GOVERNMENT OF WESTERN AUSTRALIA

Landgate

GSU-10 GNSS Test Network

A guide for testing survey grade GNSS systems on the Curtin test network

Locate Value Secure

Survey January 2024 Version 2024.1

Document control

GNSS Test Network, v2024.1 – January 2024

Produced and published by: Location Services/Land Boundaries

Document version history

Date	Author	Version	Revision Notes
January 2024	B.Hellmund	2024.1	Style and minor amendments
	Survey	1	Initial

Table of contents

Introduction

This guideline applies to Global Navigation Satellite Systems (GNSS) users in Western Australia and is issued under the direction of the Surveyor General. It describes a suggested practice for testing GNSS - hardware, firmware and software for surveying applications on the GNSS network established by Landgate at Curtin University Bentley Campus.

The GNSS network consists of 5 concrete pillars (see map on page 6) that are regularly horizontally/vertically coordinated to monitor stability and are updated from time to time.

The aim of this guideline is to encourage all surveyors to take a uniform approach when testing their GNSS equipment, so the results obtained provide a reliable validation of user systems. Some requirements for testing on the network may not reflect the surveyor's normal operational usage of that system, particularly with respect to data collection rates and the number of satellites observed.

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

These guidelines are specific to using GNSS in circumstances that follow a quality assurance approach. The following understandings and limitations therefore apply:

- These guidelines apply to GNSS hardware and software systems designed for geodetic survey applications operated in differential mode where carrier phase and pseudo-range observations are recorded by the receivers.
- All equipment used in the test will be in good working order, adjustment and the GNSS antennae will be oriented correctly throughout the test.
- Because approved methodologies for establishing legal traceability of length measurement for GNSS do not currently exist under the Australian National Measurement Act (1960), GNSS should not be used as the sole method of measuring length in legal surveys. Surveyors using GNSS for legal purposes must adhere to the requirements of the Surveyor General as the appropriate verifying authority and Chairman of the Land Surveyors Licensing Board in this State.

Frequency of testing

Surveyors should test their GNSS systems on the network at Curtin at least once per year, immediately after any repair, after a system upgrade (hardware and/or firmware) and after any upgrade of the post-processing software. Surveyors using multiple post processing software packages for their GNSS operations should compute the GNSS baseline observational data with all programs.

Minimum requirements for testing GNSS

- The Geocentric Datum of Australia 2020 coordinates (GDA2020) supplied in this document will be used to perform all processing.
- Receivers will be set to record at a **5 second** data collection rate.
- The minimum constellation specification to be simultaneously observed by all receivers is: 5 common healthy satellites having an elevation angle of 15º or more above the horizon and a GDOP of 8 or less.
- Enough data must be observed to produce an Ambiguity Fixed baseline solution and/or a Standard Deviation of less than 3 mm.
- A braced quadrilateral formed by APPLECROSS 97A (PILLAR 22), PILLAR 16, PILLAR 18 and PILLAR 19 shall be observed. The six baselines are to be observed and processed as independent vectors. Please note that due to tree cover, PILLAR 17 is now unsuitable for GNSS occupation. PILLAR 21 can be included as an additional check.
- Users should follow the recommendations set out in the manufacturer's handbook and manuals. All ancillary equipment must be in good adjustment and repair.
- Field observation recording sheets similar to the type in ***Appendix A*** should be completed for each session. The receiver type, serial number and firmware used must be recorded on these sheets.
- Meteorological readings are optionally recorded but should not be used in the GNSS processing. The reduction software defaults for tropospheric modelling are to be used.
- A minimally constrained least squares adjustment of the observed baseline network must be carried out holding PILLAR 22 (SSM APPLECROSS 97A) fixed with the values supplied in this document to verify that the survey meets the required standards. All adjustments of GNSS data should be 3 dimensional in terms of the Geocentric Datum of Australia 2020. *Note – the coordinates of APPLECROSS 97A are the GOLA published values. The GDA2020 coordinate of APP 97A is an adjusted not transformed value.*
- Post adjustment baseline vectors **(chord distances - Pillar to Pillar)** should then be compared with the values in ***Table 2*** of this document. Acceptance criteria are given as 5 millimetres or better. Other checks may be specified for surveyors engaged on government contracts requiring a particular CLASS of survey.

Data retention

Surveyors are encouraged to suitably archive raw observational data, adjustment results, baselines and photos.

Curtin GNSS test network coordinates

GDA2020 station information

Station	**PILLAR 16**	TCM Pillar 16(APP)		
GDA2020			**Cartesian**	
Latitude:		S 32° 00′ 12.77433″	X:	-2364069.661
Longitude:		E 115° 53′ 30.27648″	Y:	4870395.367
Ellipsoidal Height:		-20.930	Z:	-3360754.020
Orthometric Height **(AHD)**:		11.327		
MGA2020			**PCG2020**	
Easting		395320.396	Easting	57093.964
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′ 21.49367″	X:	-2363870.590
Longitude:		E 115° 53′ 24.49696″	Y:	4870332.626
Ellipsoidal Height:		-21.144	Z:	-3360981.126
Orthometric Height **(AHD)**:		10.125		
MGA2020			**PCG2020**	
Easting		395171.505	Easting	56942.086
Northing		6458364.366	Northing	357486.491

Station	**PILLAR 19**	TCM Pillar 19(APP)		
GDA2020			**Cartesian**	
Latitude:		S 32° 00′ 02.36019″	X:	-2364046.969
Longitude:		E 115° 53′ 26.19528″	Y:	4870593.935
Ellipsoidal Height:		-22.424	Z:	-3360481.202
Orthometric Height **(AHD)**:		9.837		
MGA2020			**PCG2020**	
Easting		395210.019	Easting	56987.064
Northing		6458953.984	Northing	358075.808

Station	**PILLAR 21**	TCM Pillar 21(APP)		
GDA2020			**Cartesian**	
Latitude:		S 31° 59′ 58.46240″	X:	-2363946.550
Longitude:		E 115° 53′ 20.78567″	Y:	4870712.225
Ellipsoidal Height:		-23.663	Z:	-3360378.730
Orthometric Height **(AHD)**:		8.618		
MGA2020			**PCG2020**	
Easting		395066.840	Easting	56845.153
Northing		6459072.548	Northing	358195.963

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

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°27'29.04"	29°27'32.10"	308.458	308.456
Pillar 16	Pillar 19	341°31'56.66"	161°31'58.82"	338.188	338.185
Pillar 16	Pillar 21	330°31'42.11"	150°31'47.14"	506.356	506.348
Pillar 16	Pillar 22	277°17'25.93"	97°17'31.64"	285.161	285.161
Pillar 18	Pillar 19	4°19'31.81"	184°19'30.91"	591.029	591.029
Pillar 18	Pillar 21	352°10'51.96"	172°10'53.93"	716.064	716.063
Pillar 18	Pillar 22	336°42'55.28"	156°42'57.93"	331.791	331.790
Pillar 19	Pillar 21	310°12'56.14"	130°12'59.00"	185.950	185.946
Pillar 19	Pillar 22	211°41'45.15"	31°41'48.70"	334.468	334.466
Pillar 21	Pillar 22	184°46'01.97"	4°46'02.65"	406.051	406.043

Table 2 - Inverse calculations

Notes

1. Station Difference Information is in GDA2020
2. **Chord distance** = Pillar to Pillar measured and legally traceable slope chord distance at stainless steel plate.
3. Heights are at stainless steel plate.
4. Orthometric heights are Australian Height Datum (AHD71)
5. Ellipsoidal Heights are an observed value holding Pillar 22 ellipsoidal height fixed and not derived using AUSGEOID2020.
6. Orthometric levels are derived from spirit levelling.
7. PILLAR 17 is now unsuitable for GNSS occupation due to tree cover.
8. Data in this document is calculated from GNSS observations on 18 January 2024.

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

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

Map

Figure 1 - Curtin University Bently Campus Map

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.	☐