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| Datum requirements for software development in Victoria  |
| Technical requirements for datums or coordinate reference systems in the development of modern spatial software  |

Introduction

This technical document summarises the essential datum or Coordinate Reference System (CRS) requirements for modern spatial software, applications, and Web mapping services. The primary objective of these requirements is to ensure a consistent approach is adopted so that all users of spatial products and services experience unambiguous and error-free georeferencing, visualisation and analysis of spatial information.

Modern spatial software and Spatial Digital Twin (SDT) platforms must ensure the correct management of CRS to support the seamless alignment of 1D, 2D, [2D+1D], 3D and 4D spatial data integrated from multiple sources. The increased availability of high accuracy spatial data has highlighted the potential for the misalignment of spatial data, particularly when operating on the global (albeit low accuracy) WGS 84/Web Mercator CRS widely used in Web mapping applications. Decisions based on incorrectly aligned spatial data can lead to significant disruption, cost, reputational damage and risk to safety.

Spatial software platforms for use in Victoria are required to support the official national datums, GDA2020 and AHD, as well as the common, well-defined transformation methods to cater for modern and historic spatial information. Associated metadata must also be maintained for all spatial data.

## 1. Support import and export of spatial data in common, well-defined CRS

Spatial data import and export must support the following common, well-defined CRS:

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| EPSG Code | CRS / datum name | CRS Type | Comments |
| **Horizontal CRS** |  |  |  |
| 4283 | GDA94 (2D) | 2D Geographic |  |
| 28348 to 28358 | MGA94 Zone 48 to 58 | 2D Projected | In Victoria - MGA94 Zone 54 and 55 |
| 3111 | VICGRID94 | 2D Projected | Optional |
| 7844 | GDA2020 (2D) | 2D Geographic |  |
| 7846 to 7859 | MGA2020 Zone 46 to 59 | 2D Projected | In Victoria - MGA94 Zone 54 and 55 |
| 7899 | VICGRID2020 | 2D Projected | Optional |
| 4326 | WGS 84 (ensemble) (2D) | 2D Geographic |  |
| 3857 | WGS 84 (ensemble) / Web Mercator | 2D Projected |  |
| **Vertical CRS** |  |  |  |
| 5111, 5711 | AHD | Vertical 1D |  |
| 1292, 9458 | AVWS | Vertical 1D | Optional. Usage expected to increase |
| **3D CRS** |  |  |  |
| 4938 and 4939 | GDA94 (3D) | 3D Geocentric and Geographic | 3D including ellipsoidal height  |
| 7842 and 7843 | GDA2020 (3D) | 3D Geocentric and Geographic | 3D including ellipsoidal height  |
| 4978 and 4979 | WGS 84 (ensemble) | 3D Geocentric and Geographic | 3D including ellipsoidal height  |
| 9464 | GDA94 + AHD | Compound 2D + 1D |  |
| 9463 | GDA2020 + AHD | Compound 2D + 1D |  |
| 9462 | GDA2020 + AVWS | Compound 2D + 1D | Optional. Usage expected to increase |

1. It is not recommended to use WGS 84/Web Mercator due to the [**known issues with WGS 84/Web Mercator accuracy and alignment**](https://icsm.gov.au/sites/default/files/GMIWG%20Advisory%20on%20WGS%2084%20and%20Web%20Mapping%20%E2%80%93%2015%20June%202020.pdf)**.**
2. If using WGS 84/Web Mercator
	* it must be treated as a low-accuracy CRS (~2m accuracy)
	* the application must require all data to be aligned with a common datum such as GDA2020. This is referred to later in this document as WGS84-aligned-to-GDA2020. WGS 84 alignment (to GDA2020, GDA94, or ‘unknown’) should be captured in CRS metadata.
3. 3D data that includes height ‘attributes’ (or ‘z-values’) should explicitly define a vertical CRS.
4. Software may be required to support 4D data in the following form:
	* 3D data with time-stamps (e.g. vehicle location over time).
	* Time-dependent 4D CRS (e.g. ATRF2014 [EPSG: 9307, 9308, 9309]) is not currently expected from most software.

## 2. Support common, well-defined CRS transformations

Spatial data import and export processes must support common, well-defined coordinate transformations to align spatial data for viewing and analysis

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| EPSG Code | Name | Transformation | Accuracy | Comments |
| 8048 | GDA94 to GDA2020 (1) | 7 – parameter (3D) | 0.01 m |  |
| 8446 | GDA94 to GDA2020 (3) | NTv2 conformal (2D) | 0.05 m | Recommended in VIC |
| 8447 | GDA94 to GDA2020 (2) | NTv2 Conformal and Distortion (2D) | 0.05 m | Recommended in other jurisdictions (e.g. NSW) |
| 9688 | GDA94 to WGS 84-aligned-to-GDA2020 | Equivalent to 8048 plus 8450 | 3m | 9689 recommended for other jurisdictions (e.g. NSW) |
| 9690 | WGS 84-aligned-to-GDA94 to GDA2020 | Equivalent to 8048 plus 1150 | 3m | 9691 recommended for other jurisdictions (e.g. NSW) |
| 8450 | GDA2020 to WGS 84 (ensemble) | Null transformation | 3m |  |
| 1150 | GDA94 to WGS 84 (ensemble) | Null transformation | 3m |  |
| 5656, 9467 | GDA94 (ellipsoid height) to GDA94 + AHD | AUSGeoid09 model | 0.15m |  |
| 8451, 9466 | GDA2020 (ellipsoid height) to GDA2020 + AHD | AUSGeoid2020 model | 0.15m | [3D] to [1D], [3D] to [2D+1D] |
| 9692, 9693 | GDA2020 (ellipsoid height) to GDA2020 + AVWS | AGQG\_20201120 | 0.1m | [3D] to [1D], [3D] to [2D+1D] |

1. The user should have control to select the preferred transformations to apply. Supply metadata to support that choice. Any transformation defaults employed should be clearly defined.
2. Data transformation should be a reversible process that does not lead to degradation of coordinate accuracy. There should be no need (other than for application performance, process efficiency or caching) to store multiple copies of data in different CRS. For example, raster data should be transformed by changing location and CRS metadata, not by resampling.
3. Ideally, software should support any CRS or transformation defined in the [EPSG](https://epsg.org/home.html) registry and make use of EPSG-compliant software and libraries.

## 3. Metadata

Metadata for CRS and coordinate transformations:

1. must clearly define all horizontal and vertical CRS that the data is aligned to. Consider appropriate 1D, 2D, [2D+1D], 3D or 4D CRS.
2. should record the lineage of CRS and transformations, e.g. using EPSG or WKID identifiers.
3. should record the spatial accuracy of the dataset. Where it is not possible to compute the accuracy from the original data sources, approximate (e.g. ~2 metres) values should be captured.

For more guidance, please refer to ANZLIC’s [Preparing metadata for GDA2020 and the AGRS](https://www.icsm.gov.au/sites/default/files/Preparing%20metadata%20for%20the%20Australian%20Geospatial%20Reference%20System_v2.pdf)

## 4. Software interfaces and spatial data platforms

Software interfaces and spatial data platforms that support data display, visualisation and analysis:

1. must describe which CRS are supported or not supported.
2. must describe which transformations are supported or not supported.
3. if using WGS 84 / Web Mercator, must describe WGS 84 alignment (i.e. WGS84-aligned-to-GDA2020, GDA94, ‘other’ or unknown), in terms of default and supported options.
4. must make metadata easily discoverable.
5. must promote the capture and maintenance of metadata.

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This document has been prepared in collaboration with other Australian jurisdictions to ensure a consistent approach is adopted throughout the national geospatial industry.