PROGRAM REPORT

WHITEHORSE 2023 GROUND GRAVITY SURVEY
Whitehorse, Yukon

Report Prepared for:

Yukon

Yukon Geological Survey

Report Prepared by:

AURORA GEOSCIENCES

PROGRAM REPORT
WHITEHORSE 2023 GROUND GRAVITY SURVEY
Whitehorse, Yukon

Survey Centre:
60° 45' N, 135° 6' W
N.T.S. 105D/11, 14

Work Performed:
October 16 – December 01, 2023

Effective Date:
January 12, 2024

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1 INTRODUCTION

This report details the ground gravity survey that Aurora Geosciences Ltd. (Aurora) conducted for the Yukon Geological Survey (YGS) to assist in locating large faults and structures in Whitehorse, Yukon. The goal of the program is to assess the geothermal potential in the area. The 10 km by 8 km survey area resulted in the collection of 325 gravity stations over 28 days. Data collection was completed from October 16 – December 1, 2023.

This work was completed by a two-person crew whose base of operations was in the city of Whitehorse. The Aurora crew accessed the survey grid by a combination of light-duty truck and ATV, depending on the ease of accessibility.

The content of this report describes the survey specifications, data acquisition, and data processing. Digital copies of raw instrument data files, processed databases, raster images and maps in Oasis format are included with this report as Appendix I. Interpretation and modelling of the data are not within the scope of this project.

2 CREW AND EQUIPMENT

2.1 CREW

The Aurora personnel who conducted the survey are shown in Table 1. A crew log describing daily operations is found in Appendix II.

Table 1. Personnel List and Deployment Dates

Name	Position	Deployments
Andre Lebel	Geophysicist (Gravity Operator)	Oct 16 – Dec 01, 2023
Hannah Warrington	Geophysical Technician (GPS Operator)	Oct 16 – Dec 01, 2023

2.2 EQUIPMENT

The Aurora crew used the following instruments and equipment to complete the survey.

Table 2. Instruments and Equipment Used

Gravity	Scintrex CG-6 Gravimeter (s/n: 18060099)
Global Navigation Satellite System (GNSS)	Leica GS15 GNSS Antennae (s/n: 1511863 and 1509564) Leica GS15 GNSS Antennae (s/n: 1502747 and 1508673) Leica CS15 Controller (s/n: 2535869) Satel radios and repeater

Other	Laptop with Oasis processing software Geophysical work box with repair tools 2 - Handheld non-differential Garmin GPS 2 - Bear spray and bear bangers 1 - Light-duty truck 1 - Trailer 2 - ATVs (season dependent)

Further details of the gravimeter instruments are found in Appendix III.

3 SURVEY LOCATION

The survey area is 10 km by 8 km covering the northern part of the city of Whitehorse (Figure 1). For planned locations that coincided with private land, those stations were either moved to public land or permission was received from the landowners.

4 SURVEY SPECIFICATIONS

The survey was conducted according to the following specifications.

Table 3. Survey Specifications

Line Orientation	Azimuth of 178°
Line Spacing	500 m
Station Spacing	500 m
GPS Location	NAD 83 (CSRS) Zone 8N UTM coordinates
Elevation	Orthometric Heights (CGVD2013 datum)
Seismic Filter for Gravity Collection	Yes
Minimum Stack Time for Gravity Collection	Readings are stacked for a minimum of 60 s (2 readings x 30 s)
Noise Threshold for Gravity Collection (Survey Stations)	Maximum standard deviation of individual 10 Hz readings within the stack of 0.050 mGal
Noise Threshold for Gravity Collection (Control Stations)	Maximum standard deviation of individual 10 Hz readings within the stack of 0.020 mGal
GNSS quality	Maximum CQ3D of 0.025 m

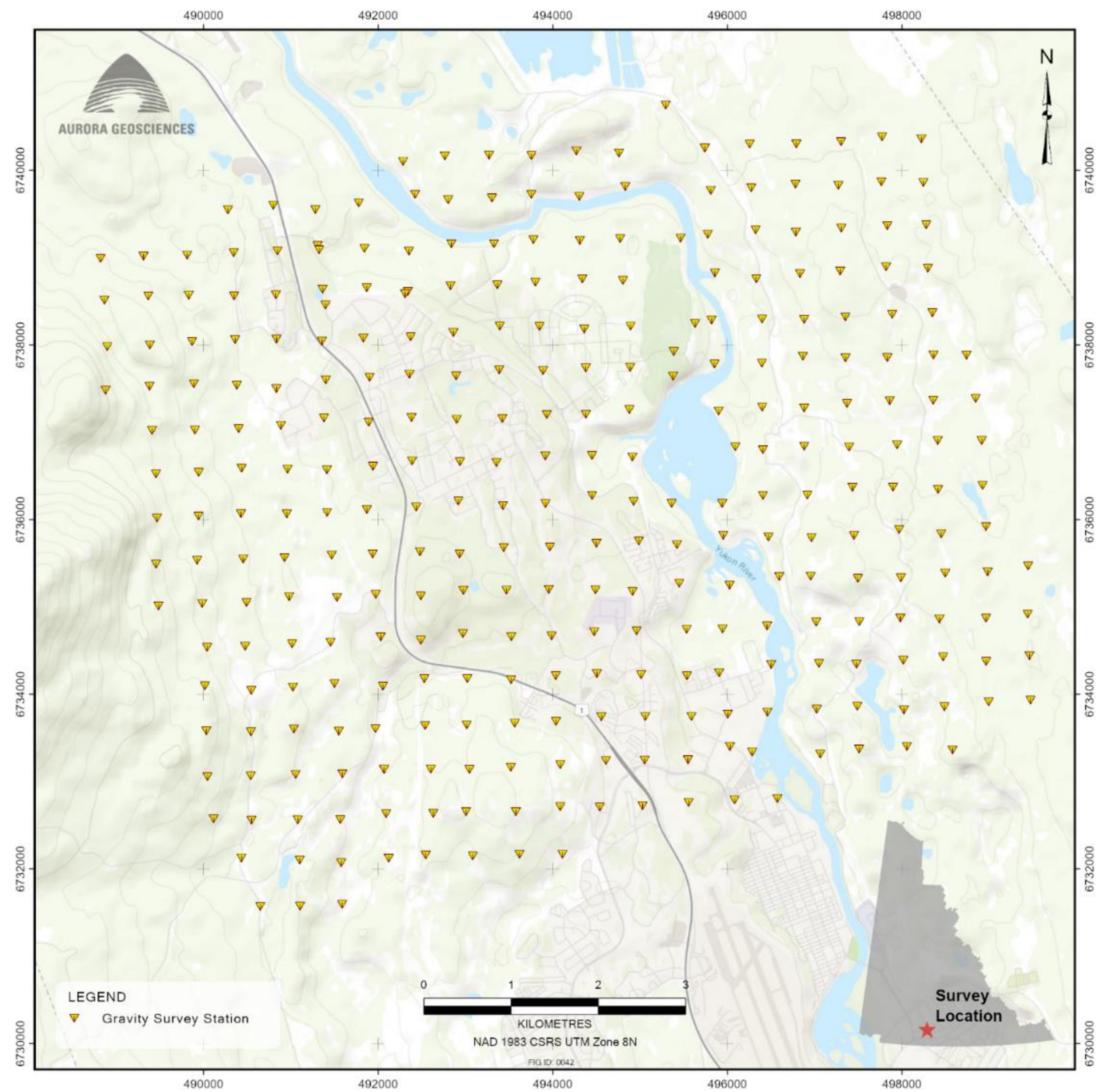

Figure 1. Plan map showing the survey area and the measured station locations.

5 DATA COLLECTION

From October 16 through December 01, 2023, 325 stations of ground gravity were collected over the survey grid. The survey was completed in one phase comprising 28 workdays with the Aurora crew taking weekends off.

Detailed survey logs that describe daily activities are provided in Appendix II.

5.1 PRE-SURVEY GRAVIMETER CHECKS

5.1.1 Gravimeter Drift Test

Prior to mobilization, the gravimeter is warmed up for a minimum of 48 hours on a level cement floor. The instrument is then cycled for at least 16 hours taking 60 seconds readings continuously to determine the remnant instrument drift and to adjust the drift constant, if required.

Gravimeter drift tests were completed prior to the initial mobilization and occurred from October 10 – 11, 2023. The results of the drift tests show that, although a tidal correction was applied to these data, a 0.005 mGal remnant tidal effect is observed (Figure 2).

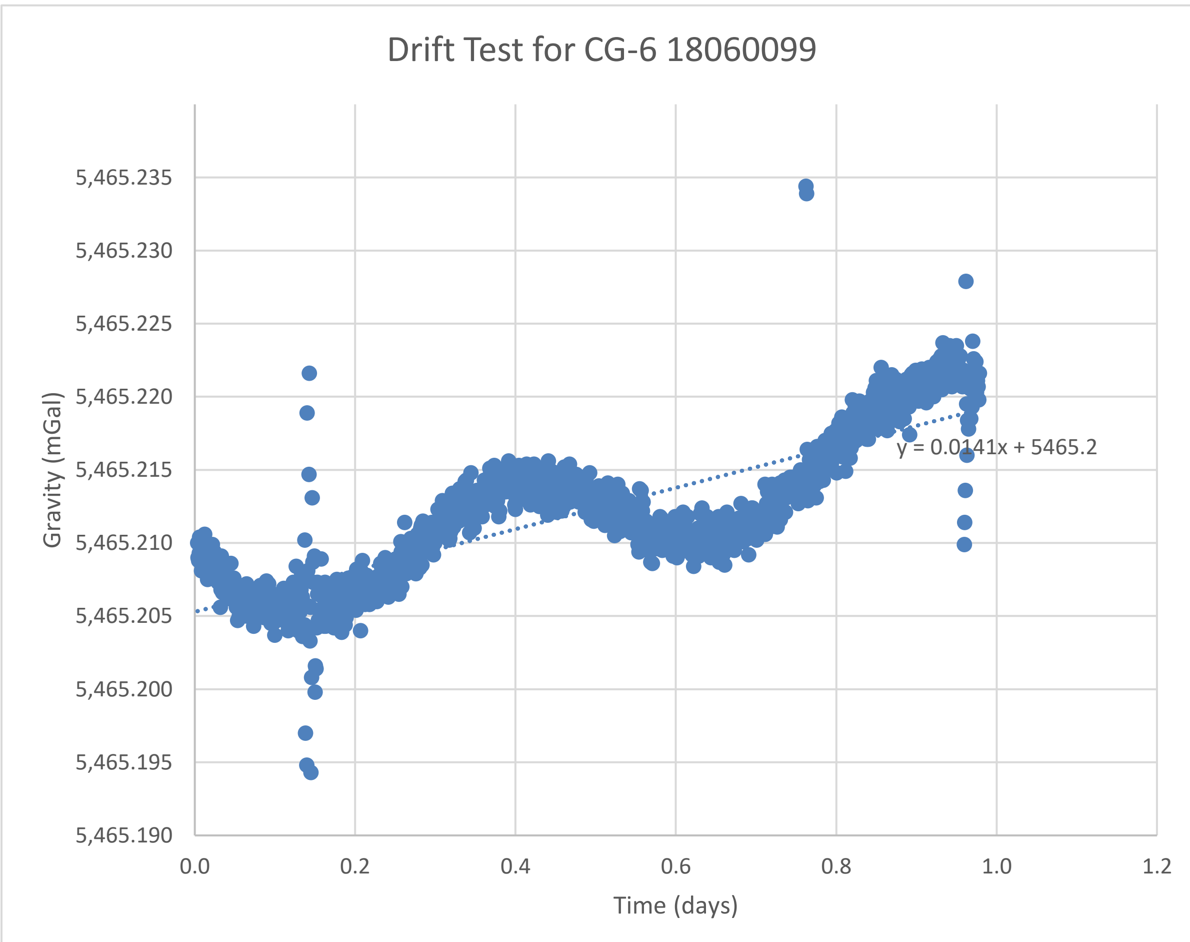

Figure 2. Drift test results prior to mobilization (October 10 - 11, 2023) and prior to correcting linear drift value.

5.2 SURVEY ACQUISITION PROCEDURES

5.2.1 Gravity Data

Prior to and post daily surveying, readings are taken at a control station. This station is established at a specific location that is stable and easily accessible for the crew. Control station readings require a minimum of three readings with a maximum range of 0.020 mGal. For this survey, the control station was established at the Aurora office in Whitehorse, YT.

Each gravity station on the survey grid is located using a handheld non-differential GPS. The station is cleared of snow, soft moss and organics, or preferentially, located on a low available boulder. The exact location of station is at the discretion of the operator as it must be a suitable site for both good quality gravity and positional measurements. The gravimeter is levelled prior to initiating a reading.

As indicated in the Survey Specifications section, the readings are stacked for a minimum of 60 seconds. If the standard deviation of the individual 10 Hz readings (after seismic filtering) exceeds 0.050 mGal, repeat readings are taken. Repeat readings are also taken periodically at the discretion of the operator to ensure quality control of the results.

Throughout the survey, a minimum of 2 readings were taken at each station, however, 3 readings were often recorded. In addition to these repeat readings, several gravity stations were remeasured to assess the quality of the overall methodology. Remeasured readings were surveyed on different days with a remeasured positional location. These remeasurements are assigned a unique line-station identifier by incrementing by 1 the station or line number.

Out of 1034 total readings, 57 were flagged for a standard deviation exceeding the 0.050 mGal threshold and a lack of repeatability in the resultant bouguer anomaly calculation. These readings were not included in the final products.

5.2.2 Positional Data

Accompanying the gravity survey is a triple-frequency Global Navigation Satellite System (GNSS) survey. This survey provides vertical control for the gravity reductions described in Section 6.2 using the GPS, Glonass and Galileo constellations. Control stations are established from the base station measurements that are broadcasted via radio to the GNSS rover for real-time kinematics (RTK) corrections. These locations are logged for post-processing after the survey. The position for a GNSS control station is only estimated once, when first established, and the same position is used for each subsequent day that the GNSS control station is occupied. The actual position of the control stations is later determined by using the Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP). The CSRS-PPP is an online application maintained by the Government of Canada which provides accurate user positions by using precise satellite orbit, clock and bias corrections derived from a global network of receivers (Table 4). All three levels of solutions from CSRS-PPP are used (ultra-rapid, rapid and final). Where possible, several days of control station data are submitted and the results are averaged. Once the final position information has been determined, an adjustment is made to the GNSS data to correct the difference between the estimated position of the control station and the averaged final position as determined by CRSR-PPP. These adjustments are shown in Table 5.

Table 4. GNSS control stations from averaged CSRS-PPP solutions.

Control Station	Dates In Use	Easting (m)	Northing (m)	Elevation (m) Height Above Ellipsoid
YGSWHOFFICEBASE	Oct 16 – Oct 20, 2023 Oct 27, 2023 Nov 07, 2023 Dec 01, 2023	490797.395	6737143.154	775.586
YGSPORTERCREEKB	Oct 23, 2023	492587.556	6738346.721	722.948
YGSWANNRDBASE	Oct 23, 2023	493156.755	6737886.854	729.452
YGSWHUNIBASE	Oct 25, 2023 Oct 30 – Nov 03, 2023 Nov 06, 2023	494570.575	6734850.029	721.119
YGSHAECKELHILLB	Oct 26, 2023	490534.189	6733635.686	847.569
YGSLONGLAKEBASE	Nov 8 – 10, 2023	497934.972	6735888.590	734.165
YGSLONGLAKEBASE2	Nov 14 – Nov 15, 2023 Nov 28, 2023	496590.922	6737803.115	686.468
YGSLONGLAKEBASE3	Nov 16 – Nov 17, 2023	497575.144	6734502.240	690.044
YGSLONGLAKEBASE4	Nov 29 – Nov 30, 2023	495998.012	6739805.645	690.720

Table 5. GNSS control station adjustments from estimated position to CSRS-PPP determined position.

Control Station	Easting Adjustment (m)	Northing Adjustment (m)	Elevation Adjustment (m)
YGSWHOFFICEBASE	1.370	0.505	4.461
YGSPORTERCREEKB	0.558	-0.659	1.825
YGSWANNRDBASE	1.266	0.919	3.866
YGSWHUNIBASE	-0.838	1.094	3.001
YGSHAECKELHILLB	-4.018	1.839	9.581
YGSLONGLAKEBASE	1.642	2.109	4.047
YGSLONGLAKEBASE2	-0.399	-0.006	-4.116
YGSLONGLAKEBASE3	-0.536	2.095	3.208
YGSLONGLAKEBASE4	0.229	-0.915	-2.851

GNSS readings are taken at the same locations as the gravity readings on the survey grid. A radio link between the base antenna at a GNSS control station and the rover allows for RTK phase-fixed positional solutions. Specification for the 3D Coordinate Quality (CQ3D) is 2.5 cm. If the 2.5 cm threshold is not met, up to 30 minutes of GNSS rover data are recorded for post-processing. Note that the CQ3D, although proportionally related to the quality of the GNSS solution, is not a proxy for an estimate of error as the relationship between the CQ3D and error is non-linear. A CQ3D of 2.5 cm does not imply a positional accuracy of 2.5 cm.

The rover measurements are not always made on the exact gravity station. When the GNSS measurement is initiated simultaneously with the gravimeter reading, the gravimeter is on the point requiring the GNSS measurement to be made approximately 25 cm away. Every effort is made to ensure the GNSS measurement point is at the same elevation as the gravity measurement point. This is acceptable because while an accurate vertical survey is critical for gravity reductions as described in the Gravity Corrections section, the same accuracy for the horizontal survey is not required.

The GNSS solutions for the ground gravity survey were, in general, good with most positions achieving a phase fixed solution through the RTK radio link. There were a few positions that did not achieve an acceptable solution by RTK but were successfully post-processed to phase-fixed solutions.

5.2.3 Bathymetry Data

When gravity readings are completed over water bodies (i.e. during the wintertime), water depths and ice thickness measurements are collected to record the bathymetry data which are used in the gravity reductions. For this survey, no gravity stations were read over frozen waterbodies, therefore no bathymetry measurements were collected.

6 DATA PROCESSING

The suite of gravity corrections to process gravity data requires Digital Elevation Model (DEM) and precise positional data. The processing steps for these corrections are described below following an explanation of the generation of the DEM and the GNSS processing.

6.1 DIGITAL ELEVATION MODEL (DEM)

A DEM is required for the terrain corrections (see Near and Far Terrain in Gravity Corrections section). The model incorporates 3 zones of DEMs (inner, intermediate, and outer) to balance high resolution close to the gravity station and consider reasonable file size and computing time. Terrain corrections are completed using each of these DEM zones (Figure 3).

Near and far-station corrections proximal to the survey area use a dense inner DEM covering the survey area and 200 m to 500 m beyond with a 2 m cell size. Intermediate far station corrections use a middle DEM that starts at the perimeter of the inner DEM and extends out 10 km beyond the inner DEM using a 20 m cell size. Distal far-station corrections use a coarse outer DEM that starts at the perimeter of the intermediate DEM and extends to 100 km beyond the intermediate DEM using a 100 m cell size.

The primary product for the inner DEM is LiDAR data provided by the Yukon Government. It is constructed from approximately 0.5 m data and is generally available as a 2 m grid. The LiDAR data have a higher resolution than 2 m and is down sampled for the inner DEM. While this data adequately covers the survey grid, the northeast corner does not extend more than 200m beyond the survey grid.

The LiDAR data is trimmed to NAD83(CSRS) UTM zone 8N coordinates 488178, 500378, 6730876, 6741220 (xmin, xmax, ymin, ymax) to produce the inner DEM.

The intermediate DEM is constructed using Arctic DEM[1] mosaic tiles 40_08_2_1, 40_08_2_2, 41_08_1_1, and 41_08_1_2. They are transformed from height above ellipsoid to the CGVD2013 vertical datum using the CGG2013a geoid (2023 CSRS reference) using the NRCAN GPS-H tool on an 80 m grid. The resultant DEM is trimmed to NAD83(CSRS) UTM zone 8N coordinates 478218, 510338, 6720916, 6751180 (xmin, xmax, ymin, ymax) and the area of the inner DEM is removed to prevent double terrain corrections.

The outer DEM uses the Canadian Digital Elevation Model (CDEM) trimmed to NAD83(CSRS) UTM zone 8 coordinates 378218, 610338, 6620916, 6851180 (xmin, xmax, ymin, ymax). Despite these data being in the CGVD28 vertical datum, a transformation to the CGVD2013 is not performed. The outer DEM is distal to the survey area and therefore has less effect on the gravity reductions, and the difference between CGVD28 and CGVD2013 are small at less than a metre.

The southcentral extreme of the outer DEM is proximal to Skagway, Alaska and these elevation data are not available from the CDEM. The area of the intermediate DEM is removed to prevent double terrain corrections.

[1] Porter, Claire, et al., 2023, *"ArcticDEM, Version 4.1",* https://doi.org/10.7910/DVN/3VDC4W, Harvard Dataverse, V1, [2023-12-11]

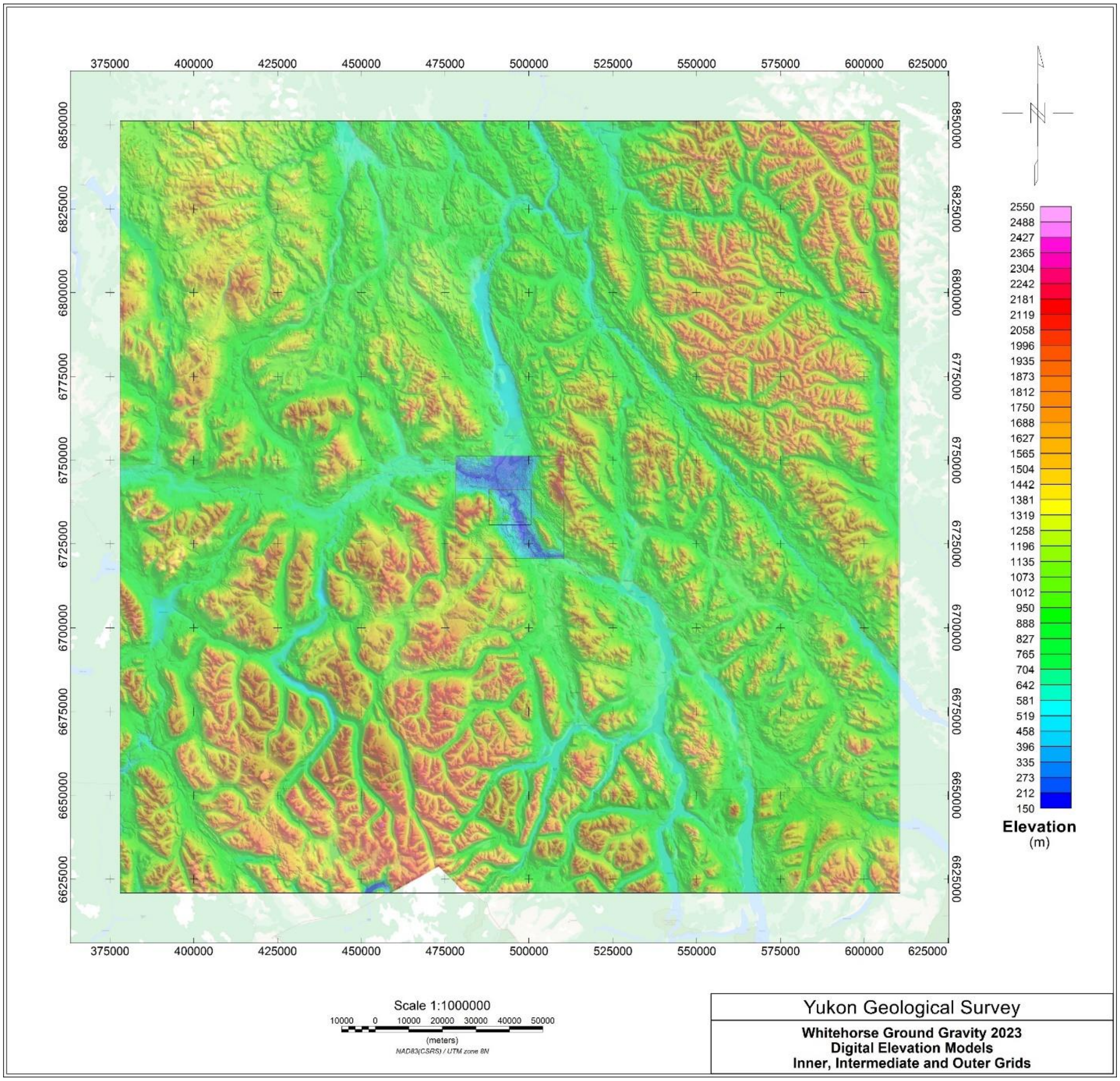

Figure 3. Outer, Intermediate, and Inner DEMs

6.2 GNSS PROCESSING

During the GNSS processing, the first check completed is typically to ensure there are no labelling errors of the GNSS points. Each station point is confirmed against the expected position to verify the proper label. The next step involves examining the survey location data to identify any points that did not achieve a full phase-fixed solution. Any points that are labelled with an RTK phase-fixed position but have 3D Coordinate Quality (CQ3D) values greater than 0.025 m are flagged. The identified points are post-processed using Leica Infinity software based on the estimated location of the base as broadcast via radio link to the rover during data collection.

Twenty-one points in the dataset were identified with these criteria and were successfully corrected by post-processing:

- October 17 (one point)
- October 18 (one point)
- October 23 (three points)
- October 30 (five points)
- November 01 (one point)
- November 02 (one point)
- November 08 (three points)
- November 09 (one point)
- November 10 (two points)
- November 16 (one point)
- November 17 (one point)
- December 01 (one point)

Additionally, four points were flagged and were not able to be successfully post-processed. These points are included in the database; however, they have been flagged as not meeting the GNSS criteria and are therefore not included in the BA calculations. Remeasurements of these stations were performed on subsequent days and are included in the database but not the table of remeasurements.

All positions are then adjusted to account for the difference between the initial estimated position of the GNSS base station(s) and the final CSRS-PPP determined position.

The National Resources Canada (NRCAN) GPS-H tool is used to transform GNSS ellipsoid heights into orthometric (metres above sea level) heights using the Canadian Gravimetric Geoid model CGG2013a.

Finally, the GNSS elevation readings and LiDAR and Arctic DEMs are compared. There is good agreement between the GNSS measured elevations and available LiDAR elevations. Almost all the LiDAR elevations were within 0.60 m of the measured GNSS readings (mean = -0.084 m, standard deviation = 0.781 m). The largest difference was a point on one of the Mount McIntyre cross country ski trails which was 2.8 m lower than measured value. The point with the second largest difference, where the LiDAR measurement is 2.4 m lower than measured, is on the steep slope. While it is possible this measurement may have been taken on a boulder, larger than average differences between GNSS measured and LiDAR elevations is common on steep slopes.

Together, these agreements between the measured GNSS elevations and the different DEM products supply confidence to the terrain correction that rely on these data.

6.3 BATHYMETRIC PROCESSING

No bathymetric processing was required for this survey as no gravity data was collected over a waterbody. All gravity station locations were located on land.

6.4 GRAVITY CORRECTIONS

A suite of corrections is applied to the raw gravity to produce the Bouguer Anomaly (BA). Drift, tilt and temperature corrections are performed on-board the CG-6 gravimeter. Tidal corrections are also part of the on-board suite of corrections but are removed and replaced with externally calculated tide corrections to ensure proper implementation. Latitude and free-air corrections are then applied resulting in the free-air anomaly.

The BA is calculated by adding the Bouguer, Bullard-B, near-station terrain and far-station terrain and bathymetric corrections (not applicable for this survey) to the free-air anomaly. As these corrections are all directly proportional to density, a suite of densities (2.4 g/cm^3, 2.5 g/cm^3, 2.6 g/cm^3, 2.67 g/cm^3, 2.70 g/cm^{3}and 2.8 g/cm^3) are used to create an individual BA for each density.

6.4.1 Adjustment to Absolute Gravity

As described in Appendix IV, the gravity reference station 9904-1990 on McIntyre Creek Rd. was surveyed on October 10,2023. This was required to establish a difference of 15.344 mGal between the reference station and the Aurora Whitehorse office control station. The absolute gravity at McIntyre Creek Rd. is adjusted to ground through the reported gradient, giving an absolute gravity value of the Aurora Whitehorse office control point of 981736.537 mGal.

6.4.2 Drift

In addition to the internal drift correction, residual drift is removed by applying the linear interpolation of gravity readings at the control station prior and post every survey day. The datum is originally set arbitrarily and then later adjusted to reflect absolute gravity.

The measurements taken at this control point are shown in Figure 4.

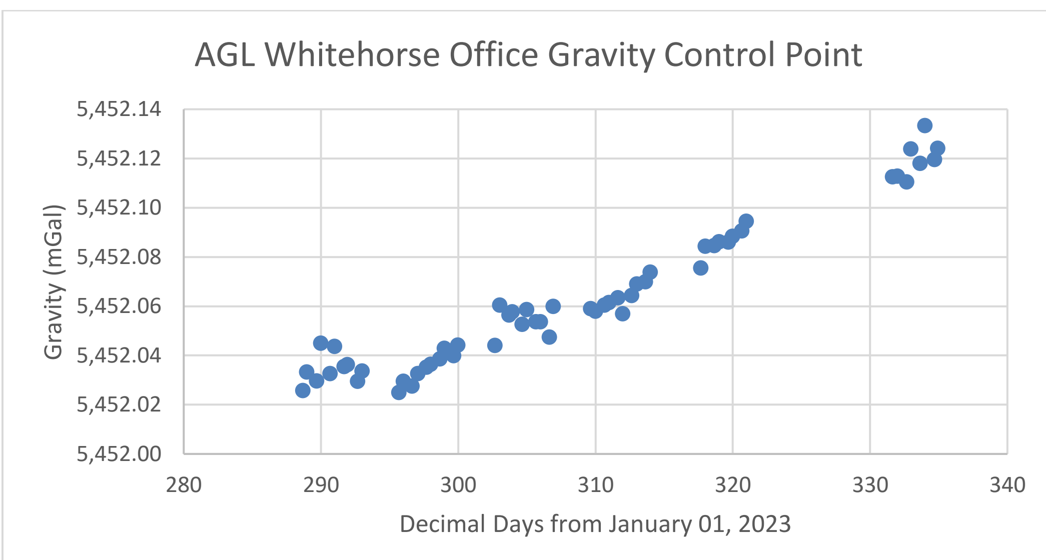

Figure 4. Pre- and post-survey measurements at Aurora Whitehorse office gravity control point.

6.4.3 Latitude

Due to the centrifugal force and equatorial distension of the terrestrial spheroid, Earth's gravitational field varies with latitude. Gravitational acceleration consequently increases from the equator towards the poles. Somigliana's equation is used to determine the expected strength of the gravitational field at the latitude of every gravity station through:

$$G_\phi = G_e \frac{1 + \mathrm{k}\sin^2\phi}{\sqrt{1 - e^2\sin^2\phi}}$$

Where G_ϕ is the expected gravitational field at latitude ϕ, $G_e$is the normal gravity at the equator (978932.67715 mGal), e is the eccentricity of the Earth (6.69438002290 X 10^{-3}) and k is an ellipsoidal parameter (1.931851353 X 10^{-3}).

6.4.4 Free-Air

The free-air correction corrects for the change in distance from the centre of the Earth through:

$$\Delta g_{FA} = H(2\frac{G_\phi(1 + f + m - 2f\sin^2\phi)}{a} - 3H\frac{G_\phi}{a^2})$$

where Δg_{FA} is the free-air correction, H is the geoid elevation of the point, G_ϕ is the expected gravitational field at latitude ϕ, a is the semi-major axis of Earth (637817 m), f is the flattening of Earth (3.35281068118 X 10^{-3}) and m is 3.44978600308 X 10^{-3}.

The free-air anomaly is calculated by subtracting G_ϕ from the observed gravity (which incorporates the on-board tilt and temperature corrections, external calculated tidal, drift and local datum corrections) and then adding Δg_{FA}.

6.4.5 Bouguer Slab and Bullard-B

The Bouguer slab correction compensates for the attraction of an infinite slab of material of density *ρ* located between mean sea level and the elevation *H* of the gravity station. The Bouguer slab correction (Δg_B) is:

$$\Delta g_B = -0.0419 * \rho * H$$

The Bullard-B correction accounts for the curvature of Earth and is applied to account for the finite nature of the crustal slab used in the Bouguer correction.

6.4.6 Near Terrain

The near-station terrain correction compensates for the effect of local differences in topography within 20 m from a gravity station. Usually, the DEM are neither fine nor precise enough for this correction and instead gravity operators must measure the average slope within six 60° sectors in a 20 m radius around the reading site. However, the LiDAR data used for this survey is in excellent agreement with the measured phase-fixed GNSS solutions and covers the survey area. As discussed in Section 6.2, the Arctic DEM is in good agreement with the both the LiDAR and the measured GNSS elevations. Given the quality of the DEM over the survey area, elevation differences are better extracted from the inner DEM and then used in the following sector equation for the gravitational effect of a sector from a vertical cylinder:

$$\delta g_T = \gamma\rho\theta\left\{(r_o - r_i) + \sqrt{r_i^2 + \Delta z^2} - \sqrt{r_o^2 + \Delta z^2}\right\}$$

where δg_T is the terrain correction required for a sector of angle θ with inner and outer radii equal to r_i and r_o , γ is the gravitational constant (6.67430 X 10^{-11}Nm²/kg²), terrain density equals ρ, and $\Delta z = |z_s - z_a|$ where z_s is the station elevation and z_a is the average terrain elevation in the sector. The 2 m DEM is interpolated to make a calculation for a suite of cylindrical sectors with $r_o - r_i = 0.1$.

The final near terrain correction (Δg_{NT}) is the sum of the contributions from all individual sectors as:

$$\Delta g_{NT} = \sum_r \sum_\theta \delta g_T(r,\theta)$$

The elevation used at the station for the near-station terrain correction is the sampled elevation from the DEM instead of the actual measured GNSS elevation. This prevents artifacts from any mismatch between the measured elevation and the DEM.

6.4.7 Far Terrain

The far-station terrain correction compensates for terrain effects from 20 m to over 100 km outside the survey area.

Three zones of DEMs, as previously described in the DEM section, are used with the following formula to evaluate the vertical component of the gravitational attraction of a flat top prism.

$$\delta g_{FT}(x,y,z) = -\gamma\rho \int_{x-u_1}^{x-u_2} \int_{y-v_1}^{y-v_2} \int_{z-w_1}^{z-w_2} \frac{w}{\sqrt{(u^2+v^2+w^2)^2}} du\, dv\, dw$$

Each DEM node becomes the centre of a prism reaching halfway to the adjacent nodes and is combined with each gravity station location. For every gravity station, the sum of the contribution of all individual DEM nodes yields the far terrain correction (Δg_{FT}).

The elevation used at the station for the far-station terrain correction is the sampled elevation from the DEM.

6.5 TREND REMOVAL

Trend removal is a common practice in gravity surveys to highlight features of interest that can be masked by large scale gravity trends. The data are gridded using a minimum curvature algorithm with a 100 m cell size and then several methods of trend removal can be used.

- For the first-order trend removal (FOTR), all points of the gridded data are used to calculate a best-fit plane which is then subtracted from the original grid.
- For the second-order trend removal (SOTR), all points of the gridded data are used to calculate a best-fit second order polynomial which is then subtracted from the original grid.
- The original gridded data are upward continued by 2500 m and the upward continued grid is subtracted from the BA grid. The resultant grid then has the long wavelengths removed and are labelled up2500TR.

For this survey, all three methods of trend removal were used to produce a residual BA product for a suite of densities.

7 RESULTS AND DISCUSSION

Details of all the remeasurements are shown in Table 6. The *Distance* column reflects the separation between the remeasurements; if the distance was greater than 20 m, the stations were treated as separate measurements. It should be noted that some stations were not within the above noted parameters, therefore, the *Accepted Range* and *Accepted Mean* columns are left blank and the original values for BA_267_Avg (where repeat readings are averaged) were left in the database. Where the distance of the remeasurements was less than 20 m, the values were averaged, and this mean was used in the database. Of the accepted values, the mean difference of the remeasurements is 0.022 mGal with a maximum difference of 0.049 mGal. These values give an indication of the overall error associated with the survey.

Several of the stations were remeasured because a phase-fixed solution was not achieved at the first site, however they are included in this analysis as the first GNSS solution was successfully post-processed.

The BA for ρ = 2.67 g/cm³ is shown in Figure 5, and the BA for ρ = 2.67 g/cm³ with the 2500 m upward continued trend removed is shown in Figure 6.

Table 6. Remeasurement Details

Line	Station	Easting (m)	Northing (m)	Distance (m)	Date (YYYY-MM-DD)	BA_267 (mGal)	Range (mGal)	Mean (mGal)	Accepted Range (mGal)	Accepted Mean (mGal)
15	2000	490542.943	6733562.379	0.078	2023-10-26	-105.592	0.049	-105.617	0.049	-105.617
15	2001	490542.946	6733562.301		2023-10-27	-105.641				
20	5000	490961.983	6736568.991	0.148	2023-10-19	-105.436	0.102	-105.385	0.102	-105.385
20	5001	490962.131	6736568.988		2023-10-20	-105.334				
20	5500	490885.829	6737071.008	0.040	2023-10-16	-104.490	0.001	-104.490	0.001	-104.490
20	5501	490885.813	6737070.971		2023-10-19	-104.489				
25	7000	491396.469	6738449.803	184.066	2023-10-18	-105.672	0.305	-105.520		
25	7001	491364.101	6738631.001		2023-10-23	-105.367				
35	500	492545.230	6732151.570	0.075	2023-10-31	-111.260	0.009	-111.256	0.009	-111.256
35	501	492545.190	6732151.507		2023-11-01	-111.251				
35	7000	492339.252	6738603.279	39.537	2023-10-23	-108.592	0.165	-108.675		
35	7001	492308.327	6738578.645		2023-10-23	-108.757				
50	4500	493916.756	6736175.792	0.099	2023-10-24	-109.983	0.009	-109.989	0.009	-109.989
50	4501	493916.854	6736175.776		2023-10-25	-109.992				
90	4000	493916.756	6736175.792	0.138	2023-11-08	-114.554	0.005	-114.557	0.005	-114.557
90	4001	493916.854	6736175.776		2023-11-09	-114.559				
						Mean	0.081		0.029	
						Maximum	0.305		0.102	

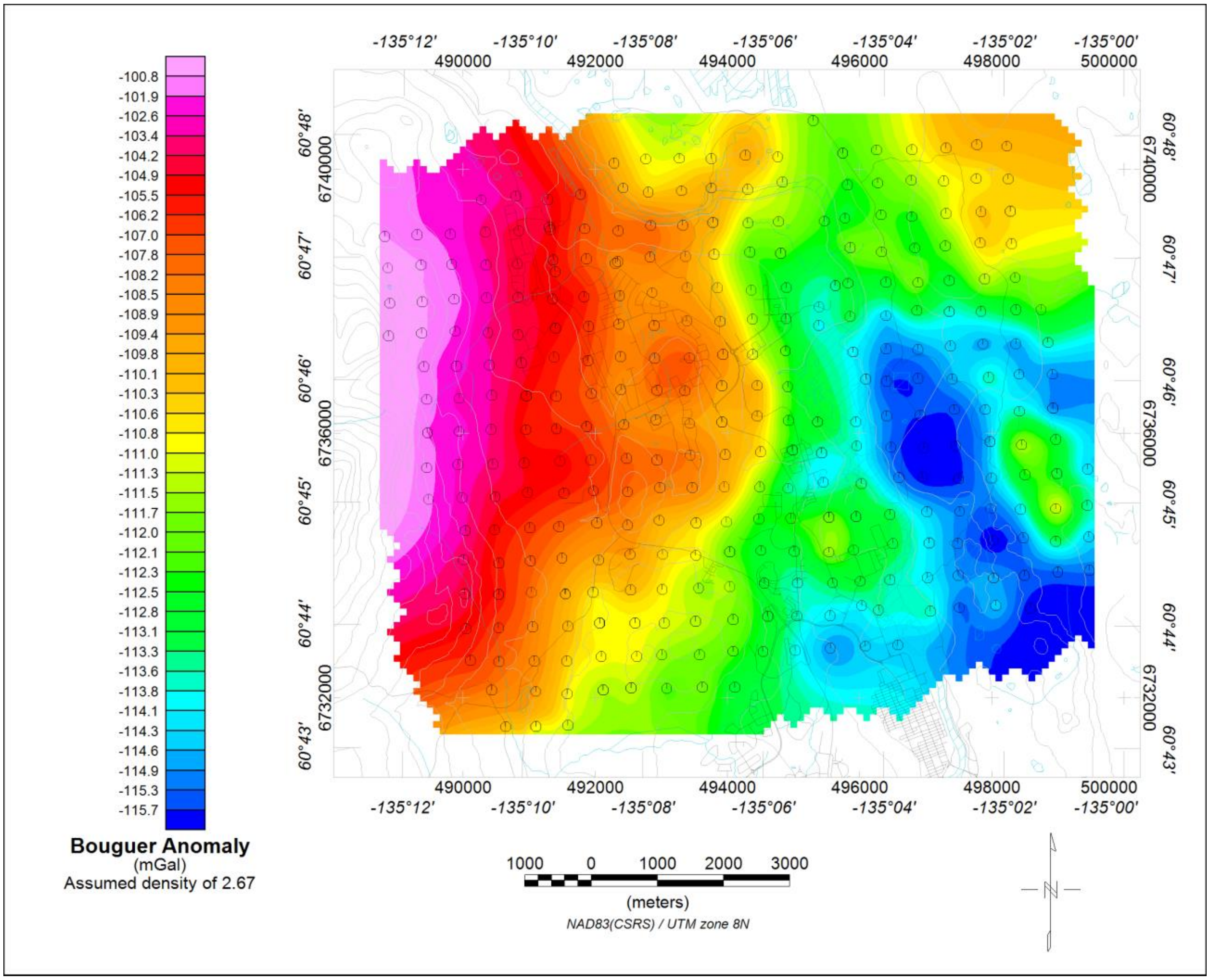

Figure 5. Bouguer anomaly for density of 2.67 g/cm³.

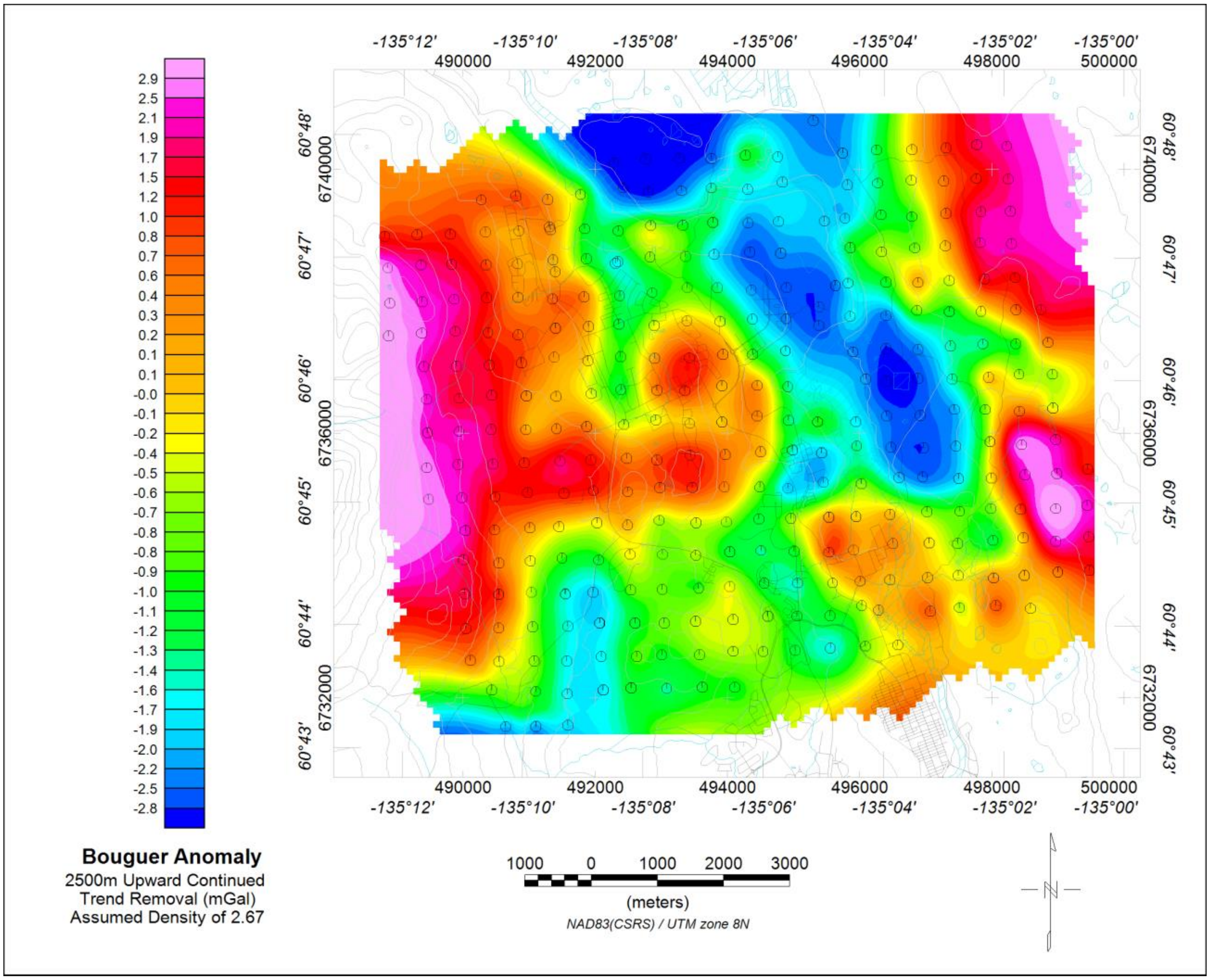

Figure 6. Bouguer anomaly for density of 2.67 g/cm³ with 2500 m upward continued trend removed.

8 PRODUCTS

The channels in the provided gravity database are described in Table 7.

Table 7. Database Channel Descriptions

Channel	Description	Units
Line	Local X coordinate.	m
Station	Local Y coordinate.	m
Time_UTC	HHMMSS of data collection in Coordinated Universal Time.	HHMMSS
Date_UTC	Date of data collection in Coordinated Universal Time.	YYYY-MM-DD
Xnad83z8	Corrected easting in NAD83 (CSRS) UTM Zone 8.	m
Ynad83z8	Corrected northing in NAD83 (CSRS) UTM Zone 8.	m
Zhae	Corrected elevation relative to the WGS84 ellipsoid.	m
Zcgvd2013_cgg2013a_2023	Corrected orthometric elevation relative to the CGG2013 Geoid using the 2023 epoch.	m
Grav_Cor_0	Gravimeter measurement with internal corrections (long-term instrument drift, instrument tilt, sensor temperature).	mGal
SD	Standard deviation of individual 10 Hz gravity measurement. The average of these is the basis for Grav_Cor_0.	mGal
Tide_Cor	Value of the tidal correction from Longman formulas, calculated using Python's *tidegravity* library.	mGal
Instrument_Drift_Cor	Drift of the instrument since the first occupation of a gravity Aurora Whitehorse Office control point on that shift.	mGal
Tie_Drift_Cor	Levelling to the gravity Aurora Whitehorse Office control point datum of 0.000 mGal.	mGal
To_Abs_Gravity	Offset for gravity Aurora Whitehorse Office control point to absolute gravity.	mGal
Latitude_Cor	Latitude correction.	mGal
FreeAir_Cor	Free air correction.	mGal
Bouguer_267_Cor	Bouguer slab correction for ρ = 2.67 g/cm^3.	mGal
BullB_267 Cor	Bullard-B correction for ρ = 2.67 g/cm^3.	mGal
NT_267_Cor	Near station terrain correction for ρ = 2.67 g/cm^3.	mGal
FT_A_267_Cor	Far station terrain correction for ρ = 2.67 g/cm^3 using the inner DEM.	mGal
FT_B_267_Cor	Far station terrain correction for ρ = 2.67 g/cm^3 using the intermediate DEM.	mGal
FT_C_267_Cor	Far station terrain correction for ρ = 2.67 g/cm^3 using the outer DEM.	mGal
Bathy_A_167_Cor	Bathymetric correction for ρ = 1.00 g/cm^3. Not used in this survey.	mGal
Lat	NAD83 (CSRS) latitude.	DD.dddddd
Long	NAD83 (CSRS) longitude.	DD.dddddd
CQ3D	A measure of quality for the GNSS solution.	m
Duration	Duration of gravity measurement.	s
Serial	Short version of gravimeter serial number.	string
Model	Model of gravimeter (string).	string

Channel	Description	Units
Tilt_X	X-axis tilt of gravity measurement.	arcsec
Tilt_Y	Y-axis tilt of gravity measurement.	arcsec
Sensor_Temp	Sensor temperature compared to its reference value.	mK
Grid	Name of survey grid.	string
Operator	Initials of gravity operator.	string
IH	Instrument height. Assumed to be constant and not used in this survey.	cm
IH_Cor	Instrument height correction. Not used in this survey.	mGal
Scaling_Adj	Adjustment for elevation scaling differences between gravimeters. Not used in this survey.	mGal
Abs_Grav	Absolute gravity established from the gravity measurement.	mGal
Flag	Note on gravity or GNSS measurement.	string
QAQC_GNSS	Quality control for GNSS readings, a “1” indicates acceptance.	Boolean
QAQC_Grav	Quality control for gravity readings, a “1” indicates acceptance.	Boolean
FreeAir_Anomaly	Grav_Cor_0 + Tide_Cor + Instrument_Drift_Cor + Tie_Drift_Cor + Latitude_Cor + FreeAir_Cor + To_Abs_Grav.	mGal
BA_267	FreeAir_Anomaly + Bouguer_267_Cor + BullB_267_Cor + NT_267_Cor + FT_A_267_Cor + FT_B_267_Cor + FT_C_267_Cor + Bathy_A_167_Cor.	mGal
BA_267_avg	Averaged repeats for BA_267.	mGal
BA_267_RepAvg	Remeasured points averaged for BA_267.	mGal
BA_240_Avg	Bouguer Anomaly points averaged for ρ = 2.40 g/cm^3 .	mGal
BA_250_Avg	Bouguer Anomaly points averaged for ρ = 2.50 g/cm^3 .	mGal
BA_260_Avg	Bouguer Anomaly points averaged for ρ = 2.60 g/cm^3.	mGal
BA_270_Avg	Bouguer Anomaly points averaged for ρ = 2.70 g/cm^3 .	mGal
BA_280_Avg	Bouguer Anomaly points averaged for ρ = 2.80 g/cm^3 .	mGal
LiDAR	Orthometric height, sampled from the 1m cell size raster derived from the 2019 LiDAR survey, obtained from Yukon Government.	(m)
LiDAR2RTK	Offset of LiDAR elevations to the measured GNSS elevations.	(m)

Table 8 describes the digital products found in Appendix I of this report.

Table 8. Products

Folder \ *File*	**Description of Contents**
Final Products\PDF,PNG,TIF**.pdf,*.png,*.tif*	Figures in pdf, png and tif format.
Processed Data\ASCII**.xyz*	Processed gravity and GNSS data in xyz format.
Processed Data\Databases**.gdb*	Processed gravity data in gdb format.
Processed Data\Grids**.grd*	Full suite of Bouguer Anomaly grids in Oasis *.grd format at 100 m cell size. Suite of densities = 2.40 g/cm³, 2.50 g/cm³, 2.60 g/cm³, 2.67 g/cm³, 2.70 g/cm³ and 2.80 g/cm³. Trend removal using FOTR, SOTR and up2500TR for density of 2.67 g/cm³ only.
Processed Data\Oasis Packed Maps**.map*	Figures in Oasis packed map format.
Raw Data\	Daily archive of instrument dump files organized by date.

Respectfully submitted,
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(signed)
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Reviewed by

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APPENDIX I

Digital Archives of the Ground Gravity Survey Data

Submitted electronically.

APPENDIX II

Program Crew Log

Submitted electronically.

APPENDIX III

Ground Gravity Survey Instrument Specifications

Submitted electronically.

APPENDIX IV

CGSN Whitehorse McIntyre Creek (9904-1990) Gravity Reference Station Report

Submitted electronically.