

# GOLD ROAD RESOURCES

## YANDINA 2021 GRAVITY SURVEYS

### PROCESSING AND LOGISTICS REPORT

January - February 2021

Report number 20020

Written by B. Wyschnja



DAISHSAT Geodetic Surveyors  
143 Brinkley Road  
PO Box 766, Murray Bridge  
South Australia 5253 Australia  
Telephone: 08 8531 0349  
Facsimile: 08 8531 0684  
david.daish@daishsat.com  
www.daishsat.com

Client Contact:  
Jarrad Trunfull  
j.trunfull@terraresources.com.au



## TABLE OF CONTENTS

1.0 INTRODUCTION .....	1
2.0 SURVEY OVERVIEW .....	2
3.0 PERSONNEL AND EQUIPMENT .....	4
3.1 Personnel .....	4
3.2 Survey equipment .....	4
3.3 Vehicles .....	4
3.4 Accommodation .....	5
3.5 Communications .....	5
4.0 GNSS SURVEYING AND PROCESSING .....	6
4.1 Set out and surveying of the grid .....	6
4.2 Survey datum and control .....	6
4.3 Processing of the position and level data .....	7
4.4 Quality control of the position and level data .....	7
5.0 GRAVITY ACQUISITION AND PROCESSING .....	8
5.1 Gravity data acquisition .....	8
5.2 Gravity base stations .....	8
5.3 Gravity data processing .....	8
5.4 Gravity meter calibrations and scale factors .....	13
5.5 Quality control of the processed gravity data .....	13
6.0 RESULTS .....	14
6.1 Stations surveyed and survey progress .....	14
6.2 Data repeatability .....	14
7.0 CONCLUSION .....	15
Appendix A - Gridded data images .....	16
Appendix B - Repeat tabulation and analysis .....	26
Appendix C - Survey information .....	27
Appendix D - Base station locations and information .....	28
Appendix E - Data USB & Field header descriptions .....	32

## 1.0 INTRODUCTION

Daishsat Geodetic Surveyors successfully carried out a precision ground gravity survey during January and February 2021 for Gold Road Resources, with 2,764 new gravity stations surveyed in the south eastern Wheatbelt region of Western Australia.

Scintrex CG-5 Autograv gravity meters were used for gravity data acquisition and base station control. Leica GX1230 differential GNSS receivers were used for gravity station positional acquisition. Gravity and GNSS data were acquired using Daishsat ATV and vehicle methods.



*Photo 1 – A Daishsat DATV, a highly modified all-terrain vehicle*

## 2.0 SURVEY OVERVIEW

Three individual areas were surveyed; named Hyden (approximately 85km southeast of Merredin), Laurel (approximately 125km south of Merredin) and E70 5100 (approximately 150km south of Merredin).

Survey stations were placed along roads, tracks, fencelines and at various other locations to gain coverage for the survey.

The survey areas were generally flat, with the majority of vegetation being open cropping farmland. There was some low to medium scrub present in some areas. At E70 5100 and Laurel, some salt lakes were avoided due to moisture & water.



*Photo 2 – DATV on the edge of a salt lake*



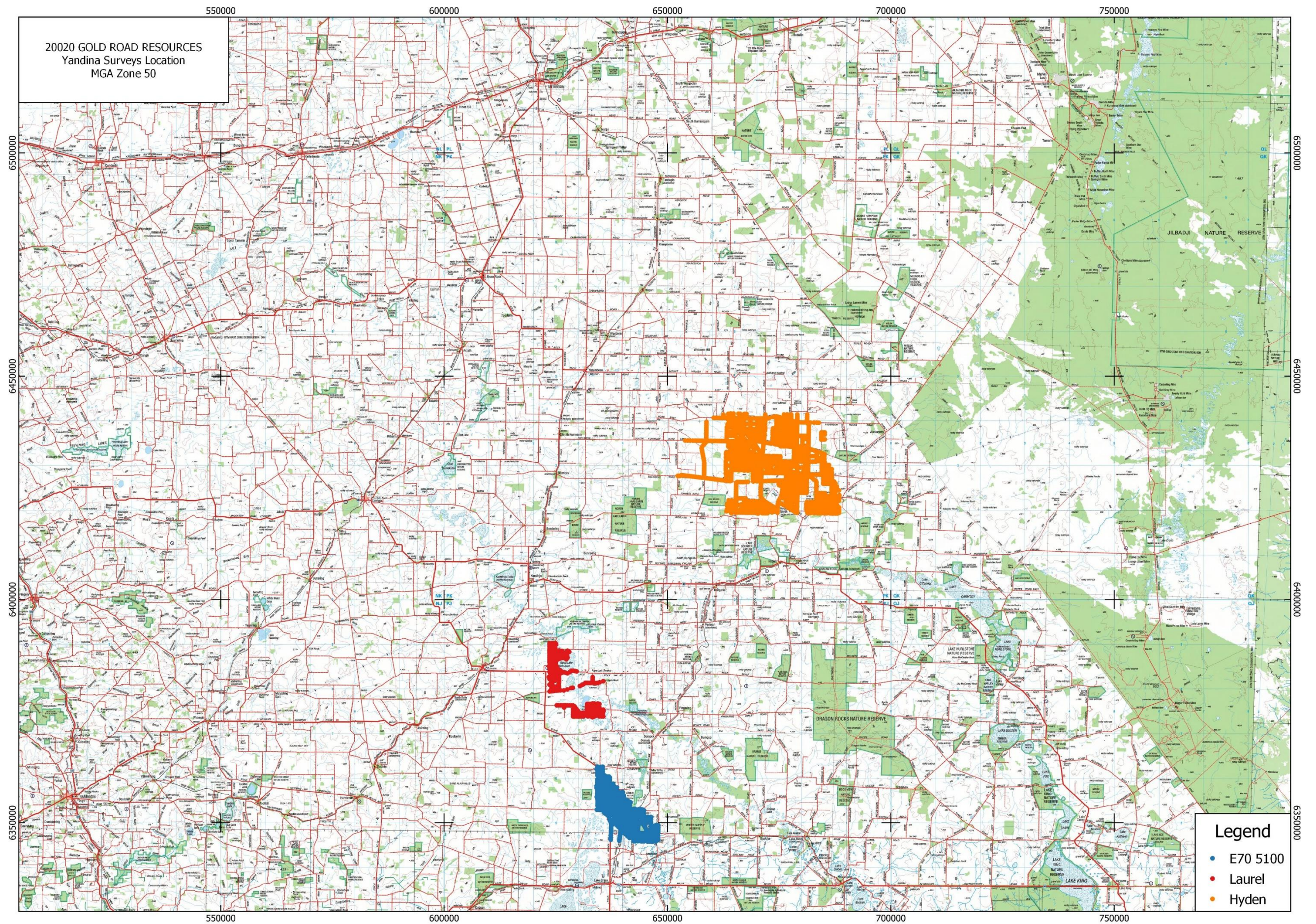


Figure 1 – Survey Location



## 3.0 PERSONNEL AND EQUIPMENT

### 3.1 Personnel

Gravity surveying, final data reduction, image processing and reporting was conducted by Daishsat Surveyors and Geophysicists. A full description of the personnel involved in the survey is listed in Appendix C – Survey information.

### 3.2 Survey equipment

Surveying equipment utilised on this survey included:

- Scintrex CG-5 Gravity meters
- Leica System GX1230 dual frequency GNSS receivers
- Garmin vehicle mounted GNSS receivers for navigation
- Notebooks for data processing and backup

### 3.3 Vehicles

Toyota Landcruisers were used for transport to & from site and acquisition along roads & tracks, with heavily customised John-Deere Gator 4WD all-terrain vehicles used for acquisition off roads and tracks (paddocks, scrub etc).

The Landcruisers are fitted with a range of safety equipment including:

- Dual fuel tanks
- Spare tyres, tubes and tyre repair kit
- Satellite phone and UHF Radio
- Garmin inReach satellite tracking device
- Self-recovery equipment including winch and snatch straps
- Tools and spares to enable field repairs as necessary
- Survival kit with EPIRB emergency locator beacon
- First Aid kits

The Daishsat ATV's were equipped with the following survey and safety equipment:

- Garmin inReach satellite tracking device
- 10L jerry can of spare fuel
- Spare tyres and tyre repair kit
- Satellite phone and UHF Radio
- Personal First Aid Kit
- Self-recovery equipment including winch, snatch straps
- Tools and spares to enable field repairs as necessary
- Survival kit with EPIRB emergency locator beacon

### 3.4 Accommodation

Crews were accommodated as close to the surveys as possible to reduce travel times.

### 3.5 Communications

Mobile phones, hand-held Iridium satellite phones and Garmin inReach satellite tracking devices enabled regular communication for safety and logistical purposes between the crew onsite and the Murray Bridge office. The inReach tracking device allowed Daishsat staff to monitor the crew location updated on a 10-minute interval basis, regardless of cellular service. UHF radios and phones were used for crew to crew communications.

Cellular networks were present at the crew accommodation which was used for data upload to the office.



*Photo 3 – DATV with CG5 gravity meter performing a gravity observation*

## 4.0 GNSS SURVEYING AND PROCESSING

### 4.1 Set out and surveying of the grid

Set out of the survey grid was done concurrently with the gravity data acquisition using Leica GX1230 dual-frequency GNSS units operating in autonomous mode. Where possible, the readings were taken as close as possible to the nominated coordinates. Some stations were moved from their nominated coordinates for various reasons including inaccessible trees and scrub, topographical features that could introduce severe local gravity terrain effects and other topographical issues making access to the station difficult or unsafe. Raw kinematic GNSS data was logged by a Leica GX1230 receiver during the gravity observations to determine the precise location of the GNSS antenna. Repeat gravity stations were strategically placed throughout the survey to monitor and control gravity meter performance and positional accuracy.

### 4.2 Survey datum and control

Three new GNSS base stations, numbered 1253 (Laurel), 1257 (Hyden) and 1260 (E70 5100), were established and utilised as primary GNSS control for each of their respective survey areas. Each was located coincident with the gravity base stations of the same number, as described in section 5.2.

Coordinates for the above GNSS base stations have been calculated using three survey days of static GNSS data connected to Australian based IGS (International GNSS Service, formerly the International GPS Service) stations using Geoscience Australia's online GNSS processing system, AUSPOS. These resulting base positions usually show final accuracy standard deviations (SD) of better than 5mm obtained for x, y and z, and can be considered first order. The resulting coordinates from AUSPOS are described in Appendix D – Base station location and information.



*Photo 4 – Base 1260 used for the survey*



A typical Daishsat base station consists of a star picket witness post with an affixed Daishsat plaque along with a short star picket driven to refusal about 10cm above ground level and emplaced about 30cm to the left of the witness post. All bases are photographed to create a permanent record that will ensure accurate access to this site as a future resource.

### 4.3 Processing of the position and level data

Raw kinematic GNSS data were logged at 5 second intervals on the Leica GX1230 GNSS receiver and static GNSS data was logged at 5 second intervals on a Leica GX1230 GNSS receiver set up on the GNSS base station. Surveys are planned such that base to rover baseline lengths are kept as short as possible to maintain reliable and accurate positional resolution. At times additional GNSS receivers are placed in the field at temporary unmarked locations to shorten the baseline lengths, and used in conjunction with the primary GNSS control receivers for processing.

At the end of each day all raw GNSS data was downloaded onto a laptop, compressed and transferred to the Daishsat FTP site. The data was processed using Waypoint's (Novatel) GrafNav GNSS post-processing software to produce positions accurate to within a couple centimetres for the antenna location at every 5 second epoch. This technique is known as Post Process Kinematic (PPK).



*Photo 5 – A Leica GX1230 GNSS receiver set up over base 1260 with a redundant base set up nearby*

### 4.4 Quality control of the position and level data

The GrafNav GNSS post-processing software has many tools and applications that assist our Surveyors and Geophysicists processing and analysing the data to ensure quality positional data is reliably and consistently obtained for all gravity stations throughout the project. Experience is required in structuring the field observations to collect reliable and accurate data in different conditions. Trees, scrub, long baseline lengths, different satellite windows and other factors can affect the GNSS observations and these need to be taken into account when planning and processing a survey. Repeat analysis on the survey data had demonstrated that accurate and reliable positional data has been collected and processed for this project.



## 5.0 GRAVITY ACQUISITION AND PROCESSING

### 5.1 Gravity data acquisition

Scintrex CG-5 Autograv gravity meters were used exclusively for the field acquisition. For each gravity observation the CG-5 gravity meter was carefully placed on its tripod and levelled, restricting the vertical and horizontal levels to 5 arc seconds. Once the meter was level, two gravity observations of 20-second stacking time were read and recorded. The instrument was monitored for any seismic or instrumental noise and the X/Y tilts, temperature and tolerance between readings was monitored during the reading by the Surveyor. The tolerance between readings is set at 0.030 of a dial reading and any readings falling outside of this were re-read. Field readings were also manually recorded by the field crews in Daishsat gravity field books along with any observations that may affect the reading.

During the day the field crews monitored any internal repeat gravity stations collected for abnormal drift and tares as well as the drift closure at the end of the day. If the meter received a bump or knock the previous station was revisited in order to detect if a tare had occurred.

### 5.2 Gravity base stations

Three gravity base stations, numbered 1253 (Laurel), 1257 (Hyden) and 1260 (E70 5100), were established and utilised for reduction and drift control for each of their respective survey areas. Each was located coincident with the GNSS base stations of the same number, as described in section 4.2.

Base 1260 was tied to the Australian Fundamental Gravity Network (AFGN) station 1950999916 at Merredin using an A-B-A loop with two gravity meters. 1253 and 1257 have both been tied to 1260 and each other to confirm values.

When in the field during field acquisition, a base station reading was taken in the morning before surveying commenced, and after the last field observation of the day. When taking a base station reading, the observed gravity values were stacked over 120 seconds to ensure accuracy. Observations were repeated until the readings repeated to 0.010 of a dial reading or less.

### 5.3 Gravity data processing

At the end of each day the raw gravity data was downloaded from the CG-5 instruments onto a laptop where preliminary quality control was carried out. Any erroneous station numbers were corrected and readings that fell outside of tolerance were removed. Once this was done Daishsat's in-house software was used to average the two 20-second readings for each gravity station, remove the Scintrex Earth Tide Correction and assign each gravity station reading an easting and northing co-ordinate and an ellipsoidal elevation. Geosoft GRAVRED software was then used to perform gravity reductions to produce a set of observed gravity values that can be used for gridding, imaging and further analysis.



The following corrections were applied to the raw gravity data using Geosoft's GRAVRED software:

**Instrument Scale Factor (SF):** This correction is applied to correct each raw gravity reading (in dial units) to a relative gravity unit value based on the meter calibration.

$$R_{SF} = r_d \times SF$$

Where:

$R_{SF}$  = scale factor corrected reading in milliGals

$r_d$  = raw gravity meter reading in dial units

SF = instrument scale factor (dial units/milliGal)

**Earth Tide Correction (ETC):** This correction is applied to correct for regular variations in the Earth's gravitational field due to changes in the relative position of the moon and sun. The Scintrex calculated ETC was removed and a new ETC was calculated using Geosoft Formulae.

$$r_{ETC} = r_{SF} + ETC$$

Where:

$r_{ETC}$  = Earth Tide Corrected reading in milliGals

$r_{SF}$  = Scale Factor Corrected reading in milliGals

ETC = Earth Tide Correction (ETC) in milliGals

**Instrument Drift Correction (IDC):** This correction is applied to compensate for the daily changes in the gravity meter due to mechanical stresses and strains encountered during surveying. The extension and contraction of the gravity meter spring with slight variations in temperature (obeying Hooke's Law) are the major cause of drift. The drift is assumed to be linear and is calculated by measuring the difference between the last and first base readings.

$$ID = \frac{r_{B2} - r_{B1}}{t_{B2} - t_{B1}}$$

Where:

ID = Instrument Drift in milliGals/hour

$r_{B2}$  = 2<sup>nd</sup> Gravity Base reading in milliGals

$r_{B1}$  = 1<sup>st</sup> Gravity Base reading in milliGals

$t_{B2}$  = Time of 2<sup>nd</sup> Gravity Base reading

$t_{B1}$  = Time of 1<sup>st</sup> Gravity Base reading



**Observed Gravity ( $G_{OBS}$ ):** The preceding corrections are applied to each of the raw gravity readings to calculate the earth's relative gravitational attraction at each of the field gravity stations. Absolute gravity values are determined relative to a known Observed gravity value at each base. Observed Gravity values were calculated for both the ISOGAL84 and AAGD07 gravity datums.

$$G_{BOS} = G_{B1} + (r_{ETC} - r_{B1}) - (t - t_{B1}) \times ID$$

Where:

$G_{B1}$	Gravity Base Observed Gravity in milliGals
$r_{ETC}$	Earth Tide Corrected reading in milliGals
$r_{B1}$	Gravity Base reading in milliGals
$t$	Time of field reading
$t_{B1}$	Time of Gravity Base reading
ID	Instrument Drift in milliGals/hour

Once Observed Gravity values were produced, an Excel spreadsheet was used to calculate Infinite Slab Bouguer Anomaly and Spherical Cap Bouguer Anomaly for each gravity station.

The following corrections were applied to produce Infinite Slab Geoidal Bouguer Anomaly values:

**Theoretical Gravity ( $G_{T67}$ ):** As the Earth is not a perfect sphere, with the polar radius being smaller than the equatorial radius, gravity values vary with latitude. This is due to the differences in the distance from the centre of the Earth's mass and differences in centrifugal accelerations at varying latitudes. The theoretical value of gravity was calculated using the 1967 variant of the International Gravity Formula and used to latitude correct the observed gravity.

$$G_{T67} = 978031.8456 \times (1 + 0.005278895 \times \sin^2 \phi + 0.000023462 \times \sin^4 \phi)$$

Where:

$\phi$	GDA94 latitude in decimal degrees
--------	-----------------------------------

**Infinite Slab Free-Air Correction (ISFAC):** Since gravity varies inversely with the square of distance, it is necessary to correct for changes in elevation between stations to reduce field readings to a datum surface.

$$ISFAC = (0.3087691 - 0.0004398 \times \sin^2 \phi) \times h_{AHD} - 0.0000001442 \times h_{AHD}^2$$

Where:

$h_{AHD}$	Height of the gravity meter above the Geoid (Ausgeoid09) in meters
-----------	--

**Infinite Slab Bouguer Correction (ISBC):** This correction accounts for the attraction of material between the station and datum plane that is ignored in the free-air calculation. A value of 2.67 t/m<sup>3</sup> was used in the correction to represent solid earth.

$$ISBC = 0.04191 \times \rho \times h_{AHD}$$

Where:

$\rho$	Earth density in gm/cc
$h_{AHD}$	Height of the gravity meter above the Geoid (Ausgeoid09) in meters

**Infinite Slab Free Air Anomaly (ISFAA):** This is obtained by applying the Infinite Slab Free Air Correction (ISFAC) to the Observed Gravity reading.

$$ISAA = G_{OBSG} - G_{T67} + ISFAC$$

**Infinite Slab Bouguer Anomaly (ISBA):** This is obtained when all the preceding reductions or corrections have been applied to the observed gravity reading.

$$ISBA = G_{OBSG} - G_{T67} + ISFAC - ISBC$$

The following corrections were applied to produce Spherical Cap Ellipsoidal Bouguer Anomaly values:

**Theoretical Gravity ( $G_{T80}$ ):** The theoretical gravity value for each gravity station was calculated using the closed form of the 1980 International Gravity Formula (Moritz, 1980) and used to latitude correct the observed gravity.

$$G_{T80} = 978032.67715 \times ((1 + 0.001931851353 \times \sin^2\phi) / \sqrt{1 - 0.00669438002290 \times \sin^2\phi})$$

Where:

$\phi$  GDA94 latitude in decimal degrees

**Atmospheric Correction (AC):** This correction removes the effect of the change in mass of the atmosphere above the ellipsoid by shifting it vertically into the interior of the geoid.

$$AC = 0.874 - 0.000099 \times h_{ELL} + 0.00000000356 \times h_{ELL}^2$$

Where:

$h_{ELL}$  Height of the gravity meter above the ellipsoid (GRS80) in meters

**Ellipsoidal Free-Air Correction (EFAC):** Since gravity varies inversely with the square of distance, it is necessary to correct for changes in elevation between stations to reduce field readings to a datum surface. The free air correction was calculated using GRS80 ellipsoidal heights and the second order approximation equation (Heiskanen and Mortiz, 1969):

$$EFAC = -1 \times (0.3087691 - 0.0004398 \times \sin^2\theta) \times h_{ELL} + (7.2125 \times 10^{-7}) \times h_{ELL}^2$$

where:

$h_{ELL}$  Height of the gravity meter above the ellipsoid (GRS80) in meters

$\phi$  GDA94 latitude in decimal degrees



**Spherical Cap Bouguer Correction (SCBC):** This correction accounts for the attraction of material between the station and datum plane that is ignored in the free-air calculation. The Bouguer correction uses the closed form equation for the gravity effect of a spherical cap of radius 166.7 km based on a spherical Earth with a mean radius of 6,371.0087714 km, height relative to the GRS80 ellipsoid, and an earth density of 2.67 t/m<sup>3</sup> was used in the correction to represent solid earth.

$$SCBC = 2 \times \pi \times (6.67428 \times 10^{-11}) \times \rho \times ((1 + \mu) \times h - \lambda \times R)$$

Where:

$\pi$       pi

$\rho$       Earth density in gm/cc

$h$       height of the gravity meter above the GDA94 ellipsoid in meters

$\mu$  &  $\lambda$  are dimensionless coefficients with following definitions

$$\mu = ((1/3) \times \eta^2 - \eta)$$

where:

$$\eta = h/R$$

$$\lambda = (1/3) \{ (d + f\delta + \delta^2) [(f - \delta)^2 + k]^{1/2} + p + m \ln(n / (f - \delta + [(f - \delta)^2 + k]^{1/2})) \}$$

where:

$$d = 3 \times \cos^2 \alpha - 2$$

$f = \cos \alpha$ ; Please Note this “f” is NOT the same as the parameter “f” in Free Air Correction above.

$$k = \sin^2 \alpha;$$

$$p = -6 \times \cos^2 \alpha \sin(\alpha/2) + 4 \times \sin^3(\alpha/2);$$

$$\delta = R_o / R;$$

$m = -3 \times \sin^2 \alpha \cos \alpha = -3 \times k \times f$  \*Note “m” is NOT the same as the parameter “m” in Free Air Correction above.

$$n = 2 \times [\sin(\alpha/2) - \sin^2(\alpha/2)]$$

$$\alpha = S/R_o, \text{ with } S = \text{Bullard B Surface radius} = 166.735 \text{ km.}$$

**Ellipsoidal Free Air Anomaly (EFAA):** This is obtained by applying the Atmospheric Correction (AC) and Ellipsoidal Free Air Correction (FAC) to the observed gravity reading.

$$EFAA = G_{OBS} - (G_{T80} - AC) - EFAC$$

**Spherical Cap Bouguer Anomaly (SCBA):** This is obtained when all the preceding reductions or corrections have been applied to the observed gravity reading.

$$SCBA = EFAA - SCBC$$

## 5.4 Gravity meter calibrations and scale factors

All the company gravity meters undergo regular calibrations over the Kensington to Norton Summit calibration range in Adelaide. Meters are also calibrated upon return from repair by the manufacturer (Scintrex in Canada).

Along with calibrations we also conduct regular tilt tests, sensor drift calibrations and temperature adjustments in our technical workshops in Murray Bridge.

The gravity meters used on the survey along with their most recent calibration factors are described in Appendix C – Survey information.

## 5.5 Quality control of the processed gravity data

Following the reduction of the gravity data, quality control was carried out to check the repeatability of the positional and gravity observations.

The elevation and gravity data were gridded using ChrisDBF to produce ERMapper compatible grid files of the Orthometric (AHD) height and the Infinite Slab Bouguer Anomaly (ISBA) data. A First Vertical Derivative filter was applied to each ISBA grid to produce First Vertical Derivative grids. These grids were imaged using Oasis Montaj where they were checked for any anomalous points. A plot of the acquired gravity stations was regularly monitored to make sure no stations were missed.



## 6.0 RESULTS

Raw and processed GNSS and gravity data are contained on a USB drive as Appendix E. A hardcopy of the gridded data images are contained in Appendix A.

### 6.1 Stations surveyed and survey progress

In total 2,763 new gravity stations were acquired during the project and of these, 257 (9.3%) were revisited for survey quality control. Station numbers and repeats are broken down by survey name in Appendix C.

The crews completed the survey in around 4 weeks, inclusive of weather standby, control, and mobilisation between survey areas.

### 6.2 Data repeatability

Analysis of the repeat data shows that measurement repeatability was excellent for both GNSS and Gravity observations. An analysis of the survey data is included in Appendix B. Based on the repeat data, one can assume the following typical accuracies for the observables:

Gravity standard deviation (SD) of repeats:	0.023 mGal
Height standard deviation (SD) of repeats:	0.020 m

## 7.0 CONCLUSION

Daishsat Geodetic Surveyors successfully carried out a precision ground gravity survey for Gold Road Resources in January and February 2021.

The survey was conducted safely, without incident and with minimal environmental impacts. Final results have been demonstrated to be accurate, reliable and conducted to the highest standards with modern calibrated acquisition equipment, professional experienced staff, proven acquisition techniques and quality control procedures.



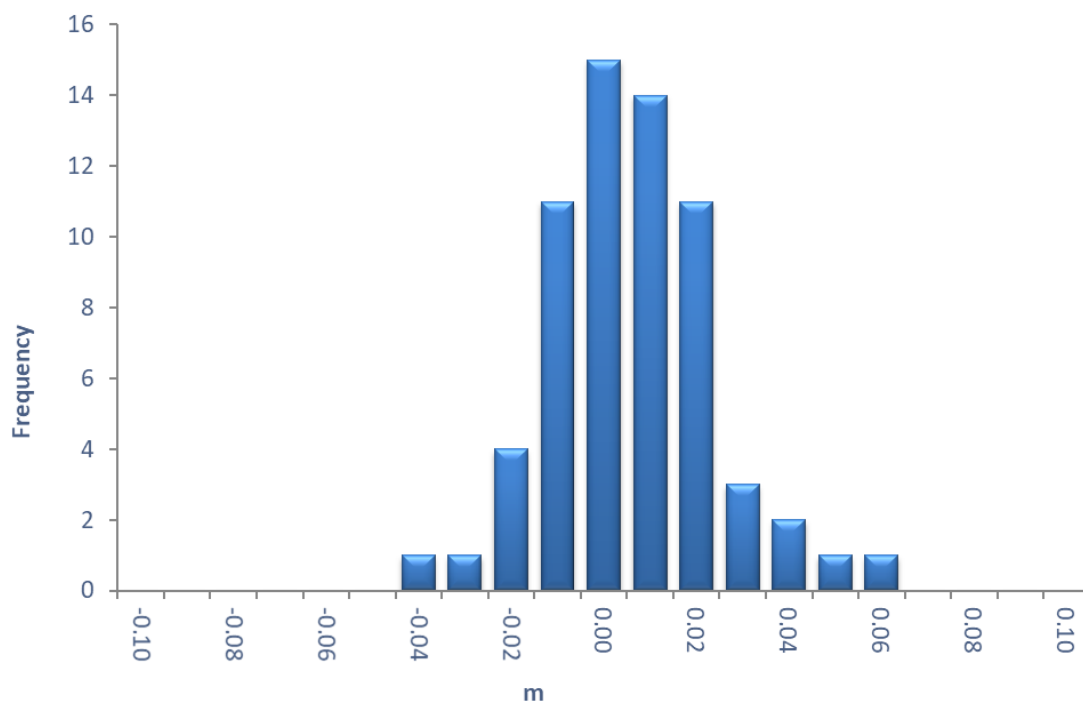
## Appendix A

### Gridded data images

## Appendix B

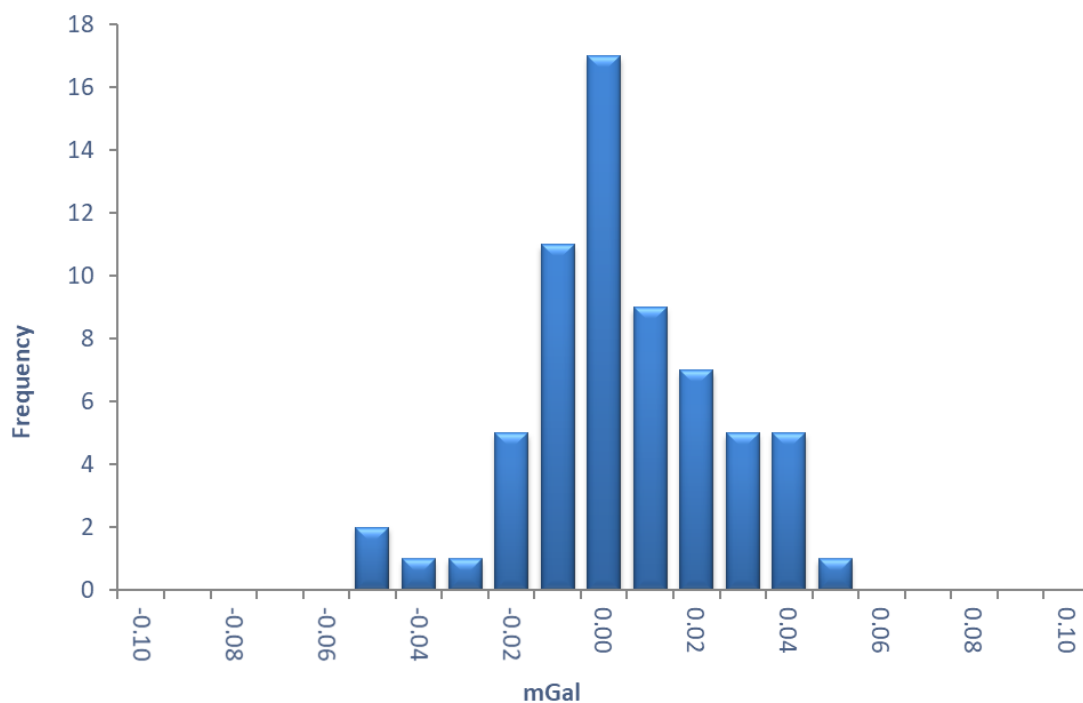
### Repeat tabulation and analysis

#### Histogram of height repeats



Height standard deviation (SD) of repeats: 0.020 m

#### Histogram of gravity repeats



Gravity standard deviation (SD) of repeats: 0.023 mGal



## Appendix C

### Survey information


20020 GOLD ROAD RESOURCES				
2021 Yandina Gravity Surveys				
Survey date	27/1/2021 - 23/2/2021			
Surveyors / Personnel	Joel Broderick / Gareth Redington / Frank Duffy / Daniel Rutherford			
Processors	Harley Jones / Ben Wyschnja			
Techniques employed	Post processed DATV / Vehicle gravity			
GNSS receiver types used	Leica GX1230			
Number of new points acquired	2,763			
Number of repeats on new points	257 (9.3 %)			
Height observation accuracy (SD)	0.02 m			
Gravity observation accuracy (SD)	0.023 mGal			
GNSS / Gravity bases used	Daishsat Bases 1253, 1257 and 1260 / AFGN station 1950999916			
Station numbers and repeats by survey name				
Survey name	New Stations	Repeats	SD (m)	SD (mGal)
Hyden	1,783	134	0.022	0.025
Laurel	286	42	0.017	0.023
E70_5100	694	81	0.017	0.018
Gravity Meters				
Meter Serial	Meter Letter	Scale Factor	Date & State of Calibration	
CG5 - 80440373	N	1.000477	28/5/20 (SA)	
CG5 - 91240603	V	1.002798	13/1/21 (SA)	

## **Appendix D**

### **Base station locations and information**

GNSS/Gravity 1253 - Jilakin Rock			
FINAL AUSPOS CO-ORDINATES			
MGA94 / AHD		GDA94 / GRS80	
EASTING (m)	623469.85	LATITUDE (DMS)	32° 39' 54.78566" S
NORTHING (m)	6385060.18	LONGITUDE (DMS)	118° 19' 0.20542" E
ZONE (UTM, South)	50	ELL HT (m)	258.15
ORTHO HT (AHD, m)	284.39		
N (AUSGEOID09, m)	-26.25		
CONTROL DETAILS			
Observed Gravity ISO GAL84 (mGal)		Observed Gravity AAGD07 (mGal)	
Calculated ObsG	979449.310	Calculated ObsG	979449.232
Gravity Control		GNSS Control	
Gravity – Daishsat using ties with 2 meters to bases 1260 and 1257. Expected accuracy better than 0.010mGal.		GNSS – Daishsat using multiple static sessions and the AUSPOS online GNSS processing system. Expected accuracy of station coordinates better than 0.005m.	
MISCELLANEOUS DETAILS			
Est. Date:	5/02/2021	Established By:	Joel Broderick
		Survey:	20020
DESCRIPTION AND ACCESS			
<p>This base station consists of a small star picket protruding from the ground and is witnessed by a Daishsat survey plaque, placed on a large star picket ~ 0.3m to the right. The base is located 50km north of Lake Grace. From the intersection of South Rd and Stubbs Rd (Highway 107) at the Lake Grace Roadhouse, zero the odometer (0.0km) head north on South Rd (which becomes Kulin-Lake Grace Rd) for approximately 17km coming to an T interesection (MGA Z50, E 637400, N 6352860). Turn left continuing east along Kulin-Lake Grace Rd for approximately 2km (19km) before turning right and heading north toward Kulin still on the Kulin-Lake Grace Rd for approximately 36.5km (55.5km) coming to a T intersection (MGA Z50, E 622705, N 6383900). Turn left at the T intersection and travel for 400m (55.9km) turning right onto Jilakin Rock Rd ( MGA Z50, E 622310, N 6383980). Continue along Jilakin Rock Rd for 2.2km (58.1km) and turn right into Micheal Lucchesi's property (MGA Z50, E 623530, N 6385190) where you will find Base 1253 on the right, approximately 135m from the farm entrance in a fence line (near 5th picket from fence corner).</p>			
<div></div>			
Field Photo Of Base			



GNSS/Gravity 1257 - Sweeney			
FINAL AUSPOS CO-ORDINATES			
MGA94 / AHD		GDA94 / GRS80	
EASTING (m)	673512.35	LATITUDE (DMS)	32° 12' 31.69125" S
NORTHING (m)	6434933.53	LONGITUDE (DMS)	118° 50' 27.68777" E
ZONE (UTM, South)	50	ELL HT (m)	363.06
ORTHO HT (AHD, m)	388.82		
N (AUSGEOID09, m)	-25.76		
CONTROL DETAILS			
Observed Gravity ISOGL84 (mGal)		Observed Gravity AAGD07 (mGal)	
Calculated ObsG	979372.578	Calculated ObsG	979372.500
Gravity Control		GNSS Control	
Gravity – Daishsat using ties with 2 meters to bases 1260 and 1253. Expected accuracy better than 0.010mGal.		GNSS – Daishsat using multiple static sessions and the AUSPOS online GNSS processing system. Expected accuracy of station coordinates better than 0.005m.	
MISCELLANEOUS DETAILS			
Est. Date:	11/02/2021	Established By:	Joel Broderick
		Survey:	20020
DESCRIPTION AND ACCESS			
<p>This base station consists of a small star picket protruding from the ground and is witnessed by a Daishsat survey plaque, placed on a large star picket ~ 0.3m to the right. The base is located approximatley 33km north of Hyden. From the intersection of Marshall St (Highway 40) and McPherson St in Hyden (MGA Z50, E 675145, N 6408145), head north on McPherson St (which becomes Hyden-Mount Walker Rd after about 300m) for 31km. Turn right onto South Kumminin East Rd (MGA Z50, E671540, N 6435205) and head east for about 2km turning left into 4887 S Kumminin Rd E (MGA Z50, E 671540, N 6435205) which is the entrance to the McSweeny property. Base 1257 is approximatley 20m directly in front, at the end of the fenceline, corner of paddock.</p>			
			
Field Photo Of Base			

GNSS/Gravity 1260 - Northfield			
FINAL AUSPOS CO-ORDINATES			
MGA94 / AHD		GDA94 / GRS80	
EASTING (m)	638329.02	LATITUDE (DMS)	32° 57' 15.85772" S
NORTHING (m)	6352795.76	LONGITUDE (DMS)	118° 28' 47.85333" E
ZONE (UTM, South)	50	ELL HT (m)	257.42
ORTHO HT (AHD, m)	284.20		
N (AUSGEOID09, m)	-26.78		
CONTROL DETAILS			
Observed Gravity ISOGL84 (mGal)		Observed Gravity AAGD07 (mGal)	
Calculated ObsG	979468.772	Calculated ObsG	979468.694
Gravity Control		GNSS Control	
Gravity – Daishsat using 1 ABA tie with 2 gravity meters to AFGN station 1950999916 at Merredin. Expected accuracy better than 0.010mGal.		GNSS – Daishsat using multiple static sessions and the AUSPOS online GNSS processing system. Expected accuracy of station coordinates better than 0.005m.	
MISCELLANEOUS DETAILS			
Est. Date:	27/01/2021	Established By:	Joel Broderick
		Survey:	20020
DESCRIPTION AND ACCESS			
<p>This base station consists of a small star picket protruding from the ground and is witnessed by a Daishsat survey plaque, placed on a large star picket ~ 0.3m to the right. The base is located 17km north of Lake Grace. From the intersection of South Rd and Stubbs Rd (Highway 107) at the Lake Grace Roadhouse, head north on South Rd (which becomes Kulin-Lake Grace Rd) for approximatley 17km coming to an T intersesection (MGA Z50, E637400, N 6352860). Turn right onto N Lake Grace-Karlgarin Rd and travel for 700m before turning right into Northfield Farm (Smith property). Base 1260 is about 30m from the road in the middle island of the 2 track driveway.</p>			
<div></div>			
Field Photo Of Base			

## Appendix E

### Data USB & Field header descriptions

(Attached to back cover)

Daishsat Data - Column Headers		
Field Header	Field Description	Units
PROJECT	Contractor Project Number	
OPERATOR	Contractor Company Name	
SURVEY_NAME	Survey Name	
STATION	Unique Station ID	
LINE	Survey Line number (if applicable, -99 for null values)	
RECORD_TYPE	Record observation type (Base, Field, Repeat, Existing_Repeat)	
METER_MODEL	Model of Gravity Meter	
METER_SN	Serial Number of Gravity Meter	
EAST_MGA94_m	Easting (MGA Grid, GRS80, GDA94)	m
NORTH_MGA94_m	Northing (MGA Grid, GRS80, GDA94)	m
ZONE	UTM Zone Number	
LAT_GDA94_DD	Coordinate Latitude (Geodetic, GRS80, GDA94)	DD
LONG_GDA94_DD	Coordinate Longitude (Geodetic, GRS80, GDA94)	DD
HEIGHT_AHD09_m	Orthometric Height - Australian Height Datum AHD (AUSGEOID09)	m
HEIGHT_GRS80_m	Ellipsoid Height (Geodetic, GRS80, GDA94)	m
N_AUSGEOID09_m	Geoid Ellipsoid separation N (AUSGEOID09)	m
DATE	Observation Date (DD/MM/YYYY)	
TIME	Observation Time (HH:MM:SS)	
DIAL_mGal	Gravity Dial Reading	mGal
SCALE_mGal	Scale Factor Applied to Dial Reading	mGal
ETC_mGal	Earth Tide Correction (Longman)	mGal
DRIFT_mGal	Drift value applied to Dial Reading	mGal
OBSG84_mGal	Observed Gravity (ISOGL84)	mGal
OBSG07_mGal	Observed Gravity (AAGD07)	mGal
TG1967_mGal	Theoretical Gravity (1967 variant)	mGal
TG80_mGal	Theoretical Gravity (1980 variant)	mGal
ISFAC_mGal	Infinite Slab Free Air Correction using Orthometric Height (AHD AUSGEOID09)	mGal
ISFAA_mGal	Infinite Slab Free Air Anomaly using Orthometric Height (AHD AUSGEOID09)	mGal
ISBC_267_mGal	Infinite Slab Bouguer Correction (2.67 t/m <sup>3</sup> ) using Orthometric Height (AHD AUSGEOID09)	mGal
ISBC_240_mGal	Infinite Slab Bouguer Correction (2.40 t/m <sup>3</sup> ) using Orthometric Height (AHD AUSGEOID09)	mGal
ISBC_220_mGal	Infinite Slab Bouguer Correction (2.20 t/m <sup>3</sup> ) using Orthometric Height (AHD AUSGEOID09)	mGal
ISBA_267_mGal	Infinite Slab Bouguer Anomaly (2.67 t/m <sup>3</sup> ) using Orthometric Height (AHD AUSGEOID09)	mGal
ISBA_240_mGal	Infinite Slab Bouguer Anomaly (2.40 t/m <sup>3</sup> ) using Orthometric Height (AHD AUSGEOID09)	mGal
ISBA_220_mGal	Infinite Slab Bouguer Anomaly (2.20 t/m <sup>3</sup> ) using Orthometric Height (AHD AUSGEOID09)	mGal
ATMC_mGal	Spherical Cap Atmospheric Correction using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
EFAC_mGal	Spherical Cap Free Air Correction using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
EFAA_mGal	Spherical Cap Free Air Anomaly using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
SCBC_267_mGal	Spherical Cap Bouguer Correction (2.67 t/m <sup>3</sup> ) using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
SCBC_240_mGal	Spherical Cap Bouguer Correction (2.40 t/m <sup>3</sup> ) using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
SCBC_220_mGal	Spherical Cap Bouguer Correction (2.20 t/m <sup>3</sup> ) using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
SCBA_267_mGal	Spherical Cap Bouguer Anomaly (2.67 t/m <sup>3</sup> ) using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
SCBA_240_mGal	Spherical Cap Bouguer Anomaly (2.40 t/m <sup>3</sup> ) using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
SCBA_220_mGal	Spherical Cap Bouguer Anomaly (2.20 t/m <sup>3</sup> ) using Ellipsoid Height (Geodetic, GRS80, GDA94)	mGal
DIFF_EAST_m	Repeat Error for MGA Easting Observation	m
DIFF_NORTH_m	Repeat Error for MGA Northing Observation	m
DIFF_GDA94_m	Repeat Error for Ellipsoid Height (GDA94)	m
DIFF_OBSG84_mGal	Repeat Error for Observed Gravity (ISOGL84)	mGal
CLOSURE_mGal	Loop Closure	mGal
BASE_GRV	Gravity Base Station Number	
BASE_GPS	GPS Base Station Number	