GOVERNMENT OF WESTERN AUSTRALIA

Landgate

GSU-8 GNSS Test Network

Guidelines for testing survey grade GNSS equipment on the Curtin Test Network

Locate Value Secure

Survey September 2025 Version 2025.0

Document control

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Document version history

Date	Author	Version	Revision Notes
January 2024	Survey	2024.1	Style and minor amendments
July 2024	Survey	2024.2	Removal of Pillar 16
September 2025	Survey	2025.0	Removal of Pillar 19 & 21 Readded Pillar 16 New Pillar 23 Added Applecross 98 (SALT) CORS

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Introduction

This guide is intended for users of Global Navigation Satellite Systems (GNSS) in Western Australia and is issued under the authority of the Surveyor General. It outlines recommended practices for testing GNSS hardware, firmware and software performance using a GNSS network established by Landgate at Curtin University Bentley Campus.

The GNSS network consists of four (4) concrete pillars and one (1) Continuously Operated Reference Station (CORS) (refer to map on page 8). All pillars are regularly coordinated horizontally and vertically to ensure stability, with updates performed periodically.

The aim of this guideline is to encourage all surveyors to take a consistent approach to testing of their GNSS equipment. Note: Some testing requirements may not reflect the user's normal operation of their GNSS equipment, particularly with respect to data collection rates and/or the number of satellites observed.

It is emphasised that these guidelines do not represent legal traceability of measurement and position by GNSS.

The following understandings and limitations apply:

- These guidelines apply to GNSS hardware and software designed for geodetic grade survey applications operated in differential mode where carrier phase and pseudo-ranges are observed.
- All equipment used in this test must be in good working order, adjusted, calibrated and the GNSS antenna must be oriented correctly.
- This test does not guarantee legal traceability of measurement of length under the *Australian National Measurement Act (1960)*. Surveyors using GNSS equipment for cadastral or other legal survey must adhere to the requirements of the Surveyor General and/or Chairman of the Land Surveyors Licensing Board in this State.

Frequency of testing

It is recommended the GNSS equipment and system test to be undertaken at least once per year, immediately after any repair, after a system upgrade (hardware and/or firmware) or after any upgrade of the GNSS post-processing software. Users of multiple post-processing software packages should undertake this test with each software packages independently.

GNSS test requirements

- A GNSS network formed by APPLECROSS 97A (PILLAR 22), APPLECROSS 98 (SALT) CORS, PILLAR 16, PILLAR 18 and PILLAR 23 must be occupied. All eight (8) baselines should be observed and processed as independent vectors. Please note that at the time of publication due to tree cover, PILLAR 17 is not suitable for GNSS occupation.
- Geocentric Datum of Australia 2020 (GDA2020) coordinates of the pillars, supplied in this document, must be used to perform this test.
- All receivers must to be configured to record data at 5-second intervals.
- The minimum of five GNSS satellites to be observed simultaneously by all receivers.
- The GNSS antenna correctly setup and oriented with elevation angle to be set to 15º or more above the horizon.
- The GDOP value must be maintained at 8 or below throughout the entire observation session.
- Enough data must be observed to produce an ‘Ambiguity Fixed’ baseline solution and/or a Standard Deviation of less than 3 mm.
- Follow the manufacturer's handbook and manuals recommendation when setting up and operating GNSS equipment.
- All ancillary equipment must be in good working order.
- It is recommended the field observation recording sheets like in ***Appendix A*** should be completed for each observing session. All equipment details such as receiver and antenna type, serial numbers and firmware should be recorded.
- Recording meteorological data is optional and this data should not be used during the GNSS processing. The processing software default parameters for tropospheric modelling should be used.
- A minimally constrained least squares adjustment (LSA) of the observed baseline network must be carried out holding PILLAR 22 (SSM APPLECROSS 97A) fixed using coordinates supplied in this document to verify that the survey network meets the required standards. Refer to the LSA software manual for details. All adjustments of GNSS data should be 3 dimensional.
- To validate the GNSS equipment the adjusted baseline vectors **(chord distances - Pillar to Pillar)** to be compared with the values listed in ***Table 2*** of this guide. +/-5 millimetres agreement is considered acceptable. Stricter criteria may be specified for GNSS equipment intended to be used on high spec projects or contracts requiring a higher survey accuracy.

Data retention

Users are encouraged to archive raw GNSS observation data, adjustment results, baselines, photos and other metadata.

Curtin GNSS test network coordinates

GDA2020 pilar coordinates

Station	**PILLAR 16**	TCM Pillar 16(APP)	
GDA2020		**Cartesian**	
Latitude:	S 32° 00′ 12.77433″	X:	-2364069.658
Longitude:	E 115° 53′ 30.27634″	Y:	4870395.370
Ellipsoidal Height:	-20.929	Z:	-3360754.021
Orthometric Height **(AHD)**:	11.327		
MGA2020		**PCG2020**	
Easting	395320.392	Easting	57093.960
Northing	6458634.409	Northing	357754.959

Station	**PILLAR 17**	TCM Pillar 17(APP)		**Information only**
GDA2020			**Cartesian**	
Latitude:		S 32° 00′ 17.25204″	X:	-2363880.342
Longitude:		E 115° 53′ 23.61636″	Y:	4870405.651
Ellipsoidal Height:		-21.308	Z:	-3360870.778
Orthometric Height **(AHD)**:		10.950		
MGA2020			**PCG2020**	
Easting		395147.058	Easting	56919.062
Northing		6458494.737	Northing	357617.157

PILLAR 17 IS NOW UNSUITABLE FOR GNSS OCCUPATION DUE TO TREE COVER.

Station	**PILLAR 18**	TCM Pillar 18(APP)		
GDA2020			**Cartesian**	
Latitude:		S 32° 00′ 21.49366″	X:	-2363870.591
Longitude:		E 115° 53′ 24.49694″	Y:	4870332.630
Ellipsoidal Height:		-22.139	Z:	-3360981.128
Orthometric Height **(AHD)**:		10.125		
MGA2020			**PCG2020**	
Easting		395171.504	Easting	56942.085
Northing		6458364.366	Northing	357486.491

Station	**PILLAR 22** APPLECROSS 97A		**Published values**
GDA2020		**Cartesian**	
Latitude:	S 32° 00′ 11.59925″	X:	-2363823.473
Longitude:	E 115° 53′ 19.49997″	Y:	4870535.922
Ellipsoidal Height:	-21.203	Z:	-3360723.182
Orthometric Height **(AHD)**:	11.077		
MGA2020		**PCG2020**	
Easting	395037.261	Easting	56811.136
Northing	6458667.689	Northing	357791.346

Station	**PILLAR 23** TCM Pillar 23(APP)		
GDA2020		**Cartesian**	
Latitude:	S 32° 00′ 39.96360″	X:	-2363850.346
Longitude:	E 115° 53′ 29.21562″	Y:	4870007.301
Ellipsoidal Height:	-22.102	Z:	-3361463.564
Orthometric Height **(AHD)**:	10.153		
MGA2020		**PCG2020**	
Easting	395301.147	Easting	57065.540
Northing	6457796.907	Northing	356917.497

Station APPLECROSS 98	SALT CORS		
GDA2020		**Cartesian**	
Latitude:	S 32° 01′ 18.43727″	X:	-2361816.739
Longitude:	E 115° 52′ 14.57270″	Y:	4870303.377
Ellipsoidal Height:	-13.874	Z:	-3362472.736
Orthometric Height **(AHD)**:	18.509 $\pm$ 0.05		
MGA2020		**PCG2020**	
Easting	393355.148	Easting	55105.950
Northing	6456591.939	Northing	355733.600

Table 1 - GDA2020 station information

Station difference information

Inverse calculations

Station		Azimuth Forward	Azimuth Reverse	Chord distance	Spheroidal distance
From	To				
PILLAR 16	**PILLAR 18**	209°27'26.99"	29°27'30.02"	308.451	308.449
PILLAR 16	**APP97A**	277°17'29.18"	97°17'34.24"	285.154	285.155
PILLAR 16	**PILLAR 23**	181°54'13.87"	1°54'14.48"	837.943	837.945
PILLAR 18	**APP97A**	336°42'55.23"	156°42'58.02"	331.790	331.790
PILLAR 18	**PILLAR 23**	167°43'09.58"	347°43'06.90"	582.232	582.234
APP97A	**PILLAR 23**	163°43'47.74"	343°43'42.51"	910.126	910.129
APP97A	**APP98 (SALT)**	219°36'33.15"	39°37'07.72"	2672.452	2672.449
PILLAR 23	**APP98 (SALT)**	238°49'18.70"	58°49'58.22"	2289.465	2289.456

Table 2 - Inverse calculations

Notes

1. Pillar differences and coordinates provided in GDA2020
2. **Chord distance** = Pillar to Pillar measured at stainless steel plate level.
3. Pillar heights are at stainless steel plate level.
4. Orthometric heights are Australian Height Datum (AHD71)
5. Ellipsoidal Heights are an observed values holding Pillar 22 ellipsoidal height fixed and not derived using AUSGEOID2020.
6. Orthometric heights are derived from spirit levelling, with the exception for Applecross 98, where height is derived from GNSS observation and Ausgeoid2020.
7. PILLAR 17 is unsuitable for GNSS occupation.
8. Applecross 98 (SALT) RINEX data is available from National Positioning Infrastructure portal.
9. GNSS distances in this document are derived from GNSS observations undertaken on 4th of September 2025.

For further information, contact a member of the Landgate Survey team:

By email geodesy@landgate.wa.gov.au or phone (08) 9273 7111

Map

Figure 1 - Curtin University Bently Campus Map & Suggested Session Plan

Appendix A

Job details				
Station Name				
Entered in receiver as (As above☐)				
Mark Description (SSM☐) or		Survey Project:		
Measuring rods/offset tape				
Measurements (Slant) (1)	m	(2) m	(3)	m
Radius:	m	Calculated Vertical Height:		m
Meas Check Height:	m	(Or) SKYHOOK Ht:		m
Offset Check Ht to ARP:	m	Offset to A.R.P:		m
Check ARP Height:	m	**ARP Height above Mark**		m
ARP Ht - Check ARP Ht:	mm	ARP Ht Entered in Receiver:		Y / N
Images Taken	Mark (☐)	Setup (☐)	Antenna Height Measurement (☐)	
Observation Time and validations				
Day / Date:	UT Day:	Session/s:		
Start (Local/UT):	Finish (Local/ UT):	Length:		Mins
Epochs set to 5 sec (☐)	Antenna orientated to North (☐)			
Mark Validated	Horizontal (☐) Vertical (☐)	Operator Name:		

Equipment details				
	Make	Model	Serial #	Firmware Version
Receiver				
Antenna				

(Tick If) Antenna occupied main mark and site clear above 15 Deg. Show ray diagram with observing schedule and/ or site obstructions below or over page.	☐