B3. Overview of the Procurement Process

This RFSA is the first of a **two-stage** procurement process. At Stage 1, the procurement framework for subsequent contracts against the Supply Arrangement will be detailed, suppliers will be evaluated against all criteria contained herein as described at Part 4 of this RFSA and SA's will be issued to those suppliers who meet all the criteria. At Stage 2, contracts will be issued based on the framework as requirements are known according to the process described therein.

B3.1 Stage 1 – Request for Supply Arrangement (RFSA) and Supply Arrangement Stage:

For Stage 1, this competitive RFSA is issued on the Government Electronic Tendering System (GETS), operated by PWGSC, and known as the Buy and Sell website (hereinafter referred to as Buy and Sell). The Evaluation will be conducted in two (2) phases.

SA's will be issued to successful Offerors who meet all of the mandatory requirements, found in Part 4 of this RFSA. With the exception of administration details applicable to individual suppliers, it is expected that all SAs will be identical.

The SA's will be available for use upon signature by NRCan and will be effective on the same date, until August 31, 2020, with four (4) additional one (1) year option periods. A Supplier will be deemed to have been added to the SA Holders list(s) upon signature of the SA.

Subsequent to the issuance of the SA's, NRCan may post a Notice of Proposed Procurement (NPP) on the PWGSC Buy and Sell website once a year which will permit additional Suppliers to submit offers to become pre-qualified SA Holders and to be authorized a SA for the provision of the required services on an "as and when required" basis for the remaining period of the SA. SA Holders will not be deleted because of the addition of new SA Holders.

B3.2 Stage 2 – Contract Stage:

For Stage 2, Contracts will be entered into during the term of the SA for requirements described in Annex "A" – Statements of Work.

Thresholds for Directed (Sole Source) Contracts and Competed Requirements

Requirements estimated at $40,000 or less, GST included

Due to the type of requirements set out in this RFSA, there may **not be** a need for contracts under $40,000.00, including GST/HST, at any time during the duration of this SA. Should requirements be under $40,000.00, the Government Contracting Regulations (GCRs) shall apply.

Requirements exceeding $40,000 but no more than $3M(including GST)

Depending upon the particular Workstream of the requirement, All SA Holders, in a given Workstream, must be invited to compete.

Notwithstanding the above, NRCan reserves the exclusive right to solicit proposals, where in NRCan's exclusive determination, a given work assignment requires specific expertise and/or capabilities possessed by multiple Contractors, or in circumstances where it is determined by NRCan (in its exclusive determination) that it is in the best interests of the Department to solicit proposals, either openly on Buy and Sell or via a traditional tender restricted to SA Holders.

Response Period: SA Holders will have at least **10 calendar days** from the date of invitation to submit bids.

C) RESULTING CONTRACT CLAUSES

C1. Statement of Work

The Contractor must perform the work in accordance with the Statement of Work at Annex "A" and the Contractor's technical proposal, dated _____.

C2. Standard Clauses and Conditions

All clauses and conditions identified in the Contract by number, date and title are set out in the Standard Acquisition Clauses and Conditions Manual(https://buyandsell.gc.ca/policy-and-guidelines/standard-acquisition-clauses-and-conditions-manual) issued by Public Works and Government Services Canada.

2035 (2020-05-28), Higher Complexity – Services, apply to and form part of the Contract.

- As applicable, replace references to Public Works and Government Services Canada (PWGSC) with Natural Resources Canada (NRCan).

C3. Dispute Resolution

Mediation

If a dispute arising from this contract cannot be settled amicably through negotiation, then the parties agree in good faith to submit the dispute to mediation as administered by the Arbitration and Mediation Institute of Canada Inc. (AMIC). The parties acknowledge receipt of the rules of AMIC. The cost of mediation shall be borne equally by the parties.

Arbitration

If the parties cannot resolve the dispute through mediation within sixty (60) days, the parties agree to submit the dispute to arbitration pursuant to the Commercial Arbitration Act (Canada). The party requesting such arbitration shall do so by written notice to the other party/parties. The cost of the arbitration and fees of the arbitrator shall be borne equally by the parties. The arbitration shall take place in the city where the contractor carries on business before a single arbitrator to be chosen jointly by the parties. If the parties cannot agree on the choice of arbitrator within thirty (30) days of written notice to submit the dispute to arbitration, each party will choose a representative who will select the arbitrator.
The parties may determine the procedure to be followed by the arbitrator in conducting the proceedings, or may ask the arbitrator to do so. The arbitrator shall issue a written award within thirty (30) days of hearing the parties. The award may be entered in any court having jurisdiction and enforced as a judgment of that court.

Meaning of "Dispute"

The parties agree that the word "dispute" in this clause refers to a dispute of fact or of law, other than a dispute of public law.

The parties understand that the Procurement Ombudsman appointed pursuant to Subsection 22.1(1) of the *Department of Public Works and Government Services Act* will, on request or consent of the parties to participate in an alternative dispute resolution process to resolve any dispute between the parties respecting the interpretation or application of a term and condition of this contract and their consent to bear the cost of such process, provide to the parties a proposal for an alternative dispute resolution process to resolve their dispute. The Office of the Procurement Ombudsman may be contacted by telephone at 1-866-734-5169 or by e-mail at boa.opo@boa.opo.gc.ca.

C4. Security Requirement

There is not security requirement associated with this Contract.

C5. Term of Contract

5.1 Period of the Contract

The period of the Contract is from date of Contract award to _____ inclusively. (*determined at RFP stage)*

C6. Comprehensive Land Claims Agreement

The Request for Supply Arrangements (RFSA) is to establish supply arrangements for the delivery of the requirement detailed in the RFSA to the Identified Users across Canada, including areas subject to Comprehensive Land Claims Agreements (CLCAs), including locations within Yukon, Northwest Territories, Nunavut, Quebec, and Labrador.

C7. Authorities

C7.1 Contracting Authority

The Contracting Authority for the Contract is:

<Provided at time of Contract Award>

The Contracting Authority is responsible for the management of the Contract and any changes to the Contract must be authorized in writing by the Contracting Authority. The Contractor must not perform work in excess of or outside the scope of the Contract based on verbal or written requests or instructions from anybody other than the Contracting Authority.

C7.2 Project Authority

The Project Authority for the Contract is:

<Provided at time of Contract Award>

The Project Authority is the representative of the department or agency for whom the Work is being carried out under the Contract and is responsible for all matters concerning the technical content of the Work under the Contract. Technical matters may be discussed with the Project Authority; however, the Project Authority has no authority to authorize changes to the scope of work or to the Basis of Payment for the Work. Changes to the scope of the Work, or to the Basis of Payment for the Work, can only be made through a contract amendment issued by the Contracting Authority.

C7.3 Contractor's Representative

<provided at time of contract award>

C8. Proactive Disclosure of Contracts with Former Public Servants

By providing information on its status, with respect to being a former public servant in receipt of a *Public Service Superannuation Act* (PSSA) pension, the Contractor has agreed that this information will be reported on departmental websites as part of the published proactive disclosure reports, in accordance with Contracting Policy Notice: 2012-2 of the Treasury Board Secretariat of Canada.

C9. Payment

C9.1 Basis of Payment – Limitation of Expenditure

The Contractor will be reimbursed for the costs reasonably and properly incurred in the performance of the Work, as determined in accordance with Annex "B" – Basis of Payment, to a limitation of expenditure of **$**_____*<inserted at time of contract award>*. Customs duties are included and Applicable Taxes is extra.

C9.1.1 Limitation of Expenditure

1. Canada's total liability to the Contractor under the Contract must not exceed $ _____. (*inserted at time of Contract Award in accordance with 9.1 above*). Customs duties are included and Applicable Taxes are extra.

2. No increase in the total liability of Canada or in the price of the Work resulting from any design changes, modifications or interpretations of the Work, will be authorized or paid to the Contractor unless these design changes, modifications or interpretations have been approved, in writing, by the Contracting Authority before their incorporation into the Work. The Contractor must not perform any work or provide any service that would result in Canada's total liability being exceeded before obtaining the written approval of the Contracting Authority. The Contractor must notify the Contracting Authority in writing as to the adequacy of this sum:

    a. when it is 75 percent committed, or

    b. four (4) months before the contract expiry date, or

    c. as soon as the Contractor considers that the contract funds provided are inadequate for the completion of the Work,
    whichever comes first.

3. If the notification is for inadequate contract funds, the Contractor must provide to the Contracting Authority a written estimate for the additional funds required. Provision of such information by the Contractor does not increase Canada's liability.

C9.2 Method of Payment

Milestone Payments

Canada will make milestone payments in accordance with the Schedule of Milestones detailed in the Contract and the payment provisions of the Contract if:

a. an accurate and complete claim for payment, and any other document required by the Contract have been submitted in accordance with the invoicing instructions provided in the Contract;

b. all work associated with the milestone and as applicable any deliverable required has been completed and accepted by Canada.

C10. Delivery

Deliverables under this Contract must be received by the Technical Authority identified herein, at the time specified in the *Statements of Work* attached hereto as **Annex "A"**. Upon completion of any contract issued against this Supply Arrangement, all Contractors must provide, to the Project Authority and the Contracting Authority, their completed **Annex "E**" – Socio-Economic Benefits form.

C11. Increase/Decease in Scope of Work

The Contractor grants to Canada the irrevocable option to increase or decrease the size of the survey area, to match the funding available at time of award or following award, at the quoted line kilometre rate for the revised kilometreage in accordance with the Basis of Payment.

C12. Data Acquisition Period

It is understood and agreed that during the data acquisition period the Contractor shall not permit its designated survey aircraft, equipment or personnel to carry out any type of airborne survey work other than that which will be specified under the Contract. The Contractor acknowledges that in the event of a breach of such covenant, the Minister shall have the right to treat the Contract as being in default in accordance with the default provisions of the Contract. The data acquisition period begins when the Contractor performs the start-up calibrations and tests and ends with the conclusion of the survey tests

C13. Invoicing Instructions

Due to Covid-19, NRCan will only accept invoices as follows:

E-mail:

Invoicing-Facturation@nrcan-rncan.gc.ca

Note: Attach "PDF" file. No other formats will be accepted

Please do not submit invoices using more than one method as this will not expedite payment.

Invoices and all documents relating to a contract must be submitted on the Contractor's own form and shall bear the following reference numbers: Contract number: _____ *<inserted at time of Contract Award>*

Invoicing Instructions to suppliers: http://www.nrcan.gc.ca/procurement/3485

C14. Certifications and Additional Information

C14.1 Compliance

The continuous compliance with the certifications provided by the Contractor in its bid and the ongoing cooperation in providing additional information are conditions of the Contract. Certifications are subject to verification by Canada during the entire period of the Contract. If the Contractor does not comply with any certification, fails to provide the additional information, or if it is determined that any certification made by the Contractor in its bid is untrue, whether made knowingly or unknowingly, Canada has the right, pursuant to the default provision of the Contract, to terminate the Contract for default.

C15. Federal Contractors Program for Employment Equity – Default by the Contractor

<inserted at time of contract award, if applicable – requirement must be over $1M including taxes>

C16. Applicable Laws

The Contract must be interpreted and governed, and the relations between the parties determined, by the laws in force in Ontario.

C17. Priority of Documents

If there is a discrepancy between the wording of any documents that appear on the list, the wording of the document that first appears on the list has priority over the wording of any document that subsequently appears on the list.

The following documents form part of and are incorporated into this contract:

a) The Articles of Agreement;
b) The General Conditions - High Complexity – Services 2035 (*insert date*);
c) Annex "A", Statement of Work;
d) Annex "B", Basis of Payment
e) Annex "C", Insurance Requirements
f) Annex "D", Wildlife Impact Mitigation and Monitoring Plan (as applicable)
g) Awarded Supply Arrangement Agreement 700000xxxx
h) The Contractor's bid dated _____.

C18. Foreign Nationals

SACC Manual clause A2000C (2006-06-16) Foreign Nationals (Canadian Contractor)

OR

SACC Manual clause A2001C (2006-06-16) Foreign Nationals (Foreign Contractor)

C19. Insurance Requirements

1. The Contractor must comply with the *Insurance Requirements* specified in **Annex "C"** attached. The Contractor must maintain the required insurance coverage for the duration of the Contract. Compliance with the insurance requirements does not release the Contractor from or reduce its liability under the Contract.

2. The Contractor is responsible for deciding if additional insurance coverage is necessary to fulfill its obligations under the Contract and to ensure compliance with any applicable laws. Any additional insurance coverage is at the Contractor's expense, and for its own benefit and protection.

3. The Contractor must forward to the Contracting Authority, within **ten (10)** days after the date of award of the Contract, a Certificate of Insurance evidencing the insurance coverage and confirming that the insurance policy complying with the requirements is in forced. For Canadian-based Contractors, coverage must be placed with an Insurer licensed to carry out business in Canada, however for Foreign-based Contractors, coverage must be placed with an Insurance with an A.M. Best Rating no less than "A-". The Contractor must, if requested by the Contracting Authority, forward to Canada a certified true copy of all applicable insurance policies.

C20. Contract Administration

The parties understand that the Procurement Ombudsman appointed pursuant to Subsection 22.1(1) of the Department of Public Works and Government Services Act will review a complaint filed by [the supplier or the contractor or the name of the entity awarded this contract] respecting administration of this contract if the requirements of Subsection 22.2(1) of the Department of Public Works and Government Services Act and Sections 15 and 16 of the Procurement Ombudsman Regulations have been met, and the interpretation and application of the terms and conditions and the scope of the work of this contract are not in dispute. The Office of the Procurement Ombudsman may be contacted by telephone at 1-866-734-5169 or by e-mail at boa.opo@boa.opo.gc.ca.

ANNEX "A" – STATEMENTS OF WORK

The following is an example of the information required when submitting a proposal against a Request for Proposal (RFP) issued against an awarded Supply Arrangement.

WORKSTREAM 1: AEROMAGNETIC SURVEY

SECTION 1 – SURVEY PARTICULARS

1. Fixed-Wing Aeromagnetic Survey

To conduct a digitally-recorded high sensitivity fixed-wing aeromagnetic survey over the **Boyd Lake area, Northwest Territories** consisting of approximately 47,000 lkm and to compile the acquired data in accordance with the technical specifications given in Section 3 of the Statement of Work for this workstream.

1.1 Delineation of Survey Areas:

The following coordinates are expressed in NAD83.

Estimated total kilometrage for this block is 47,000 line-kilometres

LAT	LONG
61.00000	-102.81327
62.00000	-104.80971
62.66394	-103.31426
62.00000	-102.00000
61.00000	-102.00000

The location map (Figure A-1) shows the **Boyd Lake, NWT area** survey blocks boundaries.

Figure A-1, A-2 and Figures C-1, C-2, and C-3 referenced in Annex "A" are available for download on the GSC FTP site at: **ftp://ftp.agg.NRCan.gc.ca/docs/RFPspecs/BoydLake/**

1.2 Height:

The contractor must calculate the smooth drape surface of the DEM. In areas of steep terrain, the smooth drape surface is to be calculated using a grade (rate of climb and descent) of 5%. The Contractor's smooth drape surface must be submitted to the Technical Authority for approval prior to mobilization to the field. The gridded smooth drape surface data must be accompanied by information specifying the source of the data, method of generation and any relevant information that can be used to evaluate the data.

The survey flying height will be 150 m NTC (nominal terrain clearance) except in areas where Transport Canada regulations prevent flying at this height. In areas where obstacles or topography conflict with the drape surface, the pilot's judgement shall prevail within reason. The survey height must be controlled according to the pre-defined smooth drape surface.

Where the above exceptions do not apply, traverse lines and control line altitudes must be flown within +/- 15 metres of the pre-planned drape surface.

1.2.1 Traverse line and Control line bearing and spacing:

Traverse line:
- bearing **135°**
- spacing **400 m**
- minimum overfly distance **1000 m**
- allowed min. separation: **300 m**
- allowed max. separation: **500 m**

Control line:
- bearing: **45°**
- spacing: **2400 m**
- minimum overfly distance **1000 m**

All traverse lines must intersect a minimum of two (2) control lines. All control lines must intersect a minimum of two (2) traverse lines. No gaps will be accepted in the final products. When a traverse or control line is flown in segments, the amount of segment overlap should be minimized and must intersect a common control or traverse line, respectively. **Reflight line segments must not be less than 6 kilometres in length.**

Two (2) traverse lines must be flown outside of the survey area where the boundary is parallel to the traverse line direction to provide valid information beyond the map boundaries. Otherwise, outside survey boundaries, all traverse lines must start or end by intersecting a control line. Notwithstanding specifications in Section 1.3 of any Request for Proposals, if that intersection is within the 1 km overfly zone, then the traverse line must extend to the next control line. No perimeter lines are to be flown.

For each survey flight, adjacent lines must be flown consecutively and in opposite directions. Racetrack flying pattern will not be permitted.

The contractor must refly lines or portions of lines where the following specifications are not met.

1.3 Specifications:

The data quality control must be done in the field on a daily basis.

All segments of a traverse line must begin and end by crossing control lines. Conversely, segments of a control line must start and end by crossing a common traverse line. All traverse lines must intersect a minimum of two (2) control lines. Two (2) traverse lines must be flown outside of the survey area where the boundary is parallel to the traverse line direction to provide valid information beyond the map boundaries. Otherwise, outside survey boundaries, all traverse lines must start or end by intersecting a control line. Notwithstanding specifications in Section 1.2.2 of any Request for Proposals, if that intersection is within the 1 km overfly zone, then the traverse line must extend to the next control line. No perimeter lines are to be flown. No gaps will be accepted in the final products. The contractor must refly lines or portions of lines where the following specifications are not met.

For each survey flight, adjacent lines must be flown consecutively and in opposite directions, racetrack flying pattern will not be permitted.

1.3.1 Diurnal Specifications:

A maximum tolerance of **3.0 nT** (peak to peak) deviation from a long chord equivalent to a period of one minute for each base station. In order to limit ULF waves (micropulsations) an additional maximum tolerance of **0.5 nT** (peak to peak) deviation from a long chord equivalent to a period of **15 seconds** for each base station. These specifications must be verified in the field prior to demobilization.

1.3.2 Altimeters:

Radar altimeter with digital output and a precise radar display, must form part of the ancillary equipment for the survey aircraft.

	Radar Altimeter
Minimum range:	**0-800** m
Accuracy (minimal)	**2%**

1.4 Compilation Specifics:

Map Scale, projection: 1:100 000 (NAD83, Universal Transverse Mercator)
Digital bases available: 1:100 000 (NAD83, Universal Transverse Mercator)
Grid size: 100 metres

For the use in the preparation of bases for each map, the contractor must use digital base maps in DXF or ArcInfo (SHP) format for each NTS map sheet relevant to the survey area, at 1:50 000 scale.

1.5 Schedule of Products:

Milestone Schedule

1.5.1 Milestone 1

Not later than **November 12, 2019**, and following completion and submission of:

- documented results of all required calibration and test flights
- mobilization and positioning of the survey aircraft, personnel, equipment and supplies at the base of operations
- completion and acceptance by the Technical Authority of an initial 4,000 line-km of digitally-recorded survey data
- delivery and acceptance by the Technical Inspector of an initial 4,000 line-km of raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight, together with the GPS base station data archived by day
- delivery and acceptance by the Technical Authority of raw magnetics base station data archived by day,

1.5.2 Milestone 2

By **February 1, 2020** and after completion of the following:

- the complete edited acquisition data (including electronic navigation) in Geosoft .GDB format
- all raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight
- all raw magnetic base station diurnal data from both stations prepared in Geosoft .GDB format, archived by day
- a copy of the preliminary flight path map,

1.5.3 Milestone 3

By **February 15, 2020** and following completion, delivery and acceptance of:

NOTE: Approval of the Technical Authority is required before the final data archive and map products can be generated. This will require a plot of the leveling adjustments and the final leveled database.

- Geosoft .MAP files or Postscript files and PDFX files for each of the following 1:100 000 scale maps:
  a) Shaded Residual Magnetic Total Field
  b) Shaded Magnetic First Vertical Derivative

- One (1) paper copies for each 1:100 000 map of the following:
  a) Shaded Residual Magnetic Total Field

b) Shaded Magnetic Second Vertical Derivative

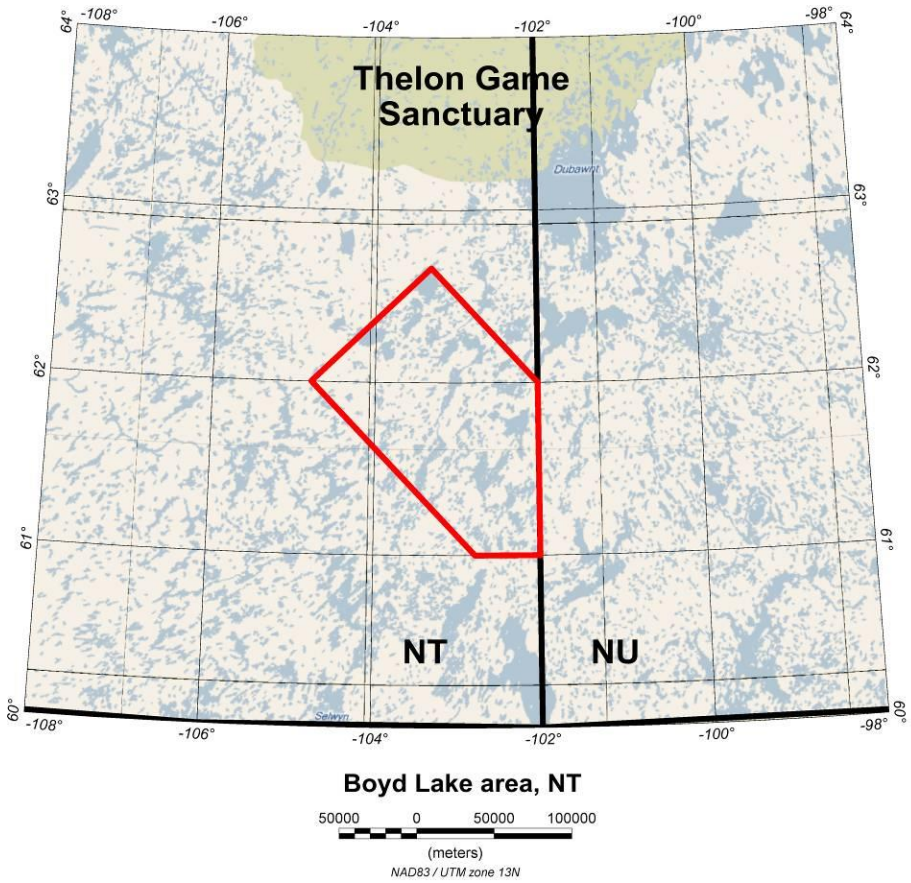
- Final digital archive of line data in Geosoft .GDB format

- Final digital archives of the following grid data:
  a) Magnetic Total Field
  b) Residual Total Magnetic Field
  c) Magnetic First Vertical Derivative
  d) Magnetic Second Vertical Derivative
  e) Digital Elevation Model

- Final Technical report (1 paper copy) signed by the Project Manager according to the GSC Technical Specifications, Section 3 of the Statement of Work, accompanied by digital file in WordPerfect or MS Word format.

- All other final products, (refer to section 3.6 of the Statement of Work).

FIGURE A-1: AEROMAGNETIC SURVEY – BOYD LAKE, NT



Boyd Lake area, NT

50000 0 50000 100000

(meters)

NAD83 / UTM zone 13N

SECTION 2 – DELIVERABLES

2.1 Schedule of Products Required

The Contractor's Project Manager shall be responsible for signing off all reports and all products being delivered, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3 of the Statement of Work.

The Contractor must make available to the Technical Inspector any digital data requested for checking purposes, to facilitate timely approval of map products.

See Section 1.5 for the Schedule of Products required for this survey.

2.2 Deliverables:

2.2.1 Pre-production Report

A report must be supplied to the Technical Authority before production flights begin. The report must include:

- Drape Model and flight path database (Geosoft .GDB format)
- Base of operations utilized;
- Statement of expected diurnal and weather conditions as well as any major operational, logistical or other problems which may hinder production;
- Projected downtime due to aircraft unserviceability;
- Magnetic calibration test (see Part 3, Technical Specifications below);
- Altimeter calibration test (see Part 3, Technical Specifications below):
- Lag tests (see Part 3, Technical Specifications below);
- Results of any other tests carried out.

2.2.2 Weekly Progress Report (Acquisition):

During the data acquisition phase, production figures **and all data acquired to date** must be provided to the GSC Project Leader on a weekly basis, each Monday morning to Technical Authority at fttp://ftp.agg.nrcan.gc.ca/data/BoydLake

2.2.3 Weekly Progress Report (Compilation):

The Contractor's Project Manager shall submit weekly reports each Monday morning describing the state of progress of the various aspects of the work as well as projections as to the completion of the work. These reports will be emailed to the Technical Inspector or other designated persons authorized by the Technical Authority.

Included in the reports will be:

- Base of operations utilized; the number of survey flying hours and the line-kilometres flown and accepted on a daily basis during the report period and their total to report date; a sketch map (letter size) showing the area of data acquisition to date; visits by the Technical Inspector or other authorized persons.

- A statement of diurnal and weather conditions as well as any major operational, logistical or other problems which may have hindered production; downtime due to unserviceability.

- The altimeter calibration (see Part 3, Technical Specifications below),

- Lag tests are required (see Part 3, Technical Specifications below),

- The results of any other tests carried out during the report week.

2.2.4 Digital Data:

The digital data are to be delivered in line and gridded archive format as itemized in Section 1.5 of any Request for Proposal and described in detail in section 3.5.2. These digital data include survey acquisition data, calibration data, geophysical and navigational processed data.

Channel names must conform to the standard described in detail in section 3.5.2 or as specified by the Technical Authority.

2.2.5 Other Deliverables:

1) Final Maps:

Final digital and paper copies of the maps as itemized in Section 1.5 of any Request for Proposals and described in detail in Section 3.4 of Part 3, Technical Specifications.

2) Digital video:

Digital video files will be labelled showing area name, date, flight number, line number, time ranges.

3) Equipment Log:

As described under "Airborne and Ground Instrumentation", Section 3.1.

4) Levelling Documents:

The final levelling network and final flight path data (digital files and plots) must be submitted.

5) Technical Report:

A technical report must be prepared by the Contractor which presents (i) a reasonably comprehensive account of the field operations, (ii) a description of compilation of the data and (iii) an inventory of the resultant end products which will be useful to users of the data. All flight logs and quality control sheets must be properly labelled and submitted for data evaluation. The specifics to be included in the project report are described in further detail in section 3.6.3.

2.2.6 Handling and Storage of Digital Data

Copies of all digital data must be stored by the Contractor for 1 year after the safe delivery of the same data to the GSC Technical Authority. During this time the data may not be erased except by explicit written authorization of the Technical Authority.

After delivery of all final maps, any related materials used to produce the final products will be delivered to the GSC Technical Authority in acceptable containers which have labels identifying their contents. The Contractor must prepare a catalogue (as part of the Technical Report) for all of these data and will submit it to the GSC Technical Authority.

SECTION 3 - GSC TECHNICAL SPECIFICATIONS (AEROMAGNETIC RFP)

A copy of the Technical Specifications must be in the possession of each of the Contractor's personnel who have a responsibility in the execution of the contract.

3.1 Airborne and Ground Instrumentation

The instrument operator shall maintain and update an equipment log noting all equipment replacement and repairs throughout the survey and the results of calibration tests carried out on the equipment.

3.1.1 Systems Timing Synchronization:

All data acquisition systems' timing in the aircraft and on ground base stations **must be synchronized** by the GPS time pulses, **in real time.**

NOTE: If the end of the GPS day occurs during a flight line, the GPS time sequence should continue until the end of this line.

3.1.2 Airborne Magnetometers:

The airborne magnetometer must be a commercially manufactured an alkali vapour optically pumped magnetometer, with a resolution of 0.01 nT or better and must be approved by the Technical Authority.

The recording of the magnetic field values shall be essentially without filtering except that imposed by the sampling interval itself.

The following define what are minimally acceptable:

	Total Field
Resolution	0.01 nT
Absolute Accuracy	±10 nT
Noise Envelope	0.10 nT
Dynamic Range	20,000 to 100,000 nT
Sampling Interval	0.1 second
Heading Effect	<2.0 nT

3.1.3. Altimeters:

Radar altimeter with digital output and a precise radar display, must form part of the ancillary equipment for the survey aircraft.

	Radar Altimeter
Minimum range:	**0-800** m
Accuracy (minimal)	**5%**

3.1.4 Satellite Navigation:

Complete GNSS coverage is required. The positional outputs are to be digitally recorded to 0.000001 degree to provide a final and minimal positional error. A twelve channel receiver is minimally acceptable.

A **dual-frequency** 12-channel GNSS acquisition system with adequate memory to record aircraft position once per second is required as a minimum. A dual-frequency GNSS base station set up near the base of operations is required.

Note: Any GNSS system utilized in this survey must have the capacity to record and store all parameters to permit post flight differential correction of the GNSS navigational data.

3.1.5 Flight Path Video Camera:

A vertically-mounted, continuous-recording video camera, with a wide angle lens to maximize ground coverage at survey altitude, must be operating at all times while the aircraft is surveying. Clearly visible time stamp updates (seconds after midnight, with tenths of seconds) are to be displayed on the video image. The display of real time GPS positional information is optional. The combined navigation system (electronic and video imaging) must be capable of providing the required accuracy over the entire survey area.

3.1.6 Ground Monitoring Station:

A digitally-recorded total field magnetometer ground station must be calibrated and operated continuously throughout the survey operation. It shall be set up at the base of operations or within the survey area, at a magnetically noise-free location, away from moving steel objects, vehicles and DC electrical power lines, which could interfere with the recording of the magnetic field diurnal variation. Ground station calibrations must be completed according to 3.2.6 and the records must be annotated for comparison and submitted to the Technical Authority. There shall be no gaps in the recording of base station data during actual survey flying.

GPS clock time must be used to record the time of the ground magnetometer readings for **all** the base stations. The time readings of the base station(s) must be synchronized with the time reading on board the aircraft. The ground monitoring magnetometer(s) must be approved by the Technical Authority.

Ground	Magnetometer Base Station
Sensitivity	0.01 nT
Recording	1 sec. or better
Int. Noise Level*	0.10 nT or better

*Refers to the peak to peak difference as determined by the 4th different quality check.

3.1.6.1 Diurnal Specifications:

A maximum tolerance of **3.0 nT** (peak to peak) deviation from a long chord equivalent to a period of one minute for each base station. In order to limit ULF waves (micropulsations) an additional maximum tolerance of **0.5 nT** (peak to peak) deviation from a long chord equivalent to a period of **15 seconds** for each base station.

These specifications must be verified in the field prior to demobilization.

3.1.7 Field Data Verification System:

The digital data must be verified on a daily basis with an in-field verification system to ensure the recorded parameters meet the contract specifications.

The field verification system must be able to apply differential GNSS corrections and to evaluate the flight path data quality. Preliminary levelled grids of the magnetic total field data will be required and must be produced in the field during the survey.

3.2 Calibration Flights

3.2.1 Magnetometer:

Calibration of the aircraft magnetometer system must be carried out using the GSC calibration range at Bourget, Ontario (see Figure C-1), Meanook, Alberta (see Figure C-2), or Baker Lake, Nunavut (see Figure C-3) at the start and end of survey operations. The Technical Authority must be notified of the scheduling of these test flights prior to their execution. This calibration must include a measurement of the heading error. Two (2) passes in each of the north, south, east and west directions must be flown to obtain sufficient statistical data to complete the form C-3 referenced in Annex "A", Section 1.

The results of these tests must be presented in the chart format which will be used during survey production and saved in the digital format that will be used for archiving the data. The same decimal accuracy is required. Test results must be submitted to the Technical Authority for approval **before the Contractor proceeds to the survey area.**

Ground station total field values covering the duration of these calibration flights, at Bourget, Ontario, Meanook, Alberta, or Baker Lake, Nunavut must be obtained from the Natural Resources Canada' Geomagnetic Laboratory, which may be accessed by internet at: http://gsc.nrcan.gc.ca/geomag/data/digitaldata_e.php. See attachment Figure C-3: Aeromagnetic Survey System Calibration Test Ranges Form, which is to be used to tabulate the Test Range results.

3.2.2 Survey Site Compensation Test:

(FOM less than **1.5 nT**)

The Contractor must determine the effects of aircraft manoeuvres: roll, pitch and yaw and to submit the results of these tests to the Technical Authority. These tests must be performed over a magnetically quiet zone, at a high altitude. They consist of flying +/-10 degree rolls, +/-5 degree pitches and +/-5 degree yaws peak to peak along line orientation of the survey's traverse and control lines over periods of 4 to 5 seconds. A compensation Figure of Merit (FOM) for the aircraft will be calculated by the Contractor, by summing up the peak-to-peak amplitudes of the 12 magnetic signatures. The FOM must be less than 1.5 nT.

The FOM must be determined once per month, during the flying period and following major equipment repair or replacement. A FOM in excess of that specified will require corrective action plus approval by the Technical Authority, before survey operations can continue.

3.2.3 Lag Tests:

Prior to the initial commencement of survey production and with any major survey equipment alteration or replacement on the aircraft, the Contractor must perform a lag test to ascertain the time difference between the magnetometer readings and the operation of the positioning devices. The results of these test flights, which must be flown in opposite directions at the normal survey height or as low as possible at the pilot's discretion across a distinct anomaly, must be submitted to the Technical Authority with the next weekly report. Lag tests must also be performed in the survey area by flying over a known point in opposite directions. This will determine lag in the digitally-recorded navigational data. Lag tests may be carried out while performing the calibration flights. To ascertain that the calculated lag remains constant within a flight and from flight to flight the Contractor will conduct regular lag tests.

3.2.4 Radar Altimeter:

Pre and post survey calibrations must be performed by flying a range of altitudes, representative of the survey area conditions, above and below the designated survey altitude. These altitudes must cover the minimum and maximum range at 5 altitudes of equal increments. Typically, these levels must be determined by the real time GPSZ and barometric altimeter above the elevation of the base air strip. An additional line is to be flown at survey height crossing over a lake (preferably 1 km in width) to ascertain the radar unit's sensitivity to the reflectivity difference of dry land and water.

A re-calibration must be performed if equipment is changed. All calibration results must be submitted to the Technical Authority in tabulated form as a Microsoft Excel file accompanied by a graph, showing GPS altitude versus the radar altitude and barometric altitude.

3.2.5 Aircraft Systems Comparison:

When more than one aircraft is used for a survey block, each aircraft must fly the same line and the data must be compared to ensure that all systems produce similar results. The test can be done on more than one line providing that at least 50 km of data have been collected in survey mode. This comparative line must be performed at least once during the survey and repeated at any time equipment is changed on an aircraft.

3.2.6 Stationary Magnetometer Sensors' Comparison Test:

Prior to the commencement of the survey and prior to the deployment of the magnetic base stations to their final location, the Contractor shall make simultaneous recordings of the ground stations and aircraft magnetometer sensor data while the aircraft is motionless on the ground, and while the stations are in the vicinity (10 km) of the static aircraft. The aircraft may be on external power to perform this test. No less than 20 minutes of data recording are required for this test, preferably during active magnetic diurnal conditions.

3.2.7 Stationary Aircraft GPS Position Test:

This GPS position test is to be performed on site upon commencement of the survey, preferably at the end of the initial altimeter or compensation flight test. Prior to aircraft GPS instrument shut-down and while the ground GPS base station is operating simultaneously, 5 minutes of aircraft GPS data shall be recorded while the aircraft is static on the tarmac.

3.3 Data Records

3.3.1 Digital:

Isolated errors or spikes and short non-sequential gaps which can be edited out are acceptable with the approval of the Technical Authority.

3.3.1.1 Airborne:

All digital data, video, and map products must be referenced to time of day as seconds after midnight, Coordinated Universal Time (UTC) rather than fiducials.

3.3.1.2 Recording Specifications:

	Recording Interval	Precision
Time	0.1 second	0.1 s

Magnetic Total Field	0.1 second	0.001 nT
Radar Altimeter	0.2 second	0.1 m
GPS Height	1.0 second	0.1m
GPS Geographic Coord.	1.0 second	0.000001 deg

3.3.1.3 Ground:

3.3.1.4 Recording Specifications

	Recording Interval	**Accuracy**
Time	1.0 second	0.1 s
Magnetic Total Field	1.0 second	0.01 nT
GPS Base Station	1.0 second	0.000001 deg

3.4 Compilation of the Survey

3.4.1 Base Maps:

The Contractor will be responsible for acquiring all navigational charts and maps necessary for flight planning and field quality control at their own expense.

3.4.1.1 Field Data Verification Procedure:

After each day's flying, the field data quality controller must maintain up-to-date log of the survey progress and production. A list of planned reflights must be prepared with annotations of flight data quality with specific details on any problems which would potentially have adverse effects on data quality.

The field quality controller must demonstrate that all survey calibrations have been completed as required according to specifications. All digital flight data, magnetic base station data and video recordings must be systematically annotated and verified to be complete.

The field quality controller must demonstrate that all airborne magnetic data and ground magnetic diurnal data, collected since the start of the survey, have been evaluated; that all data which do not meet specifications have been identified, noted and available for review by the GSC Technical Authority.

The field quality controller must demonstrate that all digital flight path data has been processed, differentially corrected. Further verification of the positioning must be completed by calculating a digital elevation model (DEM) using the differentially corrected GPS altitude (corrected to the orthometric height) and radar data. The difference, producing the DEM, must be gridded.

3.4.2 Flight Path:

GPS data must be utilized to position the flight lines throughout the entire survey area. It is the primary positional system. A plot of the flight path shall be made from the GNSS flight path data with appropriate latitude and longitude labelled registration markers to permit verification relative to NTS map coordinates.

All of the raw GPS acquisition data which provides a position fix for the aircraft during survey flight must be recorded and archived. This data is to be archived as separate flights. This data in its raw form must be converted into RINEX2 format (see www page at: http://www.ngs.noaa.gov/CORS/RINEX-2.txt for format definition) and delivered to the

Technical Authority together with the raw GPS base station data as part of the required deliverables (refer to Section 2, Deliverables and Payment Schedule).

3.4.3 Magnetic Data:

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

Base station data will be reviewed to identify any diurnal variations beyond specifications stated in Section 1.

Any lines or section of lines not meeting the specifications must be noted and reflown.

3.4.4 Altitude Data:

Proper altitude control is necessary throughout the survey to optimize the quality of the magnetic levelling.

All radar altimeter data must be checked to ensure that the full height range is being recorded.

The survey must be flown at the correct altitude with respect to the conditions stated in Section 1.

Line segments that exceed maximum altitude difference tolerance at intersections will be identified and used in determining reflights.

3.4.5 Format:

Each traverse/control line must have a unique integer (no decimal) line number with the segment number incorporated as the last digit of the line number. Control line numbers must have a different range than the traverse lines.

Example: Traverse lines: 10000 to 79001; Control Lines: 80000 to 99000. The last digit of these line numbers is the segment number. Traverse line 79001 is indicating a line segment.

3.4.6 Plotting Flight Path:

Each line must be labelled with a minimum of 2 time labels per map sheet, or a minimum of 1 label if the line direction is noted in the line label.

Line weights and labelling will be discussed with the Contractor. Sample maps shall be provided upon request. Traverse line numbers and control line numbers must be positioned inside the west and south boundaries of each map. Final labelling of flight line data must have a unique line number for each segment presented on the flight line map as well as in the corresponding digital archive data.

3.4.7 Geophysical Data:

Digital data are to be provided in Geosoft binary (GDB) line data format. *Levelling:*

3.4.8.1 - Magnetic Total Field:

Levelling of magnetic total field will be essentially based on control and traverse line intersections. The subtraction of base stations data from the airborne magnetic total field will only be authorized in special cases (subject to the review of the diurnal conditions) by the Technical Authority.

Intersection total field values, altitudes and gradients must be determined for both line and control line and will be made available digitally for verification purpose. Any modifications to these specifications must be approved by the Technical Authority.

Differences at intersections must be carefully analyzed and distributed along the control lines and/or the traverse lines to yield an identical final total field value for both lines at a given intersection. Corrections must be made to reconcile differences due to altitude. The Contractor should utilize electronic positional information (GPS) to ensure that these differences are minimal.

Final values must then be assigned to the traverse profiles at the appropriate intersections and used as corrections to the digitally-recorded values along the traverse lines. In areas of steep magnetic gradient and/or of rugged topographic relief, the intersection adjustments may be deleted or an appropriate adjustment assigned to the traverse line.

Control line data must be levelled and used in the gridding process (unless instructed otherwise by the Technical Authority).

The Contractor may employ a manual, computer or combined method of determining the levelling adjustments. Whatever method is used, the Contractor must provide a detailed description of the methodology applied to the Technical Authority.

A graphical plot of the final total field level adjustments along the traverse lines and control lines must be plotted at the compilation scale to determine any levelling problems. This map must be submitted along with the preliminary contour maps to the Technical Authority.

3.4.8.2 Gridding:

A square grid will be calculated from the levelled traverse control line data. Contour maps must be produced from this grid by a contouring program. The grid used for the compilation maps must be used for the final maps.

3.4.9 Colour Interval Maps:

The Contractor is required to assemble and produce final maps consisting of the descriptive notes, map headings, logos, map coordinates and adjoining map references, neat line, the topographic base within and all layers of data pertaining to the survey, with appropriate line weights and colours as described in 3.4.5, 3.4.10.1 and 3.4.11 within the window defined by the neatline.

The base map with surround for each map sheet must be prepared and submitted for approval. The maps must conform to generic GSC Open File standards as modified for aeromagnetic maps. The Contractor shall be made aware of the necessary modifications to the following generic specifications:

ftp://ftp.agg.NRCan.gc.ca/docs/RFPspecs/Map_Design/NRCan_OF_design_specs.pdf

The Technical Authority will provide .PDF and Geosoft .map versions of recent published survey maps to serve as templates for the current survey's maps.

The colour intervals for the Residual Total Magnetic Field must conform to a histogram equalized distribution of the data range. The colour intervals for the First Vertical Derivative of the Magnetic Field must conform to either a histogram equalized distribution of the data range or to a standardized distribution supplied by the Technical

Authority. Specific colour tables for each parameter will be provided by the GSC. Colour interval maps that incorporate contours must have their intervals adjusted so that they correspond to the major contour intervals.

The contour interval for the Residual Total Magnetic Field must be 5 nT. Contour intervals 20, 100 and 500 nT must be shown using different line weights. If the data warrants changing these intervals, this may be modified in consultation with the Technical Authority. Magnetic depressions must be indicated by "tick-marks" placed around the inside of the contours expressing the locally low areas in the magnetic total field. Highs will not require any special identification. Sample maps illustrating proper line weights and contour labelling shall be provided upon request. The direction of the contour labelling must face up gradient.

Flight path and relevant line and fiducial (time) labelling must be included as described in 3.4.7.

3.4.10 Technical Inspection of Final Compilation:

The Contractor must prepare a set of working scale preliminary maps for the entire survey area for the approval of the Technical Authority before preparing final data set consisting of:

(i) isomagnetic contours and flight path maps overlain on the colour grid of the levelled magnetic data;
(ii) colour calculated 1st vertical derivative of the magnetic field maps;
(iii) colour calculated 2nd vertical derivative of the magnetic field maps;
(iv) profile of the total magnetic field level adjustments and flight path;
(v) colour maps of the DEM calculated from the differences of the GPSZ minus radar.

Each plot submitted for approval must be accompanied by all the pertinent videos, flight logs, levelling information, etc. necessary to verify the compilation. The digital line and gridded data and a preliminary step-by-step compilation report must also be submitted at this time.

On completion of the inspection by the Technical Authority, one copy of each plot may be returned to the Contractor indicating corrections, if any, to be carried out. When these corrections have been completed by the Contractor, the Technical Authority must approve the compilation by signature on the accepted copy.

Each manuscript submitted for approval must be properly identified as a survey area, map number and the proper geographic coordinates.

3.5 Preparation of Digital Archives

In specific circumstances, digital line data must be removed where the data are not used in the gridding. These circumstances are:

- Overlapping line data where flight lines have been broken;
- Flight path ending outside of the survey boundaries.

3.5.1 General Specifications:

The digital data set is the principal end product to be delivered and it must be of the highest possible quality, essentially error-free. It is **required** that the Contractor **provide a statistical summary for each field in the line data set and also for the complete gridded data sets being submitted as final archives** (not from the Contractor's database).

Acceptable media are DVD or external hard drive. The Contractor must consult with the Technical Authority to ensure compatibility.

3.5.2 Detail Specifications:

3.5.2.1 - Line Archive:

The line archive data must be submitted in **Geosoft** binary (*.gdb) format.
Line data sample rate: **10** samples per second **for all fields**

Prior to line archive generation, the Contractor must consult with the Technical Inspector on the final structure and format.
The following is an example of the structure and format of the line archive:

Name:	Units:	Description:
LINE	-	Line number
GPSTIME	sec	Time, GPS time
LONG	deg	Longitude
LAT	deg	Latitude
EASTING	m	Easting
NORTHING	m	Northing
SURFACE	m	Drape surface
GPSALTR	m	Raw GPS altitude
GPSALT	m	GPS altitude (edited) above MSL (mean sea level)
RALT	m	Radar altitude (Terrain Clearance)
DEMRAW	m	Raw Digital Elevation Model / Topography (GPSALT - RALT)
DEMLEV	m	Levelled Digital Elevation Model / Topography (raw + corrections)
FLUXLONG	nT	Longitudinal vector of magnetic field (Fluxgate X component used for Compensation)
FLUXTRAN	nT	Transverse vector of magnetic field (Fluxgate Y component used for Compensation)
FLUXVERT	nT	Vertical vector of magnetic field (Fluxgate component used for Compensation)
MAGUNCOM	nT	Raw Uncompensated, unlagged magnetic total field
MAGCOM	nT	Raw Compensated, unlagged, un-edited magnetic total field
MAGRAW	nT	Raw magnetic total field (compensated, lagged, edited)
DIURNAL	nT	Edited Diurnal / ground magnetics (main base)
ALTCOR	nT	Altitude correction TO magnetic total field
MAGTLCOR	nT	Tie-line levelling corrections to mag
SRVMGLEV	nT	Magnetic Total field, levelled to survey
IGRF	nT	IGRF (International Geomagnetic Reference Field)
SRVMGRES	nT	Residual magnetic field, levelled to survey
DATE	yyyymmdd	Date of flight line
FLIGHT	-	Flight number
LINENAME	-	Line name. An alpha-numeric string, or LINETYPE + LINE.
LINETYPE	-	Line type. L=Traverse, T=Tie, B=Background line.

3.5.2.2 - Grid Archive:

See Section 1 for grid cell size.

One (1) Geosoft *.grd format grid file for each one of the processed variable for the entire survey.

The Universal Transverse Mercator projection with the appropriate central meridian must be used for creating the gridded data sets. All longitudes west of Greenwich should be represented as negative degrees. Each survey grid origin must be a multiple of the grid interval for both easting and northing coordinates.

3.6 Final Products

See Section 1, for list of Final Products.

3.6.1 Aeromagnetic Maps:

See Annex "A" Survey Particulars

The Contractor is required to assemble and produce final maps consisting of:

- Digital maps by NTS Map sheets, one (1) copy as described under Section 1, Subsection 1.5 Final Products.

All digital final map products (see Section 1.5) must also be delivered at resolution suitable to accurately reproduce the plotted products, two (2) copies on DVD or external hard drive.

3.6.2 Digital Archive Data:

Archives of final line data in binary Geosoft *.gdb format and archives of grid data as *.grd (FLOAT) format files, two (2) copies on DVD or external hard drive.

3.6.3 Technical Report:

A technical report must be prepared by the Contractor which presents:

(i) a reasonably comprehensive account of the field operations;
(ii) a description of compilation of the data;
(iii) an inventory of the resultant end products which will be useful to users of the data.

The project report shall including the following:

(i) Description of the field operations with statistics including a list of:
   a. Bases of operations with pertinent dates and personnel involved
   b. Description of the survey aircraft and instrumentation used.

(ii) Technical specifications of the survey including a description of the problems encountered during the survey. A discussion of the effectiveness of the survey techniques and instrumentation utilized with suggestions to improve the effectiveness of aeromagnetic surveys.

(iii) Description of the compilation procedure including a general flow chart of complete data compilation technique from correction and editing of raw data to contour map production; a list of all criteria employed in rejection/acceptance of data; a general explanation of the mathematical basis of the levelling and gridding algorithm used; personnel involved.

(iv) Index maps and a list of all the end products of the survey. In addition, for every file:

a. A detailed documentation of the file formats;
b. A list of all constants, datum levels, and conversion factors required for subsequent use of the data.

A draft copy of the Project Report must be submitted to the Technical Authority and approved by the Technical Authority prior to its finalization. The final version must be accompanied by a digital version in either MS Word or WordPerfect. One (1) copy is required.

SECTION 4 - RESPONSIBILITIES OF THE CONTRACTOR FOR SURVEY (AEROMAGNETIC RFP)

For the field operations, the selected Contractor shall be responsible for the following:

4.1 Aircraft:

The supply, maintenance and operation of fixed-wing aircraft, suitably equipped and Transport Canada approved to carry out this particular type of survey, including the supply of required fuel, oil and lubricants.

The supply of back-up fixed wing aircraft, suitably equipped, Transport Canada approved and available for the survey. The back-up aircraft shall be ready for mobilization within thirty (30) days of receiving a request in writing from the Technical Authority. (This provision can be satisfied by a documented agreement with another company providing this service.)

All technical equipment and instrumentation, with spares, necessary to execute the airborne geophysical survey in an expeditious manner (see Technical Specifications, section 3).

4.2 Qualified Personnel:

Provision of the necessary qualified personnel and their office accommodation required to complete the project work including:

Project Manager (Office or Field)
Maintenance Engineer (or contract) (Office or Field)
Field Manager (Field) (may also be one of the following:)
Pilot (Field)
Field Quality Controller (Field)
Instrument Operator or Co-pilot (Field)

A minimum of 3 field members excluding the aircraft Mechanic are required.

(a) Project Manager:
Geophysicist, with a degree in earth sciences from a recognized university or geoscientist with applied experience in aeromagnetic surveys; and 3 years experience in airborne geophysical survey projects that were comparable in scope, instrumentation and survey parameters to that required for the contract.

(b) Field Manager:
Two (2) years of related experience in this type of geophysical survey projects.

(c) Pilots:
Must hold a valid commercial pilot licence, applicable to the type of aircraft to be flown, issued by Transport Canada and must be able to provide proof on demand of the Contracting Authority.

In addition, pilots must have at least 300 hours of flying on low level airborne geophysical surveys of this type and must be able to provide proof on demand of the Contracting Authority.

(d) Field Quality Controller:
Must have related experience on at least two (2) geophysical airborne survey projects of this type within the last 3 years and must be able to provide proof, on demand of the Contracting Authority.

(e) Instrument Operator or Co-pilot:
Must have at least one (1) year of operational experience on this type of geophysical survey and must be able to provide proof, on demand of the Contracting Authority.

(f) Maintenance Engineer:
Must hold a valid Category M licence and be able to provide proof on demand by the Contracting Authority. This position may be subcontracted.

4.3 Other Responsibilities:

The Contractor is responsible for transportation, mobilization, demobilization, and subsistence, while in transit, as well as shipping between company headquarters and the respective points of arrival and departure of the aircraft, personnel, technical equipment, materials and supplies necessary for the effective performance of the work, including aviation fuel and lubricants. Compliance with all provisions of the National Transportation Act and directives, orders, rules and or regulations pursuant to those Acts.

The Contractor **must not** commit the use of the proposed aircraft, or systems specified for this project to another project until the completion of the data acquisition stage without approval of the Technical Authority.

The Contractor is responsible for arranging and paying for its own accommodation, meals and incidental expenses such as airport fees.

The Contractor is responsible for ensuring that all compilation, drafting and reproduction is carried out in Canada.

4.4. Maintenance of Survey Standards:

4.4.1 Technical Inspection:

All work is to be performed to the satisfaction and subject to the acceptance of the Technical Authority. Delegated Technical authorities will make periodic trips to the survey site to monitor field operations to observe whether operations are being carried out in accordance with the contract specifications. Copies of Annex "A" must be in the possession of the Field Operations Manager during the field operations and the Project Manager during the compilation phase.

Technical Authority will be available for consultation on technical problems that may arise during the course of the field work and have the authority to approve, in writing, changes to the Technical Specifications that will not affect the general scope of the work to be performed. Any changes which might entail reductions or additional charges to Canada must be referred to the Contracting Authority with a copy to the Technical Authority.

Notwithstanding the foregoing provisions, the Contractor shall be solely responsible for the quality of the work. The Project Manager must ensure that adequate quality control procedures are in place and are being strictly followed, so as to ensure such quality of work. He or she must in turn sign off each report and each product submitted for inspection, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3.

4.4.2 Field Verification:

Initial flight path recovery and full inspection of all data will be done in the field by the Contractor. At the end of field operations, digital copies of (1) preliminary contoured magnetic anomaly map, (2) contoured differentially-corrected Digital Elevation Model (GPS altitude minus radar) map, (3) differentially-corrected flight path map, will be produced at an appropriate scale in the field. These products will be used in the final field verification of the data.

4.4.3 Verification of In-Flight Data:

All digital data will be verified by the Contractor after each flight by a suitable process using equipment at the operations flying base (see Technical Specifications, Section 3).

4.4.4 Incomplete Survey Data:

The Contractor will re-survey, free of charges, lines or segments of lines for which the required digital data are missing or are not in accordance with the Technical Specifications (Section 3). Isolated errors or spikes and short, non-sequential gaps consisting of a few points which can be corrected by interpolation are acceptable.

4.4.5 Reflights - Lost Data:

Digital data which are lost in transit or in processing (if no digital copies have been made) or are rejected by the Technical Authority shall be re-acquired under the same conditions as set out in the Technical Specifications, Section 3, including flying services, at no cost to Canada. Any reflights to replace lost digital data will be at the Contractor's sole expense.

WORKSTREAM 2: RADIOMETRIC (GAMMA RAY SPECTROMETRIC)

The following is an example of the information required when submitting a proposal against a Request for Proposal (RFP) issued against an awarded Supply Arrangement.

SECTION 1: SURVEY PARTICULARS

1. High Sensitivity Airborne Geophysical Survey – Gamma-Ray Spectrometric and Magnetic Total Field – Great Bear Area, Northwest Territories

To conduct a digitally-recorded high sensitivity fixed-wing airborne gamma-ray spectrometric and total field magnetic survey on one block in the **Great Bear** area, Northwest Territories and to compile the acquired data in accordance with the technical specifications given in Part 3, below.

1.1 Delineation of Survey Area:

The following coordinates are expressed in NAD83 geographic coordinates.

Great Bear, NT Block survey area
Estimated total kilometreage for this block is 21,000 line-kilometres

corner # 0	65.25140	-117.62474
corner # 1	65.53132	-117.62260
corner # 2	65.56850	-117.54124
corner # 3	65.61644	-117.66115
corner # 4	65.63423	-117.69004
corner # 5	65.84826	-117.69477
corner # 6	65.86512	-117.65498
corner # 7	65.95978	-117.65169
corner # 8	66.07347	-117.64883
corner # 9	66.10780	-117.58910
corner # 10	66.33238	-117.43449
corner # 11	66.32999	-116.00154
corner # 12	66.25028	-116.00153
corner # 13	66.00047	-116.25469
corner # 14	65.25044	-116.25476
corner # 15	65.25105	-116.74870
corner # 16	65.50117	-116.74831
corner # 17	65.50117	-117.25344
corner # 18	65.25188	-117.24846
corner # 19	65.25140	-117.62474

The location map (**Figure A-1)** shows the survey boundary,

Figures A-1, A-2, and Figures C-1, C-2, C-3, and C-4 referenced in Annex “A” are available for download on the GSC FTP site at: ftp://ftp.agg.nrcan.gc.ca/docs/RFPspecs/GreatBear/.

1.2 Flying Specifications:

The data quality control must be done in the field on a daily basis.

Parts of traverse lines re-flown to complete a traverse line must cross control lines at either end and join the original traverse line at a low angle at a point where the data conforms to the technical specifications. All segments of a traverse line must begin and end by crossing control lines. Conversely, segments of a control line must start and end by crossing a common traverse line. All traverse lines must intersect a minimum of two (2) control lines. Outside survey boundaries, all traverse lines must start or end by intersecting a control line, see **Figure A-2**. No gaps will be accepted in the final products. The contractor must re-fly lines or portions of lines where the following specifications are not met.

For each survey flight, adjacent lines must be flown consecutively and in opposite directions, racetrack flying pattern will not be permitted.

The flights should be carried out during optimum diurnal and gamma-ray spectrometry data acquisition conditions as gamma-ray spectrometry will be required along control and traverse lines.

1.3 Height:

The contractor must calculate the smooth drape surface of the DEM. In areas of steep terrain, the smooth drape surface is to be calculated using a grade (rate of climb and descent) of 5%. The Contractor's smooth drape surface must be submitted to the Technical Authority for approval prior to mobilization to the field. The gridded smooth drape surface data must be accompanied by information specifying the source of the data, method of generation and any relevant information that can be used to evaluate the data.

The survey flying height will be 125 m NTC (nominal terrain clearance) except in areas where Transport Canada regulations prevent flying at this height. In areas where obstacles or topography conflict with the drape surface, the pilot's judgement shall prevail within reason. The survey height must be controlled according to the pre-defined smooth drape surface.

Where the above exceptions do not apply, traverse lines and control line altitudes must be flown within +/- 15 metres of the pre-planned drape surface.

1.3.1 Traverse line and Control line bearing, spacing and overfly:

Traverse line:
- line orientation: **N 0°**
- spacing: **200 m**
- minimum over-fly distance: **1000 m**
- allowed min. separation: **150 m**
- allowed max. separation: **250 m**

Control line:
- line orientation : **90° E**
- spacing: **1200 m**
- minimum over-fly distance: **1000 m**

1.3.2 Diurnal Specifications:

A maximum tolerance of **3.0 nT** (peak to peak) deviation from a long chord equivalent to a period of one minute for each base station. In order to limit ULF waves (micropulsations) an additional maximum tolerance of **0.5 nT** (peak to peak) deviation from a long chord equivalent to a period of **15 seconds** for each base station. These specifications must be verified in the field prior to demobilization.

1.3.3 Flying Speed:

The ground speed for the survey aircraft, flying traverse or control lines will be limited to a range between **200 km/h and 270 km/h**.

1.3.4 Precipitation Limitations:

Varying ground moisture conditions affect the airborne radioactivity measurements. No survey flying should be undertaken during or for 3 hours after measurable precipitation. In the event of heavy precipitation yielding more than 2 cm of ground soaking rain, flying should be suspended for at least 12 hours after end of precipitation or until soil returns to its "normal" moisture level.

1.4 Schedule of Products Required:

1.4.1 Milestone 1:

Not later than **July 1, 2019**, and following completion and submission of:

- documented results of all required calibration and test flights
- mobilization and positioning of the survey aircraft, personnel, equipment and supplies at the base of operations
- completion and acceptance by the Technical Authority of an initial 4,000 line-km of digitally-recorded survey data
- delivery and acceptance by the Technical Authority of an initial 4,000 line-km of raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight, together with the GPS base station data archived by day
- delivery and acceptance by the Technical Authority of raw magnetics base station data archived by day,

1.6.2 Milestone 2:

By **September 15, 2019** and after completion of the following:

- delivery and acceptance of the edited acquisition data (including electronic navigation), Geosoft *.gdb format and FP verification by the Technical Authority
- delivery and acceptance of all raw GPS digitally recorded flight path data prepared in RINEX2 (ASCII) format, archived by flight
- delivery and acceptance of all raw magnetic base station diurnal data from both stations prepared in Geosoft *.gdb format, archived by day
- a copy of the preliminary flight path map,

1.6.3 Milestone 3:

By **November 18, 2019** and following completion, delivery and acceptance of:

- plot of final compilation flight path as 1:50 000 scale maps
- plot of compilation of final levelled geophysical variables as 1:50 000 and 1:250 000 scale colour interval maps
- compilation archive of digital profile and gridded data

1.6.4 Milestone 4:

By **February 1, 2010** and following completion, delivery and acceptance by the Technical Authority of:

- Geosoft .MAP or PostScript, and PDF files for each of the following 1:50 000 and 1:250 000 maps:

  Natural Air Absorbed Dose Rate (colour interval)
  Potassium Percent (colour interval)

Uranium parts per million (colour interval)
Thorium parts per million (colour interval)
Uranium/ Thorium (colour interval)
Uranium/Potassium (colour interval)
Thorium/Potassium (colour interval)
Ternary Radioelement Map
Residual Total Magnetic Field (colour interval)
Shaded First Vertical Derivative of the magnetic field (colour interval)

- One (1) paper copy for each 1:250 000 map of the following:

Natural Air Absorbed Dose Rate (colour interval)
Potassium Percent (colour interval)
Uranium parts per million (colour interval)
Thorium parts per million (colour interval)
Uranium/ Thorium (colour interval)
Uranium/Potassium (colour interval)
Thorium/Potassium (colour interval)
Ternary Radioelement Map
Residual Total Magnetic Field (colour interval)
Shaded First Vertical Derivative of the magnetic field (colour interval)

- Final digital archive of line data

- Final digital archives of the following grid data:

(a) Natural Air Absorbed Dose Rate
(b) Potassium Percent
(c) Uranium parts per million
(d) Thorium parts per million
(e) Uranium/ Thorium
(f) Uranium/Potassium
(g) Thorium/Potassium
(h) Residual Total Magnetic Field data
(i) First Vertical Derivative of the magnetic field data
(j) Digital Elevation Model data

- Final Technical report signed by the Project Manager according to the GSC Technical Specifications Annex “A”, section 3, accompanied by digital file in MS Word.

FIGURE A-1: RADIOMETRIC SURVEY – GREAT BEAR

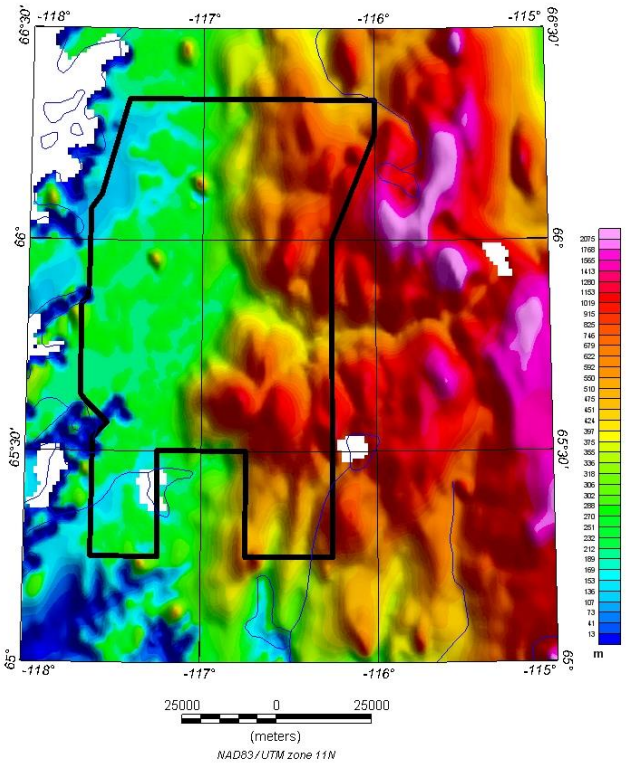


Fig. 1. Great Bear area, NT
Radiometric/Magnetic Survey Area

SECTION 2: DELIVERABLES AND SCHEDULE OF PRODUCTS REQUIRED

2.1 Deliverables

2.1.1 Weekly Progress Report (Acquisition):

During the data acquisition phase, production figures must be communicated to the Technical Authority on a weekly basis, each Monday morning by e-mail to Technical Authority.

2.1.2 Weekly Progress Report (Compilation):

The Contractor's Project Manager shall submit weekly reports each Monday morning describing the state of progress of the various aspects of the work as well as projections as to the completion of the work. These reports will be faxed and addressed to the Technical Authority or other designated persons authorized by the Technical Authority.

Included in the reports will be:

- Base of operations utilized; the number of survey flying hours and the line-kilometres flown and accepted on a daily basis during the report period and their total to report date; a sketch map (letter size) showing the area of data acquisition to date; visits by the Technical Authority or other authorized persons.
- A statement of diurnal and weather conditions as well as any major operational, logistical or other problems which may have hindered production; downtime due to unserviceability.
- The altimeter calibration (see Section 3, Technical Specifications), if applicalbe.
- Daily spectrometer test line and background data (see Section 3, Technical Specifications)
- results of daily Th source checks.
- results of daily ^{137}Cs resolution test
- results of pre- and post-sortie test flights (averages of **corrected** TC, K, U and Th)

Supporting documents, such as digital listings, must be supplied with any documented test results.

- Compilation of data. Flight path recovery and detailed processing stages. Maps inspected. Delivery schedule for each block.

- A sketch map (letter size) showing data compilation, drafting and reproduction progress at the different stages.

2.1.3 Digital Data:

The digital data are to be delivered in line and gridded archive format as itemized Section 1.5 of any Request for Proposal. These digital data include survey acquisition data, calibration data, geophysical and navigational processed data.

2.1.4 Other Deliverables:

1) Final Maps:

Final PDFX of the maps as itemized in Section 1.5 of any Request for Proposal and described in detail in section 3.4 of Section 3, Technical Specifications.

2) Flight Video and Data:

Suitable media will be labelled showing area name, date, flight number, line number, time ranges.

3) Equipment Log:

As described under "Airborne and Ground Instrumentation" of Section 3, Technical Specifications, Section 3.

4) Levelling Documents:

The final levelling network and final flight path data (digital files and plots) must be submitted. All flight logs and quality control sheets must be properly labelled and submitted for data evaluation.

5) Project Report:

A technical report must be prepared by the Contractor which presents (i) a reasonably comprehensive account of the field operations, (ii) a description of compilation of the data and (iii) an inventory of the resultant end products which will be useful to users of the data. The specifics to be included in the project report are described in further detail in Section 3.6.2, Technical Specifications.

2.1.5 Handling and Storage of Digital Data:

Copies of all digital data must be stored by the Contractor for 1 year after the safe delivery of the same data to the Technical Authority. During this time the data may not be erased except by explicit written authorization of the Technical Authority.

After delivery of all final maps, any related materials used to produce the final products will be delivered to the Technical Authority in acceptable containers which have labels identifying their contents. The Contractor must prepare a catalogue (as part of the Project Report) for all of these data and will submit it to the Technical Authority.

2.2 Schedule of Products Required

The Contractor's Project Manager shall be responsible for signing off all reports and all products being delivered, thereby certifying that the work was carried out in accordance with the Technical Specifications in Annex "A", Section 3.

The Contractor must make available to the Technical Authority any digital data requested for checking purposes, to facilitate timely approval of map products.

See Section 1.5 for the Schedule of Products required for this survey.

SECTION 3: GSC TECHNICAL SPECIFICATIONS (RADIOMETRIC)

A copy of the Technical Specifications must be in the possession of each of the Contractor's personnel who have a responsibility in the execution of the contract. The Contractor must obtain and have available in the field and office all relevant charts, maps, etc. pertaining to navigation and flight path recovery.

3.1 Airborne and Ground Instrumentation

The instrument operator shall maintain and update an equipment log noting all equipment replacement and repairs throughout the survey and the results of calibration tests carried out on the equipment. This log will be checked by the Technical Authority during the inspection visit. The geophysical, environmental and navigational systems proposed must meet or exceed the specifications described in sections 3.1.1 to 3.1.9.

3.1.1 Gamma-Ray Spectrometer:

A gamma-ray spectrometer system capable of recording at least 1024 channels will be used. The detector packages used for this survey must be thermally insulated to minimize drift. A system using on-line monitoring of a selected photopeak to control gain is required. The system will use an upward-looking detector to monitor atmospheric radon changes. The main detector will use 50.4L of sodium iodide (4π), and the upward-looking (2π) detector will use 8.4L. Uranium window counts (Section 3.1.2) must be recorded from the upward-looking detector.

The maximum dead time for either the main or upward-looking pulse height analyser must not exceed 8 microseconds per pulse. The overall signal conditioning must yield a detector resolution better than 12% full width half maximum based on the ^{137}Cs 662 keV peak.

The recorded spectral data produced by the system must be suitable for processing using the NASVD method, which requires that the Poisson nature of the recorded channel counts be retained to ensure correct spectral component analysis.

The pulse height analysis system used must be sufficiently linear to ensure that for all Peak energies between ^{137}Cs 662 keV and ^{208}Tl 2614 keV, the relationship of energy to channel number will remain acceptably constant. For example, using a 1024 channel spectrometer, if channel 1 is defined by the energy range 0 to 3 keV, and the ^{40}K 1460 keV peak falls at channel 486.5 (the energy calibration is 3.0 keV/channel), then all other peak energies will fall into channels defined by:

$$\frac{\text{(Peak Energy (keV))}}{\text{2.97 keV/channel}} < \text{(Peak Channel)} < \frac{\text{(Peak Energy (keV))}}{\text{3.03 keV/channel}}$$

The system must permit cosmic ray activity to be monitored. This should include all energies above 3000 keV, but systems with an upper limit of 6000 keV will be accepted. This radiation can be assigned to spectrum channel 1024 leaving channels 1 to 1023 for potassium, uranium and thorium measurements.

The system should provide for the entire spectrum to be displayed, preferably on a display screen as part of the acquisition system, to facilitate energy calibration checks, and to assist in verifying system resolution.

3.1.2 Spectrometer Data Recording:

The following data must be recorded digitally for each 1 second counting interval:

The entire 1024 channel spectrum from the main detector including the cosmic radiation monitor;

The system dead-time to an accuracy of 1 ms

The following windows, with limits given in keV will be recorded for each 1 second counting interval:

Potassium	1370 to 1570
Uranium	1660 to 1860
Thorium	2410 to 2810
Total Count	400 to 2810
Up Uranium	1660 to 1860
Cosmic	3000 to ≥ 6000

3.1.3 Altimeters:

A highly reliable radar altimeter and barometer, both of which have been modified for digital output, will form part of the ancillary equipment for the survey aircraft.

	Radar Altimeter
Minimum range:	0-800 m
Accuracy (minimal)	5%

3.1.4 Air Temperature and Pressure:

True atmospheric pressure must be available for the entire survey. In case of sudden failure of the onboard barometer, atmospheric pressure may be logged at the survey base for each sortie and equation 4.3 in IAEA Report 323 may then be used to estimate the pressure for each record using GPS altitude. External air temperature shall be recorded in flight.

3.1.5 Satellite Navigation:

Complete GNSS coverage must be obtained. The positional outputs are to be digitally recorded to 0.000001 degree to provide a final and minimal positional error. A twelve channel receiver is minimally acceptable.

A **dual-frequency** 12-channel GNSS acquisition system with adequate memory to record aircraft position once per second is required. A dual-frequency GNSS base station set up near the base of operations is required.

Note: Any GNSS system utilized in this survey must have the capacity to record and store all parameters to permit post flight differential correction of the GNSS navigational data.

3.1.6 Flight Path Camera:

A vertically-mounted, continuous-recording video camera, with a wide angle lens to maximize ground coverage at survey altitude, must be operating at all times while the aircraft is surveying. Clearly visible time stamp updates (seconds after midnight, with tenths of seconds) are to be displayed on the video image along with real time GPS positional information. The combined navigation system (electronic and video imaging) must be capable of providing the required accuracy over the entire survey area.

3.1.7 Field Data Verification System:

The digital data must be verified on a daily basis with an in-field verification system to ensure the recorded parameters meet the contract specifications.

The field verification system must consist of microcomputers, plus software to apply differential GPS corrections and to evaluate the flight path data quality. Preliminary levelled grids of potassium, uranium, and thorium counts will be required and must be produced in the field during the survey.

3.2 Calibration Tests

3.2.1 Gamma-ray Spectrometer Calibration:

The following tests will be completed to the requirements of the Technical Authority before mobilization to the survey area. The Technical Authority will participate in all phases of the pre- (or post-) season tests.

Prior to commencing the survey the system **must** be calibrated on an approved set of calibration pads to enable stripping ratios to be determined. This calibration will be carried out with the detectors installed in the aircraft to be used for the survey. Pre-season test flights such as over the Breckenridge test strip **must** be carried out with the approval of the Technical Authority. The test line extends from 5037173 North, 425167 East to 5042093 North, 417927 East and the approved over water background line is between 5041723 North, 414027 East to 5038373 North, 419027 East (See Figure C-4). All these coordinates are for **UTM zone 18 NAD 83.** The Technical Authority will make arrangements for a ground survey of the test strip to be completed using a calibrated gamma-ray spectrometer on the same day as the test flights. The results from these test flights will be used to determine the attenuation coefficients and radioelement sensitivities for the system. It **will** be necessary to repeat these tests if a substantial change is made to the spectrometry system (including the radar altimeter) during the survey season. The energy resolution and calibration will be established using ^{137}Cs during the pre-season testing.

The radar altimeter and system barometer must be calibrated to the GPS altimeter at the beginning of the season. This may be accomplished by flying over water or a suitable airport runway of known elevation. The aircraft will fly at 30 m intervals for 100 to 200 seconds each between 60 m and 300 m above the surface. If the altimeter or barometer is changed during the season, this test must be repeated at a site approved by the Technical Authority.

The cosmic window will be calibrated by flying at 500 m intervals for 600 seconds each between 1500 and 3500 m ASL. This calibration must be carried out during the pre-season (or post-season if required) Breckenridge test flights, or at an alternative site approved by the Technical Authority.

3.2.2 Gamma-ray Spectrometer Verification Tests:

During the course of the survey, tests must be carried out periodically to ensure that the spectrometry system is functioning correctly.

The energy resolution be confirmed daily using ^{137}Cs or by a daily on-the-ground spectral stabilization procedure. These daily results must be recorded either in tabular form or as a spectrum of at least 1024 channels, as part of the contractor's weekly reports. Using the 662 keV photopeak of ^{137}Cs a total system resolution better than 12% must be maintained. With the ^{208}Tlphotopeak at 2615 kev a resolution of better than 7% is required. If the resolution of the selected photopeak peak degrades to worse than 12% or 7%, as described above, the system resolution must be restored. An unresolved substantial change in the resolution will require a post-season re-calibration. (Section 3.2.1) On-line multi-channel spectrometric data can be analyzed to provide a FWHM resolution on the ^{208}Tl 2615 keV thorium peak at intervals of 1000 seconds of acquired data. Energy calibration and resolution data will be recorded and available in a spreadsheet format for both periodic ^{137}Cs checks or for line by line realtime checks.

Each day prior to commencing flying operations, a static test must be carried out to ensure overall system sensitivity is maintained. The best procedure is to record an on ground background spectrum for 5 minutes followed by a five minute spectrum with thorium source(s) placed at precisely repeatable locations These tests will also confirm the stability of the overall recorded spectrum. The aircraft must be parked at a precisely repeatable location for these tests

A test line, near the survey location will be selected in consultation with the Technical Authority. The test line must be flown at the start and if possible, at the end of each sortie in order to ensure that the overall sensitivity of the gamma-ray spectrometry

system is maintained constant under operational conditions. This line must be long enough to permit the acquisition of at least 100 seconds of data while flying at normal survey speed and altitude.

It should be located in an area of relatively uniform radioactivity, with physical features which permit re-flights which sample the same features precisely. Rough terrain should be avoided, as should be areas that would be susceptible to changes in surface water (swamps, etc.) during the course of the survey. The start and end points for every test run must be reproduced with the best possible precision using the real-time differential GPS navigation system. The average altitude for each test run must be within 10 m of the planned survey height. The data acquired over the test line should be corrected using available calibration constants during the fieldwork. This will permit the Technical Authority to more fully test the reproducibility of the survey results since variations caused by changes in position, elevation, temperature and pressure well be eliminated.

To facilitate monitoring of background radon changes, daily tests will include flights at survey altitude at the beginning and end of each day over a large body of water. These flights will be at least 500 m. from land, with data being acquired for at least 100 seconds. The requirement for such daily flights may be reduced at the discretion of the Technical Inspector.

Data acquired from flights over the test line and flights over water will be recorded digitally and will form part of the archival data set. Digitally recorded temperature and pressure will be used to prepare test line data which will be converted to potassium, uranium, thorium and dose rate units using the best system calibration constants available at the beginning of the survey. During the survey, the operator should correct these test line data using the calibration information available at the start of the survey. This will ensure that test line comparisons are based on data with minimal variation caused by height and positional differences.

3.2.3 Lag Tests:

Although gamma-ray spectrometer data does not easily permit the determination of lag, it is important that recording of gamma-ray spectrometer results be such that the lag between GPS and spectrometry remains constant and does not exceed a magnitude of 0.5 seconds.

3.2.4 Satellite Navigation:

A GNSS receiver calibration check must be carried out prior to commencing survey operations and in consultation with the Technical Authority. In addition, a stationary aircraft GNSS position test is to be performed at the end of a flight while the aircraft GNSS system and ground GNSS base station is operating and recording with the stationary aircraft on the airport tarmac. No less than ten (10) minutes of data recording are required for this test. This test may be performed in conjunction with the magnetometer sensors' comparison test. The post-processed elevation has to be compared to the published airport elevation.

3.2.5 Daily Calibration:

The data recorded during these calibrations are considered to be part of the raw data and must be properly labelled and given to the Technical Authority at the end of the survey flying. The barometer will record pressure-altitude or barometric pressure readings during every flight. The barometer data must be converted to static pressure for subsequent conversion of measured terrain clearance to the effective standard temperature and pressure equivalent altitude.

3.3 Data Records

3.3.1 Digital:

Isolated errors or spikes and short non-sequential gaps which can be edited out are acceptable with the approval of the Technical Authority.

3.3.1.1 - Airborne:

Information such as aircraft registration, date, line number, line segment number, direction, flight number, start time of line and any relevant scale factors for datum levels should be included as part of the relevant data. Such pertinent information should also be included on the flight log to be maintained by the Instrument Operator.

NOTE: All digital and map products must be referenced to GPS time rather than fiducials.

3.3.1.2 - Recording Specifications:

The sampling interval for the gamma-ray spectrometer data will be at 1.0 second.

Airborne (Digital)	Minimum Interval or Sensitivity	Sampling Frequency
1. 1024 channel spectrum	1 count	1/sec.
2. Live time	1 msec	1/sec.
3. Radiometric channels (six)	1 cps	1/sec
4. Radar altimeter	0.1 m	5/sec.
5. Barometric altimeter	0.1 kPa	1/sec.
6. Time	0.1 second	10/sec.
7. Navigation output	0.1 m	1/sec.
8. Temperature	1 Deg C	1/sec.

3.3.1.3 - Digital Data Log:

A digital data log must be maintained in the field to record the following information:

(i) external data label code;
(ii) data content (start and finish date/time of recording and flight numbers);
(iii) dates of verification and copying;
(iv) results of verification (i.e. any read errors, or re-reads required);
(v) date original data shipped to compilation facilities. Action taken if lost or damaged in transit.

3.4 Compilation of the Survey Data

3.4.1 Flight Path:

3.4.1.1 - Base Maps:

Compilation Scales: 1:250 000 and 1:50 000 (NAD83, UTM)
Grid Size: 100m

3.4.1.2 – Flight Path:

GPS data must be utilized to position the flight lines throughout the entire survey area. It is the primary positional system. A plot of the flight path shall be made from the digital electronic flight path data with appropriate latitude and longitude labelled registration markers to permit verification relative to NTS map coordinates.

All of the raw GPS acquisition data which provides a position fix for the aircraft during survey flight must be recorded and archived. This data is to be archived as separate flights. This data in its raw form must be converted into RINEX2 format (see www page at: http://igscb.jpl.nasa.gov/igscb/data/format/rinex2.txt for format definition) and delivered to the Technical Authority together with the raw GPS base station data as part of the required deliverables (refer to Section 2, Deliverables and Payment Schedule).

3.4.1.3 - Format:

Each traverse and control line must have a unique integer (non-decimal) line number with the segment number incorporated as the last digit of the line number. Partial lines must be truncated at the limiting interior control lines.

3.4.1.4 - Plotting Flight Path:

Each line must be labelled with a minimum of 2 time labels per map sheet, or a minimum of 1 label if the line direction is noted in the line label.

Line weights and labelling will be discussed with the Contractor. Sample maps shall be provided upon request. Traverse line numbers and control line numbers must be positioned inside the west and south boundaries of each map. Final labelling of flight line data must have a unique line number for each segment presented on the flight line map as well as in the corresponding digital archive data.

3.4.2 **All Geophysical Data Sets**:

Digital data are to be provided in Geosoft binary (GDB) line data format. The Contractor must establish a system for providing such data expeditiously when requested.

3.4.2.1 - Gridding:

Grid Size = one-quarter (¼) of the traverse line spacing specified in any Request for Proposals.

A computer program will be employed to interpolate a square-celled data grid from the final levelled traverse and control line data. Isogram contour maps will be produced from this grid by a computer contouring program.

Most map products require the data to be interpolated onto a regular grid. Many of the standard gridding algorithms are unsuited to radiometric data, because of the inherent statistical variations. A suitable gridding algorithm is one that takes the average of all data points lying within a circular or elliptical area, inversely weighted for distance from the grid point. Suitable gridding algorithms will be discussed with and approved by the Technical Authority.

NOTE: Where changes to the contour trends have been made, the gridded data must agree with the contours on the final map. If the survey area is gridded in more than one grid, the grids must have a common origin to enable grid merging without regridding.

3.4.3 **Gamma-ray Spectrometry Data**:

A detailed description of modern airborne gamma-ray spectrometry methods can be found in IAEA Technical Report 323 (Airborne Gamma-ray Spectrometry Surveying). The following has been modified from this Report:

3.4.3.1 - Energy Calibration:

The count rates in the various windows must first be determined to reduce the volume of data to be transferred from the field records to the processing database.

The simplest method of carrying out this windowing procedure is to acquire spectra summed over whole lines or groups of lines and to use the spectra to identify the channels in which the potassium 1460 keV and the thorium 2614 keV photo-peaks occur. The potassium and thorium windows are then centred on these channels and the uranium window defined in proportion to them. Window counts must be obtained over the full energy widths specified in section 3.1.2.

3.4.3.2 - Data Selection and Editing:

In order to extract the on-line data from the field records, the starts and ends of each flight line are determined and the online data read into the database. Preliminary profiles are then plotted from the digital data to check for any gaps, spikes, radio noise or other problems. If necessary the data can be edited to remove these effects.

3.4.3.3 - Dead-Time Correction:

The first step in the reduction sequence for radiometric data is dead-time correction. This is to be carried out using electronically measured dead-time data. Dead-time correction is made to each window using the expression:

$$N = \frac{n}{1 - Tr}$$

where: **N** is the corrected count in each second
n is the raw count recorded in each second
Tr is the recorded deadtime, the time taken to process all pulses reaching the detector in one second.

Dead-time correction should be applied to each window in the downward looking detector, (including the cosmic and total count windows), but not to the upward looking data as these are processed by different circuits.

3.4.3.4 - Filtering to Prepare for Background Corrections:

Digital filters should be applied to radar altimeter data to smooth sudden jumps that can arise when flying over steep terrain which cause problems when height correcting the data. A 5-point filter is suitable. The spectrometer cosmic channel must also be filtered to reduce statistical noise. In this case, an 11 to 21 point filter should be used. To calculate radon background from the upward looking detector data, heavily filtered uranium upward, uranium downward and thorium downward data are needed as described below. Original data must also be preserved. Suitable filters will be discussed with and approved by the Technical Authority.

3.4.3.5 - Cosmic and Aircraft Background:

The determination of the cosmic and aircraft background expressions for each spectral window has been described in chapter 4 of IAEA Technical Report 323. These expressions are of the form:

$$N = a + bC$$

where: **N** is the combined cosmic and aircraft background in each spectral window,
a is the aircraft background in the window,
C is the cosmic channel count and
b is the cosmic stripping factor for the window.

The expressions are evaluated for each window at each data point using the filtered cosmic channel data and the results subtracted from the data.

3.4.3.6 - Radon Background:

Determination of the constants necessary for the correction of background due to radon using upward detectors requires several steps. The procedure outlined in IAEA 323 is generally correct, but more recent studies have refined the process. The first step, determining the contributions of atmospheric radon to the various spectrometry windows is best achieved through a series of test flights over water. The method of least squares allows the constants in equations 4.9 to 4.12 (IAEA 323) to be determined. The next step is to determine the response of the upward looking detector to radiation from the ground (equation 4.13 IAEA 323). The procedure recommended by Grasty and Hovgaard (1996) summarized below, is more reliable than that in IAEA 323.

In view of the high correlation between radiation in the uranium and thorium windows, it is better to assume that the upward response originating from the ground can be correlated to either counts in the thorium window or to counts in the uranium window, although this should be discussed with the Technical Authority. This is equivalent to assuming that either a_1 or a_2 is equal to 0. Solving for a_1 or a_2 is accomplished by subtracting measurements for the upward channel and the uranium channel (or thorium channel) at approximately 30s intervals to find a set of differences. The total count channel will be used to determine whether the radioactivity is increasing or decreasing. It is necessary to first subtract the counts in the uranium channel (or thorium channel) from the total count to reduce bias of the final result. If the total count channel indicates that the radioactivity is decreasing, the sign of both the upward and downward differences must be reversed. The value of the constant is then simply the ratio of the sum of the adjusted differences in the upward channel divided by the sum of the adjusted differences in the downward channel.

The expression for the radon component in the downward uranium window is given by:

$$U_r = \frac{u - a_1 U - a_2 T + a_2 b_T - b_u}{a_u - a_1 - a_2 a_T}$$

where: $\mathbf{U_r}$ is the radon background detected in the downward U window
u is the measured count in the upward uranium window
U is the measured count in the downward uranium window
T is the measured count in the downward thorium window
$\mathbf{a_1}$, $\mathbf{a_2}$, $\mathbf{a_u}$ and $\mathbf{a_T}$ are proportionality factors and
$\mathbf{b_u}$ and $\mathbf{b_T}$ are constants determined experimentally.

Using the values for a_1 or a_2 determined above in this equation will result in a reasonable estimate of U_r which will permit the other channels to be corrected for radon.

The measured count rates u, U and T used in equation (4.6) must first be corrected for cosmic and aircraft background. The radon counts in the total count, potassium and thorium windows can be calculated from U_r using equations (4.10), (4.11) and (4.12) from IAEA Report 323.

Because of the low count rate in the upward uranium window, this window must be filtered considerably to reduce statistical noise. For a system with two upward-looking detectors of volume 8.4 L, a 200 point running average should be suitable. In areas of unusually high radioactivity pulse pile-up can occur and errors will arise in the calculated value of U_r. In these areas the radon background component should not be calculated but interpolated from adjacent sections of line.

Survey altitude test data (Section 3.2.2) will be used to monitor atmospheric background and calibrate the upward and downward looking detector systems. Variations in the uranium window can be partly due to radon but also due to soil moisture variations or small changes in the flying height or flight path. Variations due to soil moisture and flight path errors can largely be overcome by a simple normalization procedure based on the count in the thorium window. The procedure assumes a given percentage change in thorium count from the ground will correspond to the same percentage change in the uranium counts from the ground. The validity of this assumption must be discussed with the Technical Authority First, the average thorium count rate for the tests during the entire survey period is found. Then, for each test, the uranium count rate is multiplied by the average thorium count, divided by the thorium count for that flight. Changes from flight to flight in the resulting normalized uranium count are then due to variations in radon and corrections can be determined for each flight. This procedure is described more fully in IAEA Technical Report 323.

3.4.3.7 - Calculation of Effective Height AGL:

The filtered radar altimeter data will be used in adjusting the stripping ratios for altitude and to carry out attenuation corrections. They are then converted to effective height (h_e) at STP by the expression:

$$h_e = h * \frac{273.15}{T + 273.15} * \frac{P}{101.3}$$

where: **h** is the observed radar altitude
T is the measured air temperature in degrees C
P is the barometric pressure in kPa.

If necessary, the pressure (P) can be estimated from the barometric (or GPS) altitude using the expression:

$$P = P_o\, e^{H/8581}$$

where: **H** is the barometric (or GPS) altitude in metres
P_o is the barometric pressure (at sea level) in kPa.

3.4.3.8 - Stripping:

The stripping ratios, α, β, γ, a, b and g are determined over calibration pads as described in Chapter 4 of Report 323. The principal ratios α_0, β_0, and γ_0 vary with effective (see Section 3.4.4.7) altitude above the ground and should be adjusted before stripping is carried out. Since b is equal to 0 for the windows described earlier, using the five remaining stripping ratios, the background corrected count rates in the three windows can be stripped to give the counts in the potassium, uranium and thorium windows that originate solely from potassium, uranium and thorium. These stripped count rates are given by equations below:

$\alpha = \alpha_o + 0.00049 * h_e$

$\beta = \beta_o + 0.00065 * h_e$

$\gamma = \gamma_o + 0.00069 * h_e$

$D = 1 - g\gamma - a(\alpha - g\beta)$

$N_k = [n_{Th}(\alpha\gamma - \beta) + n_U(a\beta - \gamma) + n_K(1 - a\alpha)]/D$

$N_U = [n_{Th}(g\beta - \alpha) + n_U - n_K g]/D$

$N_{Th} = [n_{Th}(1 - g\gamma) - n_U a + n_K a g]/D$

Where α is the Th into U stripping ratio, β is the Th into K stripping ratio, γ is the U into K stripping ratio, a is the U into Th 'reverse' stripping ratio and g is the K into U reverse stripping ratio.

3.4.3.9 - Attenuation Correction:

The background corrected total count and stripped count rates vary exponentially with aircraft altitude. Consequently, the measured count rate is related to the count rate at the nominal survey altitude by the equation:

$$N_s = N_m e^{-\mu(h_o - h)}$$

where N_s is the count rate normalized to the nominal survey altitude, h_o,
N_m is the background corrected, stripped count rate at STP equivalent height h,
μ is the attenuation coefficient for that window.

3.4.3.10 - Conversion to Apparent Radioelement Concentrations:

The fully corrected count rate data is used to estimate the concentrations in the ground of each of the three radioelements, potassium, uranium and thorium. The procedure determines the concentrations which would give the observed count rates, if uniformly distributed in an infinite horizontal slab source. Because the U and Th windows actually measure ^{214}Bi and ^{208}Tl respectively, the calculation implicitly assumes radioactive equilibrium in the U and Th decay series. The U and Th concentrations are therefore expressed as equivalent concentrations, eU and eTh.

The calculated potassium, uranium and thorium concentrations are determined using the expression:

$$C = N / S$$

where: **C** is the concentration of element (K%, eU ppm or eTh ppm)
S is he broad source sensitivity for the window, and
N is the count rate for each window, after dead-time, background, stripping and attenuation correction.

An estimate of the air absorbed dose rate from geological sources will be made from the apparent concentrations, K%, eU ppm and eTh ppm, using the expression:

$$E = 13.1 * K + 5.67 * eU + 2.49 * eTh$$

expressed as $nGyh^{-1}$ (nano-Gray/hour)

3.4.3.11 - Calculation of Radioelement Ratios:

The ratios of the three radioelements (eU/eTh, eU/K and eTh/K) are frequently plotted as profiles. Due to statistical uncertainties in the individual radioelement measurements, some care should be taken in the calculation of these ratios. The acceptable method of determining ratios is as follows:

1. Neglect any data points where the potassium concentration is less than 0.25% as these measurements are likely to be over water.

2. Progressively sum the element concentrations of adjacent points on either side of the data point until the total accumulated concentrations of both numerator and denominator exceeds a threshold value. This threshold is normally set to be equivalent to at least 100 counts for both the numerator and denominator. This threshold will be obtained from the experimentally determined sensitivities.

3. Calculate the ratios using the accumulated sums.

With this method, the errors associated with the calculated ratios will be similar for all data points.

The grids of ratios should be produced directly from the gridded concentration data. Grid cells that have a potassium value less than 0.25% should be set to undefined. Cells that have potassium greater than this threshold can be used to compute ratios. The grids for the numerator and denominator should be ring searched to ensure both numerator and denominator exceed the 100 count threshold as required for profile calculation. Only cells that have a potassium concentration greater than 0.25% will be included in this accumulation process.

3.4.4 Technical Inspection of Final Compilation:

3.4.4.1 - Base Maps:

The Contractor will be provided with digital map files as described in any Request for Proposals.

3.4.4.2 - Colour Interval Maps of Geophysical Data:

The intervals and colour scheme will be provided by the Technical Authority, and may be modified by the Technical Authority to suit the data if warranted. Rivers will be presented in dark purple-blue. Logos will be supplied in advance to the contractor by the GSC. The map surrounds will be in black. The index map will show a screened block or hatchery for the appropriate map sheet in red colour. The digital topographic map supplied will be used as the base and will be presented in grey (screened black) except for the rivers that will be presented in dark purple-blue. A water mask can be prepared from the drainage layer for use with gamma-ray spectrometric map products. A sample colour plot will be provided to the Technical Authority before the final digital plot files will be prepared.

3.4.4.3 - Preliminary Product:

The Contractor must submit for approval to the Technical Authority, before preparation of final products, one (1) copy of each of the following:

i) Preliminary archive data, both line and grids. Preliminary or interim data to be submitted in **GEOSOFT .GDB** binary format, with projection details including Central Meridian and DATUM used in the grid generation process. These details shall be submitted as a "read me" file accompanying the grids. The Technical Authority should be consulted prior to archive generation.

ii) All gamma-ray spectrometric-colour maps at a scale of **1:50 000** and **1:250 000 (NAD83, UTM, 100m Grid)**

iii) All flight line maps at a scale of **1:50 000** and **1:250 000**

Each map submitted for approval must be accompanied by all the pertinent flight logs, levelling information, etc. necessary to verify the compilation. Digital data and a preliminary step-by-step compilation report must also be submitted at this time.

The following are some of the criteria for the acceptance of gamma-ray spectrometric maps:

- flight path will be verified
- contour values and fiducial numbers (flight line map) labelled in a legible manner
- identification of traverse and control lines on flight line map
- validity of the contours along the traverse lines with respect to position and intensity
- valid interpolation of contours between flight lines
- absence of "herringbone" or other effects due to levelling or flight line position
- proper density of contours in areas of steep gradient
- traverse lines must tie in between adjoining maps, where applicable

On completion of the inspection by the Technical Authority, one copy of each map may be returned to the Contractor indicating corrections, if any, to be carried out. When these corrections have been completed by the Contractor, the Technical Authority will approve the compilation by signature on the accepted copy.

Each manuscript submitted for approval must be properly identified as to survey area, map number and the proper geographic coordinates with the creation date labelled.

NOTE: A sample map (in digital Geosoft .MAP format or PostScript) of each of the products must be submitted for approval of presentation (fiducial labelling, colour intervals, etc.) prior to the production of any final products.

3.5 Preparation of Digital Archives

In specific circumstances, digital line data must be removed where the data are not used in the gridding. These circumstances are:

- Overlapping line data where flight lines have been broken;
- Flight path ending outside of the survey boundaries.

3.5.1 General Specifications:

The digital data set is the principal end product to be delivered and it must be of the highest possible quality, essentially error-free. It is recommended that the contractor provide a statistical summary for each field in the line data set and also for the complete gridded data sets being submitted as final archives (not from the contractor's database).

The contractor must consult with the Technical Authority to ensure compatibility of storage media.

3.5.2 Detail Specifications:

3.5.2.1 - Line Archive:

Line Data:

The line archive data must be submitted in **Geosoft** binary (*.gdb) format.
Line data sample rates:

Gamma-ray spectrometric data - 1 sample per second
Positional data – 10 samples per second
Environmental data – either 1 or 10 samples per second

Prior to line archive generation the Contractor must consult with the Technical Inspector on the final structure and format. The following is an example of the structure and format of the line archive:

Name:	Units:	Description:
LINE	-	Line number
TIME	sec	Time (sometimes fiducial counter)
GPSTIME	sec	Time, GPS
FIDCOUNT	sec	Fiducial counter
LONG	deg	Longitude
LAT	deg	Latitude
EASTING	m	Easting
NORTHING	m	Northing
SURFACE	m	Drape surface
RALT	m	Radar altitude (Terrain Clearance)
BALT	m	Barometric altitude
GPSALT	m	GPS altitude (edited) above MSL (mean sea level)
DEMRAW	m	Raw Digital Elevation Model / Topography (BALT or GPSALT - RALT)
DEMLEV	m	Levelled Digital Elevation Model / Topography (raw + corrections)
TEMP	C	Temperature
BARO_PR	kPa	Barometric Pressure

Name:	Units:	Description:
R_LIVE	ms	Live Time
R_COS	cps	Raw Cosmic count
R_UPU	cps	Raw Upward-looking Uranium count
SPECTRUM	cps	Measured spectrum, 1024 channel array
R_TOT	cps	Raw Total Count (cps=count per second)
R_POT	cps	Raw Potassium count
R_THO	cps	Raw Thorium count
R_URA	cps	Raw Uranium count
R_RDN	cps	Computed Radon Background
F_NADR	nGy/h	Natural Air Absorbed Dose Rate
F_POT	%	Final corrected Potassium concentration
F_THO	ppm	Final corrected Thorium concentration
F_URA	ppm	Final corrected Uranium concentration
F_RTK	ppm/%	Equivalent Thorium / Potassium
F_RUK	ppm/%	Equivalent Uranium / Potassium
F_RUT	-	Equivalent Uranium / equivalent Thorium
AIRCRAFT	-	Aircraft registration name (e.g. C-WXYZ)
DATE	yyyymmdd	Date of flight line
FLIGHT	-	Flight number
LINENAME	-	Line name. An alpha-numeric string, or LINETYPE + LINE.
LINETYPE	-	Line type. L=Traverse, T=Tie, B=Background line.

3.5.2.2 - Grid Archive:

See Section 1 of any Request for Proposals for grid cell size.

One Geosoft *.grd format grid file for each one of the processed variables for the entire survey.

The Universal Transverse Mercator projection with the appropriate central meridian must be used for creating the gridded data sets. All longitudes west of Greenwich should be represented as negative degrees. Each survey grid origin must be a multiple of the grid interval for both easting and northing coordinates.

3.6 Final Products

See Section 1 of the Request for Proposals for list of Final Products

3.6.1 Digital Archive Data:

All final map products must also be delivered in Geosoft .MAP and PDFX format at resolution suitable to accurately reproduce the plotted products

3.6.2 Technical Report:

A technical report must be prepared by the Contractor which presents (i) a reasonably comprehensive account of the field operations, (ii) a description of compilation of the data and (iii) an inventory of the resultant end products which will be useful to users of the data. The project report shall include the following:

(i) Description of the field operations with statistics including a list of:
- bases of operations with pertinent dates and personnel involved
- description of the survey aircraft and instrumentation used.

(ii) Technical specifications of the survey including a description of the problems encountered during the survey. A discussion of the effectiveness of the survey techniques and instrumentation utilized with suggestions to improve the effectiveness of aeromagnetic surveys.

(iii) Description of the compilation procedure including a general flow chart of complete data compilation technique from correction and editing of raw data to contour map production; a list of all criteria employed in rejection/acceptance of data; a general explanation of the mathematical basis of the levelling and gridding algorithm used; personnel involved.

(iv) Index maps and a list of all the end products of the survey. In addition, for every file:
- a detailed documentation of the file formats.
- a list of all constants, datum levels, and conversion factors required for subsequent use of the data.

A draft copy of the Project Report must be submitted to the Technical Authority and approved by the Technical Authority prior to its finalization. The final version must be accompanied by a digital version in either MSWord.

SECTION 4: RESPONSIBILITIES OF THE CONTRACTOR FOR SURVEY

For the field operations, the selected Contractor shall be responsible for the following:

4.1 Aircraft

The supply, maintenance and operation of aircraft, suitably equipped and Transport Canada approved to carry out this particular type of survey, including the supply of required fuel, oil and lubricants.

The supply of back-up aircraft, suitably equipped, Transport Canada approved and available for the survey. The back-up aircraft shall be ready for mobilization within thirty (30) days of receiving a request in writing from the Technical Authority. (This provision can be satisfied by a documented agreement with another company providing this service.)

All technical equipment and instrumentation, with spares, necessary to execute the airborne geophysical survey in an expeditious manner (see Technical Specifications, Section 3).

4.2 Qualified Personnel

Provision of the necessary qualified personnel and their office accommodation required to complete the project work including:

Project Manager (Office or Field)
Maintenance Engineer (or contract) (Office or Field)
Field Manager (Field) (may also be one of the following):

- Pilot (Field)
- Field Quality Controller (Field)
- Instrument Operator or Co-pilot (Field)

A minimum of 3 field members excluding the aircraft Mechanic are required.

a) Project Manager:
Geophysicist, with a degree in earth sciences from a recognized university or geoscientist with applied experience in radiometric surveys; and 3 years of experience in airborne geophysical survey projects that were comparable in scope, instrumentation and survey parameters to that required for the contract.

b) Field Manager:
Two (2) years of related experience in this type of geophysical survey projects.

c) Pilots:
Must hold a valid commercial pilot licence, applicable to the type of aircraft to be flown, issued by Transport Canada and must be able to provide proof on demand of the Contracting Authority.

In addition, pilots must have at least 300 hours of flying on low level airborne geophysical surveys of this type and must be able to provide proof on demand of the Contracting Authority.

d) Field Quality Controller:
Must have related experience on at least two (2) geophysical airborne survey projects of this type within the last 3 years and must be able to provide proof, on demand of the Contracting Authority.

e) Instrument Operator or Co-pilot:
Must have at least one (1) year of operational experience on this type of geophysical survey and must be able to provide proof, on demand of the Contracting Authority.

f) Maintenance Engineer:

Must hold a valid Category M licence and be able to provide proof on demand by the Contracting Authority. This position may be subcontracted.

4.3 Other Responsibilities

The Contractor is responsible for transportation, mobilization, demobilization, and subsistence, while in transit, as well as shipping between company headquarters and the respective points of arrival and departure of the aircraft, personnel, technical equipment, materials and supplies necessary for the effective performance of the work, including aviation fuel and lubricants. Compliance with all provisions of the National Transportation Act and directives, orders, rules and or regulations pursuant to those Acts.

The Contractor **must not** commit the use of the proposed aircraft, or systems specified for this project to another project until the completion of the data acquisition stage without approval of the Technical Authority.

The Contractor is responsible for arranging and paying for its own accommodation, meals and incidental expenses such as airport fees.

The Contractor is responsible for ensuring that all compilation, drafting and reproduction are carried out in Canada.

4.4 Maintenance of Survey Standards

4.4.1 Technical Inspection:

All work is to be performed to the satisfaction and subject to the acceptance of the Technical Authority. Delegated Technical authorities will make periodic trips to the survey site to monitor field operations to observe whether operations are being carried out in accordance with the contract specifications. Copies of the Statement of Work (or Annex "B") must be in the possession of the Field Operations Manager during the field operations and the Project Manager during the compilation phase.

Technical Authority will be available for consultation on technical problems that may arise during the course of the field work and have the authority to approve, in writing, changes to the Technical Specifications that will not affect the general scope of the work to be performed. Any changes which might entail reductions or additional charges to Canada must be referred to the Contracting Authority with a copy to the Technical Authority.

Notwithstanding the foregoing provisions, the Contractor shall be solely responsible for the quality of the work. The Project Manager must ensure that adequate quality control procedures are in place and are being strictly followed, so as to ensure such quality of work. He or she must in turn sign off each report and each product submitted for inspection, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3.

4.4.2 Field Verification:

Initial flight path recovery and full inspection of all data will be done in the field by the Contractor. At the end of field operations, a hard copy of (1) preliminary contoured magnetic anomaly map, (2) contoured differentially-corrected Digital Elevation Model (GPS altitude minus radar) map, (3) differentially-corrected flight path map, will be produced at an appropriate scale in the field. These products will be used in the final field verification of the data.

4.4.3 Verification of In-Flight Data:

All digital data will be verified by the Contractor after each flight by a suitable process using equipment at the operations flying base (see Technical Specifications, Section 3).

4.4.4 Incomplete Survey Data:

The Contractor will re-survey, free of charges, lines or segments of lines for which the required digital data are missing or are not in accordance with the Technical Specifications (Section 3). Isolated errors or spikes and short, non-sequential gaps consisting of a few points which can be corrected by interpolation are acceptable.

4.4.5 Reflights – Lost Data:

Digital data which are lost in transit or in processing (if no digital copies have been made) or are rejected by the Technical Authority shall be re-acquired under the same conditions as set out in the Technical Specifications, Section 3, including flying services, at no cost to Canada. Any reflights to replace lost digital data will be at the Contractor's sole expense.

WORKSTREAM 3: AIRBORNE GRAVITY SURVEY

The following is an example of the information required when submitting a proposal against a Request for Proposal (RFP) issued against an awarded Supply Arrangement.

SECTION 1: SURVEY PARTICULARS

1. Airborne Gravity Survey – Nechako Basin, BC

To conduct a digitally-recorded high sensitivity airborne gravity survey of the Nechako Basin, British Columbia, consisting of approximately 10 820 line-km and to compile the acquired data in accordance with the technical specifications given in Section 3.

1.1 Delineation of Survey Area:

The following geographic coordinates define the survey area:

	Latitude	Longitude NAD-83
corner #1	N 52°00' 00"	W 123°14' 00"
corner #2	N 52°00' 00"	W 122°00' 00"
corner #3	N 53°55' 00"	W 123°47' 00"
corner #4	N 53°55' 00"	W 125°00' 00"

The location map (Figure A-1) shows the survey boundaries.

Figure A-1, is available for download on the GSC FTP site at: **ftp://ftp.agg.NRCan.gc.ca/docs/RFPspecs/Nechako/**

1.2 Flying Specifications:

The data quality control must be done in the field on a daily basis.

Parts of traverse lines reflown to complete a traverse line must cross control lines at either end and join the original traverse line at a low angle at a point where the data conforms to the technical specifications. All segments of a traverse line must begin and end by crossing control lines. Conversely, segments of a control line must start and end by crossing a common traverse line. All traverse lines must intersect a minimum of two (2) control lines. Two (2) traverse lines must be flown outside of the survey area where the boundary is parallel to the traverse line direction to provide valid information beyond the map boundaries. Otherwise, outside survey boundaries, all traverse lines must start or end by intersecting a control line. No gaps will be accepted in the final products. The contractor must refly lines or portions of lines where the following specifications are not met. For each survey flight, adjacent lines must be flown consecutively and in opposite directions, racetrack flying pattern will not be permitted.

1.2.1 **Height**:

The contractor must calculate the smooth drape surface of the DEM. In areas of steep terrain, the smooth drape surface is to be calculated using a grade (rate of climb and descent) of 5%. The Contractor's smooth drape surface must be submitted to the Technical Authority for approval prior to mobilization to the field. The gridded smooth drape surface data must be accompanied by information specifying the source of the data, method of generation and any relevant information that can be used to evaluate the data.

The survey height will be 150 m MTC (mean terrain clearance) except in areas where Transport Canada regulations prevent flying at this height. In areas where obstacles or topography conflict with the drape surface, the pilot's judgment shall prevail within reason. The survey height must be controlled according to the pre-defined smooth drape surface. Lines that deviate more than 15 m from the planned survey altitude over a distance of more than 7 km will be reflown. Traverse lines and control lines must be flown at the same altitude at points of intersection. In addition, the altitude tolerances are limited to no more than 30 m difference between traverse lines and control lines.

1.2.2 Traverse Line and Control Line Bearing and Spacing:

Traverse line:
- bearing: **E-W**
- spacing: **2,000 m**
- allowed min. separation: **1,800 m**
- allowed max. separation: **2,200 m**

Control line:
- bearing: **N-S**
- spacing: **10,000 m**

1.3 Specific Equipment Requirements:

Aircraft:
Contractor must provide suitable aircraft capable of following the drape surface of the DEM at a sustained rate of climb/descent specified above in Section 1.2.2.

Gravimeter:

The gravimeter must have an accuracy of at least 0.5 mGal measuring the vertical component of gravity. The final data must have a half-sine wave resolution of at most 3.0 km.

Radar Altimeter:
Minimum range: 0 - 800 m
Accuracy (minimal): 2%

Laser Altimeter:
Minimum range: 0 - 300 m
Accuracy (minimal): 10 cm

GPS:
A **dual-frequency** 12-channel GPS acquisition system is required. A dual-frequency GPS base station set up near the base of operations is required. Raw dual-frequency positional GPS data must be supplied. Post-flight differential correction of the raw GPS data is mandatory using ground GPS base station data for all flights.

1.4 Compilation Specifics:

Map Scale, projection:	1:1,500 000 (NAD83, Lambert Conic Conformal)
Digital bases available:	1:250 000 maps (NAD83, Universal Transverse Mercator)
Grid size:	400 metres

For the use in the preparation of bases for each map, the contractor will be provided with digital base maps in DXF or ArcInfo (SHP) format for each NTS map sheet relevant to the survey area, at 1:250 000 scale.

1.5 Schedule of Products Required:

The Contractor's Project Manager shall be responsible for signing off all reports and all products being delivered, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3 of the Statement of Work.

The Contractor must make available to the Technical Inspector any digital data requested for checking purposes, to facilitate timely approval of map products.

1.5.1 Milestone 1:

By **March 1, 2019**:

- documented results of all required calibration and test flights,
- mobilization and positioning of the survey aircraft, personnel, equipment and supplies at the base of operations,
- completion and acceptance by the Technical Authority of an initial 2,000 line-kms of digitally-recorded survey data,
- delivery and acceptance by the Technical Inspector of an initial 2,000 line kilometres of raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight, together with the GPS base station data archived by day,

1.5.2 Milestone 2:

By **March 31, 2019:**

- delivery and acceptance of the complete edited acquisition data (including electronic navigation), Geosoft *.gdb format and FP verification by the Technical Authority,
- delivery and acceptance of all raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight

1.5.3 Milestone 3:

By **June 1, 2019** and following completion, delivery and acceptance of:

- Plot of final compilation flight path as 1:1,500 000 scale maps;
- Plot of all final compilation of levelled processed parameters at 1:1 500 000 scale
- Compilation archive of digital profile and gridded data;
- Digital files for each map sheet as described in Section 1.5 for the following:

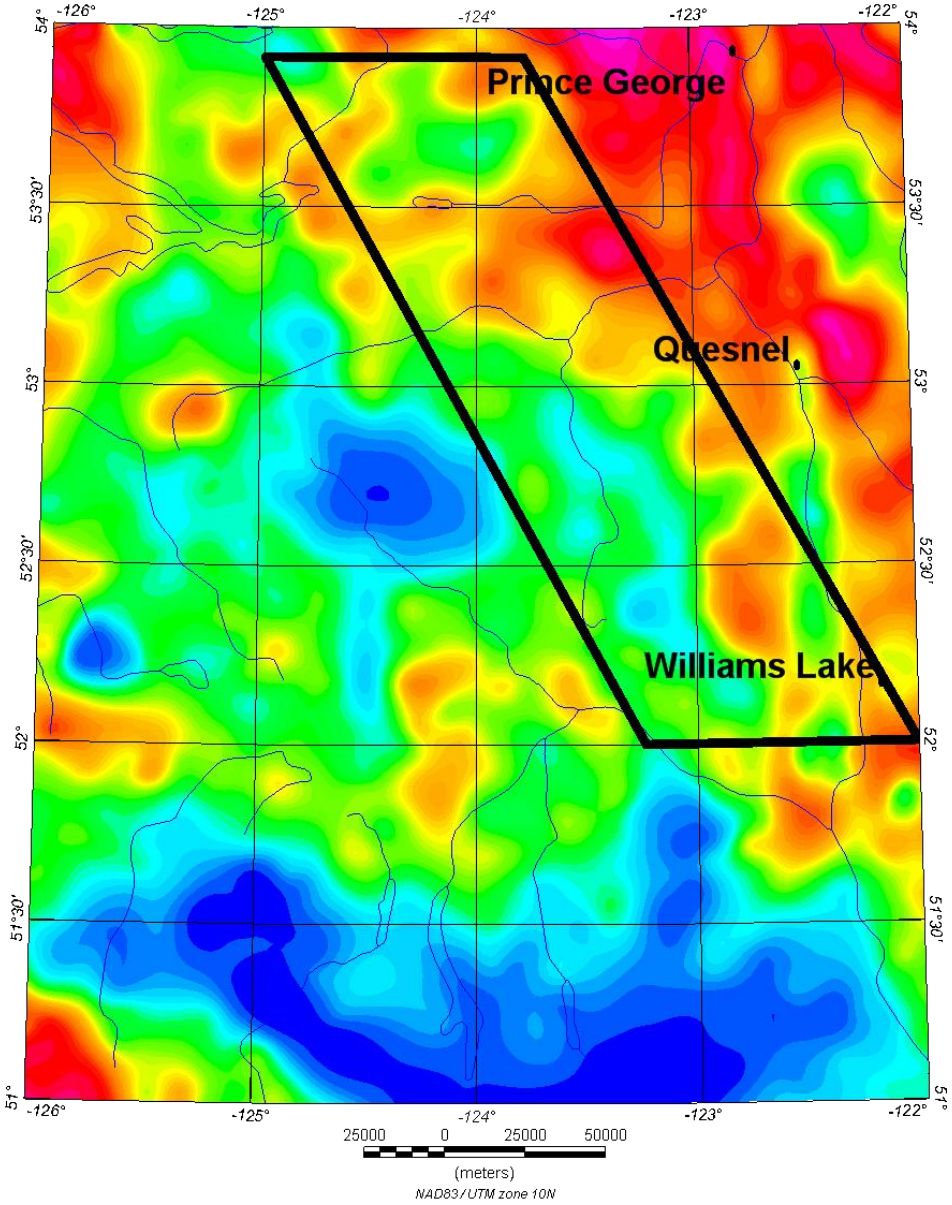
    a) Bouguer gravity anomaly
    b) First Vertical Derivative of the Bouguer gravity anomaly

- Final digital archive of line data
- Final digital archives of the following grid data:

    a) Bouguer gravity anomaly
    b) First Vertical Derivative of the Bouguer gravity anomaly

- Final Technical Report signed by the Project Manager according to the Technical Specifications (Section 3 of the Statement of Work), accompanied by digital files in MS Word and PDF formats.
- All other final products (refer to Section 3.6)

FIGURE A-1: GRAVITY SURVEY – NECHAKO BASIN, BC



SECTION 2: DELIVERABLES – GRAVITY SURVEY

2.1 Deliverables

2.1.1 Weekly Progress Report (Acquisition):

During the data acquisition phase, production figures must be communicated to the GSC Project Leader on a weekly basis, each Monday morning by e-mail to the Technical Authority.

- Base of operations utilized ; the number of survey flying hours and the line-kilometres flown and accepted on a daily basis during the report period and their total to report date ; a sketch map (letter size) showing the area of data acquisition to date; visits by the Technical Inspector or other authorized persons.

- A statement of weather conditions as well as any major operational, logistical or other problems which may have hindered production ; downtime due to unserviceability.

- The altimeters calibration (see Part 3, Technical Specifications),

- Results of the gravimeter calibration tests are required (see Part 3, Technical Specifications),

- The results of any other tests carried out during the report week.

Supporting documents, such as digital listings, must be supplied with any documented test results.

2.1.2 Weekly Progress Report (Compilation):

The Contractor's Project Manager shall submit weekly reports each Monday morning describing the state of progress of the various aspects of the work as well as projections as to the completion of the work. These reports will be emailed to the Technical Authority.

Included in the reports will be:

- Compilation of data. Flight path recovery and detailed processing stages. Maps inspected. Delivery schedule for each block.

- A sketch map (letter size) showing data compilation, drafting and reproduction progress at the different stages.

2.1.3 Digital Data:

The digital data are to be delivered in line and gridded archive format as itemized in section 1 .5 and described in detail in section 3 .5 .2. These digital data include survey acquisition data, calibration data, geophysical and navigational processed data.

2.1.4 Other Deliverables:

1) Final Maps: Final digital map files and paper copies of the maps as itemized in Section 1 .5 (above) and described in detail in section 3 .4 of Part 3, Technical Specifications.

2) Flight Video: video files will be labelled showing area name, date, flight number, line number, time ranges. Suitability of storage media to be confirmed with Technical Authority.

3) Equipment Log Book: As described under "Airborne and Ground Instrumentation", Section 3 .1

4) Levelling Documents: The final levelling network and final flight path data (compilation listings or digital files and plots) must be submitted. All flight logs and quality control sheets must be properly labelled and submitted for data evaluation.

5) Technical Report: A technical report must be prepared by the Contractor which presents:

   (i) a reasonably comprehensive account of the field operations,
   (ii) a description of compilation of the data and
   (iii) an inventory of the resultant end products which will be useful to users of the data.

The specifics to be included in the project report are described in further detail in section 3.6.3.

2.1.5 Handling and Storage of Digital Data:

Copies of all digital data must be stored, by the Contractor for 1 year after the safe delivery of the same data to the GSC Technical Authority. During this time the data may not be erased except by explicit written authorization of the Technical Authority. After delivery of all final maps, any related materials used to produce the final products will be delivered to the GSC Technical Authority in acceptable containers which have labels identifying their contents. The Contractor must prepare a catalogue (as part of the Technical Report) for all of these data and will submit it to the GSC Technical Authority.

2.2 Schedule of Products required

The Contractor's Project Manager shall be responsible for signing off all reports and all products being delivered, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3 of the Statement of Work.

The Contractor must make available to the Technical Inspector any digital data requested for checking purposes, to facilitate timely approval of map products.

See Section 1.5 for the Schedule of Products required for this survey.

SECTION 3: GSC TECHNICAL SPECIFICATIONS (GRAVITY SURVEY)

A copy of the Technical Specifications must be in the possession of each of the Contractor's personnel who have a responsibility in the execution of the contract. The Contractor must obtain and have available in the field and office all relevant charts, maps, etc. pertaining to navigation and flight path recovery.

3.1 Airborne and Ground Instrumentation

The instrument operator shall maintain and update an equipment log book noting all equipment replacement and repairs throughout the survey and the results of calibration tests carried out on the equipment.

3.1.1 Systems Timing Synchronization:

All data acquisition systems' timing in the aircraft and on ground base stations **must be synchronized** by the GPS time pulses, **in real time.**

3.1.2 Airborne Gravimeter:

Any gap longer than 0.5 s of the gravimeter or 1.0 s of the GPS in flight or of the ground GPS will be identified during the survey operations. The requirement to re-fly these sections will be determined on a case-by-case basis. The decision to re-fly portions of the survey lines will be made by the NRCan Technical Inspector based on the information provided in the weekly report and the impact of missing sections on the regional mapping activity.

3.1.3 Altimeters:

Radar and laser altimeters are recommended, but not mandatory for constant-elevation survey operations over open water if the positional accuracy of the GPS positioning can be demonstrated to provide gravity measurements with the specifications defined in section 1.2.

3.1.4 Satellite Navigation:

Complete GPS coverage must be obtained. The positional outputs are to be digitally recorded to 0.000001 degree to provide a final and minimal positional error. A twelve channel receiver is minimally acceptable.

A **dual-frequency** 12-channel GPS acquisition system with adequate memory to record aircraft position once per second is required. A dual-frequency GPS base station set up near the base of operations is required.

Note: Any GPS system utilized in this survey must have the capacity to record and store all parameters to permit post flight differential correction of the GPS navigational data.

3.1.5 Ground Gravity Reference Station:

The survey will be tied to a gravity station referred to the International Gravity Standardization Network (IGSN).

3.1.6 Flight Path Video Camera:

A vertically-mounted, continuous-recording video camera, with a wide angle lens to maximize ground coverage at survey altitude, must be operating at all times while the aircraft is surveying. Clearly visible time stamp updates (seconds after midnight, with tenths of seconds) are to be displayed on the video image. The display of real time GPS

positional information is optional. The combined navigation system (electronic and video imaging) must be capable of providing the required accuracy over the entire survey area.

3.1.7 Field Data Verification System:

The digital data must be verified on a daily basis with an in-field verification system to ensure the recorded parameters meet the contract specifications.

The field verification system must be capable of processing and performing quality control on all collected data sets and to evaluate the flight path data quality. Preliminary levelled grids of the gravity anomaly data will be required and must be produced in the field during the survey.

3.2 Calibration Tests

3.2.1 Airborne Gravimeter:

NOTE: For pre-qualification purposes, the gravity system must be flight-tested over an area with extensive ground gravity coverage. The Contractor will test the system to provide a detailed report of equipment accuracy and resolution. Both airborne gravity survey results and ground gravity data must be supplied in Geosoft .GDB format.

At the beginning and end of each flight, the Contractor shall make a calibration of the airborne gravimeter while the aircraft is motionless on the ground. The value of the gravity on the ground will be determined from a calibration reference to either an International Gravity Standardization Net (IGSN) station of a Canadian Gravity Standardization Net (CGSN) station. A minimum of 15 minutes of recording time is necessary for this test with the aircraft system on.

The contractor will calibrate the airborne gradiometer as required and using a method appropriate to the system. The contractor will document all such calibrations and receive the approval of the Technical Authority.

3.2.2 Radar and Laser Altimeters:

As mentioned in section 3.1.3, altimeters are recommended, but not mandatory for constant-elevation survey operations over open water.

Pre and post survey calibrations must be performed by flying a range of altitudes, representative of the survey area conditions, above and below the designated survey altitude. These altitudes must cover the minimum and maximum range at 5 altitudes of equal increments. Typically, these levels must be determined by the real time GNSS Z and barometric altimeter above the elevation of the base air strip. An additional line is to be flown at survey height crossing over a lake (preferably 1 km in width) to ascertain the radar unit's sensitivity to the reflectivity difference of dry land and water.

Provide raw and compensated altitude as well as relative noise comparison for radar and laser altimeters.

A re-calibration must be performed if equipment is changed. All calibration results must be submitted to the Technical Authority in tabulated form as a Microsoft Excel file accompanied by a graph, showing GNSS altitude versus the radar.

3.2.3 Daily Calibration:

Discuss all calibration tests with Technical Authority and provide results with weekly updates.

The data recorded during these calibrations are considered to be part of the raw data and must be properly labelled and given to the GSC Technical Authority at the end of the survey flying.

3.2.4 Aircraft Systems Comparison:

When more than one aircraft is used for a survey block, each aircraft must fly the same line and the data must be compared to ensure that all systems produce similar results. The test can be done on more than one line providing that at least 50 km of data have been collected in survey mode. This comparative line must be performed at least once during the survey and repeated at any time equipment is changed on an aircraft.

3.3 Data Records

All digital data, and map products must be referenced to GPS time, rather than fiducials.

Isolated errors or spikes and short non-sequential gaps which can be edited out are acceptable with the approval of the Technical Inspector.

3.4 Compilation of the Survey

3.4.1 Base Maps:

The Contractor will be responsible for acquiring the necessary navigational charts and maps at their own expense.

3.4.2 Field Data Verification Procedure:

After each day's flying, the field data quality controller must maintain an up-to-date log of the survey progress and production. A list of planned reflights must be prepared with annotations of flight data quality with specific details on any problems which would potentially have adverse effects on data quality.

The field quality controller must demonstrate that all survey calibrations have been completed as required according to specifications. All digital flight data and GNSS base station data, and video recordings must be systematically annotated and verified to be complete.

The field quality controller must demonstrate that all airborne and ground data, collected since the start of the survey, have been evaluated; that all data which do not meet specifications have been identified, noted, and made available for review by the Technical Authority.

The field quality controller must demonstrate that all digital flight path data has been processed, differentially corrected and plotted at the compilation scale on a regular basis.

3.4.3 Flight Path:

GPS data must be utilized to position the flight lines throughout the entire survey area. It is the primary positional system. A plot of the flight path shall be made from the digital electronic flight path data with appropriate latitude and longitude labelled registration markers to permit verification relative to NTS map coordinates.

All of the raw GPS acquisition data which provides a position fix for the aircraft during survey flight must be recorded and archived. This data is to be archived as separate flights. This data in its raw form must be converted into RINEX2 format (see www page at: http://igscb.jpl.nasa.gov/igscb/data/format/rinex2.txt for format definition) and delivered

to the Technical Authority together with the raw GPS base station data as part of the required deliverables (refer to Section 2, Deliverables and Schedule of Products Required).

3.4.4 Altitude Data:

Proper altitude control is necessary throughout the survey to optimize the quality of the gravitational field levelling.

All radar altimeter data must be checked to ensure that the full height range is being recorded.

Line segments that exceed maximum altitude difference tolerance at intersections will be identified and the location plotted on a flight path map to be used in determining reflights by the NRCan Technical Inspector.

3.4.5 Format:

Each traverse/control line must have a unique integer (no decimal) line number with the segment number incorporated as the last digit of the line number. Control line numbers must have a different range than the traverse lines.

Example: Traverse lines: 10000 to 79001; Control Lines: 80000 to 99000. The last digit of these line numbers is the segment number. Traverse line 79001 is indicating a line segment.

3.4.6 Plotting Flight Path:

Labelled traverse lines and control lines must be plotted on a layer separate from the contour information. Each line must be labelled with a minimum of 2 time labels per map sheet, or a minimum of 1 label if the line direction is noted in the line label.

Line weights and labelling will be discussed with the Contractor. Sample maps shall be provided upon request. Traverse line numbers and control line numbers must be positioned inside the west and south boundaries of each map. Final labelling of flight line data must have a unique line number for each segment presented on the flight line map as well as in the corresponding digital archive data.

3.47 Geophysical Data:

Digital data are to be provided in Geosoft binary (GDB) line data format. The Contractor must establish a system for providing such data expeditiously when requested.

3.4.7.1 - Gravity Anomaly

The gravity anomaly will be calculated by applying the following corrections:

- Eötvös
- Theoretical gravity (GRS80)
- Free air correction
- Bouguer correction
- Earth curvature
- Static correction based on the repeated lines and ground data
- Levelling (see below)

Control line data must be levelled and used in the gridding process (unless instructed otherwise by the Technical Authority).

The Contractor may employ a manual, computer or combined method for determining the levelling adjustments. Whatever method is used, the Contractor must provide a detailed description of the methodology applied to the Technical Inspector.

3.4.7.2 - Gridding

Grid Size = one-quarter (1/4) of the flight line spacing.

A square grid will be calculated from the leveled traverse and control line data. Contour maps must be produced from this grid by a contouring program. The grid used for the compilation maps must be used for the final maps.

3.4.8 Colour Interval Maps:

The Contractor is required to assemble and produce final maps consisting of the descriptive notes, map headings, logos, map coordinates and adjoining map references, neat line, the topographic base within and all layers of data pertaining to the survey, with appropriate line weights and colours within the window defined by the neat line.

The base map with surround for each map sheet must be prepared and submitted for approval. The maps must conform to generic GSC Open File standards. These specifications and a sample map are available to the contractor by the Technical Authority.

The colour intervals for the gravity anomaly must conform to a histogram-equalized distribution of the data range. The colour intervals for the first vertical derivative must conform to either a histogram-equalized distribution of the data range or to a standardized distribution supplied by the Technical Inspector. Specific colour tables for each parameter will be provided by the Technical Inspector. Colour interval maps that incorporate contours must have their intervals adjusted so that they correspond to the major contour intervals.

The contour interval for the gravity anomaly must be 0.5 mGal. Contour intervals of 1.0, 5.0 and 10.0 mGal must be shown using different line weights. If the data warrants changing these intervals, this may be modified in consultation with the Technical Inspector. Gravity anomaly depressions must be indicated by “tick-marks” placed around the inside of the contours expressing the locally low areas. Highs will not require any special identification. Sample maps illustrating proper line weights and contour labelling shall be provided upon request. The direction of the contour labelling must face up-gradient.

Flight path and relevant line and fiducial (time) labelling must be included as described in Section 3.4.7.

3.4.9 Technical Inspection of Final Compilation:

The Contractor must prepare a set of working scale preliminary maps for the entire survey area for the approval of the Technical Authority before preparing the final data set, consisting of:

(i) Contours and flight path maps overlain on the colour grid of the levelled gravity anomaly data,
(ii) Calculated first vertical derivative maps of the gravity anomaly in colour,

Each plot submitted for approval must be accompanied by all the pertinent videos, flight logs, computer listings, levelling information, etc. necessary to verify the compilation. The digital line and gridded data and a preliminary step-by-step compilation report must also be submitted at this time.

On completion of the inspection by the Technical Inspector, one copy of each plot must be returned to the Contractor indicating corrections, if any, to be carried out. When these corrections have been completed by the Contractor, the Technical Authority must approve the compilation by signature on the accepted copy.

Each manuscript submitted for approval must be properly identified as to survey area, map number, and the proper geographic coordinates.

3.5 Preparation of Digital Archives

In specific circumstances, digital line data must be nulled or dummied where the data are not used in the gridding. These circumstances are:

- Overlapping line data where flight lines have been broken;
- Flight path ending outside of the survey boundaries within a map sheet.

3.5.1 General Specifications:

The digital data set is the principal end product to be delivered and it must be of the highest possible quality, essentially error-free. It is recommended that the Contractor **provide a statistical summary for each field in the line data set and also for the complete gridded data sets being submitted as final archives** (not from the Contractor's database).

The Contractor must consult with the Technical Authority to ensure compatibility of the storage media.

3.5.2 Detail Specifications:

3.5.2.1 - Line Archive

The line archive data must be submitted in Geosoft binary (*gdb) format.
Line data sample rate: **not less than 1 sample per second for all fields**

The structure and format line archive of the final data may be system dependent. The channels must be ordered to match the processing steps. The following is a guide and the final structure and format will be determined by the Technical Authority:

#	Channel	Format	Unit	Description
1	LINE	A10	-	line number
2	TIME	F10.2	second	time (seconds after midnight)
3	LONG	F15.7	degrees	longitude, NAD83
4	LAT	F15.7	degrees	latitude, NAD83
5	EASTING	F15.2	m	UTMX East, NAD83 - UTM 17N
6	NORTHING	F15.2	m	UTMY North, NAD83 - UTM 17N
7	RALT	F10.2	m	radar altitude
8	LALT	F10.2	m	laser altitude
9	SURFACE	F10.2	m	drape surface
10	GPSALTRL	F10.2	m	GPS-Z elevation above GRS80 ellipsoid (post processed)
11	GPSALTPP	F10.2	m	GPS-Z elevation above GRS80 ellipsoid (post processed)
12	GPSALT	F10.2	m	GPS-Z elevation above mean sea level (post processed)
13	DEMRADAR	F10.2	m	digital elevation model from radar altimeter
14	DEMLASER	F10.2	m	digital elevation model from laser altimeter
15	DEMSRTM	F10.2	m	digital elevation model from SRTM (used for gravity corrections)
16	Fx	F12.2	mGal	gravimeter x-accelerometer
17	Fy	F12.2	mGal	gravimeter y-accelerometer
18	Fz	F12.2	mGal	gravimeter z-accelerometer

#	Channel	Format	Unit	Description
19	Az	F12.2	mGal	gps z acceleration
20	gvraw	F12.2	mGal	raw gravity (fz-az)
21	gvlat	F12.2	mGal	latitude corrected gravity, unfiltered
22	gveot	F12.2	mGal	eotvos corrected gravity, unfiltered
23	gvfa	F12.2	mGal	free air corrected gravity, unfiltered
24	gvfa100s	F10.2	mGal	free air corrected gravity, 100s full-wavelength line filter
25	gvfal100s	F10.2	mGal	free air corrected gravity, intersection adjusted, 100s full wavelength line filter
26	sbcor	F10.2	mGal	simple Bouguer correction, 2.67 g/cc
27	eccor	F10.2	mGal	earth curvature correction (2.67 g/cc based)
28	tercor	F10.2	mGal	terrain correction (2.67 g/cc based)
29	gvbgl100s	F10.2	mGal	Bouguer corrected gravity, 2.67 g/cc intersection adjusted, 100s full-wavelength line filter
30	gvfal1800	F10.2	mGal	final free air corrected gravity, 3500m half-wavelength spatial filter
31	gvbgl1800	F10.2	mGal	final Bouguer corrected gravity, 2.67 g/cc, 3500m half-wavelength spatial filter
32	DATE	A10	date	date (ddmmyyyy)
33	FLIGHT	A4	-	flight number
34	LINETYPE	A3	-	Line type (L=line, T=tie)
35	LINENAME	A7	-	Line name (Line type + Line number)

Prior to line archive generation the Contractor must consult with the Technical Authority on the final format.

3.5.2.2 -Grid Archive

One (1) Geosoft *.grd format grid file for each one of the processed variable for the entire survey.

The Universal Transverse Mercator projection with the appropriate central meridian must be used for creating the gridded data sets. All longitudes west of Greenwich should be represented as negative degrees. Each survey grid origin must be a multiple of the grid interval for both easting and northing coordinates.

3.6 Final Products

See Section 1, for list of Final Products.

3.6.1 Gravity Maps:

The Contractor is required to assemble and produce final maps consisting of:

Map by NTS Map sheets, one (1) copy each:

(1) Bouguer gravity anomaly (colour and contour interval)
(2) First Vertical Derivative of the Bouguer gravity anomaly (colour interval)

All final map products (see Section 1 of any Request for Proposals) must also be delivered in both PostScript and PDF formats at a resolution suitable to accurately reproduce the plotted products, two (2) copies on storage media acceptable to the Technical Authority.

3.6.2 Digital Archive Data:

Archives of final line data in binary Geosoft *.gdb format and archives of grid data as *.grd (FLOAT) format files, two (2) copies on acceptable storage media.

3.6.3 Technical Report:

A technical report must be prepared by the Contractor which presents:

i) a reasonably comprehensive account of the field operations;
ii) a description of compilation of the data, including all formulas used in the data processing;
iii) an inventory of the resultant end products which will be useful to users of the data.

The project report shall including the following:

iv) Description of the field operations with statistics including a list of:

a) Bases of operations with pertinent dates and personnel involved
b) Description of the survey aircraft and instrumentation used.

(v) Technical specifications of the survey including a description of the problems encountered during the survey. A discussion of the effectiveness of the survey techniques and instrumentation utilized with suggestions to improve the effectiveness of similar surveys.

(vi) Description of the compilation procedure including a general flow chart of complete data compilation technique from correction and editing of raw data to contour map production; a list of all criteria employed in rejection/acceptance of data; a general explanation of the mathematical basis of the levelling and gridding algorithm used; a specific explanation of the mathematical corrections applied in data processing; personnel involved.

(vii) Index maps and a list of all the end products of the survey. In addition, for every file:

a. A detailed documentation of the file formats;
b. A list of all constants, datum levels, and conversion factors required for subsequent use of the data.

A draft copy of the Project Report must be submitted to the Technical Authority and approved by the Technical Authority prior to its finalization. The final version must be accompanied by a digital version in either MS Word.

SECTION 4: RESPONSIBILITIES OF THE CONTRACTOR FOR SURVEY

For the field operations, the selected Contractor shall be responsible for the following:

4.1 Aircraft

The supply, maintenance and operation of aircraft, suitably equipped and Transport Canada approved to carry out this particular type of survey, including the supply of required fuel, oil and lubricants.

The supply of back-up aircraft, suitably equipped, Transport Canada approved and available for the survey. The back-up aircraft shall be ready for mobilization within thirty (30) days of receiving a request in writing from the Technical Authority. (This provision can be satisfied by a documented agreement with another company providing this service.)

All technical equipment and instrumentation, with spares, necessary to execute the airborne geophysical survey in an expeditious manner (see Technical Specifications, Section 3).

4.2 Qualified Personnel

Provision of the necessary qualified personnel and their office accommodation required to complete the project work including:

Project Manager (Office or Field)
Maintenance Engineer (or contract) (Office or Field)
Field Manager (Field) (may also be one of the following:)

- Pilot (Field)
- Field Quality Controller (Field)
- Instrument Operator or Co-pilot (Field)

A minimum of 3 field members excluding the aircraft Mechanic are required.
A minimum of 2 aircraft crew members excluding the aircraft Mechanic are required.

a) Project Manager:
Geophysicist, with a degree in earth sciences from a recognized university or geoscientist with applied experience in geophysical surveys; and 3 years of experience in airborne geophysical survey projects that were comparable in scope, instrumentation and survey parameters to that required for the contract.

b) Field Manager:
Two (2) years of related experience in this type of geophysical survey projects.

c) Pilots:
Must hold a valid commercial pilot licence, applicable to the type of aircraft to be flown, issued by Transport Canada and must be able to provide proof on demand of the Contracting Authority.

In addition, pilots must have at least 300 hours of flying on low level airborne geophysical surveys of this type and must be able to provide proof on demand of the Contracting Authority.

d) Field Quality Controller:
Must have related experience on at least two (2) geophysical airborne survey projects of this type within the last 3 years and must be able to provide proof, on demand of the Contracting Authority.

e) Instrument Operator or Co-pilot:
Must have at least one (1) year of operational experience on this type of geophysical survey and must be able to provide proof, on demand of the Contracting Authority.

f) Maintenance Engineer:
Must hold a valid Category M licence and be able to provide proof on demand by the Contracting Authority. This position may be subcontracted.

4.3 Other Responsibilities

The Contractor is responsible for transportation, mobilization, demobilization, and subsistence, while in transit, as well as shipping between company headquarters and the respective points of arrival and departure of the aircraft, personnel, technical equipment, materials and supplies necessary for the effective performance of the work, including aviation fuel and lubricants. Compliance with all provisions of the National Transportation Act and directives, orders, rules and or regulations pursuant to those Acts.

The Contractor **must not** commit the use of the proposed aircraft, or systems specified for this project to another project until the completion of the data acquisition stage without approval of the Technical Authority.

The Contractor is responsible for arranging and paying for its own accommodation, meals and incidental expenses such as airport fees.

The Contractor is responsible for ensuring that all compilation, drafting and reproduction is carried out in Canada.

4.4 Maintenance of Survey Standards

4.4.1 Technical Inspection:

All work is to be performed to the satisfaction and subject to the acceptance of the Technical Authority. Delegated Technical authorities will make periodic trips to the survey site to monitor field operations to observe whether operations are being carried out in accordance with the contract specifications. Copies of the Statement of Work (or Annex "B") must be in the possession of the Field Operations Manager during the field operations and the Project Manager during the compilation phase.

Technical Authority will be available for consultation on technical problems that may arise during the course of the field work and have the authority to approve, in writing, changes to the Technical Specifications that will not affect the general scope of the work to be performed. Any changes which might entail reductions or additional charges to Canada must be referred to the Contracting Authority with a copy to the Technical Authority.

Notwithstanding the foregoing provisions, the Contractor shall be solely responsible for the quality of the work. The Project Manager must ensure that adequate quality control procedures are in place and are being strictly followed, so as to ensure such quality of work. He or she must in turn sign off each report and each product submitted for inspection, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3.

4.4.2 Field Verification:

Initial flight path recovery and full inspection of all data will be done in the field by the Contractor. The following will also be produced in the field:

(1) preliminary contoured gravity anomaly map,
(2) contoured differentially-corrected Digital Elevation Model (GPS altitude minus radar) map,
(3) differentially-corrected flight path map.

These products will be used in the final field verification of the data.

4.4.3 Verification of In-Flight Data:

All digital data will be verified by the Contractor after each flight by a suitable process using equipment at the operations flying base (see Technical Specifications, Section 3).

4.4.4 Incomplete Survey Data:

The Contractor will re-survey, free of charges, lines or segments of lines for which the required digital data are missing or are not in accordance with the Technical Specifications (Section 3). Isolated errors or spikes and short, non-sequential gaps consisting of a few points which can be corrected by interpolation are acceptable.

4.4.5 Reflights – Lost Data:

Digital data which are lost in transit or in processing (if no digital copies have been made) or are rejected by the Technical Authority shall be re-acquired under the same conditions as set out in the Technical Specifications, Section 3, including flying services, at no cost to Canada. Any reflights to replace lost digital data will be at the Contractor's sole expense.

WORKSTREAM 4: TIME-DOMAIN ELECTROMAGNETIC SURVEY

The following is an example of the information required when submitting a proposal against a Request for Proposal (RFP) issued against an awarded Supply Arrangement.

SECTION 1: SURVEY PARTICULARS

1. Time-Domain Electromagnetic Survey (TDEM) – Cariboo Lake, BC

To conduct a helicopter borne digitally-recorded high sensitivity magnetic and time domain electromagnetic survey of the **Cariboo Lake, British Columbia**, consisting of approximately 10 000 line-km and to compile the acquired data in accordance with the technical specifications given in Section 3.

1.1 Delineation of Survey Areas:

The following coordinates define the main Block survey area:

Main Block Boundaries WGS84		
	LAT	**LONG**
corner # 1	52.75037	-120.84246
corner # 2	52.54534	-121.06659
corner # 3	52.56910	-121.24944
corner # 4	52.58316	-121.31551
corner # 5	52.63885	-121.26179
corner # 6	52.69480	-121.38391
corner # 7	52.66387	-121.47573
corner # 8	52.79855	-121.66226
corner # 9	52.84959	-121.72133
corner #10	52.86970	-121.73935
corner #11	53.10233	-121.46003
corner #12	53.03101	-121.38300
corner #13	52.94419	-121.33194
corner #14	52.87110	-121.19652
corner #15	52.82757	-121.14312
corner #16	52.79752	-120.97721

The location map (Figure A-1) shows the survey boundaries for the survey areas.

Figures A-1 and Figures C-1, C-2, and C-3 referenced in Annex "A" are available for download on the GSC FTP site at:
ftp://ftp.agg.NRCan.gc.ca/docs/RFPspecs/Caribou_Lake

1.2 Flying Specifications:

The data quality control must be done in the field on a daily basis. All traverse lines must start or end by intersecting a control line.

Parts of traverse lines reflown to complete a traverse line must cross control lines at both ends. Segments of a control line must start and end by crossing a common traverse line. All traverse lines must intersect a minimum of two (2) control lines. No gaps

will be accepted in the final products. The Contractor must refly lines or portions of lines where the following specifications are not met.

For each survey flight, adjacent lines must be flown consecutively and in opposite directions, racetrack flying pattern will not be permitted.

1.2.1 Height:

Transmitter 30 m MTC (mean terrain clearance) except in areas where Transport Canada regulations prevent flying at this height and in areas of severe topography where the pilot's judgement shall prevail within reason.

95% of the intersection points between lines and control lines shall not show altitude differences in excess of 10 m and these differences shall never exceed 20 m over any intersection point. (i.e., altitude differences between 10 m and 20 m will be allowed for 5% of the intersections).

1.2.2 Line Bearing, Spacing:

Traverse line spacing: 200 m
- allowed min. separation: 160 m
- allowed max. separation: 240 m
- bearing: N 35° E

Control line:
- spacing: 1200 m
- bearing: N 125° E

1.2.3 Diurnal Specifications:

A maximum tolerance of **3.0 nT** (peak to peak) deviation from along chord equivalent to a period of one minute for each base station. This specification must be verified in the field prior to demobilization.

1.2.4 EM Noise Specifications:

Reflights at the contractor's expense will be flown when the noise level of the EM system, as indicated on the raw traces of dB/dT of the last off-time channel , exceeds **3.5 nT/s,** on either the X or Z coil, over a distance of one kilometer or more.

1.2.5 Spheric Noise Levels:

Spheric noise will be carefully monitored and removed from the data. Significant bursts of spheric events that interfere with data processing or interpretation will be reflown.

1.3 Specific Equipment Requirements

1.3.1 EM System:

The electromagnetic system must have a proven depth of penetration of 250 m. The electromagnetic receiver is comprised of a multi-channel computer for data processing and reduction, and sensors in a towed-bird. The electromagnetic system is capable of providing the dB/dt (the horizontal X and vertical Z components).

1.3.2 Magnetometer:

The sensor will be mounted in a bird towed under the aircraft or in a stinger rigidly attached to the aircraft.

1.3.3 **Radar Altimeter**:

Minimum range: 0 - 800 m
Accuracy (minimal) 2%

1.3.4 **Aircraft**:

Contractor must provide suitable aircraft capable of draping the topographic surface at a sustained rate of climb/descent.

1.4 Compilation Specifics

Map Scale, projection: 1:20 000 and 1:50 000 (NAD83, Universal Transverse Mercator)
Digital bases available: 1:50 000 (NAD83, Universal Transverse Mercator)

Grid size: 50 metres

For the use in the preparation of bases for each map, the Contractor will be provided with digital base maps in DXF format for each NTS map sheet relevant to the survey area, at 1:50 000 scale.

1.5 Final Products

For each area,
- one Oasis montaj database digital archive of the final line data
- one Oasis montaj database digital archive of the EM Anomalies with characterization.
- One binary file per flight of the Time Domain Electromagnetic Data (TDEM) streamed data
- One binary file per flight of the TDEM halfwave data
- TDEM reference waveform, twice per flight (preflight and postflight)

For each area, one Oasis montaj format Grid file for each of the processed parameters;

- Processed Variables:
  a) Residual Magnetic Total Field Data
  b) Second Vertical Derivative Data of the Magnetic field
  c) Digital Elevation Model Data
  d) Apparent Conductivity or conductance Data unfiltered
  e) Apparent Conductivity or conductance Data de-herringboned
  f) Decay constant (X component unfiltered)
  g) Decay constant (X component de-herringboned))
  h) Decay constant (Z component unfiltered)
  i) Decay constant (Z component de-herringboned)
  j) Apparent conductance of the EM anomalies based on the thin plate model when the model is applicable.

- All other final products, logs, levelling documents and digital images (in .BIN / BDX format with viewer).
- Final Technical report accompanied by one digital file in MS Word,

Maps:

All final maps must be delivered in Oasis montaj map format and PDFX formats at resolution suitable to accurately reproduce the plotted products

Maps Scale of 1:50 000
- Residual Magnetic Total Field (colour and contour intervals) with Electromagnetic Anomalies

- Second Vertical Derivative of the Magnetic field (colour and contour intervals) with Electromagnetic Anomalies
- Decay constant (colour and contour intervals) with Electromagnetic Anomalies
- Apparent Conductance or conductivity (colour and contour intervals) with Electromagnetic Anomalies

Map Scale of 1:20 000
- Residual Magnetic Total Field contours with flight path and Electromagnetic Anomalies and their apparent conductance where applicable.

1.6 Schedule of Products Required

The Contractor's Project Manager shall be responsible for signing off all reports and all products being delivered, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3.

The Contractor must make available to the Technical Authority any digital data requested for checking purposes, to facilitate timely approval of map products.

1.6.1 Milestone 1:

By **Feb 15, 201** and after completion of the following:

- documented results of all required calibration and test flights,
- delivery and acceptance of 5000 line kilometres edited acquisition data (including satellite navigation), Geosoft *.gdb format and FP verification by the Technical Authority,
- delivery and acceptance of all raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight,
- delivery and acceptance of all raw magnetic base station diurnal data from both stations prepared in Geosoft *.gdb format, archived by day,

1.6.2 Milestone 2:

By **March 31, 2019** and after completion of the following:

- delivery and acceptance of the complete survey's edited acquisition data (including satellite navigation), Geosoft *.gdb format and FP verification by the Technical Authority,
- delivery and acceptance of all raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight,
- delivery and acceptance description of processing steps and equations,
- delivery and acceptance of all raw magnetic base station diurnal data from both stations prepared in Geosoft *.gdb format, archived by day,

1.6.3 Milestone 3:

By **June 1, 2019** and following completion, delivery and acceptance by the Technical Authority of:

- plot of final compilation flight path as 1:50 000 and 1:20 000 scale,
- plot of all final compilation of leveled processed parameters 1:50 000 and 1:20 000 scale,
- compilation archive of digital profile and gridded data.

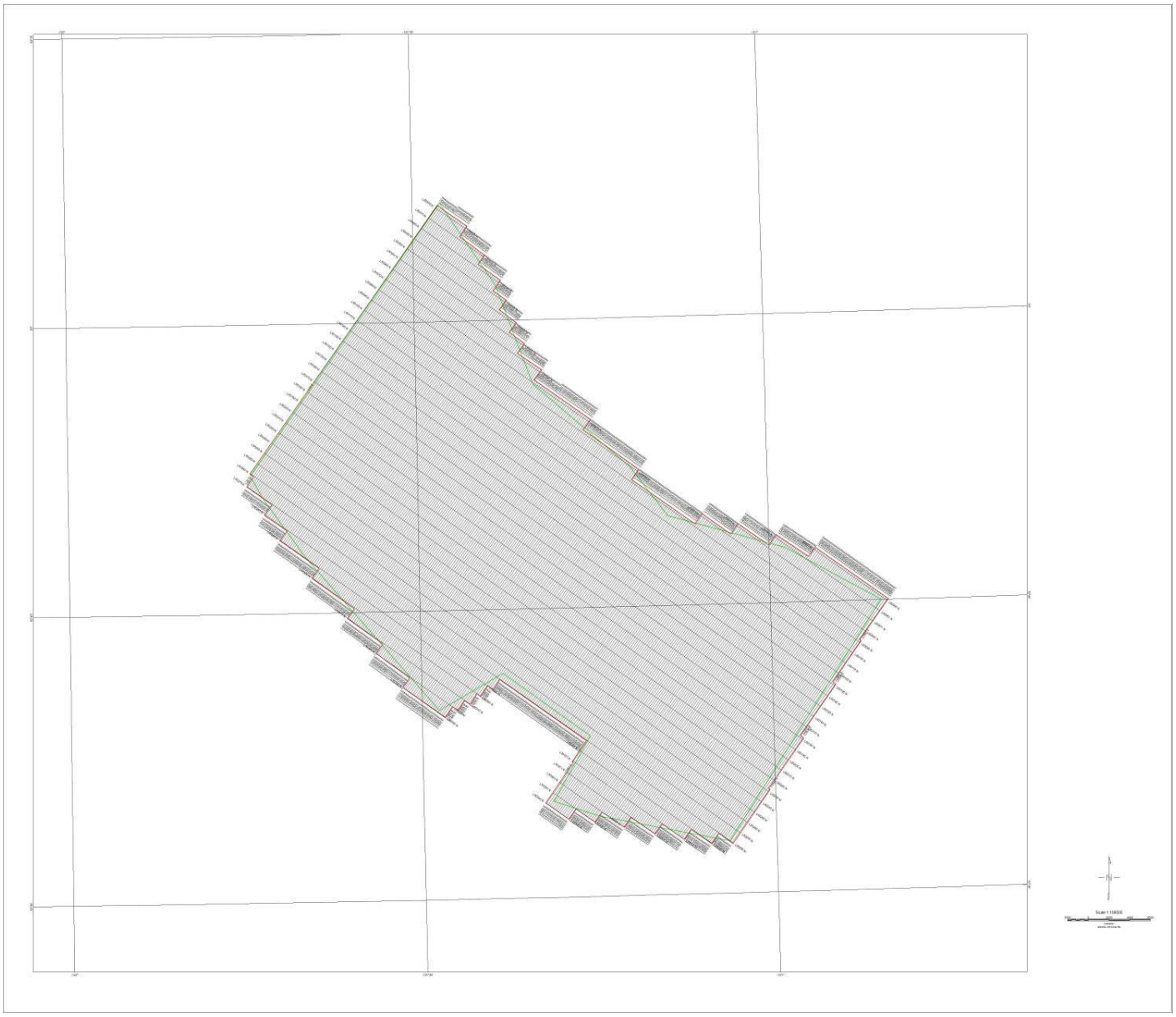
- One (1) paper copy of all maps
- Oasis montaj Maps format and PDFX files for all maps
- Final digital archives of all the gridded variables
- Final digital archive of EM line data at 5 Hz
- Final digital archive of magnetic line data at 10Hz
- Final digital archive of EM Anomaly data

- Final digital archive of Streamed data
- Final digital archive of Halfwave data
- Final digital archive of the Reference Wave data

- Final Technical report (1 paper copy) signed by the Project Manager according to the GSC Technical Specifications, Section 3, accompanied by digital file in MS Word format.

- All other final products (refer to section 3.6 of the Statement of Work).

FIGURE A-1: TIME-DOMAIN – CARIBOO LAKE, BC



SECTION 2: DELIVERABLES

2.1 Schedule of Products Required

The Contractor's Project Manager shall be responsible for signing off all reports and all products being delivered, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3 of the Statement of Work.

The Contractor must make available to the Technical Authority any digital data requested for checking purposes, to facilitate timely approval of map products.

See Section 1.6 for the Schedule of Products required for this survey.

2.2 Deliverables

2.2.1 Pre-production Report:

A report must be supplied to the Technical Authority before production flights begin. The report must include:

- Flight path database (Geosoft .GDB format)
- Base of operations utilized;
- Statement of expected diurnal and weather conditions as well as any major operational, logistical or other problems which may hinder production;
- Projected downtime due to aircraft unserviceability;
- All calibration tests (see Part 3, Technical Specifications below);
- Lag tests (see Part 3, Technical Specifications below);
- Results of any other tests carried out.

2.2.2 Weekly Progress Report (Acquisition):

During the data acquisition phase, production figures **and all data acquired to date** must be provided on a weekly basis, each Monday morning to Technical Authority.

2.2.3 Weekly Progress Report (Compilation):

The Contractor's Project Manager shall submit weekly reports each Monday morning describing the state of progress of the various aspects of the work as well as projections as to the completion of the work. These reports will be faxed and addressed to the Technical Inspector or other designated persons authorized by the Technical Authority.

Included in the reports will be:

- Base of operations utilized; the number of survey flying hours and the line-kilometres flown and accepted on a daily basis during the report period and their total to report date; a sketch map (letter size) showing the area of data acquisition to date; visits by the Technical Inspector or other authorized persons.

- A statement of diurnal and weather conditions as well as any major operational, logistical or other problems which may have hindered production; downtime due to unserviceability.

- The altimeter calibration (see Part 3, Technical Specifications below),

- Lag tests are required (see Part 3, Technical Specifications below),

- The results of any other tests carried out during the report week.

2.2.4 Digital Data:

The digital data are to be delivered in line and gridded archive format as itemized in Section 1.5 of any Request for Proposal and described in detail in section 3.5.2. These digital data include survey acquisition data, calibration data, geophysical and navigational processed data.

Digital line data are to be delivered in Geosoft .GDB format. Channel names must conform to the standard described in detail in section 3.5.2.

2.2.5 Other Deliverables:

1) Final Maps:
Final digital copies of the maps as itemized in Section 1.5 of any Request for Proposals and described in detail in Section 3.4 of Part 3, Technical Specifications.

2) Digital video:
Digital video files will be labelled showing area name, date, flight number, line number, time ranges.

3) Equipment Log:
As described under "Airborne and Ground Instrumentation", Section 3.1.

4) Levelling Documents:
The final levelling network and final flight path data (digital files and plots) must be submitted.

5) Technical Report:
A technical report must be prepared by the Contractor which presents (i) a reasonably comprehensive account of the field operations, (ii) a description of compilation of the data and (iii) an inventory of the resultant end products which will be useful to users of the data. All flight logs and quality control sheets must be properly labelled and submitted for data evaluation. The specifics to be included in the project report are described in further detail in section 3.6.3.

2.2.6 Handling and Storage of Digital Data:

Copies of all digital data must be stored by the Contractor for 1 year after the safe delivery of the same data to the GSC Technical Authority. During this time the data may not be erased except by explicit written authorization of the Technical Authority.

After delivery of all final maps, any related materials used to produce the final products will be delivered to the GSC Technical Authority in acceptable containers which have labels identifying their contents. The Contractor must prepare a catalogue (as part of the Technical Report) for all of these data and will submit it to the GSC Technical Authority.

SECTION 3: GSC TECHNICAL SPECIFICATIONS

A copy of the Technical Specifications must be in the possession of each of the Contractor's personnel who have a responsibility in the execution of the contract. The Contractor must obtain and have available in the field and office all relevant charts, maps, etc. pertaining to navigation.

3.1 Airborne and Ground instrumentation

The instrument operator shall maintain and update an equipment log book noting all equipment replacement and repairs throughout the survey and the results of calibration tests carried out on the equipment.

3.1.1 Electromagnetic Survey:

Electromagnetic data received at the receiver coils will be recorded digitally with all channels of raw data recorded to the computer's hard disk. The 60 Hz powerline monitor and the primary field strength at the receiver will be recorded. The EM field will be sampled at a minimum rate rate of four (4) samples per second.

The Contractor will confirm gate specifications with the Technical Authority.

3.1.2 Systems Timing Synchronization:

All data acquisition systems' timing in the aircraft and on ground base stations **must be synchronized** by the GPS time pulses**, in real time**.

Complete GNSS coverage must be obtained. The positional outputs are to be digitally recorded to 0.000001 degree to provide a final and minimal positional error. A twelve channel receiver is minimally acceptable.

A **dual-frequency** 12-channel GNSS acquisition system with adequate memory to record aircraft position once per second is required. A dual-frequency GNSS base station set up near the base of operations is required.

Note: Any GNSS system utilized in this survey must have the capacity to record and store all parameters to permit post flight differential correction of the GNSS navigational data.

3.1.3 Altimeters:

Radar altimeter with digital output and a precise radar display, must form part of the ancillary equipment for the survey aircraft.

	Radar Altimeter
Minimum range:	0-800 m

3.1.4 Flight Path Video Camera:

A vertically-mounted, continuous-recording video camera, with a wide angle lens to maximize ground coverage at survey altitude, must be operating at all times while the aircraft is surveying. Clearly visible time stamp updates (seconds after midnight, with tenths of seconds) are to be displayed on the video image. The display of real time GPS positional information is optional. The combined navigation system (electronic and video imaging) must be capable of providing the required accuracy over the entire survey area.

3.1.5 Field Data Verification System:

The digital data must be verified on a daily basis with an in-field verification system to ensure the recorded parameters meet the contract specifications such as flight path data quality and preliminary levelled grids of the resistivity/conductivity data.

3.2 Calibration Tests

3.2.1 Lag Tests:

Prior to the initial commencement of survey production and with any major survey equipment alteration or replacement on the aircraft, the Contractor must perform a lag test to ascertain the time difference between the EM receiver readings and the operation of the positioning devices. The results of these test flights, which must be flown in opposite directions at the normal survey height across a distinct anomaly, must submitted to the Technical Inspector with the next weekly report. Lag tests must also be performed in the survey area by flying over a known point in opposite directions. This will determine lag in the digitally-recorded navigational data. Lag tests may be carried out while performing the calibration flights. To ascertain that the calculated lag remains constant within a flight and from flight to flight the contractor will conduct regular lag tests.

3.2.2 Radar Altimeter:

Pre- and post-survey calibrations must be performed by flying a range of altitudes, representative of the survey area conditions, above and below the designated survey altitude. These altitudes must cover the minimum and maximum range at 5 altitudes of equal increments. Typically, these levels must be determined by the real time GPSZ and barometric altimeter above the elevation of the base air strip. An additional line is to be flown at survey height crossing over a lake (preferably 1 km in width) to ascertain the radar unit's sensitivity to the reflectivity difference of dry land and water.

A re-calibration must be performed if equipment is changed. All calibration results must be submitted to the Technical Authority in tabulated form as a Microsoft Excel file accompanied by a graph, showing GPS altitude versus the radar altitude and barometric altitude.

3.2.3 EM Calibrations:

Pre-flight and post-flight compensation of the TDEM system to determine reference waveform for Tx, Rx, and Rz.

Pre- and post-flight measurement of TDEM background response and assessment of noise levels.

Pre and post flight tests of the TDEM compensation and reference waveform.
If excessive drift is present on the EM system the data will be reflown at no cost.

3.3 Data Records

3.3.1 Digital:

Isolated errors or spikes and short non-sequential gaps which can be edited out are acceptable with the approval of the Technical Authority.

3.3.1.1 - Airborne:

All digital data, video, and map products must be referenced to GPS time rather than fiducials.

Recording Specifications:

	Recording Interval	Precision
Time	0.1 second	0.1 sec

Radar altimeter	0.2 second	0.1 m
GPS height	1.0 second	0.1 m
EM recording	0.2 second or less	1 part / 2^{16}

3.3.1.2 - Ground:

Recording Specifications:

	Recording Interval	**Precision**
Time	1.0 second	0.01 sec
GPS base station	1.0 second	0.1 m

3.4 Compilation of the Survey

3.4.1 Base Maps:

The Contractor will be responsible for acquiring the necessary navigational charts and maps at its own expense.

Compilation Scales: 1:50 000 and 1:20 000

3.4.2 Field Data Verification Procedure:

After each day's flying, the field data quality controller must maintain an up-to-date log of the survey progress and production. A list of planned reflights must be prepared with annotations of flight data quality with specific details on any problems which would potentially have adverse effects on data quality.

The Field Quality Controller must demonstrate that all survey calibrations have been completed as required according to specifications. All digital flight data and video recordings must be systematically annotated and verified to be complete.

The Field Quality Controller must demonstrate that all airborne data collected since the start of the survey, have been evaluated; that all data which do not meet specifications have been identified, noted and available for review by the GSC Technical Authority.

The Field Quality Controller must demonstrate that all digital flight path data has been processed and differentially corrected on a regular basis. Further verification of the positioning must be completed by calculating a digital elevation model (DEM) using the differentially corrected GPS altitude (corrected to the orthometric height) and radar data. The difference, producing the DEM, must be gridded.

3.4.3 Flight Path:

GPS data must be utilized to position the flight lines throughout the entire survey area. It is the primary positional system. A plot of the flight path shall be made from the digital electronic flight path data with appropriate latitude and longitude labeled registration markers to permit verification relative to NTS map coordinates.

All of the raw GPS acquisition data which provides a position fix for the aircraft during survey flight must be recorded and archived. This data is to be archived as separate flights. This data in its raw form must be converted into RINEX2 format (see www page at: http://igscb.jpl.nasa.gov/igscb/data/format/rinex2.txt for format definition) and delivered to the Technical Authority together with the raw GPS base station data as part of the required deliverables (refer to Section 2, Deliverables and Payment Schedule).

3.4.4 Altitude Data:

Proper altitude control is necessary throughout the survey.

All radar altimeter data must be checked to ensure that the full height range is being recorded.

The survey must be flown at the correct altitude with respect to the conditions stated in the Section 1.

Line segments that exceed maximum altitude difference tolerance at intersections will be identified to be used in determining reflights.

3.4.5 Format:

Each traverse/control line must have a unique integer (no decimal) line number with the segment number incorporated as the last digit of the line number. Control line numbers must have a different range than the traverse lines.

Example: Traverse lines: 10000 to 79001; Control lines: 80000 to 99000. The last digit of these line numbers being the segment number. Traverse line 79001 is indicating a line segment.

3.4.6 Plotting Flight Path:

Labeled traverse lines and control lines must be plotted on a layer separate from the contour information. Each line must be labeled with a minimum of 2 time labels per map sheet, or a minimum of 1 label if the line direction is noted in the line label.

Line weights and labeling will be discussed with the Contractor. Sample maps shall be provided upon request. Traverse line numbers and control line numbers must be positioned inside the west and south boundaries of each map. Final labeling of flight line data must have a unique line number for each segment presented on the flight line map as well as in the corresponding digital archive data.

3.4.7 Electromagnetic Data:

The EM data processing steps are as follows:

a) editing, stacking and filtering of the raw electromagnetic data;
b) drift correction, leveling of the individual electromagnetic channel profile data;
c) computation of TDEM decay constant (tau) and TDEM apparent conductivity in profile form;
d) preparation of original and de-herringboned grids of TDEM decay constant (tau) and TDEM apparent conductivity;
e) selection of EM anomalies;
f) model characterization of EM anomalies (apparent conductance).

Digital data are to be provided in the format described in Annex-C, section 3.5. The Contractor must establish a system for providing such data expeditiously when requested.

3.4.7.1 - Gridding:

Grid Size = ¼ of the traverse line spacing.

A square grid will be calculated from the leveled traverse and control line data. Contour maps must be produced from this grid by a contouring program. The grid used for the compilation maps must be used for the final maps.

3.4.8 Technical Inspection of Final Compilation:

The Contractor must prepare a working scale preliminary map consisting of iso-contours and flight path where requested and EM anomalies for the approval of the Technical Authority before preparing final maps.

Each map submitted for approval must be accompanied by all the pertinent videos, flight logs, levelling information, etc. necessary to verify the compilation. Digital data and a preliminary step-by-step compilation report must also be submitted at this time.

On completion of the inspection by the Technical Authority, one copy of each map may be returned to the Contractor indicating corrections, if any, to be carried out. When these corrections have been completed by the Contractor, the Technical Authority must approve the compilation by signature on the accepted copy.

Each manuscript submitted for approval must be properly identified as to survey area, map number and the proper geographic coordinates.

3.5 Preparation of Digital Archives

In specific circumstances, digital line data must be removed/dummied where the data is not used in the gridding. These circumstances are:

1. Overlapping line data where flight lines have been broken;
2. Flight path ending outside of the survey boundaries.

3.5.1 General Specifications:

The digital data set is the principal end product to be delivered and it must be of the highest possible quality, essentially error-free. It is recommended that the Contractor provide a statistical summary for each field in the line data set and also for the complete gridded data sets being submitted as final archives (not from the Contractor's database).

The Contractor must consult with the Technical Authority to ensure compatibility of storage media.

3.5.2 Detail Specifications:

3.5.2.1 -Line Archive:

The line archive data must be submitted in **Geosoft** binary (*.gdb) format.

Prior to line archive generation the Contractor must consult with the Technical Inspector on the final structure and format. The channels must be presented in the order of the processing steps. The following is an example of the structure and format of the line archive:

Name:	Units:	Description:
LINE	-	Line number
TIME	sec	Time (sometimes fiducial counter)
LONG	deg	Longitude
LAT	deg	Latitude
EASTING	m	Easting
NORTHING	m	Northing
GPSALTRL	m	Raw GPS altitude, ReaL-time
GPSALT	m	GPS altitude (edited) above MSL (mean sea level)
RALTRAW	m	Raw Radar altitude (Terrain Clearance)

Name:	Units:	Description:
RALT	m	Radar altitude (Terrain Clearance)
BALTRAW	m	Raw Barometric altitude
BALT	m	Barometric altitude
DEMLEV	m	Levelled Digital Elevation Model / Topography (raw + corrections)
MGHEIGHT	m	Magnetometer height (above terrain)
MAGUNLAG	nT	Raw unlagged magnetic total field (magnetometer in bird so no compensation needed)
MAGULED	nT	Raw, edited, unlagged magnetic total field
MAGRAW	nT	Raw magnetic total field (compensated, lagged, edited)
DIURNRAW	nT	Raw Diurnal / ground magnetics base station 1
DIURNCOR	nT	Diurnal correction (combined ground mag) - input into levelling
MAGTLCOR	nT	Tie-line levelling corrections to mag
SRVMGLEV	nT	Magnetic Total field, levelled to survey
IGRF	nT	IGRF (International Geomagnetic Reference Field)
SRVMGRES	nT	Residual magnetic field, levelled to survey
EMHEIGHT	m	Electromagnetic receiver height (above terrain)
EMTRANHT	m	Electromagnetic transmitter height (above terrain)
RXTEMON	pT/s	Raw X-coil Time domain EM On channels (01-05), also called dB/dt X-coil
RXTEMOFF	pT/s	Raw X-coil Time domain EM Off channels (06-20)
RYTEMON	pT/s	Raw Y-coil Time domain EM On channels (01-05)
RYTEMOFF	pT/s	Raw Y-coil Time domain EM Off channels (06-20)
RZTEMON	pT/s	Raw Z-coil Time domain EM On channels (01-05)
RZTEMOFF	pT/s	Raw Z-coil Time domain EM Off channels (06-20)
IXTEMON	pT/s	Intermediate X-coil Time domain EM On channels (01-05), also called dB/dt X-coi
IXTEMOFF	pT/s	Intermediate X-coil Time domain EM Off channels (06-20)
IYTEMON	pT/s	Intermediate Y-coil Time domain EM On channels (01-05)
IYTEMOFF	pT/s	Intermediate Y-coil Time domain EM Off channels (06-20)
IZTEMON	pT/s	Intermediate Z-coil Time domain EM On channels (01-05)
IZTEMOFF	pT/s	Intermediate Z-coil Time domain EM Off channels (06-20)
LXTEMON	pT/s	Levelled X-coil Time domain EM On channels (01-05), also called dB/dt X-coil
LXTEMOFF	pT/s	Levelled X-coil Time domain EM Off channels (06-20)
LYTEMON	pT/s	Levelled Y-coil Time domain EM On channels (01-05)
LYTEMOFF	pT/s	Levelled Y-coil Time domain EM Off channels (06-20)
LZTEMON	pT/s	Levelled Z-coil Time domain EM On channels (01-05)
LZTEMOFF	pT/s	Levelled Z-coil Time domain EM Off channels (06-20)
RXBEMON	fT	Raw X-coil B-field EM On channels (01-05)
RXBEMOFF	fT	Raw X-coil B-field EM Off channels (06-20)

Name:	Units:	Description:
RYBEMON	fT	Raw Y-coil B-field EM On channels (01-05)
RYBEMOFF	fT	Raw Y-coil B-field EM Off channels (06-20)
RZBEMON	fT	Raw Z-coil B-field EM On channels (01-05)
RZBEMOFF	fT	Raw Z-coil B-field EM Off channels (06-20)
IXBEMON	fT	Intermediate X-coil B-field EM On channels (01-05)
IXBEMOFF	fT	Intermediate X-coil B-field EM Off channels (06-20)
IYBEMON	fT	Intermediate Y-coil B-field EM On channels (01-05)
IYBEMOFF	fT	Intermediate Y-coil B-field EM Off channels (06-20)
IZBEMON	fT	Intermediate Z-coil B-field EM On channels (01-05)
IZBEMOFF	fT	Intermediate Z-coil B-field EM Off channels (06-20)
LXBEMON	fT	Levelled X-coil B-field EM On channels (01-05)
LXBEMOFF	fT	Levelled X-coil B-field EM Off channels (06-20)
LYBEMON	fT	Levelled Y-coil B-field EM On channels (01-05)
LYBEMOFF	fT	Levelled Y-coil B-field EM Off channels (06-20)
LZBEMON	fT	Levelled Z-coil B-field EM On channels (01-05)
LZBEMOFF	fT	Levelled Z-coil B-field EM Off channels (06-20)
POWERLNE	uV	Power line monitor (EM noise monitor)
PRIMARY	uV	Primary field intensity (EM Total Field)
TAU_Z	usec	Decay constant (tau) for Z-component
TAU_X	usec	Decay constant (tau) for X-component
CONDUCT	S	(apparent) Conductance, S = Siemens = mhos
DATE	yyyymmdd	Date of flight line
FLIGHT	-	Flight number
LINETYPE	-	Line type. L=Traverse, T=Tie, B=Background line.
LINENAME	-	Line name. An alpha-numeric string, or LINETYPE + LINE.

TDEM Raw Data

The TDEM contractors shall provide the raw TDEM data measured at full resolution, conversion software, as well as the stacked halfwave/fullwave data.

The TDEM contractor shall also provide the data comprising the reference waveform, as measured beyond the range of ground effects, once per flight.

Prior to line archive generation the Contractor must consult with the Technical Authority on the final format.

3.5.2.2 -Grid Archive:

See Section 1 for grid cell size.

One Geosoft *.grd format grid file for each one of the processed variable for the entire survey.

The Universal Transverse Mercator projection with the appropriate central meridian must be used for creating the gridded data sets. Each survey grid origin must be a multiple of the grid interval for both easting and northing coordinates.

3.6 Final Products

See Section 1, for list of Final Products

3.6.1 Digital Archive Data:

Archived on suitable media.

(i) Digital archive of line data,
(ii) Digital archives of grid data,
(iii) Digital archive of all maps,
(iv) Digital archive of streamed, halfwave and reference wave data.

3.6.2 Technical Report:

A technical report must be prepared by the Contractor which presents (i) a reasonably comprehensive account of the field operations, (ii) a description of compilation of the data and (iii) an inventory of the resultant end products which will be useful to users of the data. The project report shall include the following:

i) Description of the field operations with statistics including a list of:
- base(s) of operations with pertinent dates and personnel involved
- description of the survey aircraft and instrumentation used.

ii) Technical and geometrical specifications of the survey transmitter and receiver.

iii) Technical specifications of the survey including a description of the problems encountered during the survey. A discussion of the effectiveness of the survey techniques and instrumentation utilized with suggestions to improve the effectiveness of aeromagnetic surveys.

iv) Description of the compilation procedure including a general flow chart of complete data compilation technique from correction and editing of raw data to contour map production; a list of all criteria employed in rejection/acceptance of data; a general explanation of the mathematical basis of the leveling and gridding algorithm used; a specific description processing equations employed; personnel involved.

v) Index maps and a list of all the end products of the survey. In addition, for every file:
- a detailed documentation of the file formats.
- a list of all constants, datum levels, and conversion factors required for subsequent use of the data.

A draft copy of the Project Report must be submitted to and approved by the Technical Authority prior to its finalization. The final version must be accompanied by a digital version in either MSWord.

SECTION 4: RESPONSIBILITIES OF THE CONTRACTOR FOR SURVEY

For the field operations, the selected Contractor shall be responsible for the following:

4.1 Aircraft

The supply, maintenance and operation of fixed-wing aircraft, suitably equipped and Transport Canada approved to carry out this particular type of survey, including the supply of required fuel, oil and lubricants.

The supply of back-up fixed wing aircraft, suitably equipped, Transport Canada approved and available for the survey. The back-up aircraft shall be ready for mobilization within thirty (30) days of receiving a request in writing from the Technical Authority. (This provision can be satisfied by a documented agreement with another company providing this service.)

All technical equipment and instrumentation, with spares, necessary to execute the airborne geophysical survey in an expeditious manner (see Technical Specifications, section 3).

4.2 Qualified Personnel

Provision of the necessary qualified personnel and their office accommodation required to complete the project work including:

Project Manager (Office or Field)
Maintenance Engineer (or contract) (Office or Field)
Field Manager (Field) (may also be one of the following:)
Pilot (Field)
Field Quality Controller (Field)
Instrument Operator or Co-pilot (Field)

A minimum of 3 field members excluding the aircraft Mechanic are required.

a) Project Manager:
Geophysicist, with a degree in earth sciences from a recognized university or geoscientist with applied experience in aeromagnetic surveys; and 3 years experience in airborne geophysical survey projects that were comparable in scope, instrumentation and survey parameters to that required for the contract.

b) Field Manager:
Two (2) years of related experience in this type of geophysical survey projects.

c) Pilots:
Must hold a valid commercial pilot licence, applicable to the type of aircraft to be flown, issued by Transport Canada and must be able to provide proof on demand of the Contracting Authority.

In addition, pilots must have at least 300 hours of flying on low level airborne geophysical surveys of this type and must be able to provide proof on demand of the Contracting Authority.

d) Field Quality Controller:
Must have related experience on at least two (2) geophysical airborne survey projects of this type within the last 3 years and must be able to provide proof, on demand of the Contracting Authority.

e) Instrument Operator or Co-pilot:
Must have at least one (1) year of operational experience on this type of geophysical survey and must be able to provide proof, on demand of the Contracting Authority.

f) Maintenance Engineer:

Must hold a valid Category M licence and be able to provide proof on demand by the Contracting Authority. This position may be subcontracted.

4.3 Other Responsibilities

The Contractor is responsible for transportation, mobilization, demobilization, and subsistence, while in transit, as well as shipping between company headquarters and the respective points of arrival and departure of the aircraft, personnel, technical equipment, materials and supplies necessary for the effective performance of the work, including aviation fuel and lubricants. Compliance with all provisions of the National Transportation Act and directives, orders, rules and or regulations pursuant to those Acts.

The Contractor **must not** commit the use of the proposed aircraft, or systems specified for this project to another project until the completion of the data acquisition stage without approval of the Technical Authority.

The Contractor is responsible for arranging and paying for its own accommodation, meals and incidental expenses such as airport fees.

The Contractor is responsible for ensuring that all compilation, drafting and reproduction is carried out in Canada.

4.4 Maintenance of Survey Standards

4.4.1 Technical Inspection:

All work is to be performed to the satisfaction and subject to the acceptance of the Technical Authority. Delegated Technical authorities will make periodic trips to the survey site to monitor field operations to observe whether operations are being carried out in accordance with the contract specifications. Copies of Annex "A" must be in the possession of the Field Operations Manager during the field operations and the Project Manager during the compilation phase.

Technical Authority will be available for consultation on technical problems that may arise during the course of the field work and have the authority to approve, in writing, changes to the Technical Specifications that will not affect the general scope of the work to be performed. Any changes which might entail reductions or additional charges to Canada must be referred to the Contracting Authority with a copy to the Technical Authority.

Notwithstanding the foregoing provisions, the Contractor shall be solely responsible for the quality of the work. The Project Manager must ensure that adequate quality control procedures are in place and are being strictly followed, so as to ensure such quality of work. He or she must in turn sign off each report and each product submitted for inspection, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3.

4.4.2 Field Verification:

Initial flight path recovery and full inspection of all data will be done in the field by the Contractor.

During field operations, the following maps will be produced at an appropriate scale:

- preliminary contoured magnetic anomaly map,
- contoured differentially-corrected Digital Elevation Model (GNSS altitude minus radar) map,
- differentially-corrected flight path map.

4.4.3 Verification of In-Flight Data:

All digital data will be verified by the Contractor after each flight by a suitable process using equipment at the operations flying base (see Technical Specifications, Section 3).

4.4.4 Incomplete Survey Data:

The Contractor will re-survey, free of charges, lines or segments of lines for which the required digital data are missing or are not in accordance with the Technical Specifications (Section 3). Isolated errors or spikes and short, non-sequential gaps consisting of a few points which can be corrected by interpolation are acceptable.

4.4.5 Reflights – Lost Data:

Digital data which are lost in transit or in processing (if no digital copies have been made) or are rejected by the Technical Authority shall be re-acquired under the same conditions as set out in the Technical Specifications, Section 3, including flying services, at no cost to Canada. Any reflights to replace lost digital data will be at the Contractor's sole expense.

WORKSTREAM 5: AIRBORNE GRAVITY GRADIOMETRY SURVEY

The following is an example of the information required when submitting a proposal against a Request for Proposal (RFP) issued against an awarded Supply Arrangement.

SECTION 1: SURVEY PARTICULARS

1. Gravity Gradiometer Survey – Bay St. George, Newfoundland/Labrador

To conduct a digitally-recorded high sensitivity airborne gravity gradiometry survey in the Bay St. George area, Newfoundland and Labrador, Canada, consisting of approximately 6,600 line-kms, and to compile the acquired data in accordance with the technical specifications given in Section 3 of the Statement of Work.

1.1 Delineation of Survey Area:

The following coordinates are expressed in NAD83 / UTM zone 21N projected coordinates.

X	Y
397543	5370051
327170	5310804
319286	5320144
319800	5362039
328903	5369715
374360	5383171
389116	5380017
397543	5370051

The location map (Figure A-1) shows the survey boundaries.

Figure A-1, is available for download on the GSC FTP site at: ftp://ftp.agg.NRCan.gc.ca/docs/RFPspecs/BayStGeorgeNL/

1.2 Gravity Gradiometer Resolution:

The gravity gradiometer must have an accuracy of at least 5 eötvös measuring the horizontal and/or vertical gradients of gravity. The final data must have a half-sine wave resolution of no more than 500 m. The contractor is required to demonstrate and describe the methods used to determine accuracy and resolution.

1.3 Height:

The Contractor must calculate the smooth drape surface of the DEM. In areas of steep terrain, the smooth drape surface is to be calculated using a grade (rate of climb and descent) of 5%. The Contractor's smooth drape surface must be submitted to the Technical Authority for approval prior to mobilization to the field. The gridded smooth drape surface data must be accompanied by information specifying the source of the data, method of generation and any relevant information that can be used to evaluate the data.

The nominal terrain clearance (NTC) will be 80 m, except in areas where Transport Canada regulations prevent flying at this height. In areas where obstacles or topography conflict with the drape surface, the pilot's judgement shall prevail within reason. The survey height must be controlled according to the pre-defined smooth drape surface.

Lines that deviate more than 15 m from the planned survey altitude will be reflown.

Traverse lines and control lines must be flown at the same altitude at points of intersection. In addition, the altitude tolerances are limited to no more than 30 m difference between traverse lines and control lines.

1.4 Traverse Line and Control Line Bearing and Spacing:

Traverse line:
- bearing: N**50°E**
- spacing: **500 m**
- allowed min. separation: **450 m**
- allowed max. separation: **550 m**

Control line:
- bearing: S**140°E**
- spacing: **5000 m**

1.5 Schedule of Products:

Milestone Schedule

1.5.1 Milestone 1:

Not later than **October 15, 2019**, and following completion and submission of:

- documented results of all required calibration and test flights, mobilization and positioning of the survey aircraft, personnel, equipment and supplies at the base of operations,
- completion and acceptance by the Technical Authority of an initial **250** line-kms of digitally-recorded survey data,
- delivery and acceptance by the Technical Inspector of an initial **250** line kilometres of raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight, together with the GPS base station data archived by day.

1.5.2 Milestone 2:

By **November 1, 2019** and after completion of the following:

- delivery and acceptance of the **complete** edited acquisition data (including GNSS), Geosoft *.gdb format and FP verification by the Technical Authority, delivery and acceptance of all raw GPS digitally recorded fight path data prepared in RINEX2 (ASCII) format, archived by flight,
- a copy of the preliminary flight path map,

1.5.3 Milestone 3:

By **February 1, 2020** and following completion, delivery and acceptance of:

- Digital files in Geosoft .map and PDFX format for each of the following maps.

  a) Vertical component of gravity (1: 50 000)
  b) Vertical gravity gradient (1: 50 000)

- Final digital archive of line data

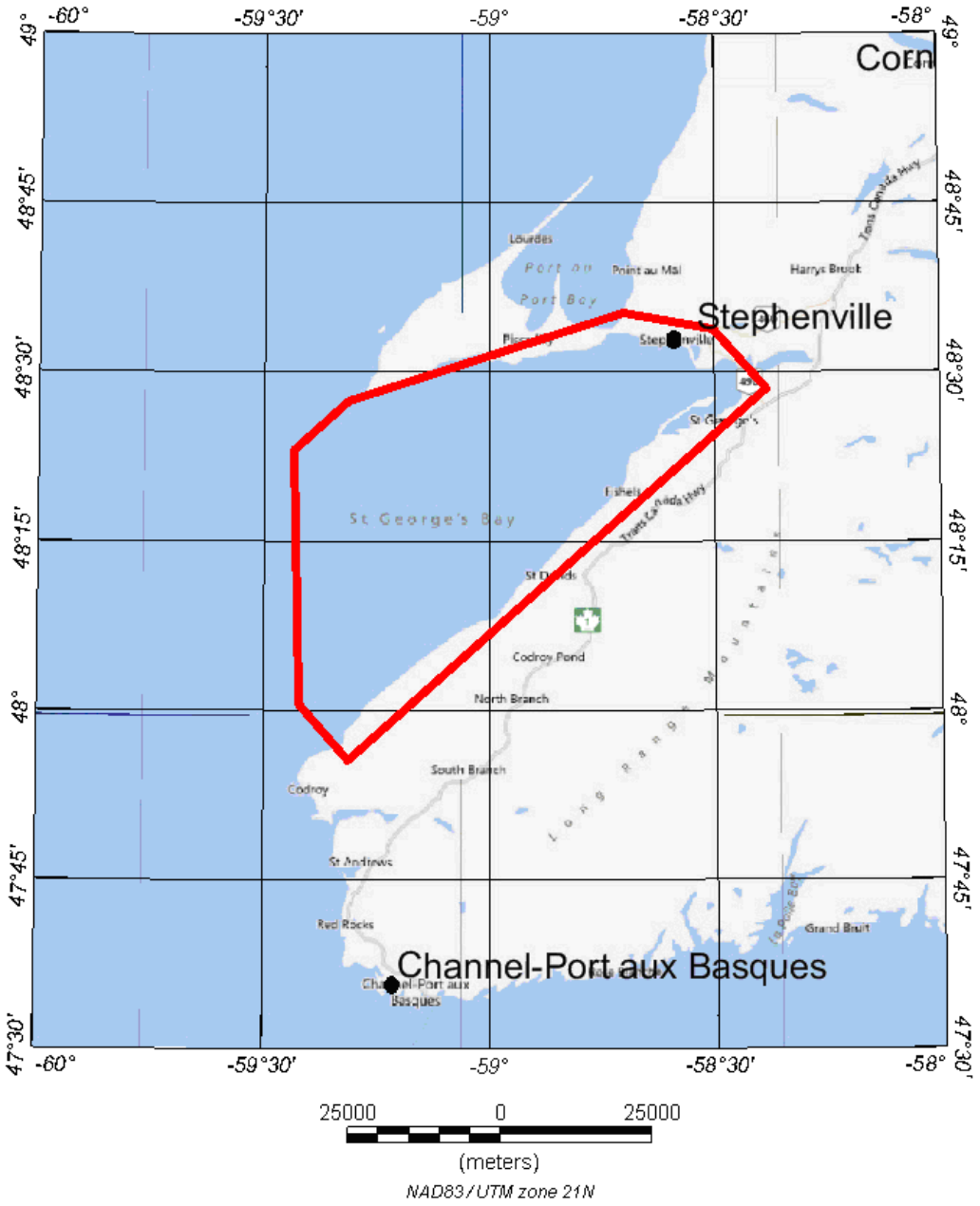
- Final digital archives of the following grid data:

  a) Vertical component of gravity
  b) Vertical gravity gradient

- Final Technical report (1 paper copy) signed by the Project Manager according to the Technical Specifications (Section 3 of the Statement of Work), accompanied by digital files in MS Word and PDF formats.

- All other final products (refer to Section 3.6).

FIGURE A-1: GRAVITY GRADIOMETRY – BAY ST. GEORGE



Bay St. George, NL

SECTION 2: DELIVERABLES

2.1 Schedule of Products Required

The Contractor's Project Manager shall be responsible for signing off all reports and all products being delivered, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3 of the Statement of Work.

The Contractor must make available to the Technical Inspector any digital data requested for checking purposes, to facilitate timely approval of map products.

See Section 1.5 for the Schedule of Products required for this survey.

2.2 Deliverables

2.2.1 Weekly Progress Report (Acquisition):

During the data acquisition phase, production data and figures must be communicated to the Project Leader on a weekly basis, each Monday morning by fax or email. Included in the reports will be:

- A database, in Geosoft GDB format, of all profile data acquired to date.
- Base of operations utilized; the number of survey flying hours and the line-kilometres flown and accepted on a daily basis during the report period and their total to report date; a sketch map (letter size) showing the area of data acquisition to date; visits by the Technical Inspector or other authorized persons.
- A statement of weather conditions as well as any major operational, logistical or other problems which may have hindered production; downtime due to unserviceability.
- The altimeters calibration (see Section 3, Technical Inspections)
- Results of the gravity gradiometer calibration tests are required (see Section 3, Technical Specifications).
- The results of any other tests carried out during the report week.

Supporting documents, such as digital listings, must be supplied with any documented test results.

2.2.2 Weekly Progress Report (Compilation):

The Contractor's Project Manager shall submit weekly reports each Monday morning describing the state of progress of the various aspects of the work as well as projections as to the completion of the work. These reports will be emailed to the Technical Authority.

Included in the reports will be:

- Compilation of data. Flight path recovery and detailed processing stages. Maps inspected. Delivery schedule for each block.
- A sketch map (letter size) showing data compilation, drafting and reproduction progress at the different stages.

2.2.3 Digital Data:

The digital data are to be delivered in line and gridded archive format as itemized in Section 1 and described in detail in Section 3.5.2. These digital data include survey acquisition data, calibration data, geophysical and navigational processed data.

2.2.4 Other Deliverables:

1) Final Maps:
Final digital and paper copies of the maps as itemized in Section 1 of the Request for Proposal and described in detail in Section 3.6 of Section 3, GSC Technical Specifications, outlined herein.

2) Equipment Log Book:
As described under "Airborne and Ground Instrumentation", Section 3.1.

3) Levelling Documents:
The final levelling network and final flight path data (compilation listings or digital files and plots) must be submitted. All flight logs and quality control sheets must be properly labelled and submitted for data evaluation.

4) Video or Digital Flight Path Images:
Images of the aircraft flight path. Storage media will be labelled showing area name, date, flight number, line number and time ranges.

5) Technical Report:
A technical report must be prepared by the Contractor which presents
(i) a reasonably comprehensive account of the field operations,
(ii) a description of compilation of the data and
(iii) an inventory of the resultant end products which will be useful to users of the data.

The specifics to be included in the project report are described in further detail in section 3.6.3.

2.2.5 Handling and Storage of Digital Data:

Copies of all digital data must be stored by the Contractor for 1 year after the safe delivery of the same data to the Technical Authority. During this time the data may not be erased except by explicit written authorization of the Technical Authority.

After delivery of all final maps, any related materials used to produce the final products will be delivered to the GSC Technical Authority in acceptable containers which have labels identifying their contents. The Contractor must prepare a catalogue (as part of the Technical Report) for all of these data and will submit it to the GSC Technical Authority.

SECTION 3: GSC TECHNICAL SPECIFICATIONS – GRAVITY GRADIOMETRY

A copy of the Technical Specifications must be in the possession of each of the Contractor's personnel who have a responsibility in the execution of the contract. The Contractor must obtain and have available in the field and office all relevant charts, maps, etc. pertaining to navigation and flight path recovery.

3.1 Airborne and Ground Instrumentation

The instrument operator shall maintain and update an equipment log book noting all equipment replacement and repairs throughout the survey and the results of calibration tests carried out on the equipment.

3.1.1 Systems Timing Synchronization:

All data acquisition systems' timing in the aircraft and on ground base stations **must be synchronized** by the GPS time pulses, **in real time.**

3.1.2 Airborne Gravity Gradiometer:

The gravity gradiometer system must be capable of measuring the vertical gravity gradient or measuring the two (2) horizontal gradients.

The Contractor must describe the instrumentation for acquiring gravity gradiometer data, and its application to the geological conditions in the survey area, including:

- Gravity gradiometer and components of the gravity field measured;
- Sampling rate;
- Monitoring of, and correction for, aircraft motion and altitude;
- Noise levels;
- Resolution of signal amplitude and spatial wavelength with examples;
- Compensation for aircraft effects;
- Advantages and disadvantages of the Contractor's gravity system(s) and configuration(s);
- Recommended configuration for the survey area;
- Measurement of, and correction for, terrain effects;
- Availability of backup instrumentation.

Any gap longer than 1.0s of the gravity gradiometer or of the GPS in flight or of the ground GPS will be reflown.

3.1.3 Altimeters:

Radar and laser altimeters with digital output and a precise radar display must form part of the ancillary equipment for the survey aircraft.

3.1.4 Satellite Navigation:

Complete GNSS coverage must be obtained. The positional outputs are to be digitally recorded to 0.00001 degree to provide a final and minimal positional error. A twelve channel receiver is minimally acceptable.

A **dual-frequency** 12-channel GNSS acquisition system with adequate memory to record aircraft position once per second is required. A dual-frequency GNSS base station set up near the base of operations is required.

Note: Any GNSS system utilized in this survey must have the capacity to record and store all parameters to permit post flight differential correction of the GNSS navigational data.

3.1.5 Flight Path Video Camera:

A vertically-mounted, continuous-recording video camera, with a wide angle lens to maximize ground coverage at survey altitude, must be operating at all times while the aircraft is surveying. Clearly visible time stamp updates (seconds after midnight, with tenths of seconds) are to be displayed on the video image. The display of real time GPS positional information is optional. The combined navigation system (electronic and video imaging) must be capable of providing the required accuracy over the entire survey area.

3.1.6 Field Data Verification System:

The digital data must be verified on a daily basis with an in-field verification system to ensure the recorded parameters meet the contract specifications.

Preliminary differential GNSS corrections, flight path and other data quality control and levelled grids of the data will be required and must be produced in the field during the survey.

3.2 Calibration Flights

3.2.1 Gravity Gradiometer:

The contractor will calibrate the gravity gradiometer as required and using a method appropriate to the system. The contractor will document all such calibrations and receive the approval of the Technical Authority.

3.2.2 Radar and Laser Altimeters:

If radar and/or laser altimeters are used, prior to the survey operations, the sensors will be calibrated along the gravity test-line at the Alexandria gravity test-range. Survey calibrations must be performed by flying a range of altitudes, representative of the survey area conditions, above and below the designated survey altitude. These altitudes must cover the expected minimum and maximum survey altitudes at five (5) altitudes of roughly equal increments. Typically, these levels must be determined by the GPSZ above the elevation of the base air strip.

3.2.3 Satellite Navigation:

A calibration check on the accuracy of the GNSS receiver must be carried out and results made available to the Technical Authority prior to the commencement of survey operations.

3.2.4 Daily Calibration:

The data recorded during these calibrations are considered to be part of the raw data and must be properly labelled and given to the GSC Technical Authority at the end of the survey flying.

3.2.5 Aircraft Systems Comparison:

When more than one aircraft is used for a survey block, each aircraft must fly the same line and the data must be compared to ensure that all systems produce similar results. The test can be done on more than one line providing that at least 50 km of data have been collected in survey mode. This comparative line must be performed at least once during the survey and repeated at any time equipment is changed on an aircraft.

3.3 Data Records

3.3.1 Airborne:

All digital data, and map products must be referenced to GPS time, rather than fiducials.

Isolated errors or spikes and short non-sequential gaps which can be edited out are acceptable with the approval of the Technical Inspector.

3.4 Compilation of the Survey

3.4.1 Base Maps:

The Contractor will be responsible for acquiring the necessary navigational charts and maps at their own expense.

3.4.2 Field Data Verification Procedure:

After each day's flying, the field data quality controller must maintain an up-to-date log of the survey progress and production. A list of planned reflights must be prepared with annotations of flight data quality with specific details on any problems which would potentially have adverse effects on data quality.

The field quality controller must demonstrate that all survey calibrations have been completed as required according to specifications. All digital flight data and base station data, and video recordings must be systematically annotated and verified to be complete.

The field quality controller must demonstrate that all airborne and ground data, collected since the start of the survey, have been evaluated; that all data which do not meet specifications have been identified, noted, and made available for review by the Technical Authority.

The field quality controller must demonstrate that all digital flight path data has been processed, differentially corrected and plotted at the compilation scale on a regular basis.

3.4.3 Flight Path:

GPS data must be utilized to position the flight lines throughout the entire survey area. It is the primary positional system. A plot of the flight path shall be made from the digital electronic flight path data with appropriate latitude and longitude labelled registration markers to permit verification relative to NTS map coordinates.

All of the raw GPS acquisition data which provides a position fix for the aircraft during survey flight must be recorded and archived. This data is to be archived as separate flights. This data in its raw form must be converted into RINEX2 format (see www page at: http://igscb.jpl.nasa.gov/igscb/data/format/rinex2.txt for format definition) and delivered to the Technical Authority together with the raw GPS base station data as part of the required deliverables (refer to Section 2, Deliverables).

3.4.4 Gravity Gradiometer Data:

All gravimetric data recorded in flight must be verified.

Any lines or section of lines not meeting the specifications must be noted and made available to the NRCan Technical Inspector.

3.4.5 Altitude Data:

Proper altitude control is necessary throughout the survey to optimize the quality of the gravitational field levelling.

All radar altimeter data must be checked to ensure that the full height range is being recorded.

The survey must be flown at the correct altitude with respect to the conditions stated in Section 1.

Line segments that exceed maximum altitude difference tolerance at intersections will be identified and the location plotted on a flight path map to be used in determining reflights.

3.4.6 Format:

Each traverse/control line must have a unique line number with the segment number incorporated as the last digit of the line control. Control line numbers must have a different range than the traverse lines.

Example: Traverse lines: 10000 to 79001; Control Lines: 80000 to 99000. The last digit of these line numbers being the segment number. Traverse line 79001 is indicating a line segment.

3.4.7 Plotting Flight Path:

Labelled traverse lines and control lines must be plotted on a layer separate from the contour information. Each line must be labelled with a minimum of 2 time labels per map sheet, or a minimum of 1 label if the line direction is noted in the line label.

Line weights and labelling will be discussed with the Contractor. Sample maps shall be provided upon request. Traverse line numbers and control line numbers must be positioned inside the west and south boundaries of each map. Final labelling of flight line data must have a unique line number for each segment presented on the flight line map as well as in the corresponding digital archive data.

3.4.8 Geophysical Data:

Digital data are to be provided in Geosoft binary (GDB) line data format. The Contractor must establish a system for providing such data expeditiously when requested.

3.4.9 Data Processing:

3.4.9.1 - Gravity Gradients:

The gravity gradiometer system must be capable of measuring or calculating gravity gradients and capable of providing the full gravity gradient tensor. The Contractor will level all gradients as required and apply a topographic correction using a digital elevation model.

The Contractor must provide a detailed description of the methodology applied to the Technical Authority.

Control line data must be levelled and used in the gridding process (unless instructed otherwise by the Technical Authority).

3.4.9.2 - Vertical Component of Gravity:

The vertical component of gravity will be calculated by vertically integrating the vertical gradient of gravity and referencing to the local Bouguer gravity.

3.4.9.3 - Gridding:

Grid Size = one-quarter (1/4) of the flight line spacing.

A square grid will be calculated from the leveled traverse and control line data. Contour maps must be produced from this grid by a contouring program. The grid used for the compilation maps must be used for the final maps.

3.4.10 Colour Interval Maps:

The Contractor is required to assemble and produce final maps consisting of the descriptive notes, map headings, logos, map coordinates and adjoining map references, neat line, the topographic base within and all layers of data pertaining to the survey, with appropriate line weights and colours within the window defined by the neat line.

The base map with surround for each map sheet must be prepared and submitted for approval. The maps must conform to generic GSC Open File standards. These specifications and a sample map are available to the contractor by the Technical Authority.

The colour intervals for the gravity anomaly must conform to a histogram-equalized distribution of the data range. The colour intervals for the first vertical derivative must conform to either a histogram-equalized distribution of the data range or to a standardized distribution supplied by the Technical Inspector. Specific colour tables for each parameter will be provided by the Technical Inspector. Colour interval maps that incorporate contours must have their intervals adjusted so that they correspond to the major contour intervals.

The contour interval for the vertical gravity gradient must be 5.0 eötvös. Contour intervals of 50 eötvös must be shown using different line weights. If the data warrants changing these intervals, this may be modified in consultation with the Technical Authority. Gravity gradient anomaly depressions must be indicated by “tick-marks” placed around the inside of the contours expressing the locally low areas. Highs will not require any special identification. Sample maps illustrating proper line weights and contour labelling shall be provided upon request. The direction of the contour labelling must face up-gradient.

Flight path and relevant line and fiducial (time) labelling must be included as described in Section 3.4.7.

3.4.11 Technical Inspection of Final Compilation:

The Contractor must prepare a set of working scale preliminary maps for the entire survey area for the approval of the Technical Authority before preparing the final data set, consisting of:

(i) Contours and flight path maps overlain on the colour grid of the levelled vertical component of gravity data,
(ii) Colour vertical gravity gradient maps,
(iii) Profile of the vertical gravity gradient level adjustments and flight path, and
(iv) Colour maps of the DEM calculated from the difference of the GPSZ minus radar or LiDAR.

Each plot submitted for approval must be accompanied by all the pertinent videos, flight logs, computer listings, levelling information, etc. necessary to verify the compilation. The digital line and gridded data and a preliminary step-by-step compilation report must also be submitted at this time.

On completion of the inspection by the Technical Authority, one copy of each plot must be returned to the Contractor indicating corrections, if any, to be carried out. When these corrections have been completed by the Contractor, the Technical Authority must approve the compilation by signature on the accepted copy.

Each manuscript submitted for approval must be properly identified as to survey area, map number, and the proper geographic coordinates.

3.5 Preparation of Digital Archives

In specific circumstances, digital line data must be nulled by adding the appropriate null value where the data is not used in the gridding. These circumstances are:

- Overlapping line data where flight lines have been broken;
- Flight path ending outside of the survey boundaries within a map sheet.

3.5.1 General Specifications:

The digital data set is the principal end product to be delivered and it must be of the highest possible quality, essentially error-free. It is recommended that the Contractor **provide a statistical summary for each field in the line data set and also for the complete gridded data sets being submitted as final archives** (not from the Contractor's database).

The Contractor must consult with the Technical Authority to ensure compatibility of the storage media.

3.5.2 Detail Specifications:

3.5.2.1 - Line Archive:

The line archive data must be submitted in Geosoft binary (*gdb) format.
Line data sample rate: **not less than 1 sample per second for all fields**

The structure and format line archive of the final data may be system dependent. The channel listing must be ordered according to the processing steps. The following is a guide and the final structure and format will be determined by the Technical Authority:

Channel Descriptions:

Name:	Units:	Description:
LINE	-	Line number
UTCTIME	sec	Time, UTC (Universal Time Clock) -- second of day
LONG	deg	Longitude
LAT	deg	Latitude
EASTING	m	Easting
NORTHING	m	Northing
GPSALT	m	GPS altitude (edited) above MSL (mean sea level)
RALT	m	Radar altitude (Terrain Clearance)
LALT	m	Laser altitude (Terrain Clearance)
DEMRAW	m	Raw Digital Elevation Model / Topography (BALT or GPSALT - RALT)
TURBULENCE_VERT	Gal	Estimated vertical platform turbulence
ROLL	deg	Aircraft roll
PITCH	deg	Aircraft pitch
YAW	deg	Aircraft yaw

Name:	Units:	Description:
NOISE_Gne	eötvös	Uncorrelated noise estimate for Gne gravity gradient, after tie-line levelling
NOISE_Guv	eötvös	Uncorrelated noise estimate for Guv gravity gradient, after tie-line levelling
TERRAIN_COR_Gdd	eötvös	Terrain effect calculated for Gdd gravity gradient
TERRAIN_COR_Gne	eötvös	Terrain effect calculated for Gne gravity gradient
TERRAIN_COR_Guv	eötvös	Terrain effect calculated for Guv gravity gradient
GRAV_A_Gne_0	eötvös	Gravity system A: self gradient, jitter corrected NE gradient, no terrain correction
GRAV_A_Guv_0	eötvös	Gravity system A: self gradient, jitter corrected UV gradient, no terrain correction
GRAV_B_Gne_0	eötvös	Gravity system B: self gradient, jitter corrected NE gradient, no terrain correction
GRAV_B_Guv_0	eötvös	Gravity system B: self gradient, jitter corrected UV gradient, no terrain correction
GRAV_A_Gne_2p67	eötvös	Gravity system A: self gradient, jitter corrected NE gradient, terrain correction density 2.67g/cc
GRAV_A_Guv_2p67	eötvös	Gravity system A: self gradient, jitter corrected UV gradient, terrain correction density 2.67g/cc
GRAV_B_Gne_2p67	eötvös	Gravity system B: self gradient, jitter corrected NE gradient, terrain correction density 2.67g/cc
GRAV_B_Guv_2p67	eötvös	Gravity system B: self gradient, jitter corrected UV gradient, terrain correction density 2.67g/cc
GRAV_Gd_FFT_0	mGal	Fourier derived vertical gravity, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Gee_FFT_0	eötvös	Fourier derived Gee horizontal gravity gradient, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Gnn_FFT_0	eötvös	Fourier derived Gnn horizontal gravity gradient, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Gdd_FFT_0	eötvös	Fourier derived Gdd vertical gravity gradient, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Ged_FFT_0	eötvös	Fourier derived Ged gravity gradient, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Gnd_FFT_0	eötvös	Fourier derived Gnd gravity gradient, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Gne_FFT_0	eötvös	Fourier derived Gne curvature gravity gradient, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Guv_FFT_0	eötvös	Fourier derived Guv curvature gravity gradient, no terrain correction applied, with a low-pass cutoff wavelength
GRAV_Gd_FFT_2p67	mGal	Fourier derived vertical gravity, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength
GRAV_Gd_FFT_2p67_kr	mGal	Fourier derived vertical gravity, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength (data kriged)
GRAV_Gee_FFT_2p67	eötvös	Fourier derived Gee horizontal gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength
GRAV_Gnn_FFT_2p67	eötvös	Fourier derived Gnn horizontal gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength

Name:	Units:	Description:
GRAV_Gdd_FFT_2p67	eötvös	Fourier derived Gdd vertical gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength
GRAV_Gdd_FFT_2p67_kr	eötvös	Fourier derived Gdd vertical gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength (data kriged)
GRAV_Ged_FFT_2p67	eötvös	Fourier derived Ged gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength
GRAV_Gnd_FFT_2p67	eötvös	Fourier derived Gnd gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength
GRAV_Gne_FFT_2p67	eötvös	Fourier derived Gne curvature gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength
GRAV_Guv_FFT_2p67	eötvös	Fourier derived Guv curvature gravity gradient, terrain correction density 2.67 g/cc, with a low-pass cutoff wavelength
DRAPE_FFT	m	Drape surface for Fourier reconstruction, smoothed flight surface
GRAV_Gd_EQS_2p67	mGal	Equivalent source derived vertical gravity, terrain correction density 2.67 g/cc
GRAV_Gdd_EQS_2p67	eötvös	Equivalent source derived Gdd vertical gravity gradient, terrain correction density 2.67 g/cc
GRAV_Gne_EQS_2p67	eötvös	Equivalent source derived Gne curvature gravity gradient, terrain correction density 2.67 g/cc
GRAV_Guv_EQS_2p67	eötvös	Equivalent source derived Guv curvature gravity gradient, terrain correction density 2.67 g/cc
DRAPE_EQS	m	Drape surface for equivalent source construction
DATE	yyyymmdd	Date of flight line
FLIGHT	-	Flight number
LINENAME	-	Line name. An alpha-numeric string, or LINETYPE + LINE.
LINETYPE	-	Line type. L=Traverse, T=Tie, B=Background line.

Prior to line archive generation the Contractor must consult with the Technical Authority on the final format.

3.5.2.2 - Grid Archive:

One (1) Geosoft *.grd format grid file for each one of the processed variable for the entire survey.

The Universal Transverse Mercator projection with the appropriate central meridian must be used for creating the gridded data sets. All longitudes west of Greenwich should be represented as negative degrees. Each survey grid origin must be a multiple of the grid interval for both easting and northing coordinates.

3.6 Final Products

See Section 1, for additional information on Final Products requirements.

3.6.1 Gravity Maps:

The Contractor is required to assemble and produce final maps consisting of:

Map by NTS Map sheets, one (1) copy

(1) Vertical component of gravity (colour and contour interval)
(2) Vertical Gravity Gradient (colour interval)

All final map products (see Section 1 of any Request for Proposals) must also be delivered in both Geosoft .MAP and PDFX formats at a resolution suitable to accurately reproduce the plotted products, two (2) copies on suitable storage media.

3.6.2 Digital Archive Data:

Archives of final line data in binary Geosoft *.gdb format and archives of grid data as *.grd (FLOAT) format files, two (2) copies on suitable storage media.

3.6.3 Technical Report:

A technical report must be prepared by the Contractor which presents:

a) a reasonably comprehensive account of the field operations;
b) a description of compilation of the data, and
c) an inventory of the resultant end products which will be useful to users of the data. The project report shall including the following:

(i) Description of the field operations with statistics including a list of:
   a. Bases of operations with pertinent dates and personnel involved
   b. Description of the survey aircraft and instrumentation used.

(ii) Technical specifications of the survey including a description of the problems encountered during the survey. A discussion of the effectiveness of the survey techniques and instrumentation utilized with suggestions to improve the effectiveness of similar surveys.

(iii) Description of the compilation procedure including a general flow chart of complete data compilation technique from correction and editing of raw data to contour map production; a list of all criteria employed in rejection/acceptance of data; a general explanation of the mathematical basis of the levelling and gridding algorithm used; a specific description of the processing including equations employed; personnel involved.

(iv) Index maps and a list of all the end products of the survey. In addition, for every file:
   a. A detailed documentation of the file formats;
   b. A list of all constants, datum levels, and conversion factors required for subsequent use of the data.

A draft copy of the Project Report must be submitted to the Technical Authority and approved by the Technical Authority prior to its finalization. The final version must be accompanied by a digital version in either MS Word.

SECTION 4: RESPONSIBILITIES OF THE CONTRACTOR FOR SURVEY

For the field operations, the selected Contractor shall be responsible for the following:

4.1 Aircraft

The supply, maintenance and operation of aircraft, suitably equipped and Transport Canada approved to carry out this particular type of survey, including the supply of required fuel, oil and lubricants.

The supply of back-up aircraft, suitably equipped, Transport Canada approved and available for the survey. The back-up aircraft shall be ready for mobilization within thirty (30) days of receiving a request in writing from the Technical Authority. (This provision can be satisfied by a documented agreement with another company providing this service.)

All technical equipment and instrumentation, with spares, necessary to execute the airborne geophysical survey in an expeditious manner (see Technical Specifications, Section 3).

4.2 Qualified Personnel

Provision of the necessary qualified personnel and their office accommodation required to complete the project work including:

Project Manager (Office or Field)
Maintenance Engineer (or contract) (Office or Field)
Field Manager (Field) (may also be one of the following:)

- Pilot (Field)
- Field Quality Controller (Field)
- Instrument Operator or Co-pilot (Field)

A minimum of 3 field members excluding the aircraft Mechanic are required.
A minimum of 2 aircraft crew members excluding the aircraft Mechanic are required.

a) Project Manager:
Geophysicist, with a degree in earth sciences from a recognised university or geoscientist with applied experience in geophysical surveys; and 3 years of experience in airborne geophysical survey projects that were comparable in scope, instrumentation and survey parameters to that required for the contract.

b) Field Manager:
Two (2) years of related experience in this type of geophysical survey projects.

c) Pilots:
Must hold a valid commercial pilot licence, applicable to the type of aircraft to be flown, issued by Transport Canada and must be able to provide proof on demand of the Contracting Authority.

In addition, pilots must have at least 300 hours of flying on low level airborne geophysical surveys of this type and must be able to provide proof on demand of the Contracting Authority.

d) Field Quality Controller:
Must have related experience on at least two (2) geophysical airborne survey projects of this type within the last 3 years and must be able to provide proof, on demand of the Contracting Authority.

e) Instrument Operator or Co-pilot:
Must have at least one (1) year of operational experience on this type of geophysical survey and must be able to provide proof, on demand of the Contracting Authority.

f) Maintenance Engineer:
Must hold a valid Category M licence and be able to provide proof on demand by the Contracting Authority. This position may be subcontracted.

4.3 Other Responsibilities

The Contractor is responsible for transportation, mobilization, demobilization, and subsistence, while in transit, as well as shipping between company headquarters and the respective points of arrival and departure of the aircraft, personnel, technical equipment, materials and supplies necessary for the effective performance of the work, including aviation fuel and lubricants. Compliance with all provisions of the National Transportation Act and directives, orders, rules and or regulations pursuant to those Acts.

The Contractor **must not** commit the use of the proposed aircraft, or systems specified for this project to another project until the completion of the data acquisition stage without approval of the Technical Authority.

The Contractor is responsible for arranging and paying for its own accommodation, meals and incidental expenses such as airport fees.

The Contractor is responsible for ensuring that all compilation, drafting and reproduction is carried out in Canada.

4.4 Maintenance of Survey Standards

4.4.1 Technical Inspection:

All work is to be performed to the satisfaction and subject to the acceptance of the Technical Authority. Delegated Technical authorities will make periodic trips to the survey site to monitor field operations to observe whether operations are being carried out in accordance with the contract specifications. Copies of the Statement of Work (or Annex "B") must be in the possession of the Field Operations Manager during the field operations and the Project Manager during the compilation phase.

Technical Authority will be available for consultation on technical problems that may arise during the course of the field work and have the authority to approve, in writing, changes to the Technical Specifications that will not affect the general scope of the work to be performed. Any changes which might entail reductions or additional charges to Canada must be referred to the Contracting Authority with a copy to the Technical Authority.

Notwithstanding the foregoing provisions, the Contractor shall be solely responsible for the quality of the work. The Project Manager must ensure that adequate quality control procedures are in place and are being strictly followed, so as to ensure such quality of work. He or she must in turn sign off each report and each product submitted for inspection, thereby certifying that the work was carried out in accordance with the Technical Specifications in Section 3.

4.4.2 Field Verification:

Initial flight path recovery and full inspection of all data will be done in the field by the Contractor. At the end of field operations, the following will be produced in the field:

(1) preliminary contoured vertical gravity gradient map,
(2) contoured differentially-corrected Digital Elevation Model (GPS altitude minus radar) map,
(3) differentially-corrected flight path map.

These products will be used in the final field verification of the data.

4.4.3 Verification of In-Flight Data:

All digital data will be verified by the Contractor after each flight by a suitable process using equipment at the operations flying base (see Technical Specifications, Section 3).

4.4.4 Incomplete Survey Data:

The Contractor will re-survey, free of charges, lines or segments of lines for which the required digital data are missing or are not in accordance with the Technical Specifications (Section 3). Isolated errors or spikes and short, non-sequential gaps consisting of a few points which can be corrected by interpolation are acceptable.

4.4.5 Reflights – Lost Data:

Digital data which are lost in transit or in processing (if no digital copies have been made) or are rejected by the Technical Authority shall be re-acquired under the same conditions as set out in the Technical Specifications, Section 3, including flying services, at no cost to Canada. Any reflights to replace lost digital data will be at the Contractor's sole expense.

ANNEX "B" – EVALUATION CRITERIA (ALL WORKSTREAMS)

The following is an example of the information required when submitting a proposal against a Request for Proposal (RFP) issued against an awarded Supply Arrangement.

1. Mandatory Requirements – 86 points

The below pertains to the **RFP stage**, after the award of a Supply Arrangement:

At time of bid closing, the Bidder must:

- comply with the following Mandatory Requirements for all Workstreams required for this survey; and
- provide the necessary documentation to support compliance.

Any proposal which fails to meet the following Mandatory Requirements will be deemed non-compliant and will not be given further consideration. **Each requirement should be addressed separately.** A proposal meeting all the mandatory criteria will automatically be awarded 86 points out of a total of 100 points allocated to the proposal. The point rated criteria have been allocated a total of 14 points.

Item	Mandatory Requirement	Compliant (Yes/No)	Reference to Bidder's Proposal
M1	The Bidder must submit a signed proposal as per the "Acceptance of Terms and Conditions" clause of the Request for Proposal. In the event of a proposal submitted by a joint venture, the proposal shall either be signed by all members of the joint venture or a statement shall be provided to the effect that the signatory represents all parties of the joint venture.	☐ Yes ☐ No	
M2	***Workstream Pre-Qualification and Experience*** The Bidder must be pre-qualified by NRCan to fly the required Workstream surveys. The Bidder and its subcontractors combined **must** have experience and demonstrated capability to carry out the required work and to compile the resultant data into geophysical map form. This will require that the Bidder has suitable survey aircraft, equipment, instrumentation and compilation facilities. The Bidder will be deemed to have demonstrated its capability and experience if it has flown and compiled at least one regional survey of at least **10,000 line kilometres** for fixed-wing magnetic or radiometric Workstreams or **2,500 line kilometres** for gravity, gravity gradient, electromagnetic, helicopter-borne magnetic or helicopter-borne radiometric Workstreams. All such surveys must have been flown **using GPS navigation aids to fly a pre-planned drape surface**. If a magnetic Workstream is required, for any proposed aircraft, identified by its registration number that has not been engaged in any prior aeromagnetic survey work for the Geological Survey of Canada calibration results **must** accompany **PART A – TECHNICAL PROPOSAL**. The supporting data for the calibration results must be submitted in digital form and detailed and itemized in the Statement of Work (SOW), 3.2.2 Compensation Test: FOM less than 1.5nT.	☐ Yes ☐ No	
M3	***Qualified Personnel*** Personnel qualifications will be **evaluated only on the basis of information shown on resumes** provided. Personnel will be evaluated on educational qualifications, experience and track record. The Bidder **must** propose personnel with the following level of education and experience: a) **Project Manager (Office or Field)**:	☐ Yes ☐ No	

Item	Mandatory Requirement	Compliant (Yes/No)	Reference to Bidder's Proposal
	Geophysicist, with a degree in earth sciences from a recognized university or geoscientist with applied experience in the required Workstream surveying; and 3 years of experience in airborne geophysical survey projects that were comparable in scope, instrumentation and survey parameters to that required for the contract. b) **Maintenance Engineer (or contract) (Office or Field):** Must hold a valid Category M license and be able to provide proof of demand by the Contracting Authority. This position may be subcontracted. c) **Field Manager (Field) (may also be one of the listed field members below):** Two (2) years of related experience in this type of geophysical survey projects. d) **Pilots (Field):** Must hold a valid commercial pilot licence, applicable to the type of aircraft to be flown, issued by Transport Canada and must be able to provide proof on demand by the Contracting Authority. In addition, pilots proposed must have **at least 300 hours** of flying on low level airborne geophysical surveys of this type and must be able to provide proof on demand by the Contracting Authority. e) **Field Quality Controller (Field):** Must have related experience on at least two (2) geophysical airborne survey projects of this type within the last three (3) years and must be able to provide proof, on demand by the Contracting Authority. f) **Instrument Operator or Co-Pilot (Field):** Must have at least one (1) year of operational experience on this type of geophysical survey and must be able to provide proof, on demand by the Contracting Authority. **A minimum of 3 field members excluding the aircraft mechanic are required.** The Bidder should provide an organization chart for this project (with names and functions), showing the actual reporting responsibilities of personnel. Personnel list and ***resume for each of the proposed personnel*** Resumes **should** contain full name, citizenship, education and professional qualifications – degrees or licences, years and granting institution, language spoken, employment record including employers, years and places of employment with type of work performed and the extent of experience in the function delegated on this project. Resumes are not required for individual mechanics who may be provided under a sub-contract.		
M4	***Systems:*** Evaluation of Systems will be in accordance with the requirements stated in the GSC Technical Specification, in Section 3. a) ***Aircraft*** – provide the following information: Type, registration, number of engine hours remaining after mobilization, before overhaul, range, cruising speed in knots, climb/descent gradient performance, aviation fuel used, hourly consumption for aviation fuel and oil. If a magnetic survey is required, for any proposed aircraft which have not performed work for the Geological Survey of Canada previously, the Contractor **must** submit calibration documentation with this RFP to demonstrate that the survey aircraft meet the minimum Calibration Flight requirements outlined in the Statement of Work, 3.2.2 – Compensation test: FOM less than 1.5 nT.		

Item	Mandatory Requirement	Compliant (Yes/No)	Reference to Bidder's Proposal
	b) ***Airborne geophysical and digital acquisition systems*** – provide the following information for each required Workstream: Manufacturer, type and model number, number of units, serial number, sampling rate, sensor range, sensor sensitivity, GPS and acquisition system timing interface mechanism. c) **Navigation System** – provide the following information: Positioning cameras, navigation and flight path recovery systems: Manufacturers, model numbers, radar altimeter, temperature and barometric pressure recording, electronic positioning system(s) including serial number, displays, resolution, accuracy, number of GPS channels. Describe the video camera lens and the image (ground distance) at survey altitude. d) ***Field Data Plotting and Verification System*** – provide the following information: Manufacturer and model number of all components including hardware and software.		
If Mandatories met (automatically awarded 86 points)		**86**	

2. Point rated requirements – 14 points

If Mandatories are met continue with this part of evaluation

TECHNICAL CRITERIA	MAX: 14 Points	Strengths, Weaknesses, Missing Information
Surpasses requirements 2 points (2 points added) **Satisfactory 0 points (no points added)** **Substandard and Inadequate -2 points (2 points deducted)**		
2.1.1 RECENT PAST PERFORMANCE	**8 points Maximum**	
Past performance will be evaluated on the following sub-categories: a) ***Quality of data acquisition with respect to specifications:*** completeness of data set and gaps in coverage noise levels on geophysical data altimeter data navigational data diurnal monitoring (if magnetic Workstream required) b) ***Timing:*** start of data acquisition conduct and efficiency of operations delivery of acquisition data delivery of final products c) ***Compilation and final products:*** number of re-submissions quality of final products d) ***Adherence to Recent Contracts:*** Mobilization on time and as proposed Milestones delivered on time No performance-related amendments required	**2** **2** **2** **2**	

TECHNICAL CRITERIA	MAX: 14 Points	Strengths, Weaknesses, Missing Information
In order to support the evaluation of the above sub-categories, provide the following: *Similar projects recently undertaken, including:* *Location, size, client, data, contact name & telephone number* *Description and details of drape surface used (maximum slope)*		
2.1.2 CURRENT WORK PLAN AND CAPACITY	**6 points maximum**	
Current capabilities and plans will be evaluated on: a) ***Current Workload:*** Ability to undertake this contract and deliver products in a timely manner, given existing workloads. In order to support the evaluation of the above sub-categories, provide the following: Details of work in progress including: Size, work remaining, expected completion date Capacity, particularly in terms of current work: Flexibility in terms of being able to cope with workload variations, overlapping capabilities of personnel b) ***Reconnaissance of Projects:*** Demonstrated understanding of survey area, operational constraints. In order to support the evaluation of the above sub-category, provide a description of operational details specific to project, including: i. Regional Facts: Weather, terrain, protected areas, mileages, specific operating licences, etc. ii. Base of Operations: Airport plus alternatives, fuel availability, flight planning, base station locations, data transfer and frequency of transfer between remote and field office, field office location iii. Drape Flying: Procedure that will be used to ensure that altitude difference at traverse – control line intersections will be minimized. iv. Timing: Time required by the Bidder between data of notification of contract award and date of commencement of survey operations in weeks or calendar days. Bar chart showing detailed scheduling which demonstrates how all activities will be coordinated to ensure achievement of required delivery data. Bidders are required to calculate and provide the total number of line kilometers separately and also provide a combined total for the **survey** area from the coordinates and the index map Figure A-1 provided in Appendix "A", attached to the "Resulting Contract" enclosed herewith, with separate traverse and control line totals, including the overfly. A flight line and control line map for the entire survey area should be submitted as part of the bid: ***Survey Area:*** Traverse Line Kilometres = _____ lkm Control Line Kilometres = _____ lkm	**2** **2**	

TECHNICAL CRITERIA	MAX: 14 Points	Strengths, Weaknesses, Missing Information
Total Line Kilometres = _____ lkm ***Quality Control*** Field procedures to ensure data integrity. Office procedures to validate the data at each processing step including steps for flight path finalization. *Provide a plan of action outlining the detailed approach and technique to be followed in carrying out the work involved in completing all aspects of this project. Measures to be taken and the quality control procedures to be implemented and followed to ensure a consistent quality of work. A detailed description for:* The field The office *Digital compilation procedure including flight path recovery, editing with speed checks, levelling, gridding, contouring, detailed procedure to produce final digital archives and maps, and checking of final products.* Description Annex & Page of Data Reduction Flow Chart	**2**	
TOTAL POINTS	**14**	
TOTAL POINTS SCORED OUT OF 100		

3. Selection Method – Highest combined rating of technical merit and price

To be considered responsive, a proposal must:

(a) Meet all of the Mandatory Requirements specified above;
(b) Must not obtain a substandard rating in any category under 2.1.1 in the point rated criteria; and
(c) Must not obtain more than one substandard rating in 2.1.2 in the point rated criteria.

Proposals not meeting (a) or (b) or (c) above will be given no further consideration. Those meeting the above will be evaluated based on the following Contractor Selection Methodology:

Highest Combined Rating of Technical Merit and Price

The responsive (compliant) Bidder with the highest combined rating of technical merit **(70%)** and price **(30%)** will be recommended for award of a contract. See the following example table below.

Example of 70% Technical Merit and 30% Price Determination			
	Bidder 1	**Bidder 2**	**Bidder 3**
Technical Points Achieved by Bidder	88	86	86
Price Quoted by Bidder	$85,000	$80,000	$75,000
CALCULATIONS			
	Technical Points Achieved	**Rated Price Points Achieved**	**Total Points Achieved**

Bidder 1	88 X 70 = 61.60 *100	**75 X 30 = 26.47 85	88.07
Bidder 2	86 X 70 = 60.20 *100	**75 X 30 = 28.13 80	88.33
Bidder 3	86 X 70 = 60.20 *100	**75 X 30 = 30.00 75	90.20
* Represents the total technical points available ** Represents the lowest priced proposal			

The winner is the Bidder scoring the highest Total Points as a result of applying the Best Value Calculations to the technical bid and the bid price respectively. Based on the above calculations a contract would be awarded to Bidder 3.

ANNEX "C" – INSURANCE REQUIREMENTS (ALL WORKSTREAMS)

Insurance is a requirement of this RFSA and any resulting contracts issued against an awarded Supply Arrangement.

Aviation Liability Insurance

1. The Contractor must obtain Aviation Liability Insurance for Bodily Injury (including passenger Bodily Injury) and Property Damage, and maintained it in force throughout the duration of the Contract, in an amount usual for a contract of this nature, but for not less than $5,000,000 per accident or occurrence and in the annual aggregate.

2. The Aviation Liability policy must include the following:

   a) Additional Insured: Canada is added as an additional insured, but only with respect to liability arising out of the Contractor's performance of the Contract. The interest of Canada should read as follows: Canada, represented by Natural Resources Canada (NRCan).

   b) Notice of Cancellation: The Insurer will endeavour to provide the Contracting Authority thirty (30) days written notice of policy cancellation.

   c) Cross Liability/Separation of Insureds: Without increasing the limit of liability, the policy must protect all insured parties to the full extent of coverage provided. Further, the policy must apply to each Insured in the same manner and to the extent as if a separate policy had been issued to each.

   d) Contractual Liability: The policy must, on a blanket basis or by specific reference to the Contract, extend to assumed liabilities with respect to contractual provisions.

   e) Employees and, where applicable, Volunteers must be included as Additional Insured.

   f) Aviation Passenger Liability and inclusive Medical Payments: If sub-limits are applicable to Contractor's policy conforming to international carriage agreements or otherwise, such sub-limits must in any event be, not less than $300,000 per person. The per accident limit should be no less than $300,000 multiplied by the number of passengers.

   g) If the policy is written on a claims-made basis, coverage must be in place for a period of at least 12 months after the completion or termination of the Contract.

   h) Employers Liability (unless we have confirmation that all employees are covered by Worker's Compensation (WSIB) or similar program).

   i) Airport Tenants' Legal Liability Broad Form: To protect the Contractor for liabilities arising from its occupancy of leased airport premises.

   j) Non-owned Aircraft Liability: To protect the Contractor for liabilities arising from its occupancy of leased airport premises.

   k) Litigation Rights: Pursuant to subsection 5(d) of the Department of Justice Act, S.C. 1993, c. J-2, s.1, if a suit is instituted for or against Canada which the Insurer would, but for this clause, have the right to pursue or defend on behalf of Canada as an Additional Named Insurer under the insurance policy, the

Insurer must promptly contact the Attorney General of Canada to agree on the legal strategies by sending a letter, by registered mail or by courier, with an acknowledgement of receipt.

For the Province of Quebec, send to:
Director business Law Directorate,
Quebec Regional Office (Ottawa)
Department of Justice
284 Wellington Street, Room SAT-6042
Ottawa, Ontario, K1A 0H8

For other Provinces and Territories, send to:
Senior General Counsel
Civil Litigation Section
Department of Justice
234 Wellington Street, East Tower
Ottawa, Ontario, K1A 0H8

A copy of the letter must be sent to the Contracting Authority, Canada reserves the right to co-defend any action brought against Canada. All expenses incurred by Canada to co-defend such actions will be at Canada's expense. If Canada decides to co-defend any action brought against it, and Canada does not agree to a proposed settlement agreed to by the Contractor's insurer and the plaintiff(s) that would result in the settlement or dismissal of the action against Canada, then Canada will be responsible to the Contractor's insurer for any difference between the proposed settlement amount and the amount finally awarded or paid to the plaintiffs (inclusive of costs and interest) on behalf of Canada.

Commercial General Liability Insurance

1. The Contractor must obtain Commercial General Liability Insurance, and maintain it in force throughout the duration of the Contract, in an amount usual for a contract of this nature, but for not less than $2,000,000 per accident or occurrence and in the annual aggregate.

2. The Commercial General Liability policy must include the following:

   a) Additional Insured: Canada is added as an additional insured, but only with respect to liability arising out of the Contractor's performance of the Contract. The interest of Canada should read as follows: Canada, as represented by Natural Resources Canada.

   b) Bodily Injury and Property Damage to third parties arising out of the operations of the Contractor.

   c) Products and Completed Operations: Coverage for bodily injury or property damage arising out of goods or products manufactured, sold, handled, or distributed by the Contractor and/or arising out of operations that have been completed by the Contract.

   d) Personal Injury: While not limited to, the coverage must include Violation of Privacy, Libel and Slander, False Arrest, Detention or Imprisonment and Defamation of Character.

   e) Cross Liability/Separation of Insureds: Without increasing the limit of liability, the policy must protect all insured parties to the full extent of coverage provided. Further, the policy must apply to each Insured in the same manner and to the same extend as if a separate policy had been issued for each.

f) Blanket Contractual Liability: The policy must, on a blanket basis or by specific reference to the Contract, extend to assumed liabilities with respect to contractual provisions.

g) Employees and, if applicable, Volunteers must be included as Additional Insured.

h) Employers' Liability (or confirmation that all employees are covered by Worker's Compensation (WSIB) or similar program).

i) Broad Form Property Damage including Completed Operations: Expands the Property Damage coverage to include certain losses that would otherwise be excluded by the standard care, custody or control exclusion found in a standard policy.

j) Notice of Cancellation: The Insurer will endeavour to provide the Contracting Authority thirty (30) days written notice of policy cancellation.

k) If the policy is written on a claims-made basis, coverage must be in place for a period of at least 12 months after the completion or termination of the Contract.

l) Owners' or Contractors' Protective Liability: Covers the damages that the Contractor becomes legally obligated to pay arising out of the operations of a subcontractor.

m) Sudden and Accidental Pollution Liability (minimum 120 hours): To protect the Contractor for liabilities arising from damages caused by accidental pollution incidents.

n) Litigation Rights: Pursuant to subsection 5(d) of the Department of Justice Act, S.C. 1993, c. J-2, s.1, if a suit is instituted for or against Canada which the Insurere would, but for this clause, have the right to pursue or defend on behalf of Canada as an Additional Named Insured under the insurance policy, the Insurer must promptly contact the Attorney General of Canada to agree on the legal strategies by sending a letter, by registered mail or by courier, with an acknowledgement of receipt.

For the Province of Quebec, send to:

Director Business Law Directorate
Quebec Regional Office (Ottawa)
Department of Justice
284 Wellington Street, Room SAT-6042
Ottawa, Ontario, K1A 0H8

For other provinces and territories, send to:
Senior General Counsel
Civil Litigation Section
Department of Justice
234 Wellington Street, East Tower
Ottawa, Ontario, K1A 0H8

A copy of the letter must be sent to the Contracting Authority. Canada reserves the right to co-defend any action brought against Canada. All expenses incurred by Canada to co-defend such actions will be at Canada's expense. If Canada decides to co-defend any action brought against it, and Canada does not agree to a proposed settlement agreed to by the Contractor's insurer and the plaintiff(s) that would result in the settlement or dismissal of the action against Canada, then Canada will be responsible for the Contractor's insurer for any difference between the proposed

settlement amount and the amount finally awarded or paid to the plaintiffs (inclusive of costs and interest) on behalf of Canada.

ANNEX "D" – FINANCIAL PROPOSAL (ALL WORKSTREAMS)

The following is an example of the information required when submitting a proposal against a Request for Proposal (RFP) issued against an awarded Supply Arrangement.

1. General Information

1.1 Taxes, as Related to Bids Received

For Canadian-based Bidders, prices/rates, as applicable, **MUST** be firm (in Canadian funds) with Canadian customs duties and excise taxes as applicable **included**, and Goods and Services Tax (GST) or Harmonized Sales Tax (HST) as applicable, **excluded**.

For foreign-based Bidders, prices/rates, as applicable, **MUST** be firm (in Canadian funds) and **exclude** Canadian Customs duties, excise taxes and GST or HST, as applicable. Canadian customs duties and excise taxes payable by the consignee will be added, for evaluation purposes only, to the prices submitted by foreign-based Bidders.

1.2 Estimated Period of the Contract

The estimated period of the contract is from Contract Award to **<provided at time of RFP>**.

1.3 Bidder Financial Offer – Pricing Details to be Completed by the Bidder

The Bidder hereby offers to Natural Resources Canada, as requested by the Minister, to furnish all necessary expertise, supervision, materials, equipment and other things necessary to perform the work as described in the Statement of Work of the Request for Proposal and in accordance with the terms and conditions of the Request for Proposal, to the satisfaction of the Minister, or his authorized representative, for the following price(s):

The Bidder is required to submit its Financial Proposal in accordance with the following Pricing Basis:

Firm All-Inclusive Rate per Line Kilometre (lkm):	$_____lkm
Total Survey Area (total lkms)	_____lkms
TOTAL ALL INCLUSIVE SURVEY COST:	**$_____**
(i.e. CEILING PRICE)	**(Excluding GST/HST)**

Fuel, Oil and Lubricants:

The Contractor will be responsible for supplying and paying for all fuel, oil and lubricants. These costs are to be included in the Firm All-Inclusive Rate per Line Kilometre.

Ground Transportation - Base of Operations:

The Contractor will be responsible for making provision for and paying for all ground transportation costs pertaining to the survey operation. These costs are to be included in the Firm All-Inclusive Rate per Line Kilometre.

Accommodation and Living Expenses:

The Contractor will be responsible for arranging and paying for all accommodation, living and miscellaneous crew expenses. Costs are to be included in the Firm All-Inclusive Rate per Line Kilometre.

The Bidder must bear in mind that no payments other than the Total All Inclusive Survey Costs stated herein shall be made to the Contractor. ***It is therefore essential that this Total All Inclusive Survey Costs include all elements of cost and profit related to the execution of this project.***

Goods and Services Tax (GST) or Harmonized Sales Tax (HST) is extra, if applicable.

ANNEX "E" – SOCIO-ECONOMIC BENEFITS

The following MUST be provided by all Contractors who have been awarded a contract and upon successful completion of the airborne survey.

Contractor's Name:	**Contract No.:**
Itemize all expenditures made at the base of operations. These expenditures may include, but are not limited to:	
Aboriginal Employment Opportunities:	
Wildlife Monitor	$
Student	$
Other (describe):	$
Other Expenditures:	
Lodging:	$
Meals:	$
Vehicle Rentals:	$
Vehicle Fuel:	$
Airport Services:	$
Airport Fuel:	$
Fuel Handling:	$
Other Local Services (describe):	$
Other Local Purchases (describe):	$
Total Expenditures:	**$**

ANNEX "F" – QUARTERLY REPORTING SPREADSHEET

Natural Resources Canada Ressources naturelles Canada

Airborne Geophysical Surveys

This Report is to be provided to the Supply Arrangement Contracting Authority: Valerie Holmes Tel: 343-292-8371 Email: valerie.holmes@canada.ca

Please select your name from the drop down list provided below.

PBN:

Details of Primary Contact regarding this Report

Name: **Tel:**

Title **Email:**

If applicable, alternate contract regarding this report

Name: **Tel:**

Title **Email:**

REPORTING PERIOD:

SA NUMBER:

TOTAL UTILIZATION VAULE FOR THE PERIOD: $

	Contract or Amendment	Contract Number	Amendment Number	Contract/ Amendment Issuance Date (DD-MM-	Contract Start Date (DD-MM-YYYY)	Contract End Date (DD-MM-YYYY)	Delivery Location	Project Authority	Total Contract / Amendment Value	Comments
1										
2										
3										
4										
5										
6										
7										