Spatial Services

Common Australian EPSG codes and preferred transformations in NSW

Information Sheet

December 2021

Australian CRS in the EPSG Geodetic Parameter Dataset (https://epsg.org) Valid as at EPSG v10.039 (30/11/2021)

The EPSG Geodetic Parameter Dataset is a registry of datums, coordinate reference systems (CRS) and transformations for global, regional, national or local application. This information sheet details common Australian EPSG codes and defines which transformation(s) are the desired default(s) for use in NSW.

Table 1: Common EPSG Codes – Datums and Coordinate Reference Systems

EPSG Code	Name (or common acronym)	CRS type
28348 to 28358	MGA zone 48 (GDA94) through MGA zone 58 (GDA94)	Projected
7846 to 7859	MGA zone 46 (GDA2020) through MGA zone 59 (GDA2020)	Projected
3395	WGS 84 (ensemble) / World Mercator [uncommon]	Projected
3857	WGS 84 (ensemble) / Pseudo-Mercator (alias: Web Mercator)	Projected
6283	GDA94 – Geocentric Datum of Australia 1994	Geodetic (Datum)
1168	GDA2020 – Geocentric Datum of Australia 2000	Geodetic (Datum)
1291	ATRF2014 – Australian Terrestrial Reference Frame 2014	Geodetic (Datum), dynamic
1156	WGS 84 (G1762) – World Geodetic System 1984 (G1762)	Geodetic (Datum), dynamic
6326	WGS 84 – World Geodetic System 1984 [ensemble, 2 m]	Ensemble (Datum)
5111	AHD – Australian Height Datum	Vertical (Datum)
1292	AVWS – Australian Vertical Working Surface	Vertical (Datum)
4938	GDA94	Geocentric (Cartesian 3D)
7842	GDA2020	Geocentric (Cartesian 3D)
9307	ATRF2014	Geocentric (Cartesian 3D)
4978	WGS 84 [ensemble]	Geocentric (Cartesian 3D)
4939	GDA94	Geocentric 3D
7843	GDA2020	Geocentric 3D
9308	ATRF2014	Geocentric 3D
4979	WGS 84 [ensemble]	Geocentric 3D
4283	GDA94	Geographic 2D
7844	GDA2020	Geographic 2D
9309	ATRF2014	Geographic 2D
4326	WGS 84 [ensemble]	Geographic 2D
5711	AHD height	Vertical
9464	GDA94 + AHD height	Compound
9463	GDA2020 + AHD height	Compound
(not defined)	ATRF2014 + AHD Height	Compound
9458	AVWS height	Vertical
(not defined)	GDA94 + AVWS height	Compound
9462	GDA2020 + AVWS height	Compound
(not defined)	ATRF2014 + AVWS Height	Compound

Note: The table above is not exhaustive. For example, AGD66 and AGD84 are not included (and ISG is not even defined in EPSG). A search at https://epsg.org for "GDA2020" will also return additional projections valid at the state or territory level, for example, EPSG:8058 - GDA2020 / NSW Lambert, EPSG:7899 - GDA2020 / Vicgrid, etc.

Table 2: Common EPSG Codes – Transformations (2D, 3D) See also Table 3 for strictly 'vertical' transformations See also Table 4 for preferred transformations, where more than one option is defined Refer to https://epsg.org for authoritative source information			
EPSG Code	Name	Description	Accuracy
8048	GDA94 to GDA2020 (1)	7 parameter transformation (3D)	0.01 m
8447	GDA94 to GDA2020 (2)	NTv2 Conformal and Distortion transformation (2D)	0.05 m
8446	GDA94 to GDA2020 (3)	NTv2 Conformal transformation (2D)	0.05 m
6276	ITRF2008 to GDA94 (1)	15 parameter transformation, ITRF2008 is latest realisation linked to GDA94 (3D)	0.03 m
9682 [1]	ITRF2014 to GDA94 (1)	15 parameter tf: ITRF2014 via GDA2020 to GDA94: Concatenation of 8049 plus 8048-reversed (3D)	0.035 m
9683 [1]	ITRF2014 to GDA94 (2)	Concatenated tf: ITRF2014 via GDA2020 to GDA94: Concatenation of 8049 with 8447 (NTV2) (2D)	0.06 m
8049	ITRF2014 to GDA2020 (1)	3 parameter plate rotation to account for Australian tectonic plate motion (3D) [2]	0.06 m
9460	ITRF2014 to ATRF2014 (1)	Null transformation (3D)	0.03 m
1150	GDA94 to WGS 84 (1)	Null transformation to WGS 84 ensemble (3D). Approximation at ± 3m using assumption that GDA94 is equivalent to low accuracy WGS 84 (ensemble)	3 m
9688 [1,3]	GDA94 to WGS 84 (2)	7 parameter transformation: Equivalent to 8048 (7P) plus 8450 (NULL) (3D)	3 m
9689 [1]	GDA94 to WGS 84 (3)	NTv2 Conformal and Distortion: Equivalent to 8447 (NTv2) plus 8450 (NULL) (2D)	3 m
8450	GDA2020 to WGS 84 (2)	Null transformation to WGS 84 ensemble (3D). Approximation at ± 3m using assumption that GDA2020 is equivalent to low accuracy WGS 84 (ensemble)	3 m
9690 [1]	WGS 84 to GDA2020 (3)	7 parameter transformation: Equivalent to 8048 (7P) plus 1150 (NULL) (3D)	3 m
9691 [1]	WGS 84 to GDA2020 (4)	NTv2 Conformal and Distortion: Equivalent to 8447 (NTv2) plus 1150 (NULL) (2D)	3 m
9686 [1]	GDA94 to WGS 84 (G1762) (1)	15 parameter tf: GDA94 via GDA2020 to WGS 84: Concatenation of 8048 and 8448 (3D)	0.25 m
9687 [1,3]	GDA94 to WGS 84 (G1762) (2)	Concatenated tf: GDA94 via GDA2020 to WGS 84: Concatenation of 8447 (NTv2) with 8448 (2D)	0.25 m
8448 [3]	GDA2020 to WGS 84 (G1762) (1)	3 parameter plate rotation to account for plate motion (3D) [2] Assumes dynamic WGS 84 realisation ≈ ITRF2014 = GDA2020 at epoch 2020.0	0.2 m
See Table 3 for vertical transformations including AHD and AVWS			

[1] indicates new transformations published in January 2021 (recorded as EPSG change ID 2020.128)

[2] The Australian Plate Motion Model is currently only a 2D (horizonal) model. It does not change the height component of the data. In future, height changes may be included in the ATRF2014 <> GDA2020 transformation in the form of a deformation model (ATRF Technical Implementation Plan v2.3).

[3] At the time of publication, a new EPSG:1309 'WGS 84 (G2139)' dynamic realisation has been published by EPSG (Nov, 2021). There are currently no GDA94 or GDA2020 transformations defined directly to WGS 84 (G2139).

Table 3: Common EPSG codes - Transformations, Vertical (1D, 2D+1D)
See also Table 2 for 3D transformations (which will also affect the vertical coordinate)
Refer to https://epsg.org for authoritative source information

EPSG Code	Name	Description	Accuracy
5656	GDA94 to AHD height (49)	AUSGeoid09 model, replaces AUSGeoid98. For reversible alternative see 9467	0.15 m
9467	GDA94 to GDA94 + AHD height (1)	AUSGeoid09 model, replaces AUSGeoid98. Reversible (3D <> 2D+1D) alternative to 5656	0.15 m
8451	GDA2020 to AHD height (1)	AUSGeoid2020 with estimated errors. For reversible alternative see 9466	0.15 m GSB
9466	GDA2020 to GDA2020 + AHD height (1)	AUSGeoid2020 with estimated errors. Reversible (3D <> 2D+1D) alternative to 8451	0.15 m GSB
~~9461~~ deprecated	~~GDA2020 to AVWS height (1)~~	~~AGQG_20191107.gsb. For reversible alternative see 9465.~~	~~0.1 m GSB~~
~~9465~~ deprecated	~~GDA2020 to GDA2020 + AVWS height (1)~~	~~AGQG_20191107.gsb. Reversible (3D <> 2D+1D) alternative to 9461.~~	~~0.1 m GSB~~
9692 [1]	GDA2020 to AVWS height (2)	AGQG_20201120.gsb. For reversible alternative see 9693.	0.1 m GSB
9693 [1]	GDA2020 to GDA2020 + AVWS height (2)	AGQG_20201120.gsb. Reversible (3D <> 2D+1D) alternative to 9692.	0.1 m GSB

[1] indicates new transformations published January 2021 (recorded as EPSG change ID 2020.128)

Preferred / default transformation recommendations

It is recommended to standardise the preferred and default transformations used in software and client applications, especially where EPSG defines more than one current transformation method. Contact your software provider for information on how to update default transformations. Note:

- Some commercial software have default transformations for older CRS, but do not yet have default transformations to GDA2020. For example, AGD66 and GDA94 data may automatically align when displayed together, but GDA94 and GDA2020 data may still show a two metre misalignment.
- In NSW, the default 2D transformation between GDA94 and GDA2020 should be the NTv2-CPD transformation. In contrast, at a national level the 7-parameter (conformal) transformation is generally preferred as the default, because it does not rely on the distribution of the NTv2 grid file(s) and applies across all GDA2020 extents. As a result, out-of-the-box default transformations may need further modification and user education to suit some jurisdictions.
- Adopting a new WGS 84-aligned-to-GDA2020 paradigm requires adoption of specific default transformations.

Table 4 provides a list of preferred transformations associated with GDA2020 transformations. Note:

1) Users are always recommended to review the default settings in their software and override as required.
2) Software developers are encouraged to actively update EPSG and/or PROJ libraries.
3) When transforming data with a vertical component, it may be desirable to transform horizontal (2D) and vertical (1D) components separately, and later recombine these into 3D data. See 3D Data and Transformations Infosheet.
4) Concatenated operations explicitly define multi-step transformations using a unique registry identifier. For example, EPSG:9685 ATRF2014 <> GDA2020 <> GDA94). Software support for concatenated operations is growing, but not yet universal.
5) Transformation pipelines are another way to chain together multiple operations when a direct or concatenated operation is not already officially defined between CRS. For example, AGD66 <> GDA2020 is not defined (except in the Australian Capital Territory), and it is instead recommended to "first transform to GDA94 and then to GDA2020" per GDA2020 Technical Manual (v1.7).

   Software is expected to increasingly recommend transformation pipelines on-the-fly based on published transformation extents, accuracy or other attributes (see for example PROJ – transformations, 'Filtering and Sorting' at PROJ help and this 2019 ICSM white paper on recommendations for handling GDA2020 within geospatial software).
6) NTv2 grid(s) are restricted, essentially, to mainland Australian locations. For datasets or workflows falling outside these grid extents, a 'fallback' is required such as the 7-parameter conformal transformation which is valid for all GDA94/GDA2020 extents. Software may support automatic or manual selection of a fallback transformation for those portions of a dataset outside the NTv2 extents, or may require splitting the dataset into separate portions before transformation.

   DCS Spatial Services maintains a custom NTv2-CPD-plus-offshore file, which extends to Lord Howe Island and Norfolk Island, for workflows which transform a mixture of onshore and offshore data. Please contact the Spatial Services Customer Hub to further discuss fallback transformations or to request this custom file. (In future, this may also be made available from the Spatial Collaboration Portal: search for "custom NTv2".)

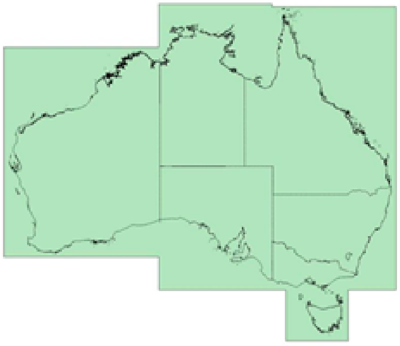
   Refer also to Table 5 for more information on the extents of NTv2 grid and 7-parameter transformations.

Table 4: Preferred Transformations (or Transformation Pipelines) in New South Wales

For CRS listed below, there is more than one current transformation (or pipeline) to GDA2020 or WGS 84≈GDA2020.
Vertical Transformations (1D, 2D+1D) are currently all unique in EPSG. Refer to Table 3.
Other transformations (e.g. AGD66 <> GDA94) should follow recommendations in EPSG comments/extent/accuracy.

CRS-1	CRS-2	Transformation(s) with preferred priority order. Default to first listed item.	Accuracy[1]
GDA94	GDA2020	(1) EPSG:8447 ‘GDA94 to GDA2020 (2)’ (NTv2-CPD) (2) EPSG:8048 ‘GDA94 to GDA2020 (1)’ (7P Conformal) (3) EPSG:8446 ‘GDA94 to GDA2020 (3)’ (NTv2-CON)	0.05 m 0.01 m 0.05 m
GDA94	WGS 84 (GDA2020 alignment preferred	(1) EPSG:9689 ‘GDA94 to WGS 84 (3)’ (NTv2-CPD), WGS 84 ≈ GDA2020 (2) EPSG:9688 ‘GDA94 to WGS 84 (2)’ (7P), WGS 84 ≈ GDA2020 (3) EPSG:1150 ‘GDA94 to WGS 84 (1)’ (NULL), WGS 84 ≈ GDA94 #3 is superseded except for older data where WGS 84 ≈ GDA94	3 m 3 m 3 m
GDA2020	WGS 84 (GDA2020 alignment preferred	(1) EPSG:8450 ‘GDA2020 to WGS 84 (2)’ (NULL), WGS 84 ≈ GDA2020 (2) EPSG:9691 ‘WGS 84 to GDA2020 (4)’ (NTv2-CPD), WGS 84 ≈ GDA94 (3) EPSG:9690 ‘WGS 84 to GDA2020 (3)’ (7P), WGS 84 ≈ GDA94 #2, #3 are superseded except for older data where WGS 84 ≈ GDA94	3 m 3 m 3 m
AGD66	GDA2020	(Step 1of2) AGD66 <EPSG:1803 ‘AGD66 to GDA94 (11)’ (NTv2)> GDA94 (Step 2of2) GDA94 <as above (NTv2-CPD)> GDA2020	0.5 m + 0.05 m
AGD66	WGS 84 (GDA2020 alignment preferred)	(Step 1of2) AGD66 <as above (NTv2)> GDA94 (Step 2of2) GDA94 <EPSG:9689 ‘GDA94 to WGS 84 (3)’ (NTv2-CPD)> WGS 84 OR (Step 1of3) AGD66 <as above (NTv2)> GDA94 (Step 2of3) GDA94 <as above (NTv2-CPD)> GDA2020 (Step 3of3) GDA2020 <EPSG:8450 ‘GDA2020 to WGS 84 (2)’ (NULL)> WGS 84	0.5 m + 3 m 0.5 m + 0.05 m + 3 m
		Superseded: EPSG:15786 ‘AGD66 to WGS 84 (17)’ (NTv2) and any other AGD66 <one-step> WGS 84 ≈ GDA94 transformations	[2.9 m]
AGD84	GDA2020	Step 1of2) AGD84 <EPSG:1804 ‘AGD84 to GDA94 (5)’ (NTv2)>GDA94 (Step 2of2) GDA94 <as above (NTv2-CPD)> GDA2020	0.1 m + 0.05 m
AGD84	WGS 84 (GDA2020 alignment preferred)	(Step 1of2) AGD84 <as above (NTv2)> GDA94 (Step 2of2) GDA94 <EPSG:9689 ‘GDA94 to WGS 84 (3)’ (NTv2-CPD)> WGS 84 OR (Step 1of3) AGD84 <as above (NTv2)> GDA94 (Step 2of3) GDA94 <as above (NTv2-CPD)> GDA2020 (Step 3of3) GDA2020 <EPSG:8450 ‘GDA2020 to WGS 84 (2)’ (NULL)> WGS 84	0.5 m + 3 m 0.5 m + 0.05 m + 3 m
		Superseded: EPSG:15785 ‘AGD84 to WGS 84 (9)’ (NTv2) and any other AGD84 <one-step> WGS 84 ≈ GDA94 transformations.	[2.9 m]
Fallback transformation (if NTv2 unavailable)		Where data (or a subset of a dataset) falls outside the NTv2 grid extents, then employ these fallback transformations (or a custom NTv2 grid which extends offshore to mirror these fallback transformations over your area of interest). See Table 5 for grid extents.	
GDA94	GDA2020	GDA94 <EPSG:8048 ‘GDA94 to GDA2020 (1)’ (7P)> GDA2020	0.01 m
AGD66	GDA94	AGD66 <EPSG:15979 ‘AGD66 to GDA94 (12)’ (7P)> GDA94	3 m
AGD84	GDA94	AGD84 <EPSG:1280 ‘AGD84 to GDA94 (2)’ (7P)> GDA94 Note: The GDAxx technical manual(s) are not explicit on these 7P extents. Offshore application of EPSG:1280 may be an extrapolation of the original intent, but the nominated 1 m accuracy is here taken to be sufficiently conservative and applicable within the extents of GDA94/2020	1 m

[1] Accuracy as shown is for individual EPSG transformation steps. Accuracy for a compound transformation pipeline is not simply additive, but that method may still provide a valid first approximation, given the conservative and estimated nature of some (lower) accuracies quoted.

<table>
<tr><th colspan="2">Table 5: Extents of NTv2 Grid Files and 7P Transformations
To support fallback transformation methods discussed in Table 4. Refer to GDA2020 Technical Manual (v1.7) Section 3.7 and Appendix B, GDA94 Technical Manual (v2.4) Section 7</th></tr>
<tr>
<td>GDA94 <EPSG:8447 (NTv2-CPD)> GDA2020
[Nominal accuracy: 0.05 m]

: Extent of the GDA94-GDA2020 conformal, and conformal and distortion grids.
See Gowans (2018) for more details on sub grids</td>
<td>GDA94 <EPSG:8048 (7P Conformal)> GDA2020
[Nominal accuracy: 0.01 m]

EPSG extent: “Australia – GDA”</td>
</tr>
<tr>
<td>AGD66 <EPSG:1803 (NTv2)> GDA94
[Nominal accuracy: 0.5 m]

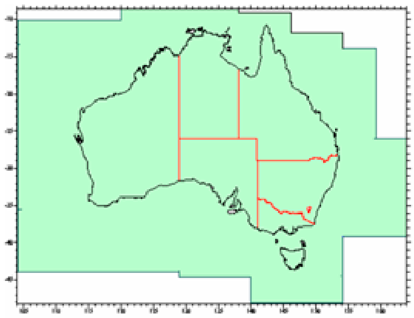



Figure B-1 AGD66 to GDA94 Transformation Grid Coverage
Includes offshore areas out to the Exclusive Economic Zone (EEZ) – mirrors conformal transformation offshore.</td>
<td>AGD66 <EPSG:15979 (7P Conformal)> GDA94
[Nominal accuracy: 3 m]

EPSG extent: “Australia – offshore including EEZ”. Only recommended for use in offshore environments. Other regional 7P transformations of better accuracy are available for on-shore transformations.</td>
</tr>
<tr>
<td>AGD84 <EPSG:1804 (NTv2)> GDA94
[Nominal accuracy: 0.1 m]

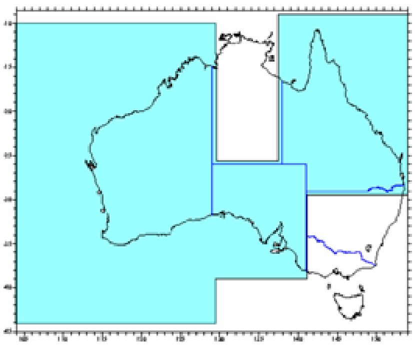
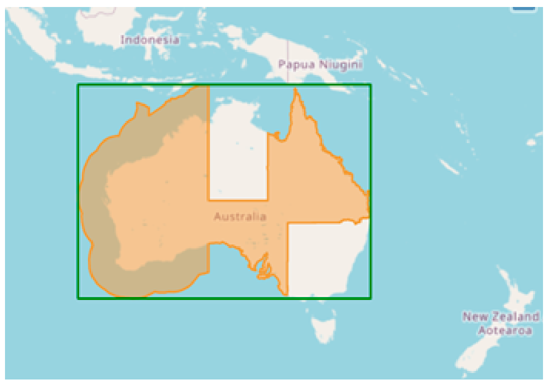



Figure B-2 AGD84 to GDA94 Transformation Grid Coverage
Extent results from merging individual sub-grids from Queensland, South Australia and Western Australia.</td>
<td>AGD84 <EPSG:1280 (7parameter)> GDA94
[Nominal accuracy: 1 m]


EPSG extent: “Australia – AGD84: QLD, SA, WA, federal areas offshore west of 129°E”.</td>
</tr>
</table>