

Submitting GNSS data for inclusion into the state-wide datum adjustment network

SIG/2018/4235

Guideline

Version 1.01

Last Reviewed 09/06/2020

This publication has been compiled by Survey Integration, Department of Natural Resources, Mines and Energy.

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Version History

Version	Date	Comments
1.00	15/06/2018	Document Created
1.01	09/06/2020	General review

Approval

Position	Name	Date
Principal Survey Advisor	Matt Higgins	09/06/2020

Summary

The Department of Natural Resources, Mines and Energy, hereafter referred to as the department, offers a service whereby spatial professionals can submit Global Navigation Satellite System (GNSS) data observed on Permanent Survey Marks (PSM) to the department for inclusion into the state-wide datum adjustment (or State Control Survey) to become a datum mark.

The department is committed to producing a quality service and performs stringent quality assurance on supplied survey data prior to it being added to the state-wide datum adjustment. The resultant coordinate information on PSMs is uploaded to the Survey Control Register (SCR) or Survey Control Database (SCDB) and made available to the public.

This document details the requirements for submitting GNSS data to the department and provides an overview of the subsequent process of updating the SCR with coordinates on datum PSMs from the state-wide datum adjustment.

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1. Datum Overview

Currently in Queensland, the geodetic datum is realised as an adjustment of Global Navigation Satellite System (GNSS) observations on Permanent Survey Marks (PSM) with their adjusted coordinates published in the SCR. This adjustment, known as ANJ, is comprised of several other adjustment datasets to form a single datum adjustment for QLD. Figure 1 below portrays how the ANJ (datum) adjustment in Queensland is comprised and linked to the international datum or Global Reference Frame, in cooperation with Geoscience Australia (GA).

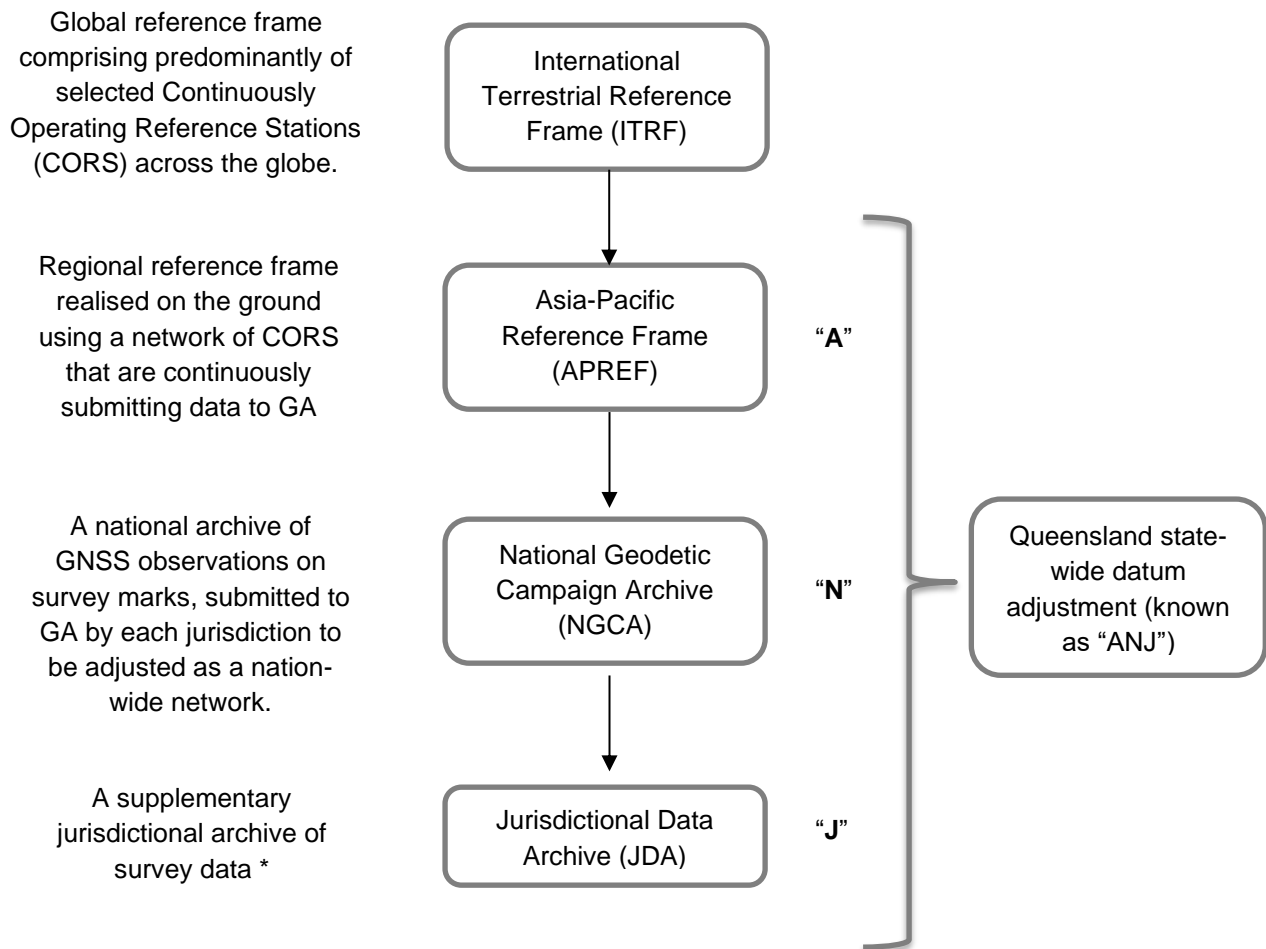


Figure 1: Composition of ANJ

* The QLD JDA comprises of survey campaigns with data not suitable for the NGCA but which are of historical significance, or from survey projects supporting critical/major infrastructure, and other smaller projects which are not necessarily conducted for geodetic purposes but may contain data that can be valuable for geodesy.

2. Data Submission Workflow

Below is a basic workflow for data that is submitted to the department. It is important to note that some of the processing is done by Geoscience Australia (GA) and the department must comply with minimum data standards set by GA.

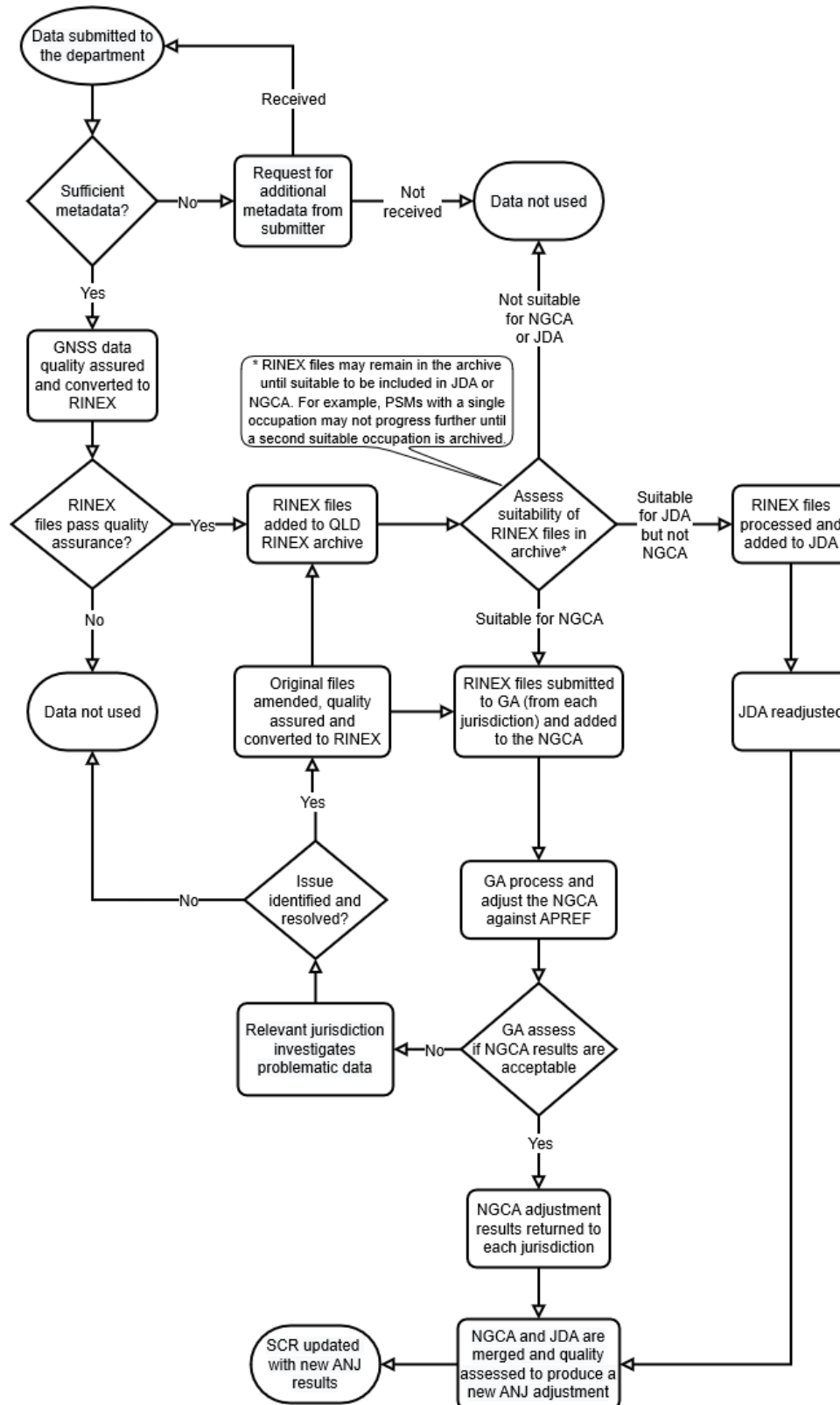


Figure 2: Data submission workflow

3. ANJ Inclusion and Loading into the Survey Control Register

For a PSM to be denoted as a datum mark in the SCR, it must first have observations incorporated into the Queensland state-wide adjustment known as ANJ. The resultant position of that mark may then be given a lineage value of DATUM.

3.1. Timeframes

DNRME aims to update the SCR with a new release of ANJ on a monthly basis or when there are sufficient additions to the state-wide datum adjustment. This timeframe may vary subject to GA processing of the NGCA, or where there has been a delay in DNRME providing new data to GA. Delays may also be experienced if unforeseen problems are encountered in final quality checking of the ANJ or while loading the adjustment results to the SCR. A new version of ANJ may not be released if there are minimal change in the number of observations added since the last release. This would typically occur during the end of year period.

3.2. SCR Rules Applied During Rollout

During an upload of ANJ into the SCR, there are a number of rules that are enforced so that the integrity of the SCR is maintained.

For a survey control mark to be given ANJ coordinates and listed as “datum” in the SCR, it must:

- Be a registered PSM in the SCR
- Have a completed Form 6 lodged, so that there is administrative information and initial coordinates for that PSM in the SCR at the time of the upload
- Be part of the ANJ adjustment at the time of the upload. This includes adhering to the minimum requirements of this document
- **Not** be a CORS site. Coordinates for CORS sites are uploaded separately to ANJ. Where a CORS site has a current Regulation 13 Certificate and a PSM number allocated, they are uploaded to the SCR with a lineage of DATUM. Where the CORS site does not have a current Regulation 13 Certificate, they are loaded into the SCR as derived.

4. Data Submissions

GNSS data can be submitted to the department by anyone, as the quality assurance performed is the same irrespective of who submitted it.

All GNSS data should be sent to GeodeticSupport@dnrme.qld.gov.au.

All PSM related forms (i.e. a Form 6 or mark maintenance form) should be completed as per the guidelines available on the department webpage for surveying standards and forms¹ and sent to CadastralAdminDataHelp@dnrme.qld.gov.au.

If your submission contains both GNSS data and PSM information, please send a single email to both of the above addresses. This will ensure your data is received by both sections and actioned accordingly.

4.1. Observations Requirements

NGCA requirements

For inclusion into NGCA the following criteria must be met:

- Occupation must be on a survey control mark
- Duration of observation must be 6 hours or more.
- Sufficient metadata for each observation as per Section 4.3 of this guideline.
- Raw data files from the receiver are supplied. Typically, receivers log in their native file format, which is the preferred file type to be submitted. If the receiver is configured to log as RINEX, then these files are considered raw and will be accepted. Native GNSS data files are converted to RINEX by the department and all RINEX files are quality assured.
- Survey control marks having only a single occupation may remain in the QLD RINEX archive until a second observation is submitted, before becoming part of the NGCA. A single occupation on a mark may be included in JDA for the interim at the discretion of the department.

Refer also to the ICSM SP1² Guidelines for control surveys.

JDA requirements

GNSS data on survey control marks that do not meet the NGCA requirements, may be included in JDA if it provides any of the following:

- Significant benefit to the geodetic datum as deemed by the department.
- Necessary linkage to historical datasets and/or other datums (E.g. AHD, tide gauge bench marks etc.).

¹ <https://www.business.qld.gov.au/industries/building-property-development/titles-property-surveying/surveying/standards-forms>

² <https://www.icsm.gov.au/>

- GNSS campaigns or projects that connect critical or significant infrastructure to datum. For example, a large scale land development as per the Cadastral Survey Requirements (CSR) or major road/rail works.

If you are intending to conduct GNSS survey work that you feel will be suitable for inclusion into the JDA, please contact GeodeticSupport@dnrme.qld.gov.au to discuss the details.

4.2. Antenna Height Measurement Requirements

A minimum of two measurements to the antenna must be recorded in the field. One directly to the Antenna Reference Point (ARP) / Bottom of Antenna Mount (BAM) and one to the manufacturers' specified Height Measurement Point (HMP)³.

The example in Figure 3 below is of a JAVAD Triumph 1. The manufacturers specified height measurement point is referred to as the Slant Height Measurement Point (SHMP) and is at the bottom of the bumper at the corner. The antenna details including the north reference point (NRP), which is the feature on the antenna to be orientated north, for most antennas can be found on the NGS antenna calibration website: <https://www.ngs.noaa.gov/ANTCAL/>. Some antennas that are not found on the NGS antenna list may be found on the IGS antenna models ftp site: <ftp://ftp.igs.org/pub/station/general/antenna.gra>. While the IGS antenna models do not necessarily show the north reference point, they will show most of the official antenna dimensions and offsets to the ARP/BAM.

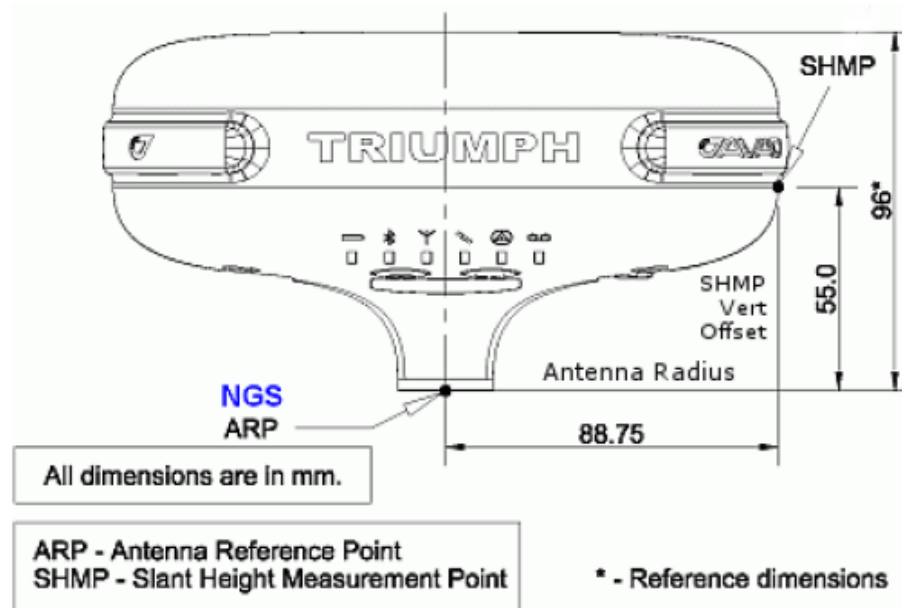


Figure 3: JAVAD Triumph 1M – Antenna Offsets Diagram

Source: https://www.ngs.noaa.gov/ANTCAL/LoadImage.xhtml?name=JAV_TRIUMPH-1+NONE.gif

If your antenna does not have a manufacturers specified HMP, then offsets to a clearly identifiable physical point on that antenna will need to be determined in order to check the antenna height reduction to ARP. A description of the HMP used should always be recorded.

³ Any physical point on an antenna or antenna accessory (E.G. Leica hook tape or Trimble lever), where the manufacturer has stated offset dimensions for accurately reducing a measured antenna height to the ARP.

The height to the ARP can be calculated using the following formula:

$$ARP = \sqrt{\text{Slant height to HMP}^2 - \text{Antenna radius}^2} + \text{HMP vertical offset}$$

It is important to pay careful attention to the sign of the HMP vertical offset, also known as the Ground Plane Offset (GPO), as this offset is directional. A negative GPO indicates that the HMP is above the ARP, such as the centre of the bumper on the Trimble R8. A positive GPO means that the HMP is below the ARP, as is the case when using the Trimble lever extension.

The calculated ARP height should be the height used in the survey record. Because the BAM check height is not corrected for slope, there will be some error in this check height, so the ARP height calculated as shown above should be recorded as the official height and the BAM height measurement used solely as a check. For a satisfactory height check, the calculated ARP height and BAM check height should agree within $\pm 0.005\text{m}$.

4.3. Metadata

Booking sheets

Booking sheets must clearly show the following information:

- Mark ID (this should be the PSM number if allocated)
- Project ID/Name/Job Reference
- Observer and Agency/Company
- Antenna type and serial number (receiver type and serial number as well if not a combined antenna/receiver unit)
- Start and Stop Time/Date (24 hour format Australian Eastern Standard Time preferred)
- Antenna height to ARP calculated as per Section 4.2
- Station setup checks that must be completed
 - Antenna heights measured and checked as per section 4.2
 - Centred and levelled
 - Antenna orientated north
 - Logging data/tracking satellites
 - PSM number (if stamped) must be physically confirmed
 - General comments, issues encountered in the field (e.g. power failure, equipment tampering), or reasons why any of the above checks failed or were not able to be carried out.

Photos

To support the booking sheets, clear photos of the following are required:

- Mark ID/PSM number (including mark type where possible)
- Antenna type and serial number

- The HMP used and associated slant height measured
- Obstructions of concern with an approximate bearing and distance to the obstruction. Not required if no obstructions of concern are present.

While the following are useful for additional information, they do not contain the level of detail required for GNSS archive metadata, processing and quality assurance. Therefore, submissions that only supply the following will not be accepted.

- Form 6
- Mark maintenance form
- AUSPOS report

If attaching these additional forms to GNSS data submissions, please ensure that the relevant departmental section is also a recipient of the submission, as outlined in Section 4 of this guideline, as the geodetic support team will not action any of these forms.

4.4. Transferring GNSS Data

For small submissions, the preferred method to receive GNSS data submission is via email to GeodeticSupport@dnrme.qld.gov.au with all the required data files as attachments.

For submissions too large to email the data files as attachments, please upload all the data files to an online file hosting service (e.g. Dropbox or ownCloud), and email the link and any password required to GeodeticSupport@dnrme.qld.gov.au.

When uploading data files to an online file hosting service, please be sure to name files appropriately and organise the data files in a logical manner similar to the example file structure in the following section. This ensures the necessary quality assurance can be performed as efficiently as possible.

4.5. Preferred File Structure

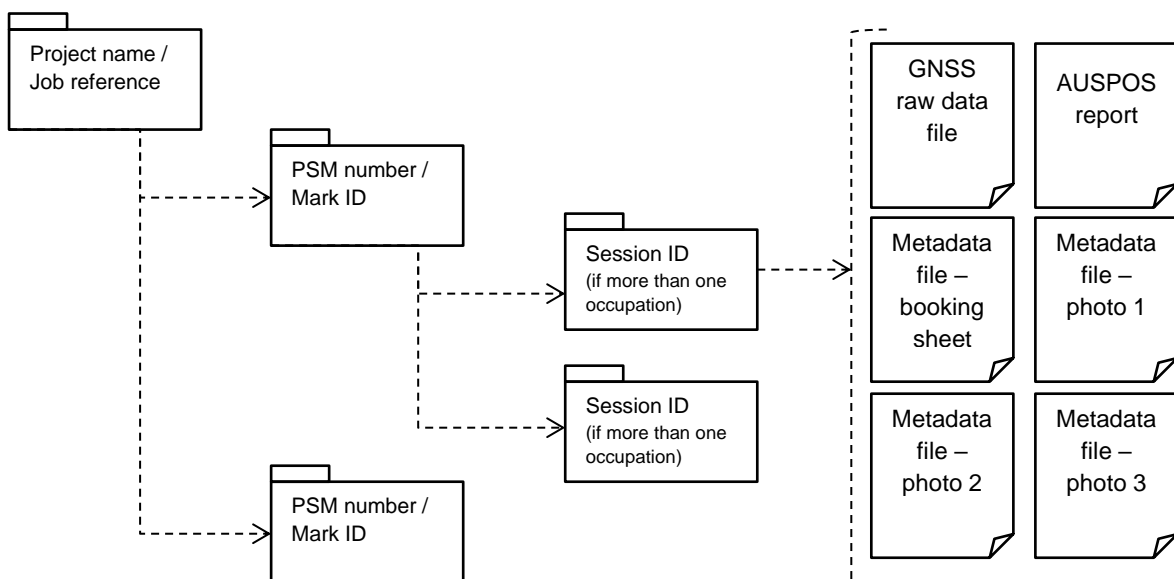


Figure 4: Preferred file structure diagram

5. Rejected Submissions

Most common reasons for data being rejected:

- **Insufficient metadata:** This is the main reason why data is rejected. If the mark ID, antenna height, antenna height measurement point, or antenna type and serial number cannot be confirmed by the booking sheets and photos, the lineage of the data will be compromised and the data will be rejected.
- **Data format:** Data supplied will be rejected if it is not able to be translated to RINEX from the native file format, or if it is supplied in a RINEX version that is not able to be parsed through the translation and quality analysis software currently used by the department or GA. Contact the geodetic support team for more information about acceptable file formats and RINEX versions.
- **Poor quality measurements:** The software used to process the NGCA has similarities with the AUSPOS software. Consequently, data that cannot be processed in AUSPOS to a suitable accuracy is highly likely to fail in the NGCA processing and will be rejected.
- **Outlier in the NGCA adjustment results.** Observations flagged as an outlier in the NGCA adjustment results will be investigated by the department. If the cause can't be identified and the issue rectified, then the data will be rejected.

The department may contact the submitter requesting any missing metadata or to discuss issues with the data that arise in the quality assurance process.

6. FAQ

Q. I have submitted data. Why is it not in Datum?

A. Assuming that the submission included all the required metadata, data not appearing in datum can be due to a number of reasons.

1. The most common reason, is that the Form 6 for this mark has not been lodged, is incomplete, or the SCR has not yet been updated with the Form 6 details. Refer also to Section 3.2.
2. The data has been rejected for one or more reasons explained in Section 5.
3. The data may be the only session on a mark. If a mark has a single session only, it may not be included in ANJ. Refer also to Section 4.1.
4. The quality assurance process may still be in progress and there are issues that must be dealt with before a load to the SCR can occur.

Q. Do you need my constrained adjustment?

A. To maintain traceability and data consistency in the network, the department reprocesses all observations from the original data files supplied. During this process, if the observation is over six hours in duration it is sent to GA for inclusion in NGCA (see Figure 2). As part of the NGCA, GA processes the observation relative to APREF stations and removes trivial baselines (in a process similar to AUSPOS). The department follows a similar data reduction process for the JDA adjustment and constrain to APREF and NGCA stations. The automated removal of trivial baselines and processing relative to APREF means that the observations used in our adjustment will be different from your submitted adjustment but consistent with the rest of the national/state network.

Q. Can I get a copy of the Relative Uncertainties (RU) and Survey Uncertainty (SU) for each station?

A. The purpose of this process is to upload the adjusted ANJ coordinates and associated Positional Uncertainties (PU) into the SCR. RU and SU is assessed as part of the initial QA but are not stored in a publicly accessible database. For more information on PU, RU and SU and the calculation thereof, please refer to the relevant ICSM SP1⁴ Guidelines.

Q. Can non-PSMs be part of ANJ?

A. Yes, but this is not typically offered as part of this service. In some circumstances a mark which has not been registered as a PSM in the SCR may be included in ANJ. Only selected non-PSMs are included in this manner at the discretion of the department. These marks, like tide gauge bench marks, may be valuable to establish links between spatial datasets and align them to a datum. However, these marks will not be published in the SCR as they are not registered PSMs.

⁴ <https://www.icsm.gov.au/>

Q. Is it possible for a mark to have an ANJ coordinate without being in the ANJ adjustment?

A. No. ANJ coordinates can only be determined for marks in the ANJ adjustment.

Q. Is the ARP always the BAM?

A. Yes, the definition of ARP coincides with that of BAM. Instances where this is not the case would be extremely rare.

Q. Who Should I contact if I have more questions?

A. Contact your local departmental surveyor⁵ for more information or email GeodeticSupport@dnrme.qld.gov.au

⁵ <https://www.dnrme.qld.gov.au/?contact=surveying>

Definitions

AHD	Australian Height Datum
ANJ	Queensland state-wide datum adjustment or State Control Survey, comprising of the separate APREF , NGCA & JDA adjustment datasets.
APREF	Asia-Pacific Reference Frame
ARP	Antenna Reference Point. The physical point on the antenna to which antenna calibration values are referenced, being the lowest, non-removable part of the antenna. See also BAM.
BAM	Bottom of Antenna Mount. The lowest, non-removable part of the antenna. See also ARP.
CORS	Continuously Operating Reference Station. A survey control mark hosting a permanent GNSS station.
CSR	Cadastral Survey Requirements
DNRME	The Queensland Department of Natural Resources, Mines and Energy
GA	Geoscience Australia
GNSS	Global Navigation Satellite System
GPO	Ground Plane Offset. The vertical offset between the HMP used and the ARP.
HMP	Height Measurement Point. Any physical point on an antenna or antenna accessory where the manufacturer has stated offset dimensions for accurately reducing a measured antenna height to the ARP.
ICSM	Intergovernmental Committee on Surveying and Mapping
ITRF	International Terrestrial Reference Frame
JDA	Jurisdictional Data Archive administered by DNRME
NGCA	National GNSS Campaign Archive administered by GA
NRP	North Reference Point. Feature on an antenna to be oriented north
PSM	Permanent Survey Mark
SCDB	Survey Control Data Base. The name of the current data base administered by the department to fulfil the purpose of the Survey Control Register under the SMIA.
SCR	Survey Control Register
SCS	State Control Survey
SHMP	Slant Height Measurement Point. See also HMP.
SMIA	Surveying and Mapping Infrastructure Act 2014
SP1	Special Publication 1
TEQC	Software developed by UNAVCO for the Translation, Editing and Quality Checking of GNSS data files.

