BG CANADA E&P INC.

COLVILLE LAKE GRAVITY SURVEY
FINAL REPORT

NEB Operation ID 9238-B071-001E
Colville Lake, Northwest Territories
April 21 to May 5, 2006

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Interest Owner: BG Canada E&P Inc.

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May 1, 2007

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INTRODUCTION

The following report describes the gravity survey conducted by *Excel Geophysics Inc.* (*Excel*) for *BG Canada Exploration and Production Inc. (BG)* during the spring of 2006. The Colville Lake gravity survey covered a total area of 3,200 km^2 in the Northwest Territories, Canada, north of Norman Wells, NT. The complete project area was comprised of two separate areas; the East Block is centered on the Northern Oil and Gas Directorate (NOG) Exploration license EL432, Southeast of Colville Lake and North of the Smith Arm of Great Bear Lake, and the West Block is centered on NOG Exploration license EL429, Southwest of Colville Lake and Northeast of Fort Good Hope. The survey was conducted from April 21 through May 5, 2006. This area contained mainly scattered, sparse forests and barren land that were accessed and surveyed via helicopter. Figure 1 shows the location of the project.

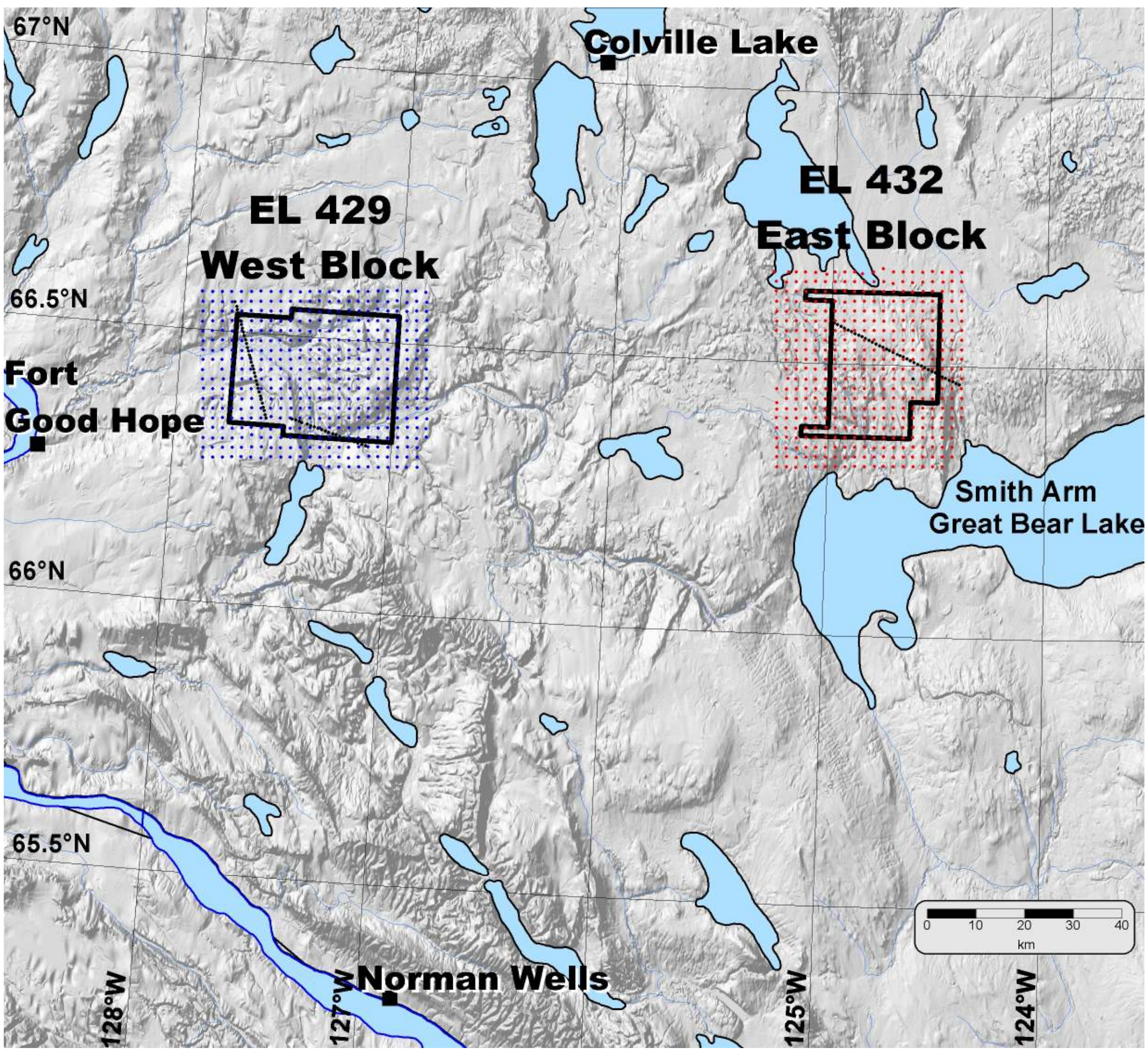

Figure 1. Colville Lake Survey Area

A two kilometer grid was laid out over the East and West Blocks. Once a significant portion of the 2 km gravity stations were collected, preliminary maps were used to place three detailed gravity profile lines. Gravity stations were collected along these detailed profiles at a spacing of 800 m. Two lines 25.6 and 16.6 km long were collected on the West Block and one line 29.6 km long was collected on the East Block.

SAFETY

Each *Excel* crew member held current safety certificates in Emergency first aid, H_2S Awareness, and WHMIS. An emergency response plan containing contact numbers and emergency procedures was distributed and explained to all field staff, and posted in an accessible location. Safety meetings were held by the field staff on a regular basis to help identify any potential safety hazards. There were no injuries, accidents, or incidents during this survey.

Excel ensured that each member of the crew was equipped with appropriate outdoor wear, two-way radio, satellite phone, and emergency first-aid kit. Helicopters were maintained on a regularly scheduled basis by *Sahtu Helicopters* and were equipped with satellite phone, first-aid supplies, fire extinguishers, and emergency beacons.

Two helicopters were on site for the duration of the survey and had constant communication with each other in the field. A third helicopter provided logistical support at the beginning and end of the project. Daily flight routes were discussed in advance to ensure that everyone on the crew knew the location of the helicopters in the event of an emergency. Within the survey area, the topography was open enough to provide landing spots in the event of an accident requiring evacuation.

GRAVITY SURVEY PARAMETERS

The following two tables outline the main details of the gravity survey as well as the people involved with this project.

Table 1. Gravity Survey Prameters

Gravity Survey Parameters	
General Survey Location	Colville Lake, NT Latitude: 64° 55' N – 65° 49' N Longitude: 125° 00' W – 122° 75' W
Survey Duration	April 21 – May 5, 2006
Gravity Station Spacing	2,000 m grid plus three detailed profiles (800 m spacing)
Gravity Stations Acquired	963
Terrain Corrections	50 m to 40 km
Methods of Transportation	2 – Hughes 500 Helicopters, provided by *Sahtu Helicopters* 1 – Bell 204, provided by *Sahtu Helicopters*
Longline Gravity Meters Used	LaCoste and Romberg U-27 (387) LaCoste and Romberg U-18 (571)
Land Gravity Meter Used	LaCoste and Romberg G-181 LaCoste and Romberg G-239

Table 2. Project Personnel

Project Personnel		
***Excel* Operations Manager**	Jessica Pugh	
Gravity Field Crew	Rob Folkersen	Lincoln Weller
	Tiffany Taggart	Jessica Pugh
	James Gieni	
Data Processors	Nicole Trenholm	Sheldon Kasper
***Sahtu Helicopter* Pilots**	Eric Petrunia	Mark Pearson
	Wayne Green	
***Sahtu Helicopter* Engineer**	Jeremy Giroux	
Community Wildlife Monitors	Ryan Kochan (Colville Lake)	Bryan McNeeley (Fort Good Hope)

GRAVITY SURVEY PROCEDURE

The survey crew consisted of five *Excel* geophysical operators, along with two pilots and one helicopter engineer from *Sahtu Helicopters*. Fuel for the helicopters had been previously trucked to Colville Lake airport via the winter road. A Bell 204 from *Sahtu Helicopters* slung fuel from Colville Lake to create three remote fuel caches, while a fourth fuel cache was created with fuel slung from Fort Good Hope. Figure 2 shows the location of the fuel caches. Two Hughes 500 helicopters from *Sahtu Helicopters* conducted the longline portion of the survey as well as set up GPS base stations. These helicopters also slung empty and remaining fuel drums from the field to Fort Good Hope and Colville Lake to clean up all fuel caches.

Excel had a supervisor on site for the duration of the project to coordinate all aspects of the operation including data quality control, client communications, aviation fuel placement, staffing, environmental compliance and adherence to safety guidelines. Operations were based out of the Colville Lake Bed and Breakfast in Colville Lake, NT. The lodge was equipped with a kitchen, sleeping accommodations for the helicopter pilots and engineer, laundry facilities, phone and internet access. Additional sleeping accommodations for the crew were located at the Colville Lake Lodge in Bern Will Brown's Cabin and in a trailer behind the Bed and Breakfast. Transportation of personnel and equipment from the Bed and Breakfast to the airport each day was provided by a truck rented from Robert Kochan in Colville Lake.

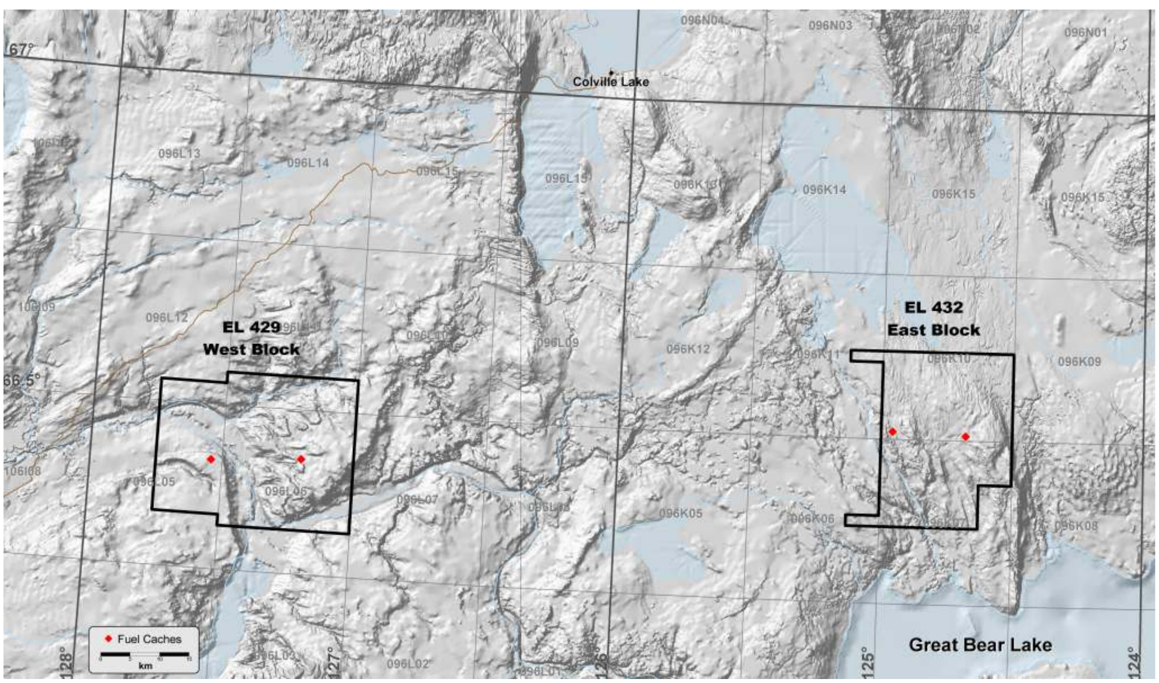

Figure 2. Fuel Cache locations

The entire project area was surveyed by helicopter. A longline gravity meter was slung under the helicopter on a 150-foot longline. Figure 3 shows an example of the Hughes

500 helicopter and Figure 4 shows the longline gravity apparatus as it appeared in the air. Gravity readings were spaced at 2,000 meters in a grid pattern through the project area. In addition to the grid stations, ninety three gravity readings spaced at 800 m intervals were collected along three profile lines within the project area. A DynaNav GPS navigation system was used for navigation to each gravity station using a preprogrammed set of coordinates. The precise location of the helicopter and gravity meter at each station was determined using geodetic grade dual frequency Leica GPS receivers. This aspect of the survey is described in detail under GPS survey procedure and processing.

Figure 3. Example of a Hughes 500 Helicopter

Gravity data acquisition was conducted by the operator in the helicopter using a laptop computer linked via data cable to the suspended gravity meter. At each station, the pilot and operator would choose a location to place the meter such that the local topography features were not significant, and could be properly modeled with available digital elevation data. The pilot would then lower the suspended meter to the ground and lay out a few feet of slack in the cable to reduce the transfer of helicopter vibration to the gravity meter. The pilot then maintained a hovering position nearby. During this hovering phase a gravity reading was acquired. On average, a gravity reading was obtained every ten minutes. Appendix D shows the number of stations collected per day and summary of the weather conditions experienced during this project.

Figure 4. Hughes 500 helicopter and longline gravity meter on the 150 foot longline

GRAVITY BASE STATIONS

The *Excel* gravity crew mobilized to the Colville Lake survey by plane from Hay River, NT. The gravity survey was tied into a Canadian Gravity Standardization Network (CGSN) gravity base in Hay River. The gravity base 9169-1978 is located outside the Mackenzie air hanger at the Hay River airport. CGSN base 9169-1978 is shown in Figure 5. Due to the remote location of the Colville Lake survey, the tie to Hay River was not well constrained. However, a comparison between the survey results and all the GSC stations in the region confirmed that this base tied is accurate to approximately 0.03 mGal. *Excel* set up three main gravity bases for this project, located at the Colville Lake air strip and at the landing pads for the two longline meters. A pin was installed at the main gravity and GPS base at the Colville Lake air strip (340 0422), as shown in Figure 6. The base out and base in gravity readings were recorded at the beginning and end of each day at these locations. Table 3 shows the coordinates and gravity values for all the Colville Lake gravity bases.

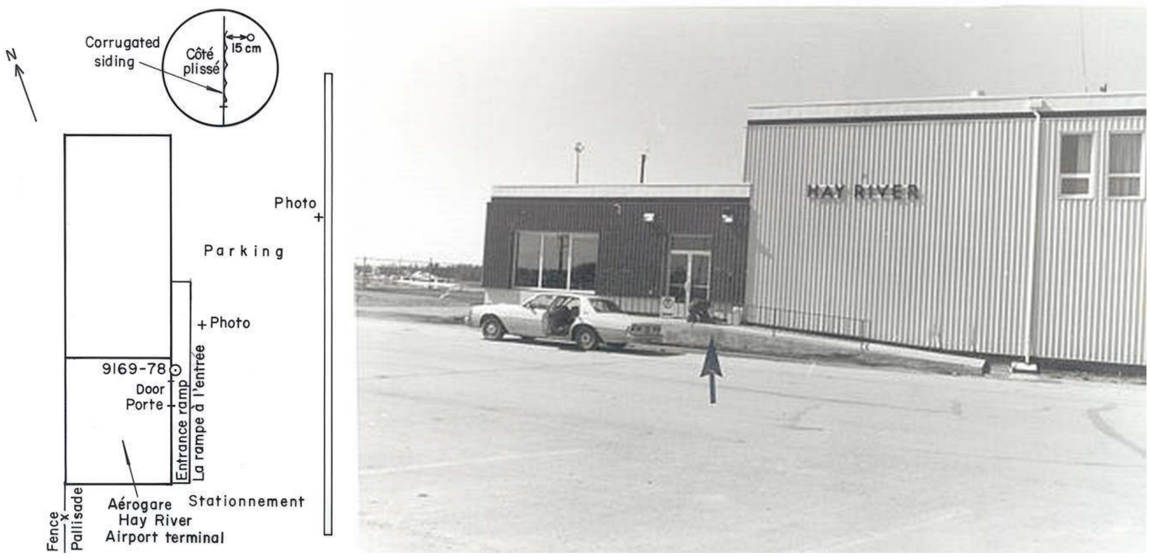

Figure 5. CGSN Gravity Base 9169-1978**,** Hay River, NT

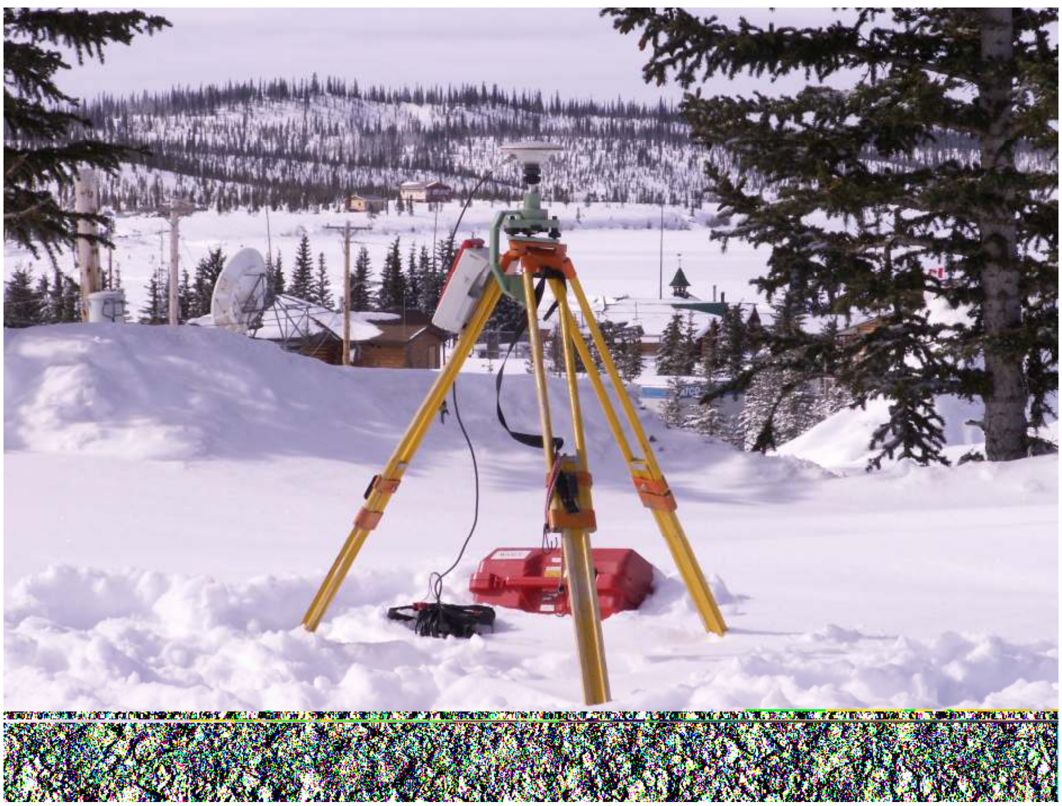

Figure 6. Colville Lake Airport Gravity and GPS Control Base 340 0422

Table 3. Colville Lake Gravity Bases (NAD83, UTM zone 10)

Base Name	UTMx (m)	UTMy (m)	Observed Gravity (mGal)
CGSN 9169-1978; Hay River	891768	6766524	981894.69
Colville Lake Airport Base 340 0422	365646.98	7439318.13	982353.89
Colville Lake Airport Longline Base 3401	365654.03	7439316.59	982353.87
Colville Lake Airport Longline Base 3402	365689.18	7439305.56	982353.97

GPS SURVEY PROCEDURE AND PROCESSING

Excel established a GPS control base at the Colville Lake Airport from the Natural Resources Canada (NRCan) GPS base in Inuvik, NT (40150M001). The coordinates of the GPS control base were determined using Novatel Waypoint GrafNet GPS processing software. This control base was reoccupied each day in order to solve the network of field bases setup each day in the survey area. The coordinates for this control base are shown in Table 4.

Table 4. Colville Lake GPS Base

Base Name	NAD 83 Latitude	NAD 83 Longitude	Ellipsoidal Elevation (m)
Colville Lake Airport 340 0422	67° 02’ 28.65349”	126° 05’ 15.38567”	255.635

Prior to gravity data acquisition each day, an *Excel* operator set up three or four Leica 500 series dual frequency geodetic quality GPS receivers as field bases. These field bases created a GPS base network to solve the data from our roving GPS units on the helicopters. A helicopter was used to access suitable sites in the survey area to set up the GPS base stations, and a G-series LaCoste and Romberg land gravity meter was used to obtain a reading at each of these sites. To ensure ample GPS coverage, the field base stations were positioned so the distance to the roving GPS unit on the helicopter was no more than ten kilometers.

Excel's operator in the longline helicopter was responsible for recording multiple instantaneous readings with the dual frequency Leica 500 GPS receiver on board. Multiple GPS readings were collected at each station to provide better accuracy for final results. A GPS reading was collected when the gravity meter was on the ground and the helicopter was positioned directly above it with the longline cable fully extended. In this position, the distance from the gravity meter to the helicopter mounted GPS antenna can be treated as a constant, measurable value. GPS readings were recorded when the meter was being lowered to the ground and when it was being picked up after a gravity reading. This provided two opportunities to obtain a GPS location, reducing or eliminating the need to repeat a gravity station due to a poor GPS solution.

The Leica 500 series GPS technology was chosen for longline gravity application because of its reliability, fast satellite acquisition, ease of operation, and small size. It also has advanced kinematic operational modes that are well suited to a non-stationary recording platform, such as a hovering helicopter.

GPS data were processed each evening using Leica Geosystem's post-processing software. Field base locations were solved from the control base at the Colville Lake Airport. Appropriate field bases were then used to calculate solutions for the GPS rover units on the helicopter. Factors such as satellite position, signal strength, and topography affect the results and the highest quality solutions were selected for each station.

GRAVITY DATA REDUCTION

The LaCoste and Romberg land gravity meter (G-series) is operated manually and is capable of reliable and repeatable gravity readings to an accuracy of better than 0.02 mGal by experienced operators. The operator must ensure that the meter is operated at the recommended regulated temperature and is level during the reading.

The date, time, dial reading and instrument height are recorded in a field notebook at each land gravity station. A gravity base is measured at the beginning and end of each day to correctly account for meter drift. Each evening the field data are entered into a portable notebook computer and corrected for sun/moon tidal effects, instrument height, and instrument drift to obtain the observed gravity. Refer to the *Observed Land Gravity Data Listing* (under separate cover) for the raw data, observed gravity and intermediate reduction values for each day.

The LaCoste and Romberg longline gravity meter (U-series) works on the same principles and basic mechanics as the land gravity meter and under field conditions is capable of reliable and repeatable gravity readings from the helicopter of better than 0.05 mGal by experienced operators. A laptop computer in the helicopter is linked to the longline meter through a data cable, enabling an operator to control the meter remotely using servomotors. Temperature is monitored on the screen and leveling is done automatically. When a reading is taken the date, time, dial reading and cheat voltage are written to a file to later be exported for processing. As with the land gravity meter, a gravity base station is recorded with the longline meter at the beginning and end of the day. In addition, a gravity reading is recorded at each helicopter refueling to confirm daily meter drift. Refer to the *Observed Longline Gravity Data Listing* (under separate cover) for the raw data, observed gravity and intermediate data reduction values for each day.

After the GPS coordinates and elevations are processed and merged with the observed gravity for each station, intermediate corrections are applied to the observed gravity to yield final Bouguer anomaly values. See Table 5 for the formulae used to determine the intermediate corrections and Bouguer gravity values. The Bouguer gravity has been calculated using variable density Bouguer and Terrain Corrections. Density values were assigned to each station by locating each station on a Surface Geology map based on the Tectonic Assemblage Map of the Canadian Cordillera (Wheeler and McFeely, 1991). The average elevation of surveyed stations in this project was 233 m. Based on this value, an elevation datum of 250 m was chosen to minimize the effects of the Free Air and Bouguer Slab Corrections. Refer to the *Variable Density Bouguer Gravity Data Listing* (under separate cover) for the Bouguer values and all intermediate corrections.

Table 5. Gravity Correction Formulae

Gravity Corrections	Description
Latitude Correction	Standard latitude correction adopted by the International Association of Geodesy, 1967. G=978031.85 * (1+0.005278895 $\sin^2$(latitude) + 0.000023462 $\sin^4$(latitude))
Free Air Correction	(elevation (m) – datum (m)) * 0.3068 mGal/m
Bouguer Correction	- (elevation (m) – datum (m))* density (g/cm^3) * (2.0 * pi * 0.006672) (note: density values vary depending on surface geology)
Terrain Corrections	Terrain corrections (50m to 40km) with variable densities computed with proprietary software.
Final Bouguer Values	Bouguer anomaly (mGal) = observed gravity – latitude correction + free air correction + Bouguer correction + terrain corrections

Gravity correction units are in mGal.

DATA QUALITY

The gravity survey was of excellent quality. A critical examination of the residual gravity maps reveals that the survey is clearly within an error envelope of 0.05 mGal. Relative station elevations were determined to better than 5 cm. Absolute elevations are probably better than 50 cm. Horizontal locations were determined to better than 1 m.

WILDLIFE

The Sahtu area is habitat for an abundant variety of animals. We had two wildlife monitors: Ryan Kochan from Colville Lake for the East Block and Bryan McNeeley from Fort Good Hope for the West Block. Either Ryan Kochan or Bryan McNeeley went out in the morning with the GPS base station helicopter to look for wildlife, assess fuel cache locations, and identify any heritage sites or other areas that the field crew should avoid. When wildlife was sighted during longline data collection, the gravity station was skidded to avoid interaction. At the completion of the survey, no environmental damage had been done and no trace of our presence remained. Appendix C gives a detailed listing of the wildlife sightings during this survey.

REFERENCES

Wheeler, J.O. and McFeely, P. (comp), 1991. Tectonic Assemblage Map of the Canadian Cordillera and adjacent parts of the United States of America. Geological Survey of Canada Map 1712A

APPENDIX A - UTM Zone 10 Coordinate System Parameters

The coordinate system used for mapping purposes is UTM Zone 10 (NAD 83). Parameters for the coordinate system are shown in Table 6.

Table 6. UTM Zone 10 Mapping Parameters

Project Mapping System	
Datum	NAD 83
Ellipsoid	WGS 84
Latitude of Origin	Equator, 0º
Central Meridian	123º W
Grid Projection	UTM Zone 10
Scale Factor	0.9996
False Easting	500,000.0 m
False Northing	0.0 m

Ellipsoids:	WGS 84
Semi-major axis	6378137.0 m
Semi-minor axis	6356752.3 m

APPENDIX B - Data Listing Format of Reports in 11 x 17 binder

Observed Land Gravity Data

The *Observed Land Gravity Data Listing* (under separate cover) contains a listing of all land gravity data collected by the crew during the survey period. The data is presented in chronological order.

The LaCoste and Romberg G-series land gravity meter uses a zero length spring supporting a mass on a beam as is standard in all modern gravity meters. While the meter is level, a counter dial is turned to adjust the position of the beam until the force of gravity is balanced by the mechanical force of the zero length spring. A calibration table is used to convert the counter reading value to a value in mGal. While the zero length spring system is prone to drift during a day, this drift can be accurately identified and corrected by reoccupying a known gravity station one or more times during the day.

Each land gravity loop is separated by a blank row. On a longline gravity project, land gravity stations are collected at fuel caches and GPS field base locations, and are named accordingly. The primary gravity base is always assigned a line number of 0 to distinguish it from other readings, and can be seen at the start and end of each gravity loop. The date, time, Greenwich Mean offset, and project location (latitude and longitude) are used to compute the sun/moon gravity tide correction.

The relative gravity is computed by summing all of the terms:

Relgrav = calibrated counter reading + Instrument Height (HI) correction
+ tide correction - drift

Gravity base values can be seen in Table 3.

Observed Longline Gravity Data

The *Observed Longline Gravity Data Listing* (under separate cover) contains a listing of all longline gravity data collected by the crew during the survey period. The data are presented in chronological order.

Each longline gravity loop is separated by a blank row. Station numbers were assigned in a row-column format during the initial layout phase of the project. The airfield gravity base was always assigned a line number 0 and is typically found at the start and end of each day. Fuel caches were assigned a line number of 55, and are frequently used to minimize the effects of system drift during a day of data collection. The longline gravity meters work under the same principle as the land gravity meters, with the addition of a capacitance plate on the end of the moving beam and two fixed plates above and below the beam. These plates are used to apply an electrostatic force to the beam which combines with the mechanical force of the zero length spring to balance the force of gravity. As with the land gravity meters, a calibration table is used to convert the counter reading to a value in mGal. The electrostatic force, known more commonly as the cheat voltage, is converted to mGal via a conversion function unique to each meter.

The relative gravity for a longline meter is computed by summing all of these terms:

Relgrav = calibrated counter reading + calibrated cheat value
+ tide correction – drift

Bouguer Gravity Data

The *Variable Density Bouguer Gravity Data Listing* (under separate cover) displays the observed gravity and coordinate data with intermediate corrections and variable density Bouguer gravity values. The table summarizes all of the collected data including the survey coordinates, elevation, and observed gravity at each station. Latitude and longitude values are given as well as UTM zone 10 coordinates in NAD 83. The elevations shown are orthometric height above mean sea level, calculated using the GSD95 geoid model. The intermediate corrections include the latitude, free air, variable density Bouguer and variable density terrain corrections. The variable density Bouguer gravity values were computed using density values determined from surface geology which range from 2.39 g/cm^3 to 2.77 g/cm^3. Terrain corrections were calculated for all stations using the most accurate digital elevation data available in the area. For the Colville Lake gravity survey, the digital elevation grid was created by integrating Canadian Digital Elevation Data, Level 1 (CDED1) and National Topographic Data Base (NTDB) data from the Centre for Topographic Information (CTI) at Natural Resources Canada.

APPENDIX C – Wildlife Sightings

Table 7. Wildlife Sightings

Date (mm/dd/yyyy)	Location		Type of Sighting	Number of Animals
	Latitude	Longitude		
4/23/2006	66.52662	124.97974	Ptarmigan	2
4/23/2006	66.95714	125.72798	Muskox	8
4/24/2006	66.58293	124.80443	Muskox	2
4/25/2006	66.45707	124.75057	Ptarmigan	1
4/25/2006	66.33365	124.60832	Fox	1
4/25/2006	66.31455	124.65088	Martin	1
4/25/2006	66.61957	125.14397	Muskox	-
4/28/2006	66.48760	127.63153	Muskox	17
4/29/2006	66.48760	127.63153	Muskox	17
4/30/2006	66.53838	127.14397	Bald Eagle	1
4/30/2006	66.47781	127.40196	Bald Eagle Nest	1
4/30/2006	66.46027	127.44648	Muskox	4
4/30/2006	66.48760	127.63153	Muskox	20-30
5/2/2006	66.31693	127.32909	Muskox	2
5/2/2006	66.31693	127.32909	Bald Eagle	1
5/3/2006	66.92389	125.63893	Muskox	18
5/4/2006	66.28889	127.32667	Moose	3

APPENDIX D – Daily Production and Weather

Table 8. Daily Production and Weather

Date	Gravity Stations Acquired	Weather
4/22/2006	3	Sunny
4/23/2006	103	Sunny
4/24/2006	128	Sunny
4/25/2006	74	Sunny
4/26/2006	8	Morning – Low ceiling cloud cover Afternoon – Sunny
4/27/2006	106	Overcast with snow in the evening
4/28/2006	0	Blizzard
4/29/2006	44	Morning – Snow Afternoon – Sunny, then clouding over
4/30/2006	138	Mostly sunny
5/1/2006	122	Sunny
5/2/2006	142	Sunny
5/3/2006	41	Sunny
5/4/2006	54	Very Windy