Government of South Australia
Department for Housing and Urban Development

Guideline for use of GNSS in Cadastral Surveys

Office of the Surveyor General

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Government of South Australia
Department for Housing and Urban Development

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Guideline for use of GNSS in Cadastral Surveys

1 Context

Global Navigation Satellite System (GNSS) surveying is common place for many different types of surveys and cadastral surveying is no exception. This guideline provides general information to surveyors so that cadastral surveys can be completed using GNSS techniques that achieve the accuracy requirements prescribed by the Surveyor-General.

The GNSS methods described in this document are for guidance only and are not a guarantee of achieving any required accuracies. Users are advised to exercise independent judgment based on the information provided.

2 Definitions

This guideline uses the definitions of Positional Uncertainty (PU), Relative Uncertainty (RU) and Survey Uncertainty (SU) (modified by changing “survey mark” to “point”) stated in the Intergovernmental Committee of Surveying and Mapping (ICSM) Standard for the Australian Survey Control Network.

Positional Uncertainty (PU)
The uncertainty of the horizontal and/or vertical coordinates of a point with respect to datum.

Relative Uncertainty (RU)
The uncertainty between the horizontal and/or vertical coordinates of any two points. RU can be expressed in SI units at the 95% confidence level, or in a proportional form such as a ratio of uncertainty per unit length or survey misclosure.

Survey Uncertainty (SU)
The uncertainty of the horizontal and/or vertical coordinates of a point independent of datum. That is, the uncertainty of a coordinate relative to the survey in which it was observed, without the contribution of the uncertainty in the underlying datum realisation.

In these definitions, uncertainty is expressed at the 95% confidence level.

3 Accuracies required for cadastral surveys

Notice of the Surveyor-General (No.1) - Accuracy sets the standard of accuracy for cadastral surveys in South Australia and is summarised in Table 1. (Adelaide City, High and Low Density Urban and Rural areas are defined in section 1.1 of the Notice)

Table 1: Accuracy Tolerances for Cadastral Surveys

	Adelaide City	Urban		Rural
		High Density	Low Density	
Polygon Misclosure	0.02m + 1/20000			
Marks & Improvements	0.03m	0.03m	0.05m	0.10m
PSM Coordination	0.015m	0.02m		0.05m
PSM Horizontal Joins	0.03m	0.05m		0.10m

Polygon Misclosure – is the test applied to data lodged with the survey plan to ensure all parcels close to within the tolerance. It is independent to the measurement method.

Marks and Improvements and PSM Coordination accuracy values are independent of datum, i.e. Survey Uncertainty (SU)

PSM 'Horizontal Joins' accuracy is the positional difference (based on bearing and distance) between the surveyed (or measured) position of a PSM and the published coordinates of the PSM.

Note that these tolerances also apply to any heights surveyed as part of a cadastral survey.

In addition, surveyors are required to submit new PSM coordinates if their measurements disagree with existing coordinates outside the PSM horizontal joins tolerance in Table 1, i.e.

- Adelaide City 0.03m
- Urban areas 0.05m
- Rural areas 0.10m

The PU of the submitted coordinates must be less than:

- 0.050m for urban areas
- 0.100m for rural areas

While PU, SU & RU are defined at the 95% confidence level, tolerances expressed in Table 1 are an outer limit. Further explanation of these tolerances is contained in Cadastral Survey Guidelines section 13.4.

4 GNSS survey methods

There are several GNSS methods that can be used to derive the coordinates and heights of PSMs, reference marks and improvements on cadastral surveys:

4.1 Post processed methods

- Classic Static
- Rapid (fast or quick) static
- AUSPOS

These methods derive coordinates based on the processing of observed GNSS data to produce baselines between points. Coordinates and heights, along with their associated estimated uncertainties, are calculated from the derived baselines. Observation methods and a least squares adjustment allow the uncertainties to be propagated throughout a network of observed points. More information on these methods can be found in ICSM Guideline for Control Surveys by GNSS.

A brief summary of each method follows:

Classic Static

GNSS observations over long distance baselines, typically used for control surveys rather than cadastral surveys. For larger cadastral projects, classic static could be used for surveying the control network. An adjustment can then be completed to estimate the uncertainty of each point in the network.

Rapid Static

Rapid static is the fastest of the post processed methods. Occupation times are manufacturer specific, however can be as little as 6 minutes depending on baseline length and site conditions. At least two occupations are required to ensure measurement accuracy and reliability. This method is more accurate than real-time methods and longer baselines can potentially be observed. An adjustment can then be completed to estimate the uncertainty of each point.

Theoretically both classic static and rapid static methods can be used to measure points on a cadastral survey, however these methods are slow compared to real time methods and require post processing of baseline data. The intricacies of these methods are beyond the scope of this document.

AUSPOS

AUSPOS is often used to connect the cadastral survey to datum if there are no PSMs with MGA2020 coordinates close to the survey. AUSPOS is discussed in section 9.

4.2 Real time methods

- Single Reference Station Real Time Kinematic (RTK)
- Network RTK
- Precise Point Positioning (PPP)

These methods generate a coordinate and height, based on corrections received by the GNSS receiver. The receiver software estimates the accuracy. No measurements (i.e. baseline data) are stored, only the resultant position.

Accuracy statements for GNSS systems provided by instrument manufacturers are specified for ideal GNSS observing conditions and tend to ignore environmental factors such as obstructions and multipath. The accuracy of measurements displayed at the time of measurement are optimistic and, in some cases, may be erroneous and misleading.

The nature of real time GNSS surveying makes it difficult to determine the accuracy of measurements. It requires attention to detail and a high level of professional knowledge and experience to ensure accuracy tolerances can be met. Therefore, it is essential to validate measurements through independent occupations and comparing to coordinated PSMs.

Due to their ease of use and accuracy capabilities, real time methods are preferred for cadastral surveys over the more time-consuming post processed methods listed in Section 4.1. The ICSM Guideline for Control Surveys by GNSS contains information on real time surveying equipment and observation techniques.

5 Factors affecting GNSS accuracy

5.1 Site dependant effects

The accuracy of GNSS measurements is adversely affected by:

- Obstructions that could block GNSS signals (e.g. trees, buildings)
- Existence of surfaces that cause GNSS signal multipath (e.g. buildings, towers)
- Potential GNSS signal interference (e.g. high voltage powerlines, radio transmitters)

5.2 Atmospheric effects

- High solar activity will degrade GNSS signals passing through the ionosphere. (Solar activity predictions can be found at the Space Weather, Australian Bureau of Meteorology website)
- Rapidly changing weather conditions, which increases the tropospheric effects on GNSS signals, can degrade observation accuracies, particularly if weather conditions are different at the base and rover receivers.

Always consider another measurement technique (e.g. total station) if site and/or atmospheric conditions are compromised.

5.3 Accuracy of GNSS receiver

Manufacturers express the accuracy of their GNSS receivers in terms of a millimetre value and parts per million (ppm). The parts per million refers to the distance from the RTK base or in the case of Network RTK (depending on the system), the location of the nearest physical base. The values are higher than those quoted for static or rapid static GNSS methods.

If the receiver supports Precise Point Positioning (PPP), an accuracy statement will be provided. This statement covers the accuracy of the PPP system coupled with the receiver.

GNSS manufacturers and system suppliers qualify that their accuracy statements are for optimal GNSS observation conditions, including minimal obstructions or multipath effects and a stable atmospheric and ionospheric environment.

6 Real time GNSS observation guidelines

To mitigate against the various factors that affect GNSS accuracy, the Office of the Surveyor-General recommends the following:

- Set the elevation mask to at least 10°. Satellites at lower elevations tend to introduce more error, as they are more susceptible to multipath and atmospheric effects.
- Position Dilution of Precision (PDOP) is a measure of the accuracy of the measurement caused by the geometry of the observed satellites. The PDOP during the observations should be less than 4.
- Record observations at 1 second intervals, with the final coordinates determined using averaging. This is usually a setting in the receiver software.
- Validate GNSS measurements against PSMs with known coordinates (and height if required)
- Crucial measurements (including PSM coordination) should be checked by independent GNSS observations (i.e. two observations, at least 30 minutes apart with the **receiver re-initialised between observations**):
  - If using RTK, a different RTK base must be used to be considered an independent observation.
  - An independent check could also be obtained by measuring with both RTK and PPP.
- PSMs should be observed with a tripod or bipod to ensure stability of the GNSS receiver. Tiltable poles **should not** be used due to the additional error source of the tilting function.
- Observation time depends on accuracy required:
  - PSM coordination - at least 1 minute
  - Marks and Improvements – 30 seconds

These times are a guideline only and must be extended if environmental (i.e. site or atmospheric conditions are compromised.

7 GNSS and heights

GNSS accuracies for height are generally 2 to 3 times worse than that for horizontal position which is reflected in receiver accuracy statements. If accurate heights are required for a cadastral survey, more attention must be paid to site and weather conditions.

Particular attention must be given to measuring the antenna height. It is crucial to consult the technical specifications of the antenna or receiver (if it is an integrated unit) to determine the location of the Antenna Phase Centre (APC) or Antenna Reference Point (ARP) and the recommended methods of measuring the antenna height.

If heights are required for a cadastral survey, it is recommended to survey to at least two PSMs with an Australian Height Datum (AHD) height. When working with MGA2020 coordinates the AusGeoid2020 model **must be used** to convert the measured ellipsoidal height to AHD.

8 Evaluation of quality of real time GNSS measurements

To assess the quality of GNSS measurements during real time surveys the Office of the Surveyor-General recommends the approach described in the ICSM Guideline for Control Surveys by GNSS – Section 5.

This approach uses an **outlier test**. This test determines the agreement between coordinates obtained from two or more GNSS occupations of the same mark. By comparing the **actual agreement** against the **expected agreement** (based on the specific equipment and technique used), the outlier test provides valuable insights into the reliability of the measurements obtained during multiple occupations and whether the required SU can be met.

ICSM Guideline for Control Surveys by GNSS – Section 5 has a worked example which is replicated in the Appendix. This example can also be applied to some Network RTK systems and PPP surveys using the appropriate rms values supplied by the equipment manufacturer and/or service provider.

The baseline length refers to the distance of the GNSS receiver from the nearest RTK base (whether a Continuously Operating Reference Station (CORS) or own base) that is being used to generate the correction. This is also true for some Network RTK systems

Using the formulae in Appendix 1 and knowing the SU that is required (0.02m for PSM coordination in urban areas & 0.05m for rural areas) the maximum baseline length can be determined for the most common GNSS receiver accuracy statements, shown in Table 2:

Table 2: Maximum baseline lengths for corresponding receiver accuracy statements and urban and rural tolerances

Receiver accuracy statement	Max urban baseline length SU = 0.02	Max rural baseline length SU = 0.05
8mm + 0.5ppm	7km	20km
8mm + 1ppm	3km	20km
10mm + 1ppm	1km	19km

These baseline lengths assume

- **ideal site conditions**
- **2 independent observations**
- **baselines of equal length**

The baseline length can be increased if 3 or more measurements are observed, however it is important to note that the measurements must be independent, i.e. 3 measurements, each at least 30 minutes apart, ideally from 3 different bases.

Importantly, this evaluation does not take into account site and atmospheric factors that affect GNSS.

9 AUSPOS post processing

AUSPOS is a free online public service developed by Geoscience Australia that generates coordinates and heights from logged GNSS data. The service requires the submission of dual frequency GPS RINEX data. RINEX is the international standard file type for GNSS data storage and exchange.

The data must be observed in static mode for at least 2 hours over the mark that is to be coordinated. A longer observation time on a clear site has a higher chance of being successfully processed with a suitable accuracy.

AUSPOS only uses GPS satellites and does not use the other constellations that a GNSS receiver will show being logged.

In the cadastral context, AUSPOS can be used when conducting a survey using RTK where there are no suitable or accessible coordinated PSMs for survey control. Collecting data at the survey's RTK base and submitting it to AUSPOS will generate coordinates and PU for the RTK base station, as well as a height and its associated PU.

As the success or failure of an AUSPOS generated position can only be determined after the data is logged and processed by Geoscience Australia, it is important to ensure:

- The site is clear of obstructions that could block satellite signals. Given that AUSPOS uses GPS satellites only, even a few trees around the site will cause problems with the processing.
- The site is free of reflective surfaces that could cause GPS signal multipath
- The site is not directly under powerlines, particularly high voltage lines, or near any other radio transmission sources.
- As much data as possible is logged. The more data the higher chance of success.

When submitting the data to the AUSPOS Online Processing Service, use the AUSPOS checklist to ensure that the data complies. The most common errors are:

- Submitting the file too soon after the observation time. Wait until 2pm SA time the day **after** the observations were collected.
- The recording interval is not divisible by 30 seconds.
- Submitting receiver raw data files. The file **must** be converted to RINEX format.
- Entering the incorrect antenna height into AUSPOS. The antenna height entered must be the vertical height to the Antenna Reference Point (ARP). Refer to the technical specifications of the receiver or antenna to determine the ARP. A correction is almost always required to antenna heights measured in the field.

If data has been observed at a PSM and submitted to AUSPOS then RINEX files should be sent to the Office of the Surveyor General for potential inclusion in the state geodetic adjustment.

9.1 Validation of AUSPOS results

When using the AUSPOS positioning service, it is important to check the following in the returned AUSPOS report:

- Section 1: User Data (see Figure 1)
    - Check to ensure that the antenna type and height is correct
    - Check the observation time correlates with what was observed in the field

1 User Data

All antenna heights refer to the vertical distance from the Ground Mark to the Antenna Reference Point (ARP).

Station (s)	Submitted File	Antenna Type	Antenna Height (m)	Start Time	End Time
6028	95230630.25o	TRMR10 NONE	1.759	2025/03/04 22:32:00	2025/03/05 04:53:30

Figure 1: Extract from AUSPOS report displaying details of the user submitted data

- Section 3.3 & 3.4: GDA2020 coordinates and Positional Uncertainty
    - Check that the PU is within the accuracy tolerance.

Note: PU will always be higher than SU as it includes the uncertainty of the datum. (see Figure 2)

3.4 Positional Uncertainty (95% C.L.) - Geodetic, GDA2020

Station	Longitude East (m)	Latitude North (m)	Horizontal (m)	Ellipsoidal Height(Up)(m)	Derived AHD(m)
6028	0.013	0.013	0.016	0.044	0.179

Figure 2: Extract from AUSPOS report displaying Positional Uncertainty (PU)

- Section 6: Ambiguity Resolution
    - note that ambiguity resolution **success rate of 50% or better** for a baseline formed by a user site indicates a reliable solution. AUSPOS will generally supply a warning if that criteria hasn't been met. (see Figure 3)

6 Ambiguity Resolution - Per Baseline

Baseline	Ambiguities Resolved	Baseline Length (km)
KELN - WAGN	83.3 %	191.697
ALBY - NCLF	95.0 %	156.625
KARR - MRO1	80.0 %	634.484
KELN - NNOR	90.5 %	157.140
MRO1 - WAGN	95.0 %	739.047
KELN - PERT	84.6 %	173.409
KELN - YELO	87.0 %	188.314
KARR - 76WV	0.0 %	1179.301
WAGN - YAR2	85.7 %	514.178
HYDN - WAGN	90.0 %	169.786
ALIC - YELO	81.8 %	1634.553
ALBY - WAGN	90.0 %	183.138
BURA - KELN	83.4 %	131.632
AVERAGE	80.5%	465.639

Please note for a regional solution, such as used by AUSPOS, ambiguity resolution success rate of 50% or better for a baseline formed by a user site indicates a reliable solution.
*WARNING:
This solution has not resolved any ambiguities for your submitted data. Please use this solution with caution.

Figure 3: Extract from an AUSPOS report displaying the ambiguity resolution of the baselines processed. Note that one baseline didn't process and therefore the solution in this case shouldn't be used.

10 Legal traceability of GNSS measurements

Legal traceability in measurements refers to the ability of a measurement outcome or standard value to be linked to specified references, typically national or international standards. In Australia, the *National Measurement Act 1960 (Cth)* governs the principles for legal traceability.

For GNSS surveying, the National Measurement Institute determined that the relevant physical quantity is position. (Note that this is different to total stations, where the relevant physical quantity is length.) The National Measurement (Recognized-Value Standard of Measurement of Position) Determination 2017 (Cth) defines GDA2020 using coordinates of 109 Australian Fiducial Network (AFN) stations. This determination is due for replacement in 2026.

Geoscience Australia (GA) has been appointed as a verifying authority for position under the National Measurement Act. GA issues Regulation 13 Certificates for CORS, providing legally traceable positions and their uncertainties with respect to the National Measurement (Recognized-Value Standard of Measurement of Position)

In South Australia, legal traceability for GNSS surveys can be achieved by connecting the cadastral survey to GDA2020 through one of the following geodetic infrastructures:

- **CORS network**, where the CORS has a valid Regulation 13 certificate. (AUSPOS uses Regulation 13 CORS)
- **Network PSMs**. These PSMs have been included in the state and national geodetic adjustment which in turn is linked to CORS that define GDA2020.
- **Non network PSMs**. Whilst not in a geodetic adjustment, many of these PSMs have been coordinated through measurements connected to CORS or Network PSMs as per above.

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11 Summary

GNSS measurements can be affected by different factors, many of which are outside the control of the surveyor. It is important to consider site, atmospheric and receiver accuracies when considering the use of GNSS for cadastral surveys. Measurements must be independently checked and validated to ensure accuracy and reliability.

The following is a summary of the suitability of real time GNSS for cadastral surveys in the different accuracy zones. This summary is intended as a guide only, it is ultimately up to the surveyor to determine if GNSS is a suitable method for their cadastral survey given the accuracy tolerances required in Table 1.

Adelaide City

GNSS is not a recommended method for cadastral surveys within the Adelaide City Zone due to the accuracy required and poor GNSS observing conditions caused by tall buildings and other obstructions.

Urban (High and Low Density)

Accuracy tolerances for PSM coordination are difficult to achieve in most urban areas. PSMs in urban areas are likely to have adverse site conditions and be too distant from CORS to meet the accuracy requirements.

Marks and Improvements could be observed by GNSS under ideal observation conditions, but extra care is required, particularly relating to site conditions and baseline lengths.

A possible exception is large urban subdivisions where measurements are taken on open sites before buildings are constructed. Site conditions are likely to be suitable for both PSM coordination and measurement of marks and improvements, however maximum baseline lengths from CORS or own base must be adhered to.

Rural

Given the accuracy tolerances for rural cadastral surveys, GNSS is well suited to these types of surveys, however site conditions must be considered. There are many rural areas (for example the Mt Lofty Ranges) where there is significant tree coverage, particularly along road reserves, which will affect the accuracy of GNSS measurements.

When using real time methods, maximum baseline lengths are 20km. GNSS accuracy degrades beyond this distance.

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Appendix

Example of evaluation of real time GNSS surveys using coordinate comparison (from Guideline for Control Surveys by GNSS – Section 5.) This approach can be adopted for Network RTK & PPP surveys.

Demonstrating the concept of coordinate comparison is best achieved through an example survey. In this survey, the task involves coordinating PSM A and PSM B with a horizontal SU requirement of better than 0.02m and a horizontal PU requirement of better than 0.05m at a 95% confidence level (two sigma). (Urban PSM coordination accuracy tolerances.)

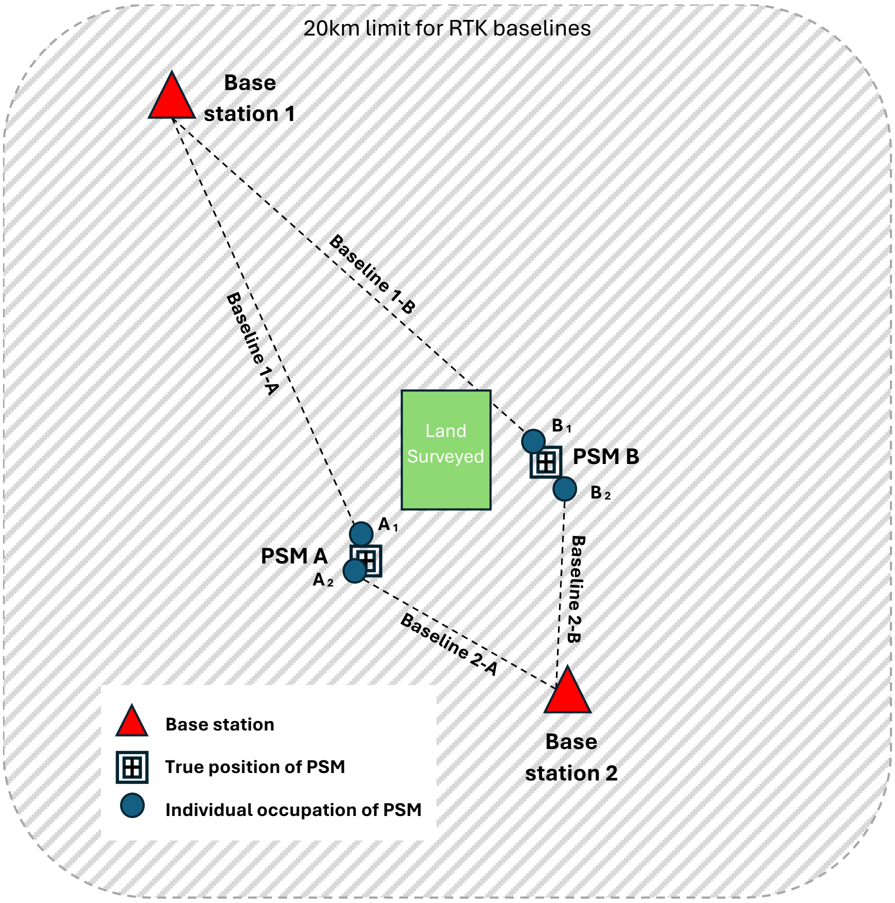

Figure 4: Example of a RTK survey to coordinate 2 PSMs utilising 2 base stations

To achieve this, the surveyor initiates the process by setting up a GNSS base receiver at base station 1 and uses a GNSS rover receiver to occupy PSMs A and B. After this initial setup, the base receiver from base station 1 is relocated to base station 2, and the surveyor reoccupies PSMs A and B. For PSM A, the first occupation involves measuring baseline 1-A, yielding coordinates at A_1. The second occupation measures baseline 2-A, resulting in coordinates at A_2. Likewise, B_1 and B_2 denote the coordinates obtained from the two occupations of PSM B.

In the following calculations, it is assumed that the two base stations have been surveyed to a high quality such that any Relative Uncertainty (RU) between them has minimal effect when comparing A_1 to A_2 or B_1 to B_2. Base station coordinates may either be CORS or marks with surveyed coordinates.

In this example, the equipment manufacturer specifies that the RTK survey should achieve a root mean square (RMS) of 8 mm + 1 ppm horizontally for each baseline measurement. Estimating the expected uncertainty in each measurement (at 95% confidence in two dimensions) involves multiplying the the expected RMS by a coverage factor of 2.45 (as defined in the ICSM Guideline for Adjustment and Evaluation of Survey Control). If the baselines 1-A and 1-B are 3km long and baselines 2-A and 2-B are 1km long, the **expected uncertainties** can be calculated as follows:

- Uncertainty $A_1 = (0.008\text{m} + 1\text{ppm} \times 3000\text{m}) \times 2.45 = 0.027\text{m}$
- Uncertainty $A_2 = (0.008\text{m} + 1\text{ppm} \times 1000\text{m}) \times 2.45 = 0.022\text{m}$
- Uncertainty $B_1 = (0.008\text{m} + 1\text{ppm} \times 3000\text{m}) \times 2.45 = 0.027\text{m}$
- Uncertainty $B_2 = (0.008\text{m} + 1\text{ppm} \times 1000\text{m}) \times 2.45 = 0.022\text{m}$

The following steps outline the **testing of the quality of the survey using** coordinate comparison:

1. The two occupations of PSM A (i.e. A_1 and A_2) can be tested using their **expected uncertainties** to calculate an **outlier test** as follows:

$$\text{outlier test}_A = \sqrt{\text{uncertainty } A_1{}^2 + \text{uncertainty } A_2{}^2}$$

$$\text{outlier test}_A = \sqrt{0.027^2 + 0.022^2} = 0.035\text{m}$$

2. Therefore, if the horizontal distance between the coordinates of each occupation, A_1 and A_2, is less than or equal to the outlier test (0.035m in the example above), it is reasonable to conclude that the equipment and technique are performing according to manufacturer's specifications and that neither measurement to PSM A is an outlier.

3. If the difference between the two occupations does not pass the outlier test, then a new independent occupation should be made. Note that consistently failing the outlier test at multiple PSMs may indicate a problem with the coordinates of one or both of the base stations. The errors from each base station should be analysed and any systematic bias should be noted and/or corrected.

4. Having made two occupations that pass the outlier test, the mean of the two sets of coordinates (A_1 and A_2) can be calculated and the SU of that mean can be estimated as follows:

$$\text{SU}_{\text{mean A}} = \sqrt{\frac{(\text{uncertainty } A_1{}^2 + \text{uncertainty } A_2{}^2)}{\text{number of occupations}^2}}$$

$$\text{SU}_{\text{mean A}} = \sqrt{\frac{(0.027^2 + 0.022^2)}{2^2}} = 0.017\text{m}$$

The quality of the two occupations of PSM B can then be tested in a similar manner to PSM A, such that:

1. The uncertainties for the two occupations of PSM B are used to calculate an outlier test for B_1 and B_2 using the same formula as for PSM A. (worked example: $\text{outlier test}_B = 0.035\text{m}$).
2. Assuming the outlier test is passed, the SU for the mean coordinates from the two occupations of PSM B can also be calculated as for PSM A. (worked example: $SU_{mean\ B} = 0.017\text{m}$).

It is then up to the surveyor to decide whether the SU of the PSMs meets the specification of the survey. If the SU did not meet the requirements, the design of the RTK survey can be improved by:

- Improving the estimated uncertainty in the measurements by reducing the distance between the base station and the PSMs (e.g. moving base station 1 closer in the example), or;
- Improving the SU of the mean coordinates by adding an additional independent occupation at each PSM.

The final step in evaluating the quality of the real-time GNSS survey is to **estimate horizontal PU of each PSM** based on the SU of the mean coordinates and the horizontal PU of the nearest reference station. Using base station 2 in the example above, the horizontal PU of PSM A can be estimated as:

$$PU_A = \sqrt{{PU_2}^2 + {SU_{mean\ A}}^2}$$

If the PU of the coordinate of the base station 2 is 2cm (i.e. PU_2=0.020m) then,

$$PU_A = \sqrt{0.020^2 + 0.017^2} = 0.026\text{m}$$

Similarly, the PU of PSM B can be calculated as 0.026m

In this example, the SU PSM A & PSM B is better than 0.02m and the PU of PSM A & PSM B is better than 0.05m. **Therefore, the accuracy requirements have been met.**

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References

Bureau of Meteorology, Australian Space Weather Forecasting Centre, accessed 15 September 2025

Department of Primary Industries, Parks, Water and Environment Tasmania, 25 May 2012, Circular Memorandum No. 2/2012 Using RTK GNSS in Cadastral Surveys, accessed 5 September 2025

ICSM (Intergovernmental Committee of Surveying and Mapping), 7 December 2020, Standard for the Australian Survey Control Network, version 2.2, accessed 5 September 2025

ICSM, 7 December 2020, Guideline for Control Surveys by GNSS, version 2.2, accessed 5 September 2025.

ICSM, 7 December 2020, Guideline for the Adjustment and Evaluation of Survey Control, version 2.2, accessed 5 September 2025.

Landgate, 1 October 2021, SPP-06 Surveys Using Global Navigation Satellite Systems (GNSS), Version 2, accessed 1 October 2025

Office of the Surveyor-General (SA), 29 September 2023, Cadastral Survey Guidelines, Version 6.0, accessed 5 September 2025

Queensland Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development, 20 January 2025, Cadastral Survey Requirements, version 8.02, accessed 5 September 2025

Surveyor General of NSW, 23 May 2014, Surveyor General's Directions No. 9 GNSS for Cadastral Surveys, version 2.5, accessed 5 September 2025

Surveyor-General of the ACT, 29 October 2012, Guideline No.10 GNSS and Cadastral Surveys, accessed 5 September 2025

Surveyor-General Victoria, July 2021, Victorian Cadastral Surveys Practice Directives, Edition 2, accessed 5 September 2025

Surveyors Board NT, 13 March 2017, Provisional Standards and Guidelines for the use of GNSS on Cadastral Surveys within the Northern Territory, version 3.5, accessed 5 September 2025