Transport
for NSW

New South Wales Travel Zone Projections (TZP24) Technical Guide

January 2025

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NSW GOVERNMENT

Acknowledgement of Country

Transport for NSW acknowledges the traditional custodians of the land on which we work and live.

We pay our respects to Elders past and present and celebrate the diversity of Aboriginal people and their ongoing cultures and connections to the lands and waters of NSW.

Many of the transport routes we use today – from rail lines, to roads, to water crossings – follow the traditional Songlines, trade routes and ceremonial paths in Country that our nation's First Peoples followed for tens of thousands of years.

Transport for NSW is committed to honouring Aboriginal peoples' cultural and spiritual connections to the lands, waters and seas and their rich contribution to society.

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Glossary and abbreviations

Term	Definition	Abbreviation
Australian and New Zealand Standard Industry Classifications	The standard classification was jointly developed by the Australian Bureau of Statistics and Statistics New Zealand for the collection, compilation and publication of statistics by industry in Australia and New Zealand. This classification is hierarchical with four levels, namely Divisions (1 digit; the broadest level), Subdivisions (2 digit), Groups (3 digit) and Classes (4 digit; the finest level).	ANZSIC
Australian Bureau of Statistics	The ABS is Australia's national statistical agency, providing trusted official statistics on a wide range of economic, social, population and environmental matters of importance to Australia.	ABS
Australian Curriculum, Assessment and Reporting Authority	An independent statutory authority responsible for data collection and reporting to support education for students nationwide. Provides NSW enrolments to be used in TZP.	ACARA
Australian Statistical Geography Standard	The Australian Statistical Geography Standard is the ABS' geographical framework, effective from July 2011.	ASGS
Average Annual Growth Rate (%)	The growth rate over a given period divided by the number of years in the period	AAGR
Compound annual growth rate (%)	The mean annualised growth rate for compounding values over a given time period	CAGR
Department of Planning, Housing and Infrastructure	New South Wales state government agency responsible for effective and sustainable planning to support the growth in the state of New South Wales	DPHI
Eagle Eye	A web-based application used for analysing and developing insights from multiple data sets used for school provisional planning in NSW. The tool is developed by Service Planning at School Infrastructure NSW.	
Employment	Employed persons by place of work	Emp

Estimated Resident Population	The total number of people that live within a defined area. This includes both people residing in private and non-private dwellings (i.e., college dormitories, jails, and nursing homes).	ERP
Freight Movement Model	Transport for NSW in-house model associated with freight movements across New South Wales	FMM
Future Employment Development Database	A database of various assumed employment developments across NSW, which provides small area level future inputs into the employment model and is used as the primary input to shift census trend projections.	FEDD
Greater Metropolitan Area	The Greater Metropolitan Area is the area used for TfNSW's Strategic Travel Model. The GMA includes the Sydney Greater Capital City Statistical Area (GCCSA), the Southern Highlands and Shoalhaven SA4, Illawarra SA4, Newcastle and Lake Macquarie SA4 and Lower Hunter, Port Stephens, Maitland SA3s as defined by the ABS.	GMA
Household size	The ratio of *persons in occupied private dwellings* to *occupied private dwellings* (e.g., if the *household ratio* in Sydney is 1.91, this implies on average there are 1.91 persons in each occupied private dwelling).	
Household Travel Survey	The largest and most comprehensive source of personal travel data for the Sydney GMA.	HTS
Intergenerational Report	2021 report by the NSW Treasury that assesses long-term changes over the next 40 years, which includes the state's population, age profile, economic growth, and workforce.	IGR
Iterative Proportional Fitting	A statistical method that aligns known totals to an estimated distribution.	IPF
Land Use	In the context of TZP, it refers to Population, Workforce, Employment and Student projection outputs at Travel Zone level.	LU
Local Government Area	Area of the third tier of government in Australia with responsibilities under the Local Government Act. LGA boundaries are defined as of 2018.	LGA
New South Wales	The State of New South Wales is the area analysed for the TZP24 projections.	NSW
Non Private Dwelling	Communal accommodation provided by institutions such as hospitals or prisons and transitory accommodation such as hotels and motels.	NPD
Occupancy Rate	The ratio of occupied to unoccupied private dwellings	OR
Occupied Private Dwellings	A private dwelling that is occupied by one or more people. When using Census data, this represents a	OPD

	private dwelling that is occupied by one or more people on Census night.	
Place of Enumeration	Refers to variables that are based on the location at which the person is counted on Census Night (e.g., the number of people who stayed in a particular zone on Census night).	PoE
Place of Institution	Refers to variables that are based on education locations (e.g., the number of people attending a tertiary institution within a particular zone).	PoI
Place of Usual Residence	Refers to variables that are based on the home location of the population (e.g., the number of people who live in a particular zone).	PUR
Place of Work	Refers to variables that are based on employment locations (e.g., the number of 'Retail Trade' industry jobs within a particular zone).	PoW
Population in Non-Private Dwellings	Estimated resident population who reside in communal or transitory type accommodation (e.g., prisons, boarding schools, hospitals, and defence establishments).	PNPD
Population in Occupied Private Dwellings	Estimated resident population who reside in private dwellings.	POPD
Population Synthesiser	A model that uses land use data to create 'agents' for input into STM.	Pop Synth
SGS Economics and Planning	An urban public policy consultancy consisting of economists, planners and spatial analysts. SGS has developed the Travel Zone projections since 2015.	SGS
Strategic Travel Model	The STM combines travel behaviour with population, employment, and transport networks to estimate future travel under different strategic land use and transport scenarios.	STM
Structural Private Dwelling	A privately owned building or structure that people live in. This may include a house, an apartment, or it may be a mobile dwelling such as a caravan.	SPD
Sydney Housing Supply Forecast	The Sydney Housing Supply Forecast is a spatial dataset that distributes future housing supply across Sydney for the next 20 years, prepared at a Mesh Block level by the NSW Department of Planning, Housing & Infrastructure It is used to guide infrastructure planning and service delivery to support new housing development and population growth; and informs long-term strategic planning.	SHSF
Transport for New South Wales	Transport for NSW is the lead agency of the NSW Transport cluster. Its role is to lead the development of a safe, efficient, integrated transport system that keeps people and goods moving, connects communities and shapes the future of our cities, centres, and regions.	TfNSW

Transport Planning	Leads integrated planning of transport outcomes across NSW to ensure solutions meet the needs of all users and support future growth and transport demand.	
Travel Zone	Travel Zones (TZs) are the smallest standard geography used for a number of transport datasets in NSW. They represent geographical areas that are used in origin-destination transport modelling. The latest version was created in 2023 and is known as TZ21; it largely aligns with 2021 ABS Destination Zones. See Transport Open Data Home Page | Transport Open Data and search Travel Zone	TZ or TZ21
Trip Attractors	Variables related to destinations. These destinations range from places of work and education to destinations such as shopping centres.	
Trip Generators	Variables related to the origin location of travel (i.e., place of residence).	
Unemployment Rate	The number of unemployed persons expressed as a percentage of the workforce.	UR
Unoccupied Private Dwellings	A private dwelling that is unoccupied although was built specifically for living purposes and is habitable (such as a vacant house, holiday home, hut or cabin). When using Census data, this represents a private dwelling that is unoccupied on Census night.	UOPD
Urban Development Program	Urban Development Programs (UDPs) are the NSW Government's program to monitor land supply and development and assist in the coordinated delivery of enabling infrastructure to support new development, UDPs focus on the planning and delivery of housing and employment land and infrastructure to support new development in key growth regions of NSW, including Metropolitan Sydney and in Regional NSW.	UDP
Victoria University	The Centre of Policy Studies at Victoria University created the State Victoria University Employment Projections by 1-digit ANZSIC industry group from 2021-2066.	VU
Workforce	For any group, persons who are employed or are unemployed but are actively seeking work.	WF

1 Introduction

1.1 Background

Transport Planning within Transport for NSW ('TfNSW') produces the 2024 Travel Zone ('TZ') level projections (population, students, workforce and employment) for New South Wales ('NSW') as an input into the Strategic Travel Model ('STM'). The Travel Zone projections are also used for a range of other strategic and policy work across government and the private sector.

The data produced is available to download from the TfNSW Open Data Hub and is used as input into a diverse range of local planning and research work by a wide range of practitioners.

TZP is developed to support a strategic view of New South Wales and is calibrated with that State view in mind. When modelling the possible land use, it should be understood there is no one single future. Therefore, these projections seek to represent the most likely urban and regional future based on current data, trends and an understanding of policy/structural changes that may impact the future.

Projections are regularly updated through major and interim updates. Major updates realign to ABS Census data releases and geographies, while interim updates incorporate other updated datasets and approach improvements.

In 2015, SGS was engaged to undertake a review of the land use modelling undertaken by the TfNSW. This review was documented in the SGS report – *Appraisal of BTS Land Use Projections (November 2015)*. In general, SGS found the approach was reasonable and rigorous based on available data and resources allocated. However, a number of ways to improve the approach were identified.

In order to leverage internal resources, ensure consistency and manage risk it was recommended that the TfNSW land use modelling approach be further reviewed and improved in stages (or modules) with a clear plan developed for an ultimate overhauled structure leveraging best practices, data, approaches, and software.

SGS was engaged to work within TfNSW to further review and refine the land use TZP approach. This work was completed in stages to first focus on the automation of existing processes; and then to include improvements to data, approaches, and linkages between modules.

In 2018, SGS worked with TfNSW to feed the 2016 Census into the model to create the Interim Travel Zone Projections 2016 v1.51. This update was completed in January 2019. A major update was undertaken in 2019/2020 to develop TZP19 based on 2019 NSW population projections that have been released from the Department of Planning, Industry and Environment ('DPIE') developed prior to the COVID-19 pandemic. Following this in 2022, an interim update was undertaken to develop TZP22 using updated 2022 NSW population projections from the Department of Planning and Environment ('DPE'), as well as updated employment projections released from Victoria University ('VU') based on the impacts of COVID-19. TZP22 also built upon the improvements made to TZP19, with enhanced automation and data validation features.

This projection set, TZP24, is a major update to TZP with significant module enhancements, new travel zones, and updates to incorporate ABS Census 2021. The projections extend from 2021 to 2066 and are based on 2024 NSW population projections that have been released from the Department of Planning, Housing and Infrastructure ('DPHI'), as well as 2024 employment projections prepared by Victoria University ('VU').

1.2 Audience and objective of this report

This is a technical report which documents the overall approach, assumptions, and data sources for the development of the Travel Zone Projections 2024 (TZP24). It is intended for a reader with a general understanding of economic and projection techniques.

This version of the TZP24 technical guide details the high-level methodology to develop the travel zone projections. It provides an overview of the respective modules used to develop the constituent parts of the projections and the data flow of information between them.

It should be noted that further detail regarding the functionality of each module is also contained in individual model files. Detailed datasheets also include the final TZP24 results along with several additional summary breakdowns by Districts, LGAs and Precincts.

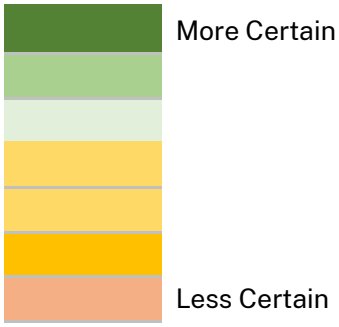
1.3 Data limitations and cautions

The TZP dataset is extremely detailed with millions of datapoints across 60+ variables, 18 time periods and 4,236 travel zones. Further, for a strategic transport model what is critical is that **all** people/workers/students are allocated down to a zone - to then create travel flows from one location to another. This requirement means there cannot be undefined/unallocated locations or variable categories and that there must be a strong nexus between all data variables throughout the model.

This detail is required for the STM to create and allocate trips and means assumptions are required to fill data gaps/uncertainty, which may not be necessary under other circumstances where undefined categories are not problematic, and certainty of outcomes is more critical. Therefore, similar to the STM, the TZP dataset should be seen as a strategic state-wide dataset. A high degree of caution should be exercised when using the data, particularly at more detailed levels. Users should further note that a comprehensive analysis of individual sites or precincts has not been undertaken in the development of TZP. Figures for an individual TZ should not be considered accurate, even in base or historic years, as source data is generally not available at this geographic extent; instead, estimates have been derived using rules to disaggregate source data from larger geographic areas down to this level. When modelling the possible land use, it should be understood there is no one single future. Therefore, these projections seek to represent the 'most likely' urban future based on current data, trends, and a current understanding of policy/structural changes. It does not reflect a pure policy aspiration or project-specific scenario which would need to be further developed as a separate scenario. Table 1 provides an indicative view of the certainty of the data at different spatial, temporal and detail levels.

Table 1 Data Certainty Summary

Location and Geographic Detail	Certainty
State	
Greater Sydney	
Six Cities	
Regional NSW	
Statistical Area Level 2	
Local Government Area	
Centre	
Travel Zone	
Time	Certainty
2021	
2022-2025	
2026	
2027-2030	
2031	
2036	
2041	
2046	
2051	
2056	
2061	
2066	
Area Outlook	Certainty
Established	
Established Renewal	
Growth Area	
Currently Undeveloped	
Forecast Variable Detail	Certainty
Total	
Total Minimal Categorisation (i.e., Broad Industry Category Employment/Labour Force Status (Employed vs. Unemployed)	
Detailed Breakdown (Employment by ANZSIC Industry/Population by 5-year age cohort)	



1.4 High Level Results

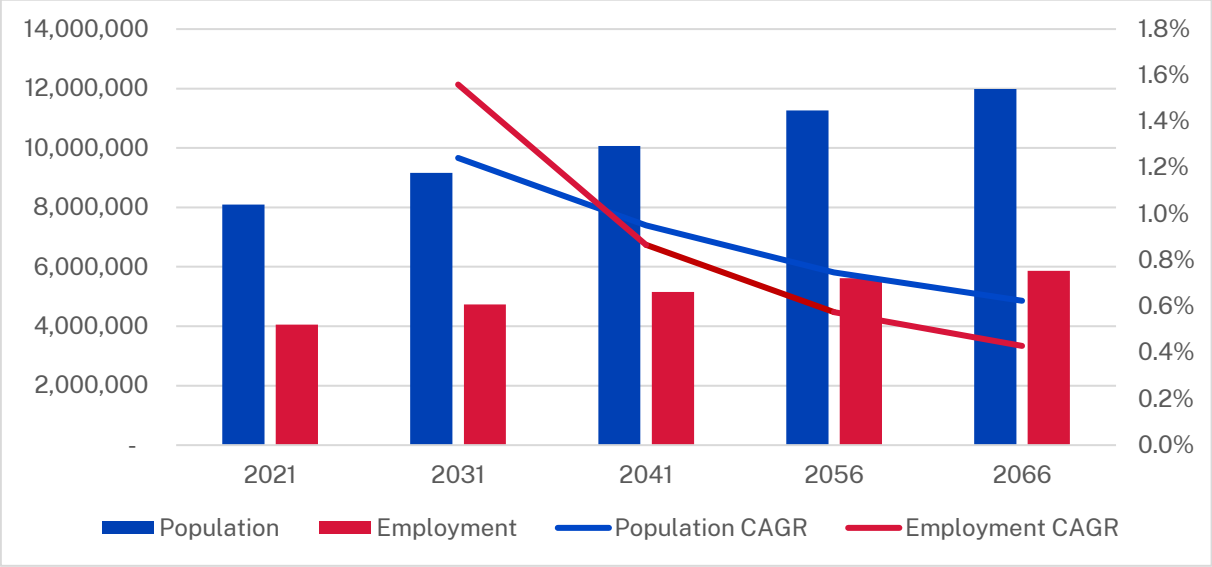
This chapter provides a high-level overview of the Travel Zone Projections 2024 results. For an additional fine-grain level view of results, data is presented on the TZP24 Travel Zone Map Explorer with interactive maps, and the TZP24 Dashboard, accessible on the TfNSW website.[1]

1.4.1 Land Use Forecasts

By 2066, there are projected to be more than 5.9 million jobs and more than 11.9 million people in New South Wales. The majority of people and jobs will be in established urban areas across the Sydney Greater Metropolitan Area which has approximately 78 per cent of people and 81 per cent of jobs as of 2024; this will increase to 83 per cent of the total population and 84 per cent of jobs by 2066.

Figure 1 shows a summary of the NSW population and employment growth out to 2066. Growth rates for both population and employment are similar between 2021 and 2031. Employment shows a declining growth rate post-2031. The ratio of people to jobs across NSW was approximately 2.00 persons for every job in 2021, which will drop to approximately 1.95 persons for every job by 2041 and will increase back to approximately 2.04 persons for every job by 2066.

Figure 1 NSW population and employment growth



Source: TZP24 Population and Dwelling Projections and TZP24 Employment Projections

CAGR is the Compound Annual Growth Rate (%)

The following pages provide a summary of the forecasts by the Six Cities. The Six Cities (Eastern Harbour City, Central River City, Western Parkland City, Central Coast City, Illawarra-Shoalhaven City, and Lower Hunter and Greater Newcastle City). The LGAs of Dungog, Singleton, and Wingecarribee plus the SA2 of Tea Gardens - Hawks Nest combined with the Six Cities together form the Sydney Greater Metropolitan Area. Anything outside of this is considered the Rest of NSW for the purposes of this reporting. Figure 2 illustrates the Six Cities definition spatially.

[1] https://www.transport.nsw.gov.au/data-and-research/reference-information/

Figure 2 Six Cities context map

Source: Transport for NSW, 2024

1.4.2 Population

Table 2 shows a summary of the population projections by the Six Cities and NSW. This shows the Six Cities currently have around 78% of the State's population, which increases to 82% by 2066. The strongest growth is in the Illawarra – Shoalhaven and Western Parkland City which is associated with identified growth areas and land availability.

Table 2 Estimated Resident Population Projections by Six Cities 2021-2066

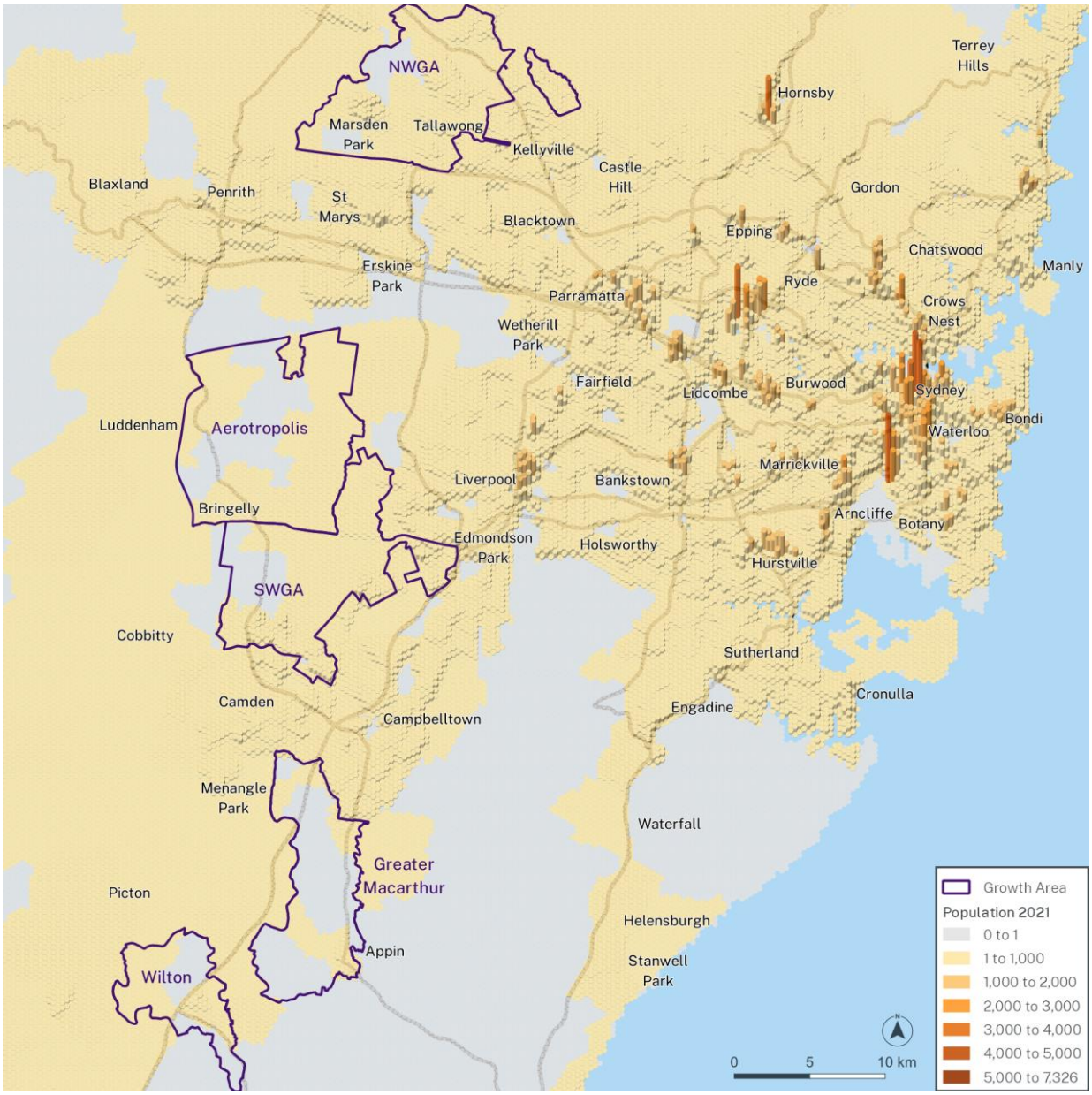
City	2021	2031	2041	2056	2066	CAGR 2021-41	CAGR 2041-66
Eastern Harbour City	2,135,900	2,372,100	2,544,100	2,727,800	2,845,800	0.9%	0.4%
Central River City	1,615,700	1,938,200	2,178,500	2,436,800	2,600,000	1.5%	0.7%
Western Parkland City	1,161,700	1,365,200	1,578,600	1,908,900	2,087,600	1.5%	1.1%
Central Coast City	348,500	378,400	408,400	457,200	488,900	0.8%	0.7%
Illawarra-Shoalhaven City	422,400	499,600	575,200	681,400	751,700	1.6%	1.1%
Lower Hunter and Greater Newcastle City	613,700	697,900	781,900	911,300	995,700	1.2%	1.0%
Total Six Cities	6,297,900	7,251,400	8,066,700	9,123,400	9,769,700	1.2%	0.8%
Remainder GMA	92,400	101,100	109,800	124,300	133,400	0.9%	0.8%
Total GMA	6,390,300	7,352,500	8,176,500	9,247,700	9,903,100	1.2%	0.8%
Rest of NSW	1,706,700	1,808,600	1,893,900	2,013,300	2,081,300	0.5%	0.4%
Total NSW	8,097,000	9,161,100	10,070,400	11,261,000	11,984,400	1.1%	0.7%

CAGR is the Compound Annual Growth Rate (%)

GMA is the Greater Metropolitan Area (see Section 2.4 Spatial Geographies for additional details)

Figure 3 shows the distribution of population (based on ERP) for Greater Sydney which shows a concentration of population around the inner city and distributed along key transport corridors, such as Parramatta to Sydney CBD and emerging population in the North West and South West of Sydney. High densities of population are seen to the south of Sydney CBD around Green Square.

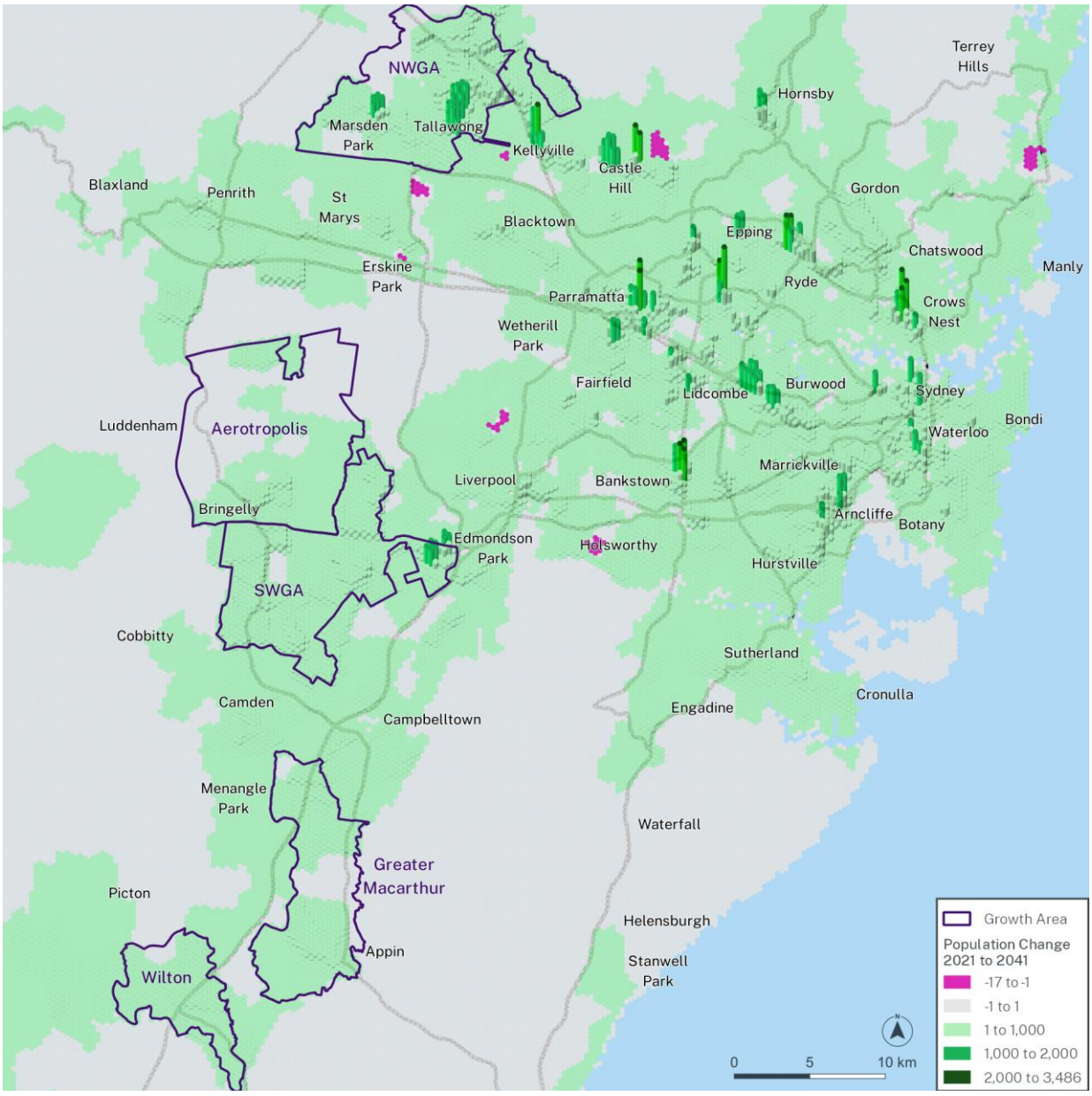
Figure 3 Greater Sydney Population Distribution 2021



Source: Transport for NSW, 2024

Growth between 2021 and 2041 as shown in Figure 4 continues along existing distributions with more focus around South Western Sydney around the South West Growth Area as well as continued growth in the North West.

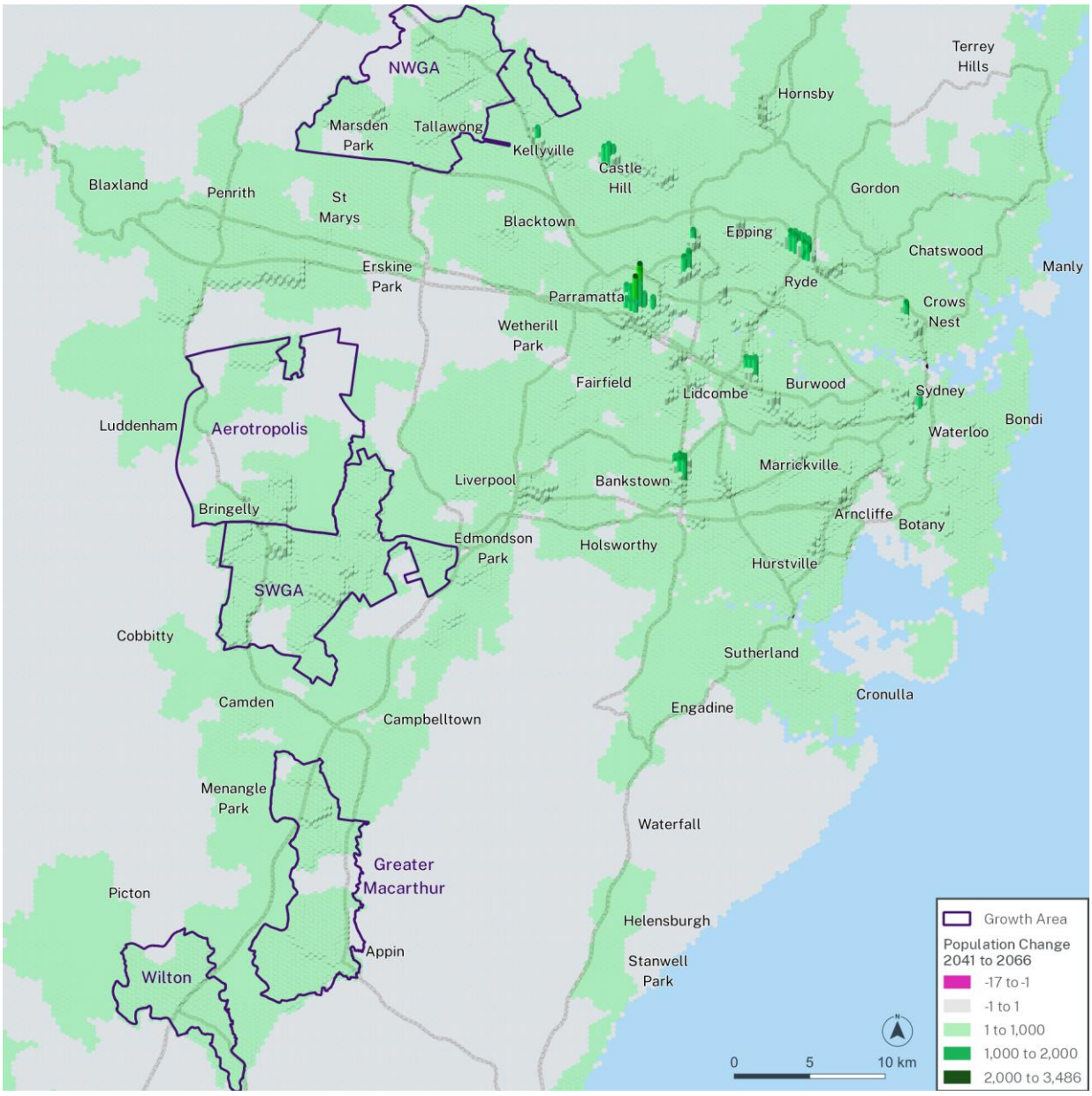
Figure 4 Greater Sydney ERP Growth Distribution 2021-2041



Source: Transport for NSW, 2024

Growth continues westward towards 2066 as shown in Figure 5, particularly in the South West. Emerging populations are establishing around the Western Sydney Aerotropolis, with continued growth around Macquarie Park, Parramatta, Castle Hill and Bankstown.

Figure 5 Greater Sydney ERP Growth Distribution 2041-2066



Source: Transport for NSW, 2024

1.4.3 Workforce and Employment

Table 3 shows the distribution of the resident workforce across NSW forecasted to 2066. Workforce represents the available number of people, based on where they live, that is either actively employed or looking for work. Therefore, it differs from employment which is based on the number of jobs at the location of work.

This means that workforce and employment will have a different spatial distribution as people travel, sometimes large distances to work and there may be a proportion of the population that is unemployed and looking for work. The projections of workforce show a similar spatial and growth trend to population as it is also based on where people live, but also considers the age of the resident population and whether they are participating in the workforce.

Table 3 Employed workforce projections by Six Cities: 2021-2066

City	2021	2031	2041	2056	2066	CAGR 2021-41	CAGR 2041-66
Eastern Harbour City	1,196,300	1,299,600	1,376,800	1,433,100	1,463,700	0.7%	0.2%
Central River City	778,400	993,300	1,109,000	1,212,300	1,266,700	1.8%	0.5%
Western Parkland City	535,000	668,700	763,500	895,300	957,300	1.8%	0.9%
Central Coast City	157,800	175,700	186,000	201,700	211,400	0.8%	0.5%
Illawarra-Shoalhaven City	191,500	223,800	252,800	292,200	317,100	1.4%	0.9%
Lower Hunter and Greater Newcastle City	291,000	348,300	381,100	428,900	459,300	1.4%	0.7%
Total Six Cities	3,150,000	3,709,500	4,069,200	4,463,400	4,675,600	1.3%	0.6%
Remainder GMA	41,600	46,100	49,000	53,700	56,600	0.8%	0.6%
Total GMA	3,191,600	3,755,600	4,118,200	4,517,100	4,732,200	1.3%	0.6%
Rest of NSW	770,600	854,500	887,100	922,100	940,200	0.7%	0.2%
Total NSW	3,962,200	4,610,100	5,005,200	5,439,200	5,672,500	1.2%	0.5%

CAGR is the Compound Annual Growth Rate (%)
GMA is the Greater Metropolitan Area (see Section 2.4 Spatial Geographies for additional details)

The growth of the workforce is also driven by increasing participation rates over the next 20 years due to a variety of factors such as the continuing trend of increasing female participation rates and people staying in the workforce for longer.

Employment projections by City are shown below in Table 4. Employment is expected to continue to grow most strongly within the Western Parkland City, and Lower Hunter and Greater Newcastle City.

Table 4 Employment projections by Six Cities: 2021-2066

City	2021	2031	2041	2056	2066	CAGR 2021-41	AAGR 2041-66
Eastern Harbour City	1,554,100	1,796,100	1,911,900	2,043,500	2,131,100	1.0%	0.4%
Central River City	644,400	784,600	877,600	975,300	1,013,500	1.6%	0.6%
Western Parkland City	421,200	543,900	655,800	754,000	788,800	2.2%	0.7%
Central Coast City	137,200	154,000	163,600	176,800	185,500	0.9%	0.5%
Illawarra-Shoalhaven City	177,500	209,500	236,000	276,000	303,400	1.4%	1.0%
Lower Hunter and Greater Newcastle City	296,900	346,100	373,200	411,800	435,400	1.2%	0.6%
Total Six Cities	3,231,300	3,834,200	4,218,200	4,637,400	4,857,700	1.3%	0.6%
Remainder GMA	47,600	50,400	52,000	55,300	58,100	0.5%	0.4%
Total GMA	3,278,900	3,884,600	4,270,200	4,692,800	4,915,700	1.3%	0.6%
Rest of NSW	773,600	846,400	887,100	928,200	951,300	0.7%	0.3%
Total NSW	4,052,500	4,731,000	5,157,300	5,621,000	5,867,100	1.2%	0.5%

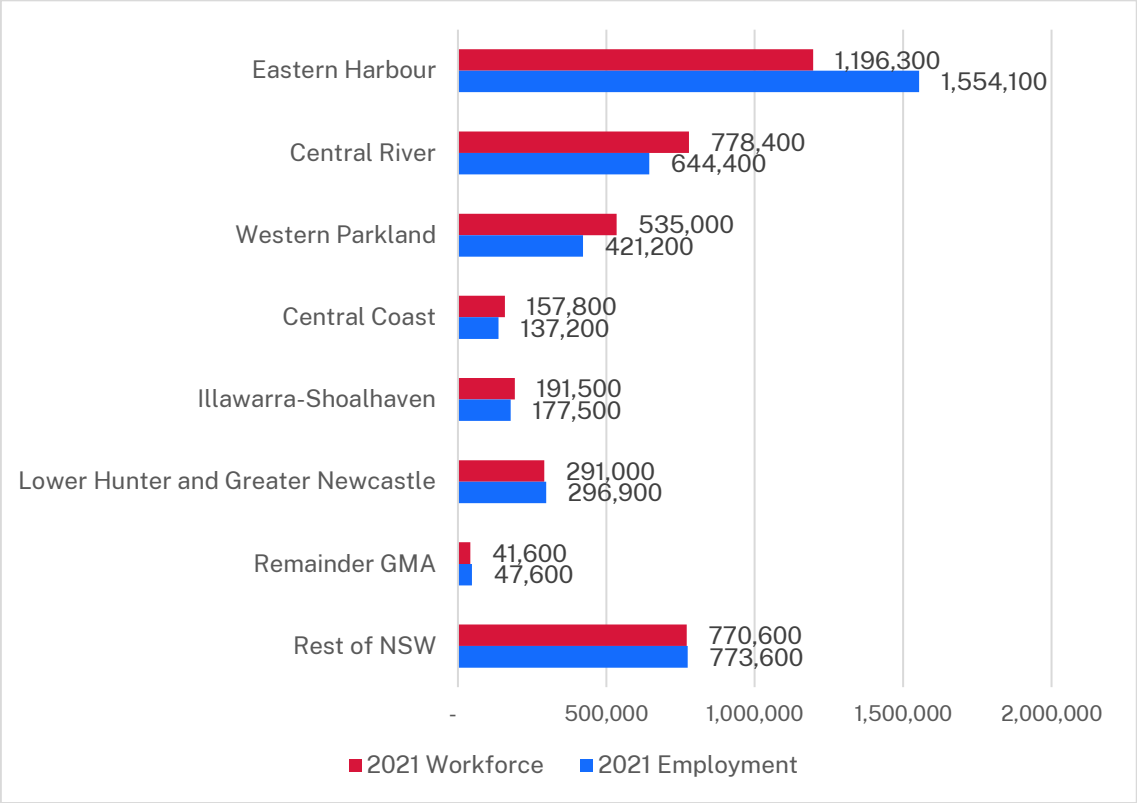
CAGR is the Compound Annual Growth Rate (%)
GMA is the Greater Metropolitan Area (see Section 4.4 Spatial Geographies for additional details)

Comparing city-wide employment to workforce, Figure 6 and Figure 7 show the persistence of distributional features.

The Eastern Harbour City will continue to have a large net inflow of workers, while the Central River City and Western Parkland City will have significant outflows. Noting that the rate of population growth and therefore workforce growth is much higher in the Central River City and Western Parkland City compared to employment growth.

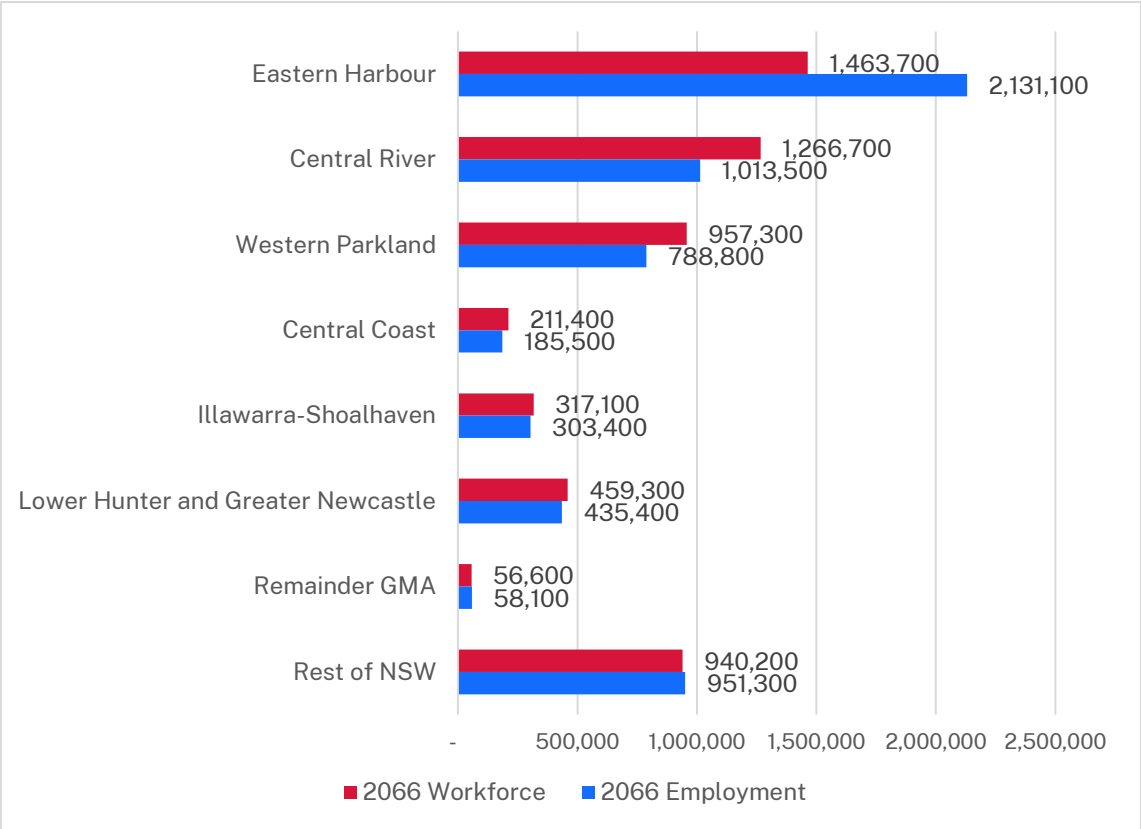
These summaries are based on total employment and therefore do not consider specific employment industries and their resident workforce distribution.

Figure 6 Workforce and employment by Six Cities 2021



Source: TZP24 Workforce Projections and TZP24 Employment Projections

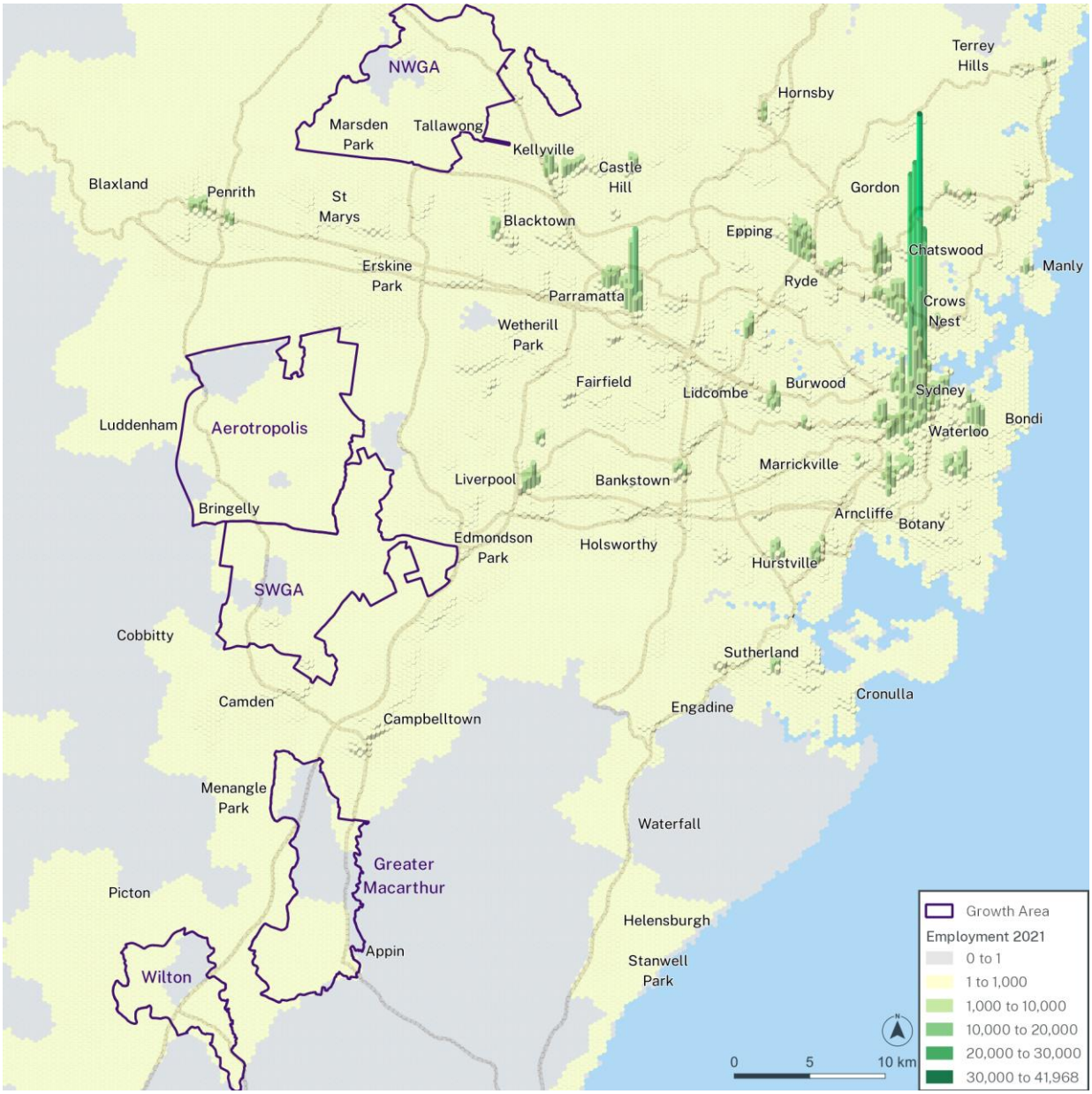
Figure 7 Workforce and employment by Six Cities 2066



Source: :
TZP24 Workforce Projections and TZP24 Employment Projections

The existing employment distribution as shown in Figure 8 shows the high concentration of employment in the Sydney CBD and inner suburbs extending towards Macquarie Park and Parramatta with sparse employment on the western edge of the city, highlighting the gap in the workforce and employment distribution.

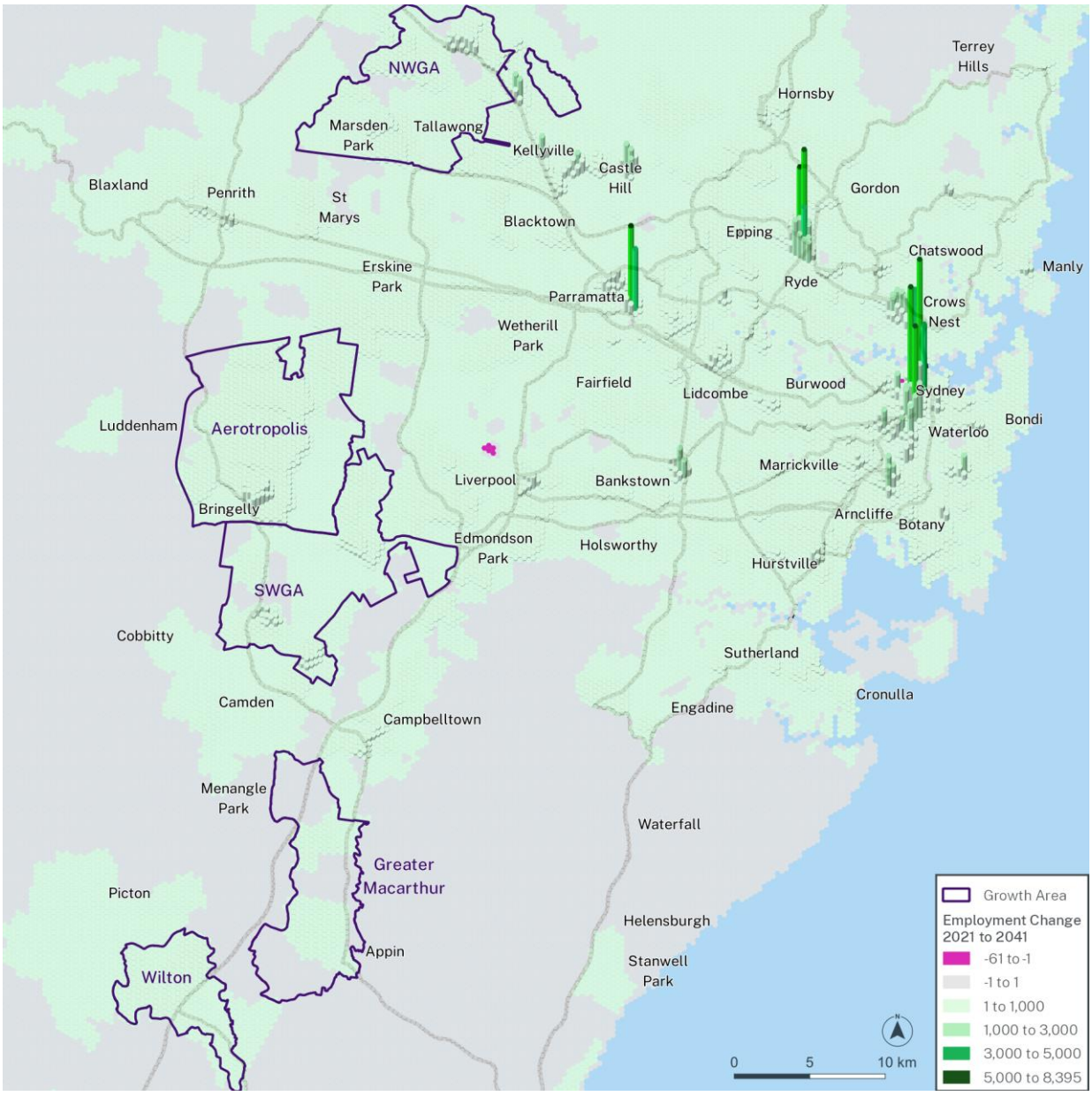
Figure 8 Greater Sydney Employment Distribution 2021



Source: Transport for NSW, 2024

Growth in employment to 2041 consolidates in the eastern part of the city with emerging employment hubs centred around the Western Sydney Aerotropolis and more employment focused in the North West and South West Growth Areas highlighted in Figure 9.

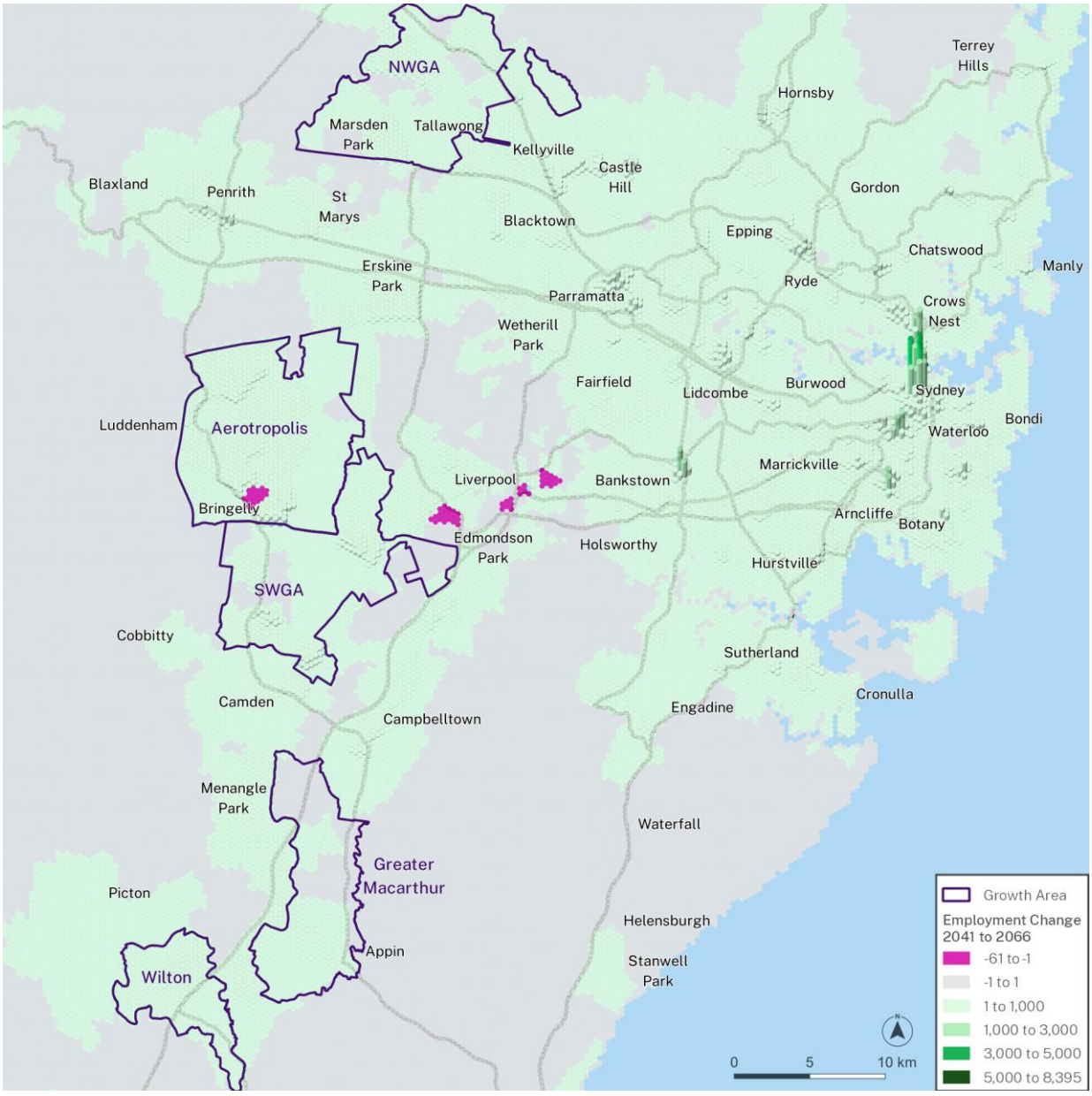
Figure 9 Greater Sydney Employment Growth Distribution 2021-2041



Source: Transport for NSW, 2024

Figure 10 shows this continuing towards 2066 with significant employment generated by the Aerotropolis, continued growth in Liverpool and the corridor south to Campbelltown-Macarthur. Growth in the Sydney CBD continues to be strong.

Figure 10 Greater Sydney Employment Growth Distribution 2041-2066



Source: Transport for NSW, 2024

1.5 Report structure

The remainder of the report is structured as follows:

Section 2	Model framework and data specification
Section 3	Module 0: Concordance Module
Section 4	Module 1: Dwellings and Population
Section 5	Module 2: Age by Sex
Section 6	Module 3: Households by Household Type
Section 7	Module 4: Students
Section 8	Module 5: Workforce Segmentation
Section 9	Module 6: Employment
Section 10	Module 7: Checks and Validation

2 Model framework and data specification

This chapter is a comprehensive summary of the data generated by the Travel Zone Projection modelling team and how it links with internal and external requirements. Understanding the overall linkages between each module of the model is critical to understanding the role and function of each.

2.1 TZP dataset overview

TfNSW creates Travel Zone Projections of population, workforce, students, and employment using a model, which are used as inputs in the Population Synthesiser ('Pop Synth'), STM and the Freight Movement Model ('FMM') models for transport forecasting.

The population synthesiser is used to create 'agents'. The resulting agents, along with additional TZP inputs, are then used by the STM to create travel flows. Some of the TfNSW small area data is also published online and used for other purposes.

At a high level, the data covers three dimensions:

- **Time Period**: Annual forecasts from 2021 to 2031 and 5 yearly time periods from 2031 to 2066
- **Geography**: TZP24 is available in TZ21 geography with 4,236 travel zones across New South Wales.
- **Profiling Variables**: Over 150 variables covering people, households, employment and students.

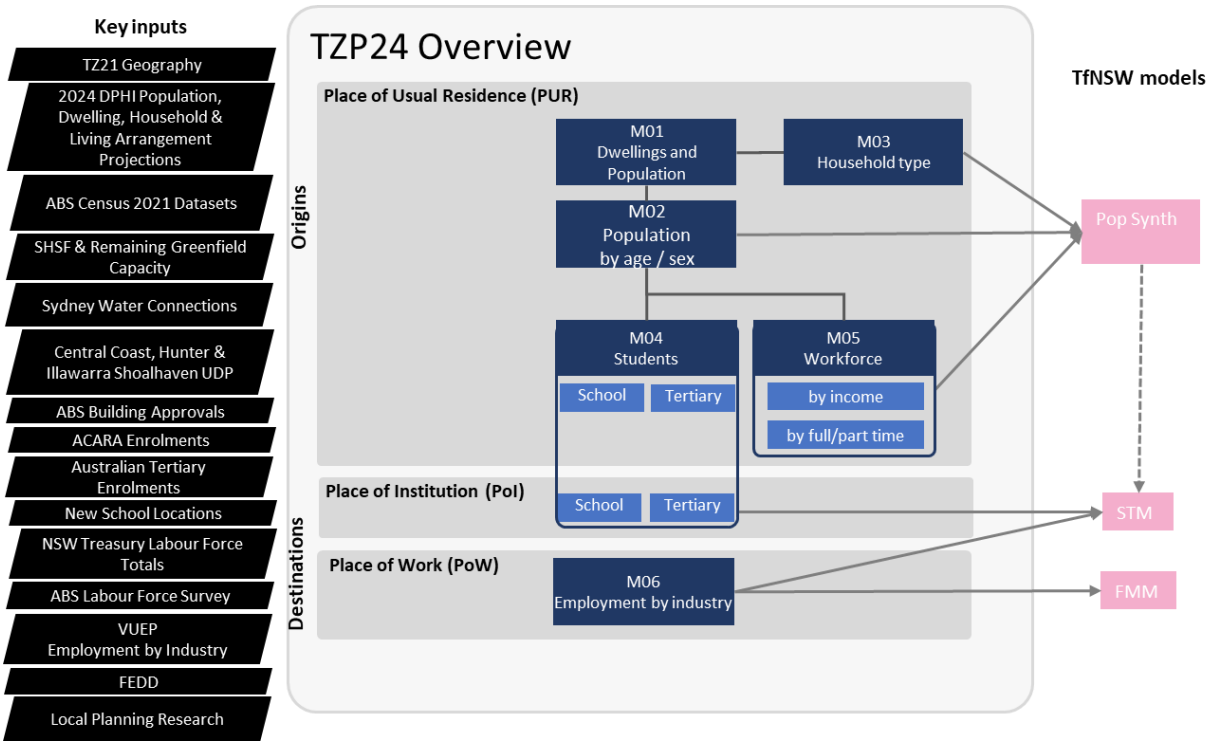
These various attributes are currently created using a series of interrelated Microsoft Excel, VBA, Python and R based modules.

The remainder of this section provides additional detail about the TZP framework, time periods, geographies, and variables.

2.2 TZP modelling overview

The following diagram highlights the key data inputs and steps used to create TZP24. It also highlights the key links to the Population Synthesiser and STM/FMM models.

Figure 11: Travel Zone Projections 2024 Overview



Source: SGS Economics and Planning, 2024

At a high level, official DPHI SA2 population and household projections are disaggregated to travel zones using a number of small area input sources on current and future development trends. From this, the population is further segmented by age and sex, school and tertiary enrolment type, and workforce status and households are further segmented by household type.

VU Employment Projections at the SA4 level by industry (at 1 digit industry) at POW are used to create employment projections by 33 ANZSIC industries at Travel Zone level. Employment by industry numbers are first disaggregated from the SA4 level to SA3s and finally to travel zones using a number of small area input sources on historical and future employment trends.

The following section provides a high-level summary of the TZP24 process. This summary is then discussed in further detail in forthcoming sections of the report.

2.2.1 Modules 1/2/3: Dwellings, population, and segmentation

Structural Private Dwellings (SPD) is the first variable to be estimated by Travel Zone using several housing capacity data sources and a capacity allocation process. SPD is then disaggregated to obtain the distribution of Occupied Private Dwellings (OPD) and Unoccupied Private Dwellings (UPD). Estimated Resident Population (ERP) is computed by combining its components Population in Occupied Private Dwellings (POPD) and Population in Non-Private Dwellings (PNPD).

Base distribution (2021)

The base distribution for SPD is sourced from ABS 2021 Census data using the sum of OPD and UPD by Statistical Area 1 (SA1) and realigned to Travel Zone geography. It is then benchmarked to the SA2 control totals to align with DPHI projections for 2021.

Control Totals

DPHI provided the following inputs:

- Collapsed SA2 Population by Sex and Age Projections from 2021 to 2041
- Collapsed SA2 Households by Household Type Projections from 2021 to 2041
- Collapsed SA2 Living Arrangement Projections from 2021 to 2041
- Collapsed SA2 Implied Dwelling Demand Projections from 2021 to 2041

Adjustments to this data were made as follows:

- The DPHI inputs up to 2041 were trended out to 2066.
- The above inputs were concorded from Collapsed SA2 to SA2 based on 2021 ERP.
- The data was adjusted to account for zero dwellings and zero population in fully industrial SA2s.

These data inputs are used as follows:

- SA2 Implied Dwelling Demand Projections are used as the control totals for SPD in Module 1
- SA2 Total Household Projections are used as the control totals for OPD in Module 1
- The ratio of SA2 POPD to PNPD from the SA2 Living Arrangement Projections is used in conjunction with the SA2 Population Projections to generate the control totals for POPD and PNPD in Module 1
- SA2 Population by Sex and Age Projections are used as the control totals for POPD Age & Sex in Module 2
- SA2 Households by Household Type Projections are used as the control totals for Households by Household Type in Module 3, with some adjustments to account for Minimum POPD 15+

Projection distribution

- The SHSF forms the primary input into the forecast distribution of dwellings. A number of other localised greenfield and planned development information is also sourced. All dwelling development data is treated as ‘priority capacity’ with a ‘preferred timing’. SA2 control totals are then distributed down to this ‘priority capacity’.
- In cases where ‘priority capacity’ is lower than the SA2 dwelling growth from the control totals, all of the ‘priority capacity’ is allocated and any remaining developments are allocated on a pro rata basis using the distribution of dwellings in the previous forecast year.
- In cases where ‘priority capacity’ exceeds the SA2 dwelling growth from the control totals, any unused capacity is pushed out to the next forecast year in order to meet the

DPHI projections. This effectively means demand is lower than the planned supply, so developments are delayed or occur slower than anticipated.

Dwellings are then systematically used as the basis to identify occupied private dwellings, population splits, age-sex, household types, enrolments, and workforce status. All population segments refer to persons living in private dwellings (i.e., this excludes people living in non-private dwellings such as nursing homes, jails, etc.).

Base 2021 disaggregation ratios (i.e., occupancy rates, household size, age/sex segmentation, and household type segmentation) are largely sourced from the ABS 2021 SA1 Census data and realigned to Travel Zone geography. Data is then benchmarked back to the control total data by SA2.

An Iterative Proportional Fitting (IPF) approach is used to evolve the travel zone distribution over time to align with the SA2 controls totals while still reflecting variation at the travel zone level. This is used to estimate the distribution of POPD by Age & Sex, and the distribution of Households by Household Type. The population and household profile of seed values for new residential locations (i.e., where no base exists) is sourced from the respective local region.

The following inputs are used to project population, households and dwellings:

- DPHI SA2 Population, Implied Dwelling Demand, Household, and Living Arrangement Forecasts (FY21-66)
- ABS Building Approvals data (FY22-23)
- Sydney Water Dwellings data (FY22-23)
- Sydney Housing Supply Forecast Data (FY24-43) & Additional Greenfield Capacity (FY44-66)
- Central Coast Urban Development Program data (FY24-66)
- Hunter Urban Development Program data (FY23-66)
- Illawarra Shoalhaven Urban Development Program data (FY23-66)
- Various local planning and research information
- ABS Census data (2021)

A process map of Modules 1, 2 and 3 are included in Appendix B: Travel Zone Projections 2024: Process Maps.

2.2.2 Module 4: Student enrolments

Student Enrolments by place of residence are first estimated and then translated into a place of institution.

Population by age is translated into primary, secondary, and tertiary students using a similar process as for other population segmentation. A base distribution is sourced from the 2021 ABS Census and 2021 Australian Curriculum, Assessment and Reporting Authority (ACARA) enrolment data. Official enrolment forecasts are then disaggregated to SA4 and then Travel Zone level using the IPF approach.

An Optimal Capacity Allocation Model (OCAM) model is then used to convert students by place of residence to place of institution. This assigns students to their closest school up to its capacity and within a maximum travel time threshold. New schools are introduced based on their proposed locations and analysis of provisional gaps.

The following key inputs are used to project enrolments at the Primary, Secondary and Tertiary levels:

- Current enrolments from ACARA 2021
- Planned school locations from Schools Infrastructure NSW
- Australian University Enrolments by Institution 2021
- Population projections by Age 2021-2066 (M02)

2.2.3 Module 5: Workforce and Income

SA4 place of usual residence employment data is provided by Victoria University and is utilised to break down the population into employed (workforce), unemployed and persons not in the labour force. Workforce numbers are then disaggregated into Travel Zones. These numbers are also split into full-time/part-time employment categories, income bands and ANZSCO 1-digit occupations, which are utilised for calibration of the TfNSW STM. SA4 and travel zone variance in participation rates, unemployment rates, full-time/part-time status, income bands, and occupation are captured by drawing on quarterly trends from data published as part of the ABS Labour Force Survey, along with the projected age-sex composition of the workforce identified from Module 02.

The following primary inputs are used to project workforce projections:

- Victoria University Employment Projections
- ABS SA4 Labour Force Survey data
- ABS Census data (2021)
- NSW Intergenerational Report (updated with 2024 DPHI population)

2.2.4 Module 6: Employment

SA4 employment by 1-digit industry projections are calculated externally by VU. These forecasts are then disaggregated into 45 industries using the ABS Census 2021 to inform within-industry shares, with adjustments made to reflect future expected development in certain areas. These forecasts are then disaggregated to the SA3 level, and finally to travel zones.

A key input in all stages of the employment forecasting module is the Future Employment Development Database (FEDD), which provides small area level future employment inputs and is used as the primary input to shift census trend projections. Similar to the SHSF data for dwellings, this database is used as a 'possible capacity' and 'preferred timing' dataset. Historical trends are shifted where the FEDD signals a clear shift in policy and base trends.

SA3 disaggregation is conducted in two stages. First, a baseline forecast is generated that attempts to model the spatial distribution of employment in the absence of any knowledge of future development and shifts in policy. A series of land use indicators, including travel time and employment land; as well as historical population-to-employment ratios are used to allocate SA4 jobs to SA3s. Once this base forecast is generated, adjustments are made to account for future developments contained in the FEDD. SA3s where there are large discrepancies between the base forecast and FEDD developments are adjusted to achieve a forecast where the jobs in the FEDD can be accommodated, where possible.

Travel zone disaggregation follows a similar line of reasoning, with SA3 employment allocated to travel zones based on the historical distribution and adjusted to account for projects contained in the FEDD.

Following the generation of travel zone employment by industry projections, further disaggregation is conducted to obtain employment by full-time/part-time status, income bands, and occupations. The methodology used to disaggregate the place-of-work variables here are the same as in Module 5, with the exception of income bands, where the variance in income bands is linked to the forecast industry of employment for jobs. This ensures that evolving areas of New South Wales see an equivalent change in the income distribution.

The following primary inputs are used to project employment:

- Victoria University Employment Projections
- ABS Labour Force Survey data
- ABS Census data (2021)
- Future Employment Development Database, which contains various assumed employment developments across NSW. Though it is statewide, it has a heavy skew towards Greater Sydney. These employment assumptions were compiled by TfNSW and reviewed by SGS (see Appendix A: Future Employment Development Database (FEDD)).

2.3 Time periods

Projections are created in the base year of 2021 and extend out to 2066. Future periods are produced in five-yearly periods, with the first 10 years produced annually.

The resulting future periods are as follows:

Forecast Years	Notes
2021	Base Year
2022	
2023	
2024	
2025	
2026	
2027	
2028	
2029	
2030	
2031	
2036	
2041	
2046	
2051	
2056	
2061	
2066	

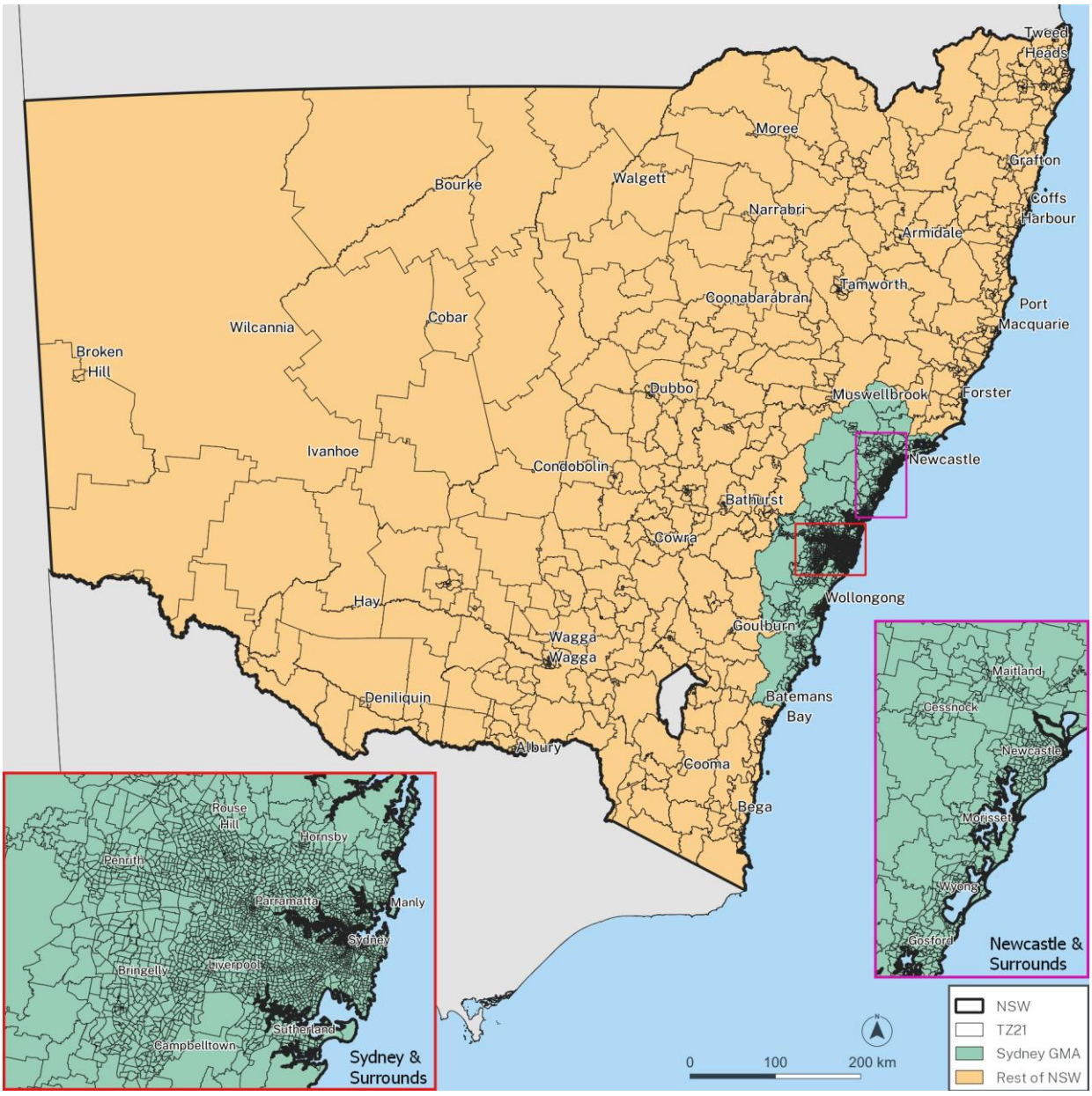
2.4 Spatial geographies

The Greater Metropolitan Area ('GMA') is the area used for TfNSW's Strategic Travel Model. This includes the Sydney Greater Capital City Statistical Area ('GCCSA'), the Southern Highlands and Shoalhaven SA4, Illawarra SA4, Newcastle and Lake Macquarie SA4 and Lower Hunter, Port Stephens, Maitland SA3s as defined by the ABS.

All land use variables are generated by the TfNSW 2021 Travel Zone (TZ21) geography classification. The TZ21 geography of 4,236 travel zones cover the entire state of NSW (including the Sydney GMA and the Rest of NSW) and aligns with the 2021 ABS Census Destination Zones and the associated ASGS (SA2, SA3 and SA4) structure.

A geographic map of key areas is shown in Figure 12.

Figure 12: NSW State, Sydney GMA, and Travel Zone Boundaries



Source: Transport for NSW, 2024

2.5 Variable breakdowns

Numerous variables are created in each of the six modules. Projections of these variables are used for both external requirements and as inputs into subsequent modules. Detailed breakdowns are required to create an accurate picture of trip attraction and generation as part of the STM. However, too many variable breakdowns may undermine the data quality and can make the process overly complicated. Understanding the exact requirements and tailoring module structure around this is critical.

2.5.1 Core Transport Model TZP variable requirements

The core purpose of the TfNSW TZP data is for input in the Pop Synth, STM and FMM. TZP variables are used in different ways in Transport models, each model has its own requirements and data transformations.

The TZP variables required for these transport models fall into two primary categories.

- **Generator variables** that relate to the origin location of travel, that is, by place of usual residence (PUR).
- **Attractor variables** that relate to destinations. These destinations range from places of work (PoW) and educational institutions (PoI) to destinations such as shopping centres.

Table 5 summarises the inputs required by the population synthesiser as well as additional fields which need to be generated but are not required by the population synthesiser.

Table 5: Population Synthesiser data input requirements

Place of count	Category	Sub category	Variable
PUR	POPD	POPD	POPD
PUR	POPD	Age-Sex	Males 0 - 9 Males 10 - 19 Males 20 – 29 Males 30 - 39 Males 40 - 59 Males 60 - 79 Males ≥80 Females 0 - 9 Females 10 - 19 Females 20 – 29 Females 30 - 39 Females 40 - 59 Females 60 - 79 Females ≥80
PUR	POPD (>15)	In the Labour Force (iLF)	Full-time workers Part-time workers Unemployed

Place of count	Category	Sub category	Variable
		Not in the Labour Force (NiLF)	Not in Workforce[#]
PUR	POPD	POPD (<15) POPD (15+) (Note, this includes people employed and not employed)	Children (≤15 years old) Negative or Nil income $1-$149 $150-$299 $300-399 $400-499 $500-649 $650-799 $800-999 $1,000-$1,249 $1,250-$1,499 $1,500-$1,749 $1,750-$1,999 $2,000-$2,999 $3,000-$3,499 $3,500 or more
PUR	POPD	Enrolled students	Primary School Student Secondary School Student Tertiary Institution Student
PUR	POPD	Students in each tertiary type	University – Full time University – Part time Technical – Full time Technical – Part time
PUR	OPD	Household Types	Couples with Children Couples Only Single Parent Single Person Other Types

 # Generated variables not required by the Pop Synth.

Table 6 lists the attractor variables which are produced by the TfNSW Place Forecasting team for use by the STM as well as additional variables that are generated but are not required as STM inputs.

Table 6: STM data input requirements

Place of count	Category	Sub category	Variable
PUR	POPD	POPD	POPD
PoW	Total Employment	Total Employment	Total Employment
PoW	Total Employment	Income Bands (weekly)	Negative or Nil income $1-$149 $150-$299 $300-399 $400-499 $500-649 $650-799 $800-999 $1,000-$1,249 $1,250-$1,499 $1,500-$1,749 $1,750-$1,999 $2,000-$2,999 $3,000-$3,499 $3,500 or more
PoW	Total Employment	Other industries	Retail Trade Agriculture, Forestry and Fishing[#] Mining[#] Electricity, Gas, Water and Waste Services[#] Construction[#] Wholesale Trade[#] Transport, Postal and Warehousing[#] Information Media and Telecommunications[#] Manufacturing[#]
PoW	Total Employment	Retail	Retail Trade
PoI	Students	School students	Primary School Students Secondary School Students

Place of count	Category	Sub category	Variable
		Tertiary students	Tertiary Institution Students

[#] *Generated variables not required by the STM.*

In addition to inputs for the STM, TZP24 also provides 34 attraction variables for use in the Freight Movement Model (FMM). The data segmentation required by the FMM is detailed in Table 7.

Table 7: FMM data input requirements

Place of count	Category	Sub category	Variable
PoW	Total Employment	Non-Manufacturing (1-digit ANZSIC)	Agriculture, Forestry and Fishing Mining Electricity, Gas, Water and Waste Services Construction Wholesale Trade Retail Trade Accommodation and Food Services Transport, Postal and Warehousing Information Media and Telecommunications Financial and Insurance Services Rental, Hiring and Real Estate Services Professional, Scientific and Technical Services Administrative and Support Services Education and Training Health Care and Social Assistance Arts and Recreation Services Other Services
PoW	Total Employment	Manufacturing (2-digit ANZSIC)	Food Product Manufacturing Beverage and Tobacco Product Manufacturing Textile, Leather, Clothing and Footwear Manufacturing Wood Product Manufacturing Pulp, Paper and Converted Paper Product Manufacturing Printing (including the Reproduction of Recorded Media) Petroleum and Coal Product Manufacturing Basic Chemical and Chemical Product Manufacturing Polymer Product and Rubber Product Manufacturing

Place of count	Category	Sub category	Variable
			Non-Metallic Mineral Product Manufacturing Primary Metal and Metal Product Manufacturing Fabricated Metal Product Manufacturing Transport Equipment Manufacturing Machinery and Equipment Manufacturing Furniture and Other Manufacturing Food Product Manufacturing Beverage and Tobacco Product Manufacturing

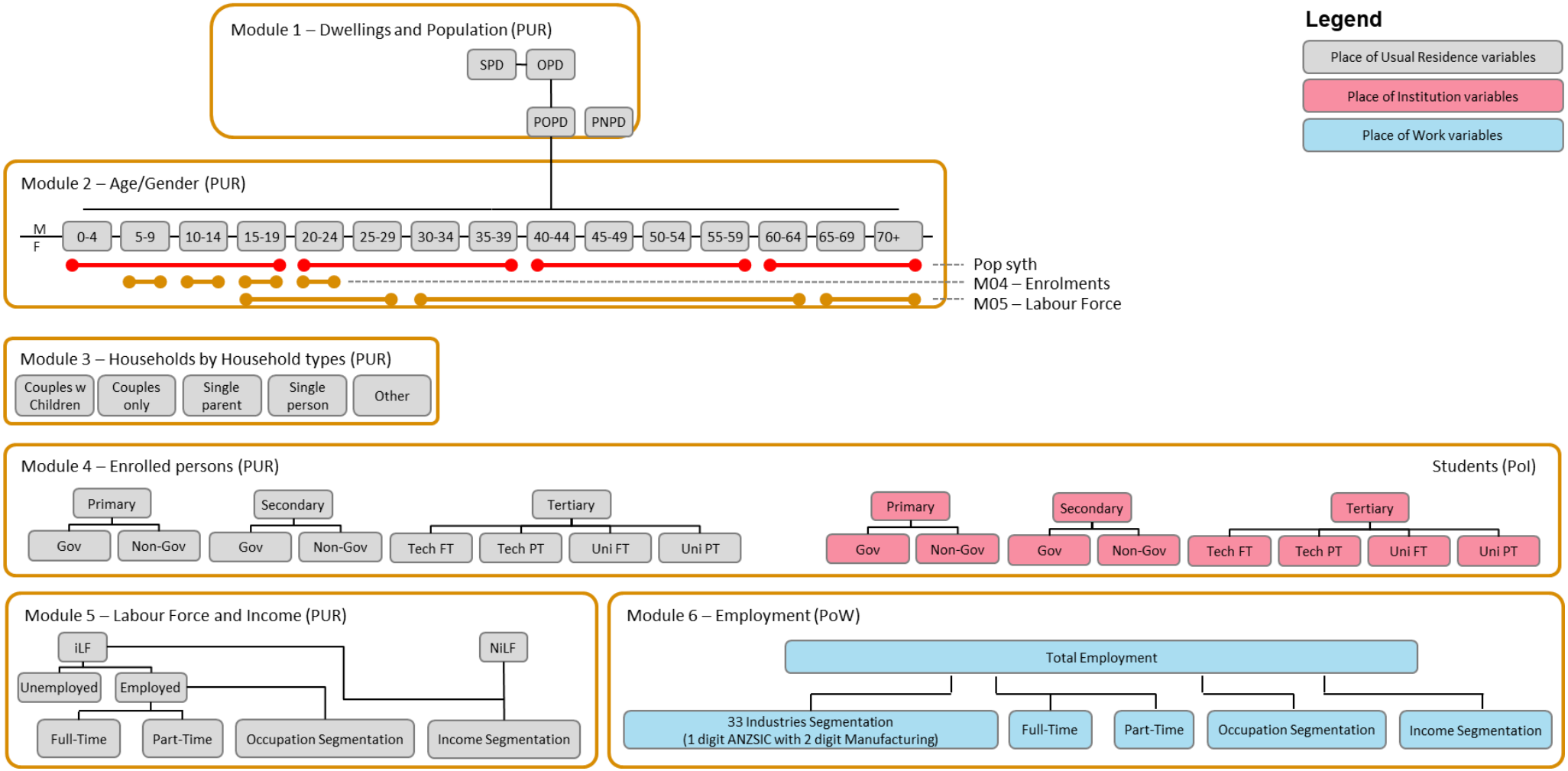
2.5.2 Broader TZP variables requirements (by each module)

Beyond the core transport model requirements, the data is also available to download from the TfNSW Open Data Hub and used as input into a diverse range of local planning and research work by a wide range of practitioners.

As highlighted earlier in this chapter, there are also interrelationships between Modules and associated variable requirements. For example, detailed age/sex breakdowns are required for the development of Workforce variables.

Figure 13 seeks to define the entire scope of variables that the Place Forecasting team needs to produce. This covers requirements for Transport Modelling, website publishing and Module interdependencies.

Figure 13: Model variable generation and module dependencies



Source: SGS Economics and Planning, 2024

Detailed Module Specification

3 Module 0: Concordance Module

This chapter provides a summary of the concordance module of TZP24. This was a new module introduced in TZP19 to separate all concordance computations. TZP 2016 v1.51 and older versions performed concordance calculations separately within each module.

3.1 Module 0 Technical Model Overview

The following sections provide an overview of how the model operates.

3.1.1 M00a – ABS Input Data

This module acts as the mechanism used to create and store the spatial distribution of key ABS dwelling and population variables at SA1 and SA2 for use in later modules.

Inputs

Key Inputs:

- ABS Census 2021, PUR Database
- ABS Census 2021, PoE Database
- ABS Regional Population Growth

Functions

This module has one key function:

- Store and create spatial distributions of key variables sourced from ABS for use in later modules.

3.1.2 M00b – Concordance Module

This module converts data from geographies of sourced data to geographies utilised in later modules. The concordances are done via weights created from geospatial data and ABS census data to weight concordance by Area, Population, Dwellings or Employment.

Inputs

Key Inputs:

- ABS Census 2021, PoE Database - SA1 Occupied Private Dwellings
- ABS Census 2021, PoE Database - SA1 Unoccupied Private Dwellings
- ABS Census 2021, PoE Database - SA1 Non-Private Dwellings
- ABS Census 2021, PUR Database - SA1 Estimated Resident Population
- ABS Census 2021, PUR Database - SA1 Population Occupied Private Dwellings
- ABS Census 2021, PUR Database - SA1 Population Non-Private Dwellings
- ABS Census 2021, PUR Database - SA1 Population by Age by Sex
- DPHI Sydney Housing Supply Forecast 2023 FY24-43
- ABS Quarterly Building Approvals FY22-23 (YTD Q2 2022 and YTD Q2 2023)
- Sydney Water Dwelling Connections Data FY22-23
- DPHI Central Coast Urban Development Program Forecasts FY24-66
- DPHI Hunter Urban Development Program Forecasts FY23-66
- DPHI Illawarra and Shoalhaven Urban Development Program Forecasts FY23-66

Functions

This module has several key functions:

- ABS Census Dwelling and Household inputs are converted from M00a from ABS SA1 2021 to TZ21
- ABS Census Population inputs from M00a are converted from ABS SA1 2021 to TZ21
- ABS Census Population by Age by Sex inputs are converted from ABS SA1 2021 to TZ21
- DPHI SHSF 2023 data is converted from ABS Mesh Block 2021 to TZ21
- ABS Building Approvals data is converted from ABS SA1 2021 to TZ21
- Sydney Water Corporation Dwelling Connections data is converted from ABS Mesh Block 2021 to TZ21
- DPHI Central Coast Urban Development Program Forecasts are converted from custom geography to TZ21
- DPHI Hunter Urban Development Program Forecasts are converted from custom geography to TZ21
- DPHI Illawarra and Shoalhaven Urban Development Program Forecasts are converted from custom geography to TZ21

3.1.3 M00c – Planning Input Data

This module processes data supplied by DPHI to an appropriate format and a standard ABS geography for use in later modules.

Inputs

Key Inputs:

- 2024 NSW Household Projections by Collapsed SA2 from 2021 to 2041
- 2024 NSW Implied Dwelling Demand Projections by Collapsed SA2 from 2021 to 2041
- 2024 NSW Living Arrangement Projections by Collapsed SA2 from 2021 to 2041
- 2024 NSW Population Projections by Collapsed SA2 from 2021 to 2041

Functions

This module has several key functions:

- Trend out the DPHI input data to extend the data from 2041 to 2066
- Concord the input data from Collapsed SA2 geography to ABS SA2 geography using 2021 ERP
- Extract POPD and PNPD proportions from the living arrangements data for use in Module 1
- Combine Population Age Groups into 5-year age groups for use in Module 2
- Combine Household Type categories into required categories for use in Module 3
- Combine Living Arrangement categories into required categories for use in Module 3
- Zero out any households, dwellings or population in regions entirely containing industrial areas

Calculation of POPD and PNPD control totals in TZP24

For TZP24, the following DPHI population inputs were provided as follows:

- ERP by Sex and 5-year age group Projections by Collapsed SA2 from 2021 to 2041
- Living Arrangement Projections by Collapsed SA2 from 2021 to 2041

After trending out the DPHI inputs to 2066, the split of POPD/PNPD by SA2 was derived using the following method:

- The above inputs are concorded from Collapsed SA2 to SA2 based on 2021 ERP.
- The proportion of POPD to PNPD is calculated by SA2 by Age from the living arrangements data.
- These proportions are multiplied by the ERP by Age SA2 distribution to obtain the POPD by Age SA2 distribution.
- Once the POPD by age distribution is created, the ERP Male Female Split is applied from the ERP by Sex and 5-year age group SA2 distribution to obtain the POPD by Sex and 5-year age group SA2 distribution.
- The PNPD by Sex and 5-year age group SA2 distribution is calculated by subtracting POPD by Sex and 5-year age group SA2 distribution from ERP by Sex and 5-year age group SA2 distribution.
- Total POPD is calculated by aggregating POPD by age.
- Total PNPD is calculated using ERP minus POPD.

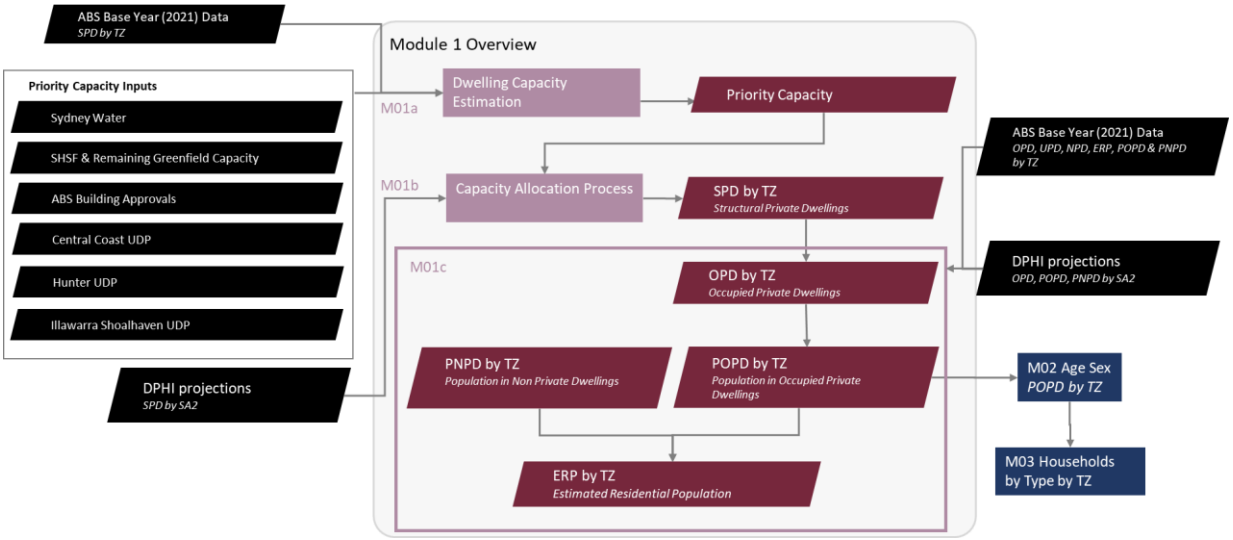
4 Module 1: Dwellings and Population

This chapter provides a summary of the dwellings and population module of TZP24.

4.1 Module 1 Overview

The diagram below presents an overview of the module and its relationship to the other modules.

Figure 14: Module 1 Overview



Source: SGS Economics and Planning, 2024

This module is made up of six components:

- **Dwelling Capacity Estimation** – Combining Sydney Housing Supply Forecasts for the metropolitan area, Sydney Water connections data, ABS Building Approvals, Central Coast UDP data, Hunter UPD data, and Illawarra and Shoalhaven UDP data to determine dwelling capacity for each Travel Zone.
- **Dwelling Projections (Structural Private Dwellings)** – Using the identified dwelling capacity for each Travel Zone, a capacity allocation process is used to produce Structural Private Dwellings (SPD) by Travel Zone.
- **Household Projections (Occupied Private Dwellings)** – Applying occupancy rates from the census to the estimated SPD, Occupied Private Dwellings (OPD) by Travel Zone are projected.
- **Population in Occupied Private Dwellings Projections** – Applying average household sizes by Travel Zone to the OPD projections, Population in Occupied Private Dwellings (POPD) is projected at Travel Zone level.
- **Population in Non-Private Dwellings Projections** – Combining the Population in Non Private Dwellings census distribution and future Non Private Dwelling developments, Population in Non-Private Dwellings is projected at Travel Zone level.
- **Estimated Resident Population Projections** – Summing the POPD and PNPD projections at Travel Zone level.

4.2 Module 1 Technical Model Overview

The following sections provide an overview of how the model operates.

4.2.1 M01a – Capacity Estimation

This module determines dwelling capacity at a Travel Zone level drawing on a range of data sources. This first module has been built to incorporate the most up-to-date and available datasets available at the time.

This module requires inputs from the following sources:

Inputs

- SHSF Data (FY24-43) & Additional Greenfield Capacity (FY44-66)
- Sydney Water Corporation Dwelling Connections Data (FY22-23)
- Central Coast Urban Development Program Forecasts (FY24-66)
- Hunter Urban Development Program Forecasts (FY23-66)
- Illawarra and Shoalhaven Urban Development Program Forecasts (FY23-66)
- ABS Buildings Approval Data (FY22-23)

Functions

- SHSF & Additional Greenfield Capacity forecasts, Sydney Water, Central Coast UDP, Hunter UDP, Illawarra and Shoalhaven UDP, and Building Approvals inform the additional priority capacity available in each Travel Zone.

Sydney Housing Supply Forecast and Additional Greenfield Capacity

The DPHI Sydney Housing Supply Forecast is a spatial dataset that distributes future housing supply across Sydney for the next 20 years and is updated annually. It is a 'point-in-time' forecast, based on current zoning and planning controls, announced and proposed State and Local strategic planning, planning proposals and gateway determinations.

It sets out where, when and how much housing are expected to be built across Sydney and is used to guide infrastructure planning and service delivery to support new housing development and population growth; and inform long-term strategic planning.

The SHSF data provided by DPHI, extends to 2043 and underpins the model being the major input into the primary dwelling capacity estimation in M01a.

These inputs represented housing policy as of November 2023 prior to the release of the NSW response to the National Housing Accord. They include the impact of adjusted greenfield capacities in NWGA and SWGA and Transit Oriented Development (TOD) Tier 1 and Tier 2 sites forecast over the next 15 years. Low and mid-rise policy reforms were excluded given the lack of spatial granularity of this component.

This data was provided at the Mesh Block level; this is then concorded to travel zone geographies before being fed into the capacity calculation model. After updating years between 2022-23 with data from Sydney Water and ABS Building approvals, SHSF capacity data is the leading input from 2024-43.

For the remainder of the forecast period beyond the next 20 years, Additional Greenfield Data is supplied by DPHI which is calculated based on the planned capacity, minus dwelling completions across the various precincts. This capacity is allocated to areas within these precincts where remaining capacity for development exists and is the leading capacity input from 2044-66.

While SHSF covers Sydney, DPHI also provided future urban development program housing supply forecasts for the Central Coast, Hunter and Illawarra-Shoalhaven regions. This data was provided at a custom geography and are concorded to travel zone, before being fed into the capacity calculation model.

4.2.2 M01b – Dwelling Projections

This module distributes the DPHI Implied Dwelling projections by SA2 to Structural Private Dwellings by Travel Zone based on the capacity estimates from M01a.

Structural Private Dwellings (SPD) are privately owned buildings or structures that people live in. This may include houses, apartments, or mobile dwellings such as caravans.

Inputs

Key inputs:

- Implied Dwelling Projections by SA2 from 2021 to 2066 (output from M00c)
- ABS 2021 base year Structural Private Dwellings data (output from M00b)
- Additional Priority Capacity (output from M01a)
- Locked Capacity manual inputs
- SPD Calibration (%) within SA2s manual input

Functions

This module has two primary functions:

- Summarise the capacity inputs from M01a and determine if manual locked capacity or SPD calibration adjustments are required
- Calculate the final Structural Private Dwelling distribution in each Travel Zone in the base year (2021) using the ABS base year data and the SPD control totals by SA2 (i.e. Implied Dwellings).
- For all forecast years from 2021 to 2066, the Capacity Allocation Process is used to calculate the Structural Private Dwelling distribution by Travel Zone whilst maintaining SPD control totals by SA2.
    - Structural Private Dwellings are firstly allocated by any additional locked capacity manual inputs.
    - Following on from this, dwellings are then allocated to Travel Zones based on additional priority capacity.
    - In the case of excess priority capacity (i.e., there is too much priority capacity to satisfy growth in the SA2 control totals), the additional priority capacity is adjusted to Travel Zones on a pro rata basis. Any unallocated additional priority capacity is added to the next forecast year's additional priority capacity.
    - In the case there is residual of dwelling growth (i.e., there is not enough priority capacity to satisfy growth in the SA2 control totals), the remaining allocation is prorated based on the previous forecast year's SPD distribution.
- The final SPD output can be redistributed to follow a user input as supplied in SPD Calibration where required. This means that regardless of the final SPD output for a specific SA2, the travel zones in that SA2 will follow the user input's expected distribution and override locked capacity, priority capacity and pro rata allocations.

4.2.3 M01c – Households and Population by Travel Zone

This module distributes the DPHI household and population forecasts to produce Occupied Private Dwellings (OPD), Population in Occupied Private Dwellings (POPD), Population in Non-Private Dwellings (PNPD) and Estimated Resident Population (ERP) by Travel Zone.

The calculated variables for this module are:

- **OPDs** are a subset of SPDs by only considering dwellings that are occupied by one or more people.
- **POPD** represents people who reside in private dwellings. This represents approximately 98 per cent of the population.
- **PNPD** represents people who live in colleges, aged-care facilities, jails, and other non-conventional dwelling forms. This segment of the population is not used for trip generation in the STM and is therefore not further disaggregated.
- **ERP** is comprised of the sum of POPD and PNPD.

Inputs

- Household Projections by SA2 from 2021 to 2066 (output from M00c)
- Population in Occupied Private Dwelling Projections by SA2 from 2021 to 2066 (output from M00c)
- Population in Non-Private Dwelling Projections by SA2 from 2021 to 2066 (output from M00c)
- Estimated Resident Population Projections by SA2 from 2021 to 2066 (output from M00c)
- Structural Private Dwellings by Travel Zone (output from M01b)
- ABS 2021 base year Occupied Private Dwellings, Population in Occupied Private and Population in Non-Private Dwellings data (output from M00b)

Functions

This module has several key functions:

- Calculate base year (2021) occupancy rates and household sizes based on ABS Census data. While occupancy rates and household sizes at an SA2 level are set to 2021 census values as default, these can be overridden by manual user inputs.
- The **OPD** projections by Travel Zone are forecasted using the following process:
    - First Cut – The SPD distribution by Travel Zone is multiplied by the assumed base occupancy rate for each Travel Zone to estimate the first cut of OPD by Travel Zone.
    - Second Cut – OPD forecasts are benchmarked downwards to the SA2 OPD control totals. This step is undertaken to ensure that the process is conservative.
    - Third Cut – OPD forecasts are rebalanced to the SA2 OPD control totals prorated with the number of Unoccupied Private Dwellings (i.e., the number of SPD less OPD). This is done to maintain the SA2 control totals whilst ensuring OPD does not exceed SPD.
    - Manual adjustments – Allows manual adjustments to OPD whilst maintaining SA2 control totals.
    - Final Cut – Applies the manual adjustments to the Third Cut of OPD to produce the final cut of the OPD distribution by Travel Zone.
- The **POPD** projections by Travel Zone are forecasted using the following process:

- First Cut – The OPD distribution by Travel Zone is multiplied by the assumed base household size for each Travel Zone to estimate the first cut of POPD by Travel Zone.
- Second Cut – POPD forecasts are rebalanced to the SA2 POPD control totals, either by POPD growth or POPD stock. The choice of methodology for rebalancing is based on user input and provides the option to determine which methodology generates the best POPD distribution for each SA2.
- Manual adjustments – Allows manual adjustments to POPD whilst maintaining SA2 control totals. This can be used to reduce Travel Zones with unreasonably high POPD density towards the end of the forecast period.
- Final Cut – Applies the manual adjustments to the Second Cut of POPD to produce the final cut of the POPD distribution by Travel Zone.

- The **PNPD** projections by Travel Zone are forecasted using the following process:

  - First Cut – Distribute the PNPD projections by SA2 to Travel Zones based on the Census distribution of PNPD and future Non-Private Dwelling development inputs.
  - Second Cut – Adjust PNPD growth based on a manual user input. This can be used to reduce Travel Zones with unreasonably high PNPD density towards the end of the forecast period.
  - Third Cut – PNPD forecasts are rebalanced to the SA2 PNPD control totals by PNPD growth.
  - Manual adjustments – Allows manual adjustments to PNPD whilst maintaining SA2 control totals.
  - Final Cut – Applies the manual adjustments to the Third Cut of PNPD to produce the final cut of the PNPD distribution by Travel Zone.

- As noted above, the module allows for manual adjustments to the OPD, POPD and PNPD Travel Zone forecasts:

- This functionality exists to deal with issues arising in the model which yield outputs out of line with likely development activity. The manual adjustments are entirely contained within SA2 geographies independent of other areas and are output via intra travel zone shifts within the higher geography (SA2).
  - This is done by shifting target areas where validation checks have not been reached and seeks to increase the accuracy of the broader TZP framework.
  - The final outputs following any manual adjustments are structurally the same as they maintain the same SA2 distributions, and only provide the user with the ability to introduce travel zone level shifts in OPD, POPD and PNPD (and therefore ERP).

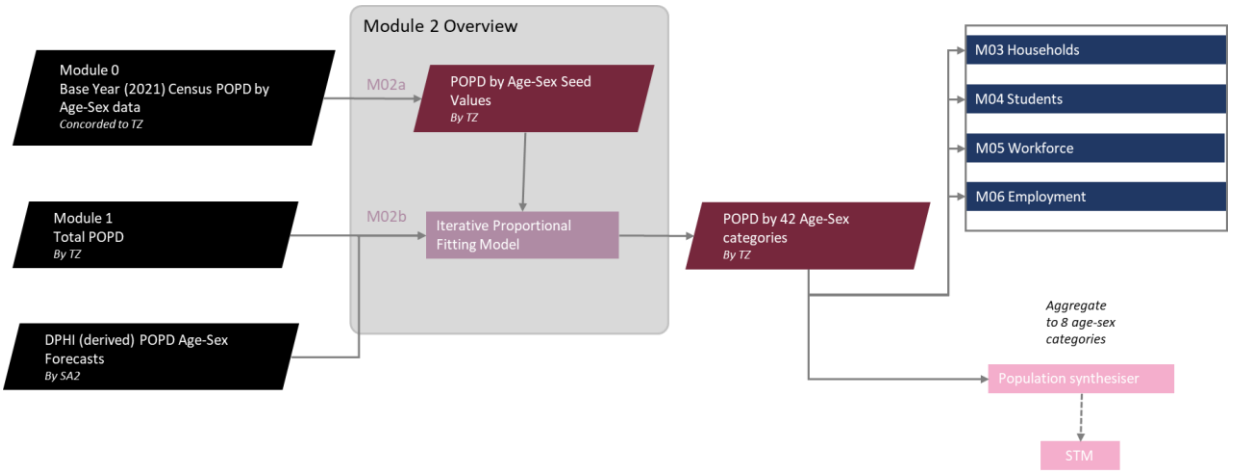
5 Module 2: Age by Sex

This chapter provides a summary of the age-sex module of TZP24. This approach is the same as that was used for the TZP22 projection release.

5.1 Module 2 Overview

The following diagram presents an overview of the POPD by age/sex module and how it interacts with the broader TZP framework. Understanding where inputs are sourced and what outputs are required is critical when operating the module.

Figure 15: Module 2 Overview



Source: SGS Economics and Planning, 2024

Following on from the computation of the TZ POPD distribution in Module 1, POPD is then disaggregated into several age-sex categories for each time period.

- 42 age by sex categories, segregated by 5-year age groups and sex, are created for use in subsequent modules.
- Results are aggregated into 8 age by sex categories for the population synthesiser and STM.

While the objective of the previous module was an accurate estimate of population levels in each travel zone, the age-sex module takes these values and primarily focuses on their distribution across age-sex categories. As such, this process is almost entirely automated.

The control totals for Module 2 are the POPD values by Travel Zone from Module 1.

The module starts by using the census age/sex distribution as the base distribution for the base year and Iterative Proportional Fitting (IPF) is used to adjust this distribution to the age/sex control totals for that period. For the next forecast year, the age-sex distribution of the previous forecast year is used as a starting value and IPF is again used to adjust this distribution to the age/sex control totals for that period. The resulting distribution then becomes the base distribution for the next period, and so on.

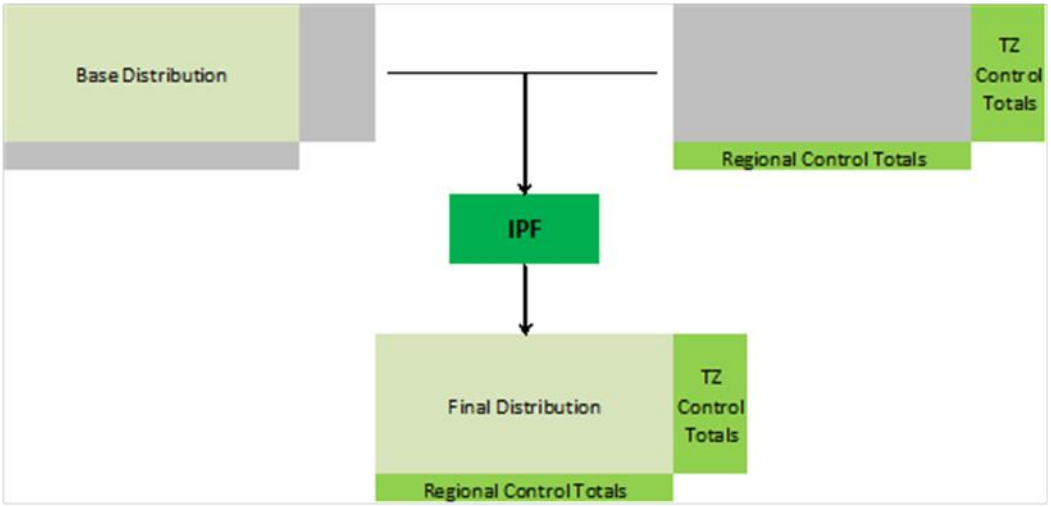
Iterative proportional fitting (IPF) concept overview

IPF is an iterative method that aligns known totals to an estimated distribution. In the age-sex module, total POPD of each travel zone is known, having been estimated previously. Similarly, for each control region (SA2), the total for each age-sex category is known from the DPHI POPD by age-sex projections.

Using these totals, along with an approximated base distribution, an iterative process is used to estimate POPD in each age-sex category by travel zone. This process is run for every region in each period. For the base period (currently 2021), the IPF starting distribution is approximated using 2021 census data. Future forecast periods align the final distribution of the preceding forecast period as the base (starting) distribution for the IPF procedure.

The IPF methodology is outlined below. The approach involves a number of iterations where the distribution is firstly aligned to row totals, then on the next iteration it is aligned to column totals and continues back-and-forth between row totals and column totals until a convergence criterion is achieved. This results in a final distribution that aligns with the base distribution while matching the row and column control totals.

Figure 16: IPF Procedure



5.2 Module 2 Technical Model Overview

The following sections provide an overview of how the model operates.

5.2.1 M02a – Base Distribution

Brings in relevant data from various ABS census and structures them for the IPF process by smoothing inaccuracies resulting from small census data counts.

Inputs

Key Inputs:

- Age by Sex census data by TZ21 (output from M00b)
- Manual inputs to adjust census data anomalies

Functions

This module performs a key function:

- Travel Zones with a low total population are adjusted to reflect the age-sex structure of the overarching SA2 because they are influenced by ABS randomisation.

5.2.2 M02b – Iterative Proportional Fitting

Performs an IPF process to estimate POPD age and sex breakdowns by Travel Zone over time. The IPF model uses a base distribution, along with Travel Zone POPD control totals, and regional age-sex control totals to calculate a Travel Zone age by sex distribution that is consistent with the three inputs.

Key assumptions

- For future years, the IPF procedure uses the age-sex distribution of the previous period as a starting point.
    - This approach reflects the fact that at small geographic levels, age distribution over time is more heavily influenced by migration than by cohort ageing (e.g., families located in zones close to schools or young adults migrating based on access to employment and housing forms).
- Regional trends in the age-sex structure are captured at a Travel Zone level by the IPF procedure.
- Future growth Travel Zones (which have no historical age-sex distribution) are assumed to have a starting distribution that mirrors the distribution of the overarching SA2.

Inputs

Key Inputs:

- Base period ERP totals by Travel Zone (output from M01c)
- POPD totals by Travel Zone (output from M01c)
- Age-sex POPD control totals by SA2 (data supplied by DPHI)
- Base year age-sex distribution by Travel Zone (output from M02a)

The IPF process requires several parameter inputs:

- **Convergence criteria** – the iterative process is complete when the sum of the absolute differences (between Travel Zone POPD control totals and regional age-sex control totals) are below this level.
- **Future years** – the module will perform the IPF procedure for every forecast period up to 2066.
- **Base year** – the module will use the base year 2021.
- **POPD Criterion** – the share of a Travel Zone's POPD that must live in a private dwelling for the TZ-specific age-sex distribution to be used. Travel Zones that do not satisfy this criterion will be assigned the SA2 age-sex distribution.

Functions

This module runs the IPF procedure to estimate POPD within each age-sex category for the base year and all future periods.

The following is a summary of the estimation process:

- Read input parameter data
- For each region that requires estimation:
    - Bring in the Travel Zone POPD base year distribution as row control totals and the SA2 base year age-sex distribution as column control totals
    - Bring in the age-sex distribution base (starting) distribution
    - Use IPF procedure to estimate final age-sex distribution in the base year
- For each future period:
    - Bring in the Travel Zone POPD distribution as row control totals and the SA2 age-sex distribution as column control totals
    - Bring in the age-sex output from the previous period
    - Use the IPF procedure to estimate the final age-sex distribution for that period

5.2.3 M02c – Module Outputs and Summaries

Functions

This module has one primary function:

- Aggregate data from the Travel Zone geography to SA4 and SA2 geography for each required output.

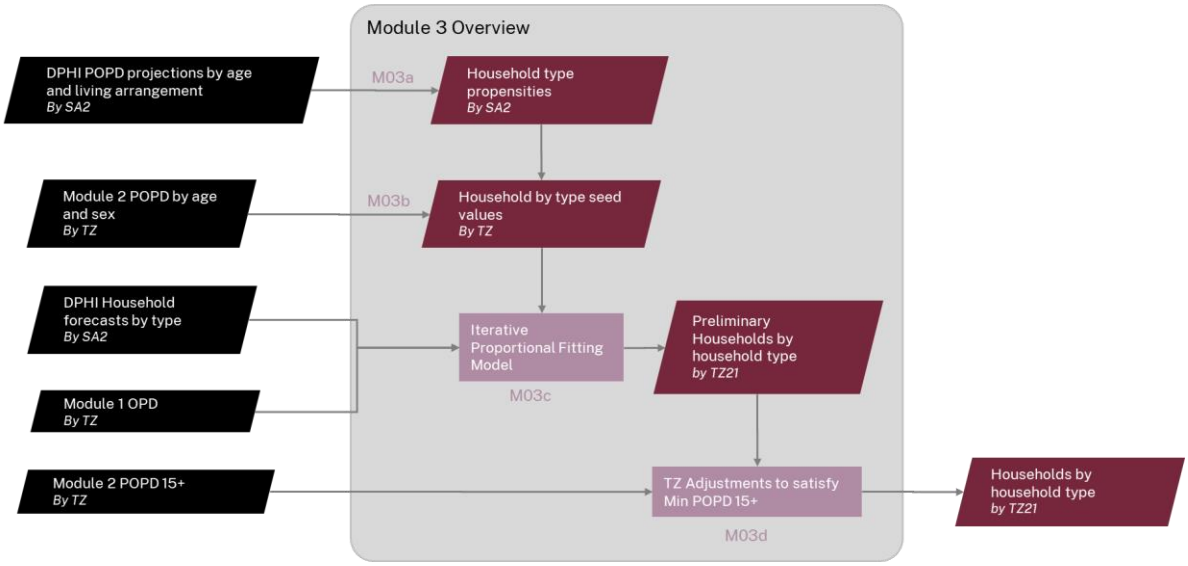
6 Module 3: Households by Household Type

6.1 Module 3 Overview

This chapter provides a summary of the household module of TZP24.

The following diagram presents an overview of the module and how it interacts with the TZP framework.

Figure 17: Module 3 Overview



Source: SGS Economics and Planning, 2024

The primary function of the Households by Household Type module is to use the outputs of previous modules, along with DPHI household forecasts and POPD projections to forecast Travel Zone households by household type. The control totals for this module are the SA2 households by household type data supplied by DPHI.

The household types considered are:

- Couples with Children
- Couples only
- Single parent
- Single person
- Other, which is comprised of Group households, and Multiple and other family households.

The inputs into Module 3 specify the household totals at the travel zone level and the distribution of household types at the collapsed SA2 level, which is converted to the SA2 level. Thus, the focus of Module 3 is on the distribution of these household types at the travel zone level. This distribution is achieved using the Iterative Proportional Fitting (IPF) approach explained in Module 2 (Section 5).

For each time period, the IPF approach requires an approximate distribution of household types at the travel zone level as a starting point (the ‘seed value’).

The module also ensures the Minimum POPD 15+ criteria are met. This is explained further in the breakout box below.

6.2 Module 3 Technical Model Overview

The following sections provide an overview of how the model operates.

6.2.1 M03a – Household type propensities

This module generates SA2 population household type propensities by age and household type.

Key assumptions

To convert the POPD projections by age and living arrangement to POPD projections by age and household type the following table is used to aggregate living arrangement categories to household types.

Table 8: Household groups definition

Household type	TZP living arrangement	DPHI 2024 living arrangement
Couples with children	Children <15 with 2 parents	Child aged under 15 * p_1 *(p_1 = proportion of parents (with children <15) who live partnered)*
	Child aged 15+ living at home with 2 parents	Child aged 15+ living with parents* p_2 *(p_2 = proportion of parents (with children 15+) who live partnered)*
	Partnered with children <15	Partnered with child(ren) aged under 15
	Partnered with children 15+	Partnered with child(ren) aged 15+ only
Couples only	Partnered with no children at all	Partnered with no children
Single parent	Children <15 with 1 parent	Child aged under 15 * q_1 *(q_1 = proportion of parents (with children <15) who live as a single)*
	Child aged 15+ living at home with 1 parent	Child aged 15+ living with parents * q_2 *(q_2 = proportion of parents (with children 15+) who live as a single)*
	Single parent with children <15	Single with child(ren) aged under 15 (single parent)
	Single parent with children 15+ only	Single with child(ren) aged 15+ only (single parent)
Single person	Living alone	Single and living alone
Other	Single in a group household	Single and living in a group household
	Single in family living arrangement	Single and living with a family (related or unrelated individual)
		Single and living in an 'Other Family'

Inputs

Key Input:

- SA2 POPD forecasts by age and living arrangement 2021-2066 (data supplied by DPHI to 2041 then trended)

Functions

This module performs the following functions:

- Converts POPD projections by age and living arrangement to POPD projections by age and household type
- Calculates the SA2 POPD household type propensities by age for 2021-2066

6.2.2 M03b – Calculating seed values

Estimates the distribution of households by household type at the travel zone level for 2021-2066 to use as seed values, using the Travel Zone POPD projections by sex and age from Module 2 and the POPD household type propensities from Module 03a.

Key assumptions

- Only persons of age 15+ are considered in the Household by Household Type categories. This is a simplifying assumption to remove the need for additional assumptions, such as needing to know the average number of children per household for each category.
- To convert population projections by household type to household projections the following Household-Population factors are assumed for all travel zones.

Table 9: Household – Population factors

Household type	Scale factor	Assumption
Couples with children	0.5	2 adults per house
Couples only	0.5	2 adults per house
Single parent	1.0	1 adult per house
Single person	1.0	1 adult per house
Other	0.4204	Based on the average household size from the ABS Census 2021

Inputs

Key Inputs:

- SA2 POPD living arrangement propensities by age and household type 2021-2066 from Module 03a
- Travel Zone POPD projections by sex and age 2021-2066 from Module 02b

Functions

The starting distribution comes from the POPD by age group at the TZ level, for which shares of household type by age group from the DPHI SA2 living arrangement projections are applied (i.e., POPD household type propensities calculated in M03a).

For instance, if 30% of an age group are single parents within an SA2, 30% of the households in all the TZ in that SA2 will be single parents. If 30% are couples (say without children), then 15% of households will contain couples without children.

This module performs the following functions:

- Converts Travel Zone POPD projections by sex and age to TZ21 POPD projections by age
- Generates POPD by age and household type projections for 2021-2066
- Estimates the Travel Zone distribution of households by household type for 2021-2066 for use as a base distribution in the IPF

Minimum POPD 15+

As part of the validation requirements for the STM, consistencies between households by household type (Module 3) and POPD 15+ (Module 2) are required. To achieve this, Minimum POPD 15+ is calculated using the distribution of households by household type for 2021-2066. Accordingly, the Minimum POPD 15+ criteria are:

- At the SA2 level, Minimum POPD 15+ must be equal to or lower than the computed POPD 15+ from Module 2.
- At the Travel Zone level, Minimum POPD 15+ must be equal to or lower than the computed POPD 15+ from Module 2.

What is Minimum POPD 15+?

Minimum POPD 15+ is computed by multiplying the number of households and the minimum household size for each household type. This is then summed across all household types.

The minimum household size (persons 15+) for each household type is assumed to be as follows:

Household type	Minimum household size
Couples with children	2.0
Couples only	2.0
Single parent	1.0
Single person	1.0
Other	2.0

How is this issue rectified?

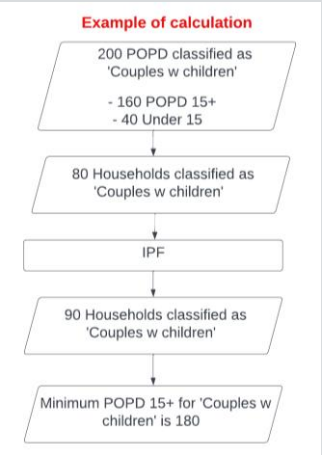
Where Minimum POPD 15+ is higher than the computed POPD 15+ from Module 2, this implies that the number of households is too high.

To rectify the issue, the number of households in the problematic SA2/TZ needs to be adjusted downwards to meet the criteria. This will reduce the Minimum POPD 15+ for that SA2/TZ so that it becomes equal to or lower than the computed POPD 15+.

Why Minimum POPD 15+ instead of Minimum POPD?

Only persons of age 15+ are considered in the Household by Type categories for Module 3. This is a simplifying assumption to remove the need for additional assumptions, such as needing to know the average number of children per household for each category.

Because the Household outputs are computed using persons 15+ only, the Minimum POPD calculated must also only consider persons 15+. The flowchart illustrates an example of how Minimum POPD 15+ is calculated.



Source: SGS Economics and Planning, 2024

6.2.3 M03c – IPF

This module estimates the distribution of households by household type for 2021-2066.

Key assumptions

- The minimum household sizes used to calculate SA2 Minimum POPD 15+ are as per the table presented above in the breakout box.
- The DPHI SA2 households by household type projections are forecasted up to and including 2066. Where the SA2 Minimum POPD 15+ criteria are not met, the smallest possible adjustment is made. That is, POPD 15+ will equal Minimum POPD 15+ for any SA2s needing adjustment for the relevant years.

Inputs

Key Inputs:

- SA2 POPD 15+ 2021-2066 (output from M02c)
- SA2 households by household type projections 2021-2066 (data supplied by DPHI)
- Travel Zone OPD 2021-2066 (output from M01b)
- Estimate of the Travel Zone household distribution by type 2021-2066 (output from M03b)

Functions

This module performs the following functions:

- Checks to ensure the SA2 Minimum POPD 15+ criteria are met, and if this is not met, it adjusts households by household type downwards for the relevant SA2 in the relevant year so that the criteria are met.
- Performs the IPF procedure using seed values for 2021-2066 from M03.
- Calculates a preliminary Travel Zone distribution of households by household type for 2021-2066

6.2.4 M03d – Travel Zone Adjustments

This module exists to deal with the Minimum POPD 15+ issue at the Travel Zone level by adjusting the Travel Zone distribution of households by household type within each SA2. This is done iteratively until the Travel Zone Minimum POPD 15+ criteria are satisfied.

Key assumptions

- The minimum household sizes used to calculate Travel Zone Minimum POPD 15+ are as per the table presented above in the breakout box.
- The changes in this module are entirely contained within SA2 geographies (to ensure DPHI SA2 control totals are met), independent of other areas and are output via intra travel zone shifts within the higher geography (SA2).
    - For any adjustments made, the smallest adjustment is used to satisfy the criteria. That is, POPD 15+ will equal Minimum POPD 15+ for any travel zones needing adjustment for the relevant years.

Inputs

Key Inputs:

- Travel Zone POPD 15+ 2021-2066 (output from M02c)
- SA2 household by household type projections 2021-2066 (output from M03c)

Functions

This module performs the following functions:

- Calculates Travel Zone Minimum POPD 15+ to 2066
- Checks to ensure the Travel Zone Minimum POPD 15+ criteria are met for 2021-2066
- For travel zones where the TZ Minimum POPD 15+ criteria are not satisfied:
    - Households are adjusted downwards, which consequently adjusts Minimum POPD 15+ downwards.
    - This ensures that POPD 15+ from M02 is not lower than Minimum POPD 15+.
    - Households from the other travel zones in the same SA2 are adjusted upwards to compensate for this decrease.
    - This is done iteratively until all travel zones satisfy the Minimum POPD 15+ criteria within each SA2.
- The iterative process generates a final Travel Zone distribution of households by household type for 2021-2066.

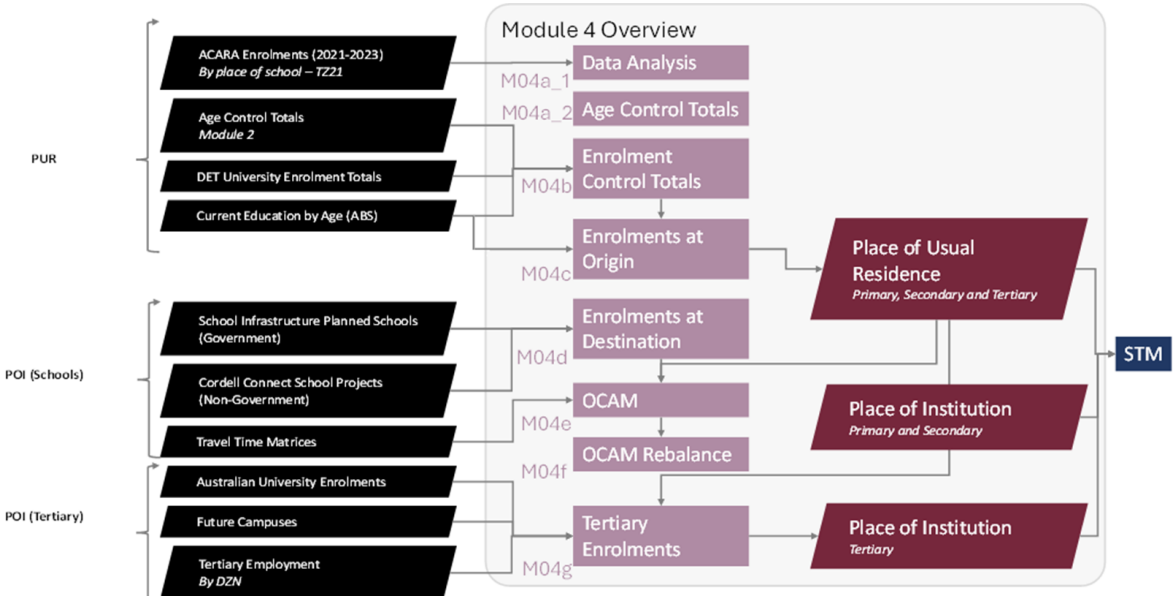
7 Module 4: Students

This chapter provides a summary of the student module.

7.1 Module 4 Overview

The primary function of the student module is to use some outputs from other modules to project primary, secondary and tertiary students. The outputs generated from this module will result in Primary, Secondary and Tertiary students at both place of usual residence and place of institution.

Figure 18: Module 4 Overview



Source: SGS Economics and Planning, 2024

7.2 Module 4 Technical Model Overview

7.2.1 M04a – Age Control Totals

This module converts the population by 5-year age group outputted from module 2 to school and tertiary age groups.

Input

- Age by sex and 5-year age groups

Functions

- The 5-year age groups are first disaggregated into single-year age groups using propensities from the 2021 Census. The propensities are the proportions of single-year age groups within the broader 5-year age groups they belong.
- Population by single-year age group is then aggregated into school and tertiary age groups.

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7.2.2 M04b – Enrolments Control Totals

This module sets the state control totals for students at their place of usual residence in the base year. The 2021 state control totals for school students are aligned to enrolment data from ACARA; University students are aligned to the Department of Education and Training Higher Education Statistics dataset, while the control totals for Vocational Education and Training (VET) students are derived from the 2021 Census.

Input

- 2021 Census data detailing current age and education status
- NSW school enrolments (ACARA enrolments (2021))
- NSW University students at place of usual residence from the Australian Bureau of Statistics
- Department of Education and Training Higher Education Statistics 2021 - Enrolment Count by Type of Attendance by Institution

Functions

- The IPF method is used to align Census enrolments with the enrolment state control totals. The IPF method used is the same as that used to produce outputs in Module 2. In this module, IPF is applied to calculate the age group distributions by education enrolment.

7.2.3 M04c – Enrolments at Origin

This module estimates the total number of enrolled residents by travel zone. It utilises the IPF method to distribute age control totals by institutions. The POPD by age groups and travel zone totals estimated in Module 2 is aligned with the state-regional enrolled resident control totals as estimated in Module 4a. This ensures the total number of enrolled persons by school type for each travel zone is equal to the population total for that travel zone and the institution type.

This module outputs students at place of usual residence at the travel zone level.

Inputs

- 2021 Census data
- M04a – Enrolments by school and tertiary age groups, type of education institution, and attendee status

Functions

- The 2021 Census data is first converted from SA1 to travel zones to create the seeds for the IPF.
- Propensities for education types and attendee statuses within each age group in 2021 are held constant in the forecast horizon beyond 2024.
- For 2022-2023, control totals are based of ACARA's actual enrolment totals, which are subsequently broken down for each education type into age groups as per to the proportional split in 2021.
- Students at travel zone level are calculated using the IPF method, which calibrates the seeds from the 2021 Census to the age group control totals in Module 4a and state control totals in Module 4

7.2.4 M04d – Enrolments at Destination

This module finalises actual enrolment totals (where available) at the travel zone level, for each education type, and calculates additional capacity of future schools. Additional capacity is calculated as per data provided by School Infrastructure NSW for government schools, and Cordell Connect for non-government schools, as well as own estimates of new schools based on future demand.

Unless a specific estimate of the capacity of new schools has been identified by data, default capacities have been applied to future schools, based on a 90th percentile of enrolments in existing schools. This led to the following assumptions:

- Primary schools have an additional default capacity of 568 students
- Secondary schools have an additional default capacity of 1,046 students

Inputs

- Enrolments at origin from M04c
- Future planned government schools from School Infrastructure NSW
- Future non-government school projects from Cordell Connect
- Potential future schools identified by SGS/Transport Planning

Functions

- A list of existing schools across NSW is used to form the travel zone destinations in the base year.
- Planned future government schools are identified by School Infrastructure NSW and future expected non-government schools are identified by Cordell Connect projects. Further new schools have been assumed by Transport Planning based on demand, and SGS based on expected shortfalls of capacity in specific SA4s.
- A final set of school additional capacity forecasts by sector (government or non-government) and enrolment type (primary or secondary) at the travel zone level will then flow into the Optimal Capacity Allocation Model (OCAM).

7.2.5 M04e – OCAM

This module forecasts school students by place of institution. Forecasted primary and secondary school enrolled persons are allocated from origins (calculated in M04c) to institutions using an allocation algorithm (Optimal Capacity Allocation Model) which assigns students to their closest school up to its capacity and within a maximum travel time threshold.

The OCAM replaced the use of a gravity model in TZP24 to improve the quality of student forecasts, particularly for proposed schools, as the OCAM considers incremental change in capacity between each forecast year to allocate students and focuses on allocating additional students. This compares to the previously used gravity model, which used totals at each forecast year to allocate students and therefore is less suitable with student distributions changing over time, notably with new schools opening.

If an enrolled person cannot be allocated to a school within a specific car travel time due to schools in that area being at capacity, they are left as 'unallocated'. The maximum travel time at which students can be allocated to a school before they are left unallocated is detailed as follows:

- **Primary Government:** 25 minutes
- **Primary Non-Government:** 30 minutes

- **Secondary Government:** 30 minutes
- **Secondary Non-Government:** 45 minutes

Tolerance Limits

Treatment of unallocated students is determined by tolerance limits, and whether the total number of unallocated students fall below these tolerance limits or not. Tolerance limits are specified in M04d, as follows:

Enrolment Type	Number of Unallocated Students
Primary Government	5,000
Primary Non-Government	3,000
Secondary Government	3,200
Secondary Non-Government	3,000

How are they used?

Tolerance limits specify the maximum number of unallocated students that can be unallocated for the OCAM to automatically reallocate them. If the number of unallocated students falls above the tolerance limit, further schools will need to be manually added and the OCAM will require an additional run.

Example

Primary Government has a set tolerance limit of 5,000 students. If for, say, 2025, the OCAM has a certain number of unallocated students, it will do one of two things.

- Scenario A: If the number of unallocated primary gov students is greater than the tolerance limit, these unallocated students will remain unallocated and new schools need to be added in or before 2025, and the OCAM needs to be re-run
- Scenario B: If the number of unallocated primary gov students is less than the tolerance limit, the OCAM just allocates the unallocated students to their nearest school.

Inputs

- School capacity forecasts
- Students at place of usual residence
- Travel time matrices (2021-2061)

Function

- The OCAM allocates students from origin to destinations, effectively placing students in schools based on proximity and capacity constraints
- Constraints are placed on how far a school can be for a student to be allocated to it – these constraints are inferred using a series of relevant travel time matrices between 2021 and 2061. For each year where the OCAM allocates students, the most appropriate travel time matrix is applied.

Assumption

- The 2061 travel time matrix is used to allocate students from origin to destinations for 2066 forecasts.

7.2.6 M04f – Enrolments Rebalancing

This module takes forward the OCAM outputs, and applies rebalancing to remove any negatives, and further manual adjustments to ensure reasonableness of final outputs. A series of QA checks are conducted in this module to ensure outputs are reasonable, and to inform where manual adjustments may be required.

Temporary schools existing before the opening of a new schools, and existing schools that are moving to a location have been treated with a manual adjustment as follows:

- If a new school has a temporary location prior to opening in its permanent location, the new school's permanent location is assigned all the capacity of the temporary school for the OCAM. The OCAM will therefore assign students to the permanent location, and these are then given back to the temporary location in this rebalancing module
- If an existing school is moving to a new location in the future, the existing school will be assigned the capacity for the OCAM. The OCAM will therefore assign students to the existing school, and these enrolments are given to the new location in this rebalancing module from the year the relocation occurs

An adjustment is then made to redistribute negative enrolments by reallocating the sum of the negative enrolments proportionally to the travel zones with positive enrolments.

A further final set of manual adjustments are done for the following occurrences:

- **New schools with an insufficient number of enrolments:** where new schools have 0 or a low number of enrolments, they are boosted with 50 enrolments in the initial year (arbitrary assumption), and the number of students added in each subsequent year grows by 10% and capped at 100 additional students (e.g., if a school requires a manual adjustment in 2026, 50 students will be added in 2026, 55 students (additional 10%) are added in 2027, and so on, capped at 100 additional students)
- **Schools which close and reopen:** where schools close (i.e., hit 0 enrolments) and reopen (enrolments start to rise again), a manual adjustment is made to ensure they do not close. Where this occurs, the number of students added to a school is equivalent to the number of students at that school in the year prior to closure. This total is added for all years in and after the year of closure
- **Schools which close:** where schools close, a manual adjustment is made to ensure they are maintained. The process for manual adjustment is equivalent to that applied for schools closing and reopening (above)
- **Lord Howe Island adjustment:** As TZ 8450 (Lord Howe Island) has no travel time associated with the rest of NSW, PUR growth in this TZ is not accounted for by the OCAM, and a manual adjustment must be made in this module to ensure POI aligns with PUR in this travel zone.

Inputs

- Module 4e – OCAM outputs
- Module 4c – Enrolments at Origin (for checking alignment)

Function

- The module makes some final adjustments to the initial OCAM outputs, reallocating negative enrolments, and making manual adjustments where required

7.2.7 M04g – Tertiary Enrolments

This module estimates tertiary enrolments at VET training institutions and Universities under a full-time and part-time split.

Total enrolments at place of institutions are aligned to total students at place of usual residence as the STM requires that total students at origins equate to destinations.

Enrolments for potential future tertiary institutions are also projected. Future University campuses are assigned to travel zones along with estimated capacities, based on research and likely geographic locations. Enrolment forecasts at VET training institutions estimated using the census Place of Work data given the uncertainty of future VET training locations.

Inputs

- Module 4c – Enrolments at Origin
- University and VET campus-level enrolments and places of institutions provided by Transport Planning
- Research information regarding future University campuses and enrolments provided by Transport Planning
- Employment by industry (Tertiary Education) from the 2021 Census

Function

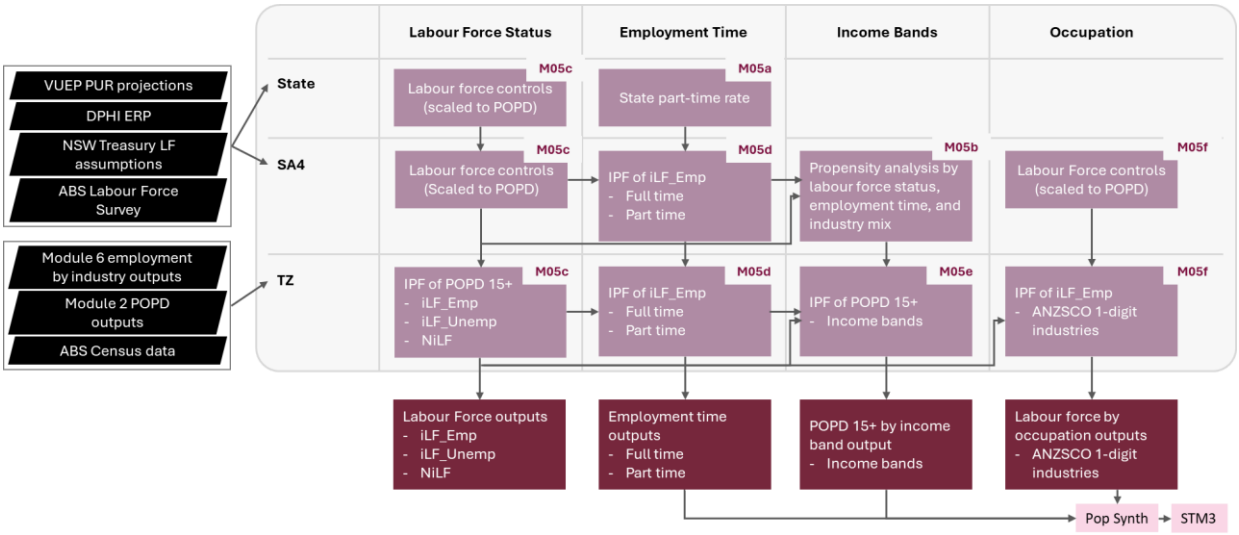
- The module collates the tertiary enrolment data and allocates a travel zone(s) to each institution.
- Employment by higher education industries and Destination Zones are converted to the travel zone level to develop employment-to-enrolments ratios for different tertiary institutions. The ratios are then used to distribute total enrolments at tertiary institutions to the associated campuses.
- Tertiary students at their place of usual residence are distributed to travel zones with tertiary institutions, using propensities drawn from the actual 2021 University and VET enrolments data.

8 Module 5: Workforce Segmentation

8.1 Module 5 Overview

The following diagram presents an overview of the revised Workforce module and how it interacts with the broader TZP framework.

Figure 19: Module 5 Overview



Source: SGS Economics and Planning, 2024

The primary function of the Workforce module is to use the outputs of prior modules to segment the working-age population in a largely automated manner. This is undertaken at the State level, sub-regional level (SA4) and TZ level. The module also breaks down the data into four stages: Workforce Status (Employed, Unemployed and Not in Labour Force), Employment status (full-time/part-time), Income Bands and Occupation. Trends and external data sources are used for high geographies, while a more automated approach is used for smaller geographies. Specifically, the outputs generated by the Workforce modules are presented in Table 10.

Table 10 Segmented workforce output variables

Segmentation of the working age population (POPD 15+) by workforce status	Segmentation of employed population by employment status (full-time/part-time)	Segmentation of the working age population (POPD 15+) by income bands	Segmentation of the employed population by occupation
• In Workforce and Employed (Emp) • In Workforce and Unemployed (Unemp) • Not In Workforce (NiLF)	• Employed full-time (Emp_FT) • Employed part-time Emp_PT)	• Negative or Nil income • $1-$149 • $150-$299 • $300-399 • $400-499 • $500-649 • $650-799 • $800-999 • $1,000-$1,249 • $1,250-$1,499 • $1,500-$1,749 • $1,750-$1,999 • $2,000-$2,999 • $3,000-$3,499 • $3,500 or more	• Clerical and Administrative Workers • Community and Personal Service Workers • Labourers • Machinery Operators and Drivers • Managers • Professionals • Sales Workers • Technicians and Trades Workers

Before each module is described individually Table 11 provides some broader reasoning and process elements established in this Module.

Table 11 Workforce module reasoning and process

	Workforce Status	Employment time	Income Bands	Occupation
By State	Disaggregation starts at the State level for a number of reasons: • The analysis can draw on a wider range of datasets only available at a more aggregate geographic level. • High-level modelling can be conducted that is not possible at a smaller area level. The data can be easily checked against other key indicators and form a benchmark for subsequent disaggregation. (e.g., disaggregated NSW Treasury data can be aggregated to a total population for NSW and checked against national and state trends)			
By State	VUEP provides control totals for those Employed. Using NSW Treasury Participation Rates and Population 15+, control totals for Unemployed and Not in Labour Force are calculated.	ABS Labour Force Survey data for NSW helps to provide part-time rates for the State and sub-regions.	Income distribution is not modelled at the State level. This is because labour force survey data is available at an SA4 level (see below).	Occupation distribution is not modelled at the State level. This is because VUEP provides occupation controls at an SA4 level (see below).
By SA4	The stage 1 IPF process produces regional-level control totals where VUEP does not provide them (i.e., Employment time and Income Bands). It is better to complete this process from State to SA4 and then SA4 to TZ, rather than jumping straight from State to TZ level: • Additional sub-regional (SA4) data that is not available at a TZ level can be introduced into the process			

	Workforce Status	Employment time	Income Bands	Occupation
	Additional checks and QA can be performed at an aggregate level where results are easier to interpret (i.e., the number of workers in the "Eastern Suburbs" and be checked rather than just TZ456).			
By SA4	VUEP provides control totals for those Employed. Unemployment rates from the ABS Labour Force Survey and Population 15+ are used to determine those Unemployed, and Not in Labour Force. This captures regional (SA4) variations in both workforce characteristics and demographic structure. This intermediate step enables the incorporation of the most recent labour force survey data, which is more recent and robust than census data.	This captures regional (SA4) variations in both workforce characteristics and demographic structure. This intermediate step enables the incorporation of the most recent labour force survey data, which is more recent and robust than census data.	Income distribution is complex and similar to the full-time/part-time split, and this is influenced by a wide range of factors. Analysis similarly showed that workforce status and employment time are the most significant determinants (and are also influenced by age-sex structure) and hence were used to project this attribute. As real income growth will cause a shift across income bands, an appropriate rate (currently NSW IGR compound average growth rate in real GSP per capita) is chosen to account for this.	VUEP provides control totals for those Employed by Occupation.
By TZ	Robust metropolitan and sub-regional control totals should now have been established. Therefore, the final IPF process has a much less significant task and simply needs to disaggregate these control totals reasonably across the current and projected population by TZ. Census data is used to capture local variations within each TZ.			

8.2 Module 5 Technical Model Overview

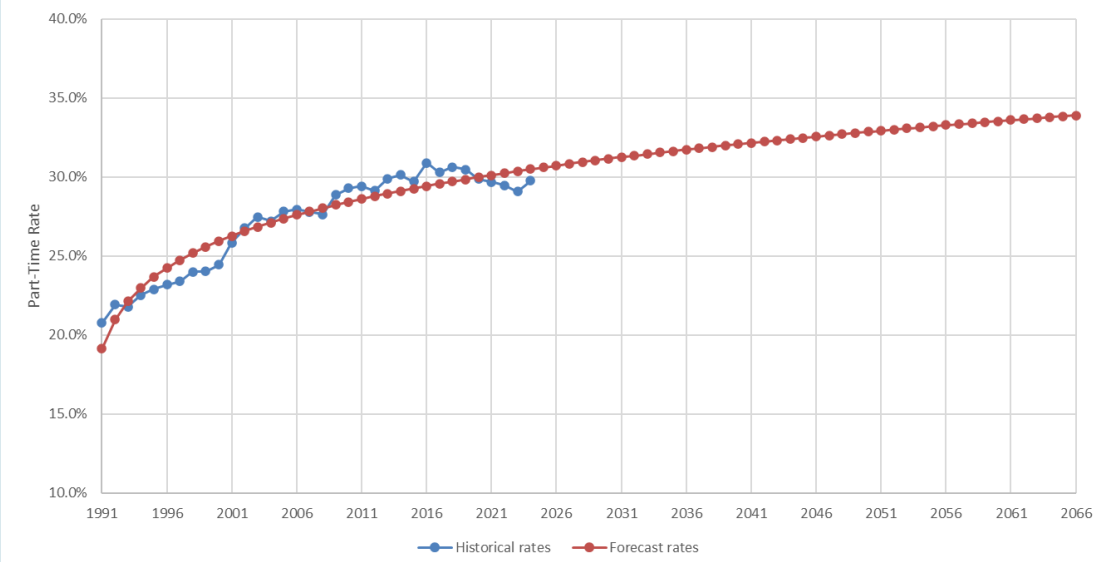
8.2.1 M05a – State Part-Time Rate

Labour Force projections of Employed, Unemployed and Not in the Labour Force have already been created at a State level using a combination of VUEP control totals and NSW Treasury labour force assumptions. The only component not provided is a State part-time rate projection.

Module 05a utilises historical ABS Labour Force Survey data to project the propensity for workers to engage in part-time employment out to 2066. The modelling approach chosen is a univariate log-log regression, which was selected because it achieves reasonable projections with a far greater degree of automation.

Log-log regression: This diagram presents the observed and projected part-time rates for the NSW Workforce

The estimated regression: $\log_e PR = \alpha + \beta \log t$



Source: SGS Economics and Planning, 2024

Inputs

Key Inputs:

- ABS - Labour Force Survey data 6291.0.55.001 (LM1)

The module also requires a number of parameter inputs:

- Data specification inputs detailing the first and last years of historical data and the base projection year
- A Part-time employment rate upper limit
- User-defined part-time rate upper limits

Functions

- Estimates the parameters α and β for the State
- Compiles the historical and projected part-time rates
- Checking the final Part-time projections (viewed alongside historical data)

8.2.2 M05b – Labour Force Starting Distribution

The purpose of M05b is to calculate starting distributions of Workforce Status (Employed, Unemployed and Not in Labour Force), Workforce Time (Full-time/Part-time) and Workforce Incomes at a State, SA4 and Travel Zone level to be used as inputs to the IPF procedures in M05c, M05d and M05e.

With all three geographies having had their starting distributions calculated through different methodologies, the purpose of the starting distribution is to ensure each geography is calibrated in preparation for the forthcoming IPF procedure. The result of the IPF procedure is that the three geographies will equal each other.

Inputs

Key Inputs:

- SA1 to TZ21 concordance (obtained internally from TfNSW)
- ABS Census - Labour force status by age by SA1
- ABS Census - Labour force status and hours worked (full-time/part-time) by age by SA1
- ABS Census - Income band by hours worked (full-time/part-time) by SA1
- Travel zone control totals for POPD by age (obtained from M02b)
- State Workforce Control Totals (obtained through VUEP and NSW Treasury and adjusted to equal M02 POPD control totals)
- Labour force survey participation and unemployment rate data by age by SA4 (base year and most recent year)
- Population in occupied private dwellings by State
- Population in occupied private dwellings by age by sex by SA4
- Population in non-private dwellings by age by sex by State
- Historical and projected part-time employment shares by age by State (obtained from M05a)

Functions

The first function of M05b is to produce State control totals and SA4 starting distributions for the stage 1 IPF processes of M05d (Emp_FT, Emp_PT). M05c (Emp, Unemp, NiLF) does not require a starting distribution as SA4 control totals are provided by VUEP. Once these inputs are finalised, a python script computes the outputs via the processes described below:

- The model utilises VUEP Labour Force that has been adjusted to align with POPD calculations from Module 02.
- SA4 starting distributions for the base year are computed using part-time employment rates from the base year labour force survey in conjunction with SA4 age-sex structures.
- SA4 starting distributions for projected years are computed using part-time employment rates from the most recent labour force survey in conjunction with SA4 age-sex structures of the relevant projected year.

The second function of the module is to estimate the travel zone starting distributions. It also computes age-specific income band propensities by TZ (which are used in M05e to calculate IPF process starting distributions). This follows the process outlined below:

- Convert SA1 level census data to TZ21.
- Zones with a low total population are likely to contain data that has been heavily influenced by the process the ABS has adopted to ensure confidentiality. In these cases, the values for the zones are adjusted to reflect the structure of the broader SA2 geography. This results in the following propensities:
    - Workforce status propensity by age group
    - Employment time propensity by age group

    - Income band propensity by workforce characteristics (employed full-time, employed part-time, unemployed, and not in the workforce).
- For each year, starting distributions for workforce status and employment time segmentation are calculated by combining the propensities by age group with the projected age structure of each travel zone.
- For each year, the starting distribution for income band segmentation is calculated by combining the income band propensities by workforce characteristics with projections of workforce status (obtained from M05c) and employment-time (obtained from M05d).

8.2.3 M05c – Labour Force IPF

Module 05c performs the IPF process. This process aligns totals for Workforce Status (Emp, Unemp, NiLF) for the State, SA4 and TZ. The result is that the Workforce Status at the travel zone level will equal control totals at an SA4 level and the State level.

Inputs

Key Inputs (from M05c):

- State control totals by workforce segment and year
- SA4 control totals by workforce segment and year
- POPD by SA4 and year
- POPD by travel zone and year
- Starting IPF process distribution of workforce segment by travel zone and year

The module also requires a number of parameter inputs:

- Determine the number of SA4s across NSW (28)
- Set a convergence criterion – the iterative process is considered complete when the sum of the absolute differences (between estimated regional workforce segment totals and regional workforce segment control totals) are below this level (i.e., differences are less than 0.1)
- Future year – module will perform IPF up to the specified year (2066)
- Base year – specify the base year (currently 2021)
- Input data structure – Defines the data structure of the SA4 and travel zone level input
- Required for the model to read input data correctly

Functions

Using the SA4 Workforce control totals as regional control totals, an IPF process estimates the workforce segments for all constituent travel zones. The estimation process is summarised below:

- Read the input parameter data.
- For each year and region that requires estimation:
    - Read travel zone POPD control totals and starting distribution data (see above for calculation detail).
- Use the IPF procedure to estimate final travel zone workforce distribution.

8.2.4 M05d – Part-Time Segmentation IPF

Module 05d performs an IPF process that first aligns State Workforce Employment Time (Employed Full-Time, Employed Part-Time) to the Workforce Employment Time by SA4. The second stage is then to align Workforce Employment Time by SA4 to Workforce Employment Time by travel zone. The result is that Workforce Employment Time totals at the travel zone level add up to equal the

State control total.

Inputs

Key Inputs:

- State control totals by employment-time segment and year
- Workforce by SA4 and year
- Starting IPF process distribution of employment-time segment by SA4 and year
- Workforce by travel zone and year
- Starting IPF process distribution of employment-time segment by travel zone and year

The module also requires a number of parameter inputs:

- Determine the number of SA4s across NSW (28)
    - Set a convergence criterion – the iterative process is considered complete when the sum of the absolute differences (between estimated SA4 workforce employment time totals and travel zone workforce employment time totals) are below this level (i.e., differences are less than 0.1)

- Future year – module will perform IPF up to the specified year (2066)
- Base year – specify the base year (currently 2021)
- Input data structure – defines the data structure of the SA4 and travel zone level input
- Required for the model to read input data correctly

Functions

This module first runs the IPF procedure to estimate the workforce, by SA4 employment-time category. Using these as regional control totals, as second IPF process then estimates the employment-time segments for all constituent travel zones. The estimation process is summarised below:

- For each year and region that requires estimation: Read State employment-time segment control totals, SA4 workforce control totals and starting distribution data.
- Use the IPF procedure to estimate the final SA4 employment-time distribution.
- For each year and region that underwent the first stage IPF procedure: Read travel zone workforce control totals and starting distribution data (see above for calculation detail).
- Use the IPF procedure to estimate the final travel zone employment-time distribution.

8.2.5 M05e – Income Segmentation

Module 05e segments POPD who are of working age (15+) into fifteen income bands. Propensities for individuals to fall within each income band are modelled as a function of their workforce characteristics (employed full-time, employed part-time, unemployed, and not in the workforce) and real income growth.

For each workforce and employment-time segment, census data is used to determine the propensity of that segment to fall within fifteen census income categories. Assuming a uniform distribution within categories, the fifteen bands are disaggregated to form 41 sub-bands. Combining these propensities with projections of POPD by workforce characteristics (obtained from M05c and M05d) results in a preliminary estimate of POPD within each income band. However, this estimate is based on income levels in the 2021 census year, and real wage growth over time will result in a shift across income bands. Using an assumed rate of long-term real income growth (currently set as 1.1% in line with the compound average growth rate in real GSP per capita from the 2021 NSW IGR);

along with the median earnings of each income sub-band, the shifts across bands are calculated. These shifts are then applied to the preliminary estimate to derive a final income band distribution by SA4.

> Real Income Growth Example
>
> If for a given SA4 in 2021, part-time workers had a 25% propensity to fall within income sub-band 6. In the absence of real income growth, this implies that if there were 100 part-time workers in 2021, 25 of them would fall into income sub-band 6.
>
> However, as real income does in fact grow, these 25 part-time workers will instead shift across income sub-bands - falling within income sub-band 8 rather than sub-band 6.
>
> Similarly, individuals from a lower sub-band may now fall within sub-band 6. Another alternative is that 10 years of real income growth for a particular sub-band (e.g., sub-band 1) is insufficient to cause a shift.

Once income band estimates by SA4 have been derived, these are used as regional control totals in a travel zone level IPF process. This ensures that regional income band characteristics are maintained while still allowing for intra-regional variation based on travel zone-specific workforce characteristics and income band propensities.

Inputs

Key Inputs:

- Census income by workforce characteristics by SA4 (obtained via ABS TableBuilder)
- Labour force characteristics by SA4 and year
- Working age POPD by travel zone and year
- Workforce characteristics by travel zone and year

The module also requires a number of input parameters:

- Determine the number of SA4s across the State (28)
- Set a convergence criterion – the iterative process is complete when the sum of the absolute differences (between estimated SA4 income band totals and SA4 income band control totals) are below this level
- Future year – module will perform IPF up to the specified year (2066)
- Base year – specify the base year (currently 2021)
- Input data structure – Defines the data structure of the SA4 and travel zone level input
    - Required for the model to read input data correctly
- Real Income Growth Rate – compound average growth rate in real GSP per capita (2021 NSW IGR)
    - Defines the rate at which individuals will shift across income bands

Functions

- Computes the median income for each of the 41 income sub-bands and applies the assumed real income growth rate to these across time. This determines the shift across income sub-bands.
- The disaggregation of the fifteen census income categories into the 41 sub-bands (assuming a within-category uniform distribution).
- For each year, the preliminary 41 sub-band propensities are adjusted for real income growth.
- These 41 sub-bands are then applied to workforce segment projections to derive final estimates of working age population by income band and SA4.

- Travel zone starting distribution is read from M05c (see above for calculation detail) and the IPF procedure estimates the final income band distribution.

8.2.6 M05f – Occupation segmentation

Module 05f segments POPD who are of working age (15+) into ANZSCO 1-digit occupations. SA4 control totals are provided by Victoria University, which are first scaled to match POPD, and then distributed down to the TZ level using an IPF process.

Inputs

Key Inputs:

- SA4 workforce by occupation control totals
- TZ occupation distribution
- TZ workforce forecasts

Functions

This module first generates the TZ occupation distribution, before running an IPF algorithm to align the SA4 occupation control totals with the TZ workforce forecasts. The estimation process is summarised below:

- Generate the starting TZ distribution for the IPF by aggregating SA1 Census data to the TZ level
- For each year and region that requires estimation: Read SA4 occupation segment control totals, SA4 workforce control totals and starting distribution data.
- Use the IPF procedure to estimate the final travel zone workforce by occupation forecasts

9 Module 6: Employment

9.1 Module 6 Overview

The Employment module has one key function. Its role is to disaggregate the quantum of jobs by industry at the SA4 level down to an SA3 and travel zone level. This spatial disaggregation is a two-step process, being estimated first by SA3 and then by travel zone.

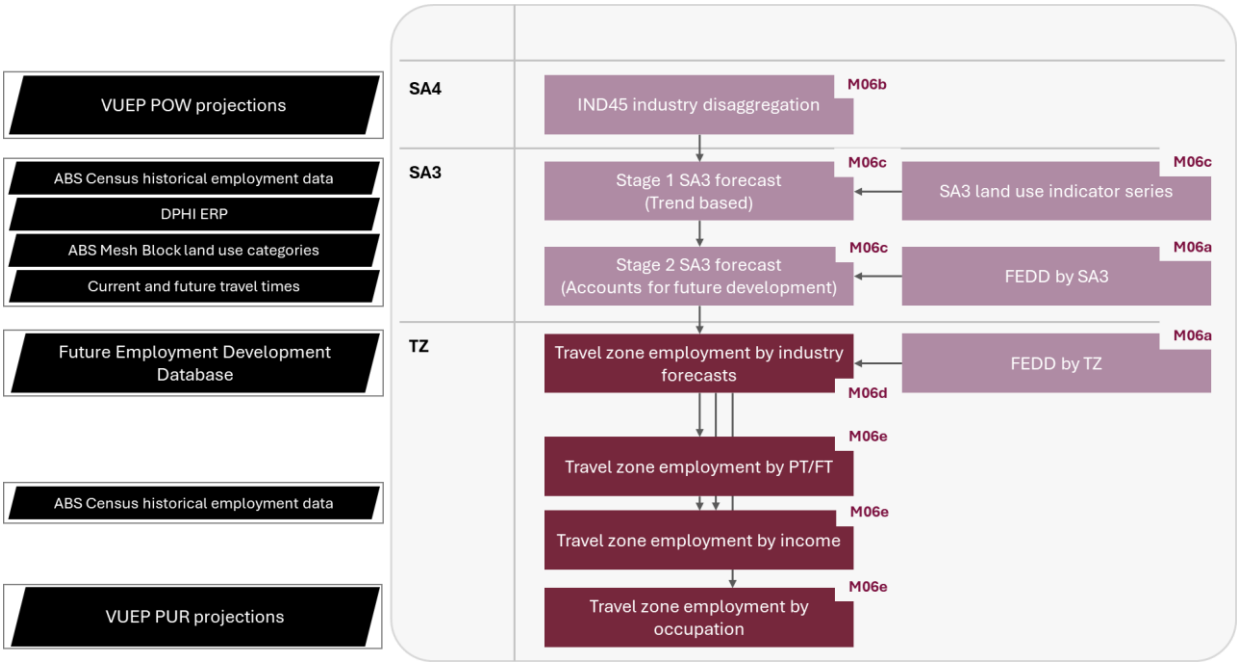
Unlike demographic characteristics, projecting the growth and distribution of employment by industry is more reliant on professional judgement and is influenced by both endogenous and exogenous factors. With this in mind, the design of the modules focuses on the following:

- Automated procedures to produce first-cut estimates (e.g., the total and distribution of employment for individual industries (e.g., Retail) across NSW)
- Largely automated procedures to account for exogenous shifts in employment across NSW, informed by planned projects and future policy directions

An important distinction between Module 6 and previous modules is that estimates are not restricted to persons living in private dwellings. This is due to the fact that employment acts as a 'destination' variable and is used as a relative attractor within the STM.

The figure below presents an overview of the employment module and how it interacts with the TZP framework.

Figure 20 Module 6 Overview



Source: SGS Economics and Planning, 2024

9.2 Module 6 - Technical Model Overview

9.2.1 M06a – FEDD

This module houses the individual project models for all FEDD projects and the control workbook which itemises each project and their priority status.

Inputs

Key inputs:

- FEDD project models
- FEDD control workbook

Functions

This module does not contain any processing and exists to house data.

9.2.2 M06b – Input processing

This module processes several key inputs that are required to run the remainder of Module 6, namely:

- Disaggregation of VUEP SA4 control totals into 45 industries
- Aggregation of FEDD projects by SA4, SA3 and Travel Zone

When disaggregating VUEP SA4 control totals to 45 industries, the existing distribution of employment (2021) was used in majority of cases, except for several SA4s which are set to undergo significant transformations in their land use. For these cases, the industry distribution of the FEDD projects in those SA4s were used as a basis for informing adjustments. The following SA4s have been adjusted in this manner:

- Sydney – South West
- Sydney – Outer West and Blue Mountains
- Sydney – Blacktown

Inputs

Key inputs:

- VUEP SA4 Place of Work control totals (ANZISC 1-digit industries)
- 2021 SA4 Place of Work industry distribution (ANZSIC 2-digit industries, extracted from ABS TableBuilder)
- FEDD project models (from M06a)
- FEDD control workbook (from M06a)
- TZ21 concordance (supplied by Transport Planning)

Functions

- Disaggregation of VUEP SA4 control totals into 45 industries
  - Disaggregate ANZSIC 1-digit control totals into ANZSIC 2-digit industries based on the existing (2021) distribution
  - Apply manual adjustments where necessary
  - Aggregate ANZSIC 2-digit industries to the custom 45 industries
- Aggregation of FEDD projects by SA4, SA3 and Travel Zone

- Read in all individual FEDD project models
- Clean data to ensure formats are consistent
- Aggregate to SA4, SA3 and Travel Zone

9.2.3 M06c – SA3 forecasts

Module M06c is where majority of the modelling in M06 occurs. This module uses historical land use trends, future population and transport network travel times to develop a 'baseline' SA3 employment by industry forecast, before incorporating the FEDD projects to adjust SA3s where there are significant expected changes to historical land use patterns. The baseline forecast projects a future state where there is no information about future projects or policy directions, while the subsequent adjustments incorporate planning, policy and development intelligence that is housed within the FEDD project assumptions.

The baseline forecasts use the following indicators to allocate employment:

- Population forecasts, used to allocate jobs in population serving industries
- Effective Job Density (EJD), used to account for accessibility based on projected travel times
- Agricultural land, used to allocate jobs for industries that are heavily reliant on the availability of agricultural land
- Industrial land, used to allocate jobs for industries that are heavily reliant on the availability of industrial land
- Historical employment growth and level shares, used to allocate jobs that tend to cluster where there is an existing mass of employment

Once baseline forecasts are generated, adjustments are made to add additional jobs where future development is planned. Where FEDD projects are marked as priority status, SA3s are locked to ensure the level of required employment for future FEDD projects can be achieved, and in all other cases the FEDD is treated as an attraction factor and is used to add as many jobs as possible to ensure close alignment to future development patterns. Given employment by industry is constrained by the VUEP control totals, perfect alignment with the FEDD is not achieved in all SA3s.

A further processing algorithm is used to ensure that SA3 and industry forecasts do not decline where the SA4 forecast for that industry is growing. This step is performed to ensure that the FEDD is not detrimental to surrounding SA3s where the SA4 is growing slowly.

In addition to producing SA3 forecasts, this module also prepares historical employment data prepared externally to the TZP model that is used as the basis for the base year (2021) estimate and for informing past trends. At a high level, estimates of historical employment were prepared as follows:

- Source Census data of employment by industry and occupation for years 1996-2021 by destination zones
- Systematically reallocate unallocated/undefined categories (both spatial and across industry and occupation)
- Allocate respective Census year destination zone employment data to Mesh Block (MB) categories based on land use category and spatial overlap (e.g., if a destination zone is comprised of two MBs, one with a commercial land use and one with an industrial land use, then professional services jobs are largely allocated to the first MB, while manufacturing jobs are primarily allocated to the second).
- Align MB estimate to VUEP SA4 industry control totals
- Aggregate MB employment data to TZ21 travel zones

Inputs

Key inputs:

- Population forecasts (DPHI)
- Historical population (ABS ERP)
- Historical employment (SGS)
- Travel Time Matrices (Transport Planning)
- Agricultural land (ABS)
- Industrial land (ABS)
- FEDD (M06a)
- TZ21 concordance (Transport Planning)

Functions

- Assemble a database of land use indicators used to generate the baseline SA3 employment by industry forecasts
- Clean and process all data required to run the employment allocation sub modules
- Generate the baseline SA3 employment by industry forecast
- Generate the final SA3 employment by industry forecast, accounting for future development and policy directions

9.2.4 M06d – TZ forecasts

This module disaggregates the SA3 forecasts established in M06c down to the travel zone level. Because the SA3 forecasts account for FEDD projects already, there is minimal effort required to allocate SA3 industry employment into travel zones. The module follows a similar process to M06c, whereby the existing (2021) Travel Zone employment distribution is used to disaggregate SA3 forecasts in the first instance, before priority FEDD projects are locked and non-priority FEDD projects are used as attracting forces to shift jobs into the correct Travel Zones.

As with M06c, a final processing step is conducted to ensure that the inclusion of FEDD projects do not adversely impact trends in surrounding Travel Zones.

Inputs

Key inputs:

- SA3 employment by industry forecasts (M06c)
- FEDD (M06a)
- Travel Zone employment by industry, 2021 (SGS)
- TZ21 concordance (Transport Planning)

Functions

- Clean and process data required to run the allocation functions
- Allocate SA3 industry employment to Travel Zones with priority FEDD projects first
- Allocate remaining SA3 industry employment to other Travel Zones using non-priority FEDD projects as attraction factors and the existing distribution where no FEDD projects are present
- Conduct smoothing to ensure there is no ‘bouncing’ or an erroneous decline of employment in individual Travel Zones

9.2.5 M06e – POW disaggregation

This module disaggregates Travel Zone employment forecasts generated in M06d into three variables:

- Employment time (full time/part time)
- Income bands
- Occupations

The three sub-modules used to disaggregate employment are identical to those used in M05; and further detail on their methodology can be found in the previous section of this report.

A slight adjustment has been made to the income disaggregation submodule for income bands to account for the changing industry distribution in various regions of NSW. More specifically:

- The future income profile of a region is directly related to the types of jobs that are forecast to locate there
- Instead of applying the existing (2021) income band distribution to all forecast years, the existing income band distribution within each industry has been applied to the employment by industry forecasts to determine a distribution for each forecast year
- This aims to shift the overall income band distribution in the future to better align with the types of jobs that are forecast in each region.
- For example:
  - Sydney – South West is expected to change rapidly as the Western Sydney Airport and surrounding Aerotropolis precincts come online
  - The existing income band distribution of this region does not reflect the higher-paid knowledge-intensive jobs that are expected to locate in the Aerotropolis
  - Applying the existing income band distribution within each industry to the forecast industry distribution in Sydney – South West will, therefore, result in a higher weight being placed on the higher income bands as the Aerotropolis develops and higher income jobs move into the area

Inputs

Key inputs:

- State part-time rate forecast (M05a)
- Employment by industry forecasts (M06d)
- Existing (2021) employment time distribution (ABS Census, extracted from TableBuilder)
- Existing (2021) employment by income band distribution (ABS Census, extracted from TableBuilder)

Functions

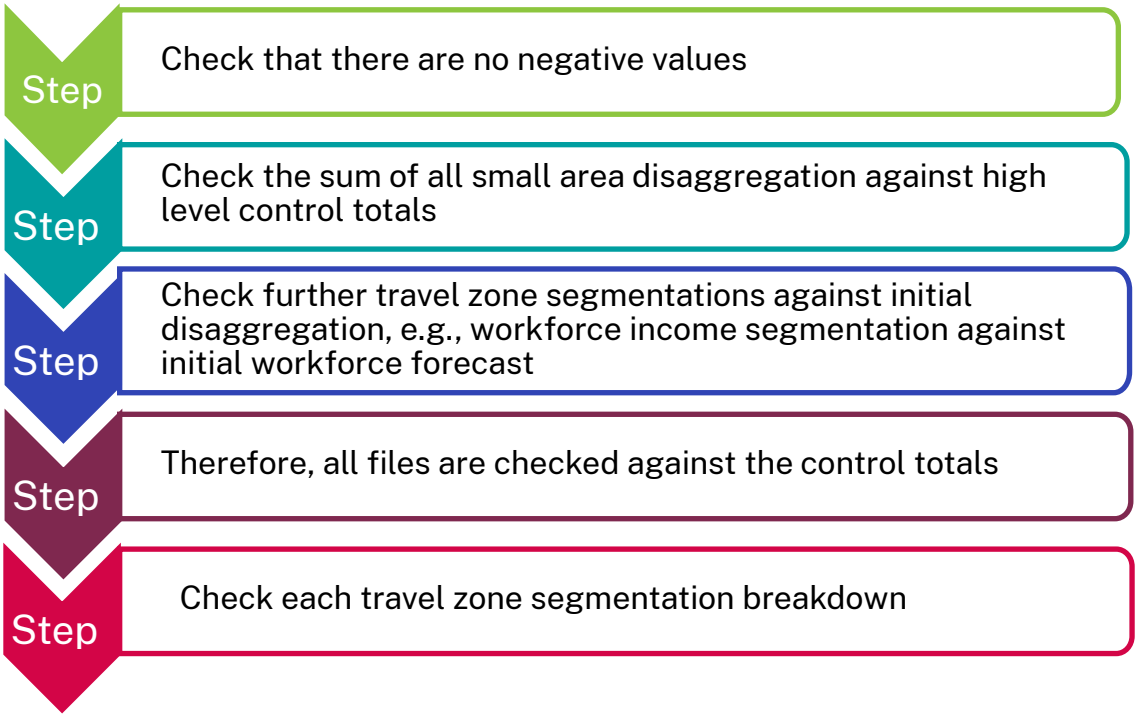
- Clean and process data required to run the disaggregation sub-modules
- Disaggregate employment into full-time/part-time, following the same methodology in M05d
- Disaggregate employment into income bands, following the same methodology in M05e except for the seed construction (outlined above)
- Disaggregate employment into occupations, following the same methodology in M05f

10 Module 7: Checks and Validation

10.1 Overview

The quality checks module is the last step in the model. This module is a Python Script that takes the output from previous modules and performs a number of automated calculations to evaluate quality and consistency within and between the outputs of the various modules. The checks module has three main functions – negatives checks, control totals checks and validations checks. The negatives check determines whether output files contain any negative numbers. The control totals check determines whether the DPHI control totals for the State are consistent with aggregated figures in the output files. The validations check further checks for consistency between different sub-geographies.

10.2 The Overall Logic of the Order of the Checks



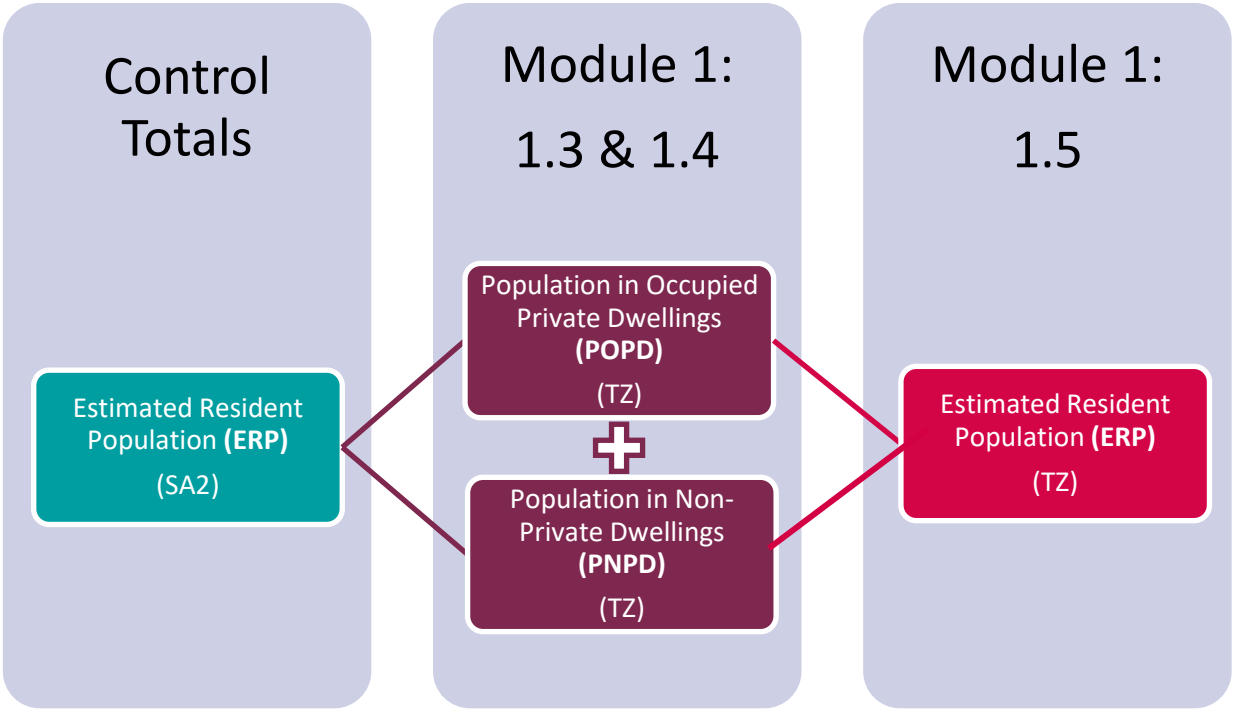
The checks module is configured to be run from start to finish in its entirety. Each module output file along with global functions is loaded at the start of the module run and then required in each section of the script. The checks module takes an average of two minutes to run.

10.3 Control Totals

The control totals step of the module checks that figures in the module output files are consistent with the DPHI control totals by SA2. This validation also checks for consistency between output files of different modules. For example, the workforce for any given area (Module 5) is equivalent to the population in occupied private dwellings aged 15+ (Module 2). This check sums all geographic areas for each file and only checks for consistency between the aggregate figures, not for different sub-areas. Each test is outlined below.

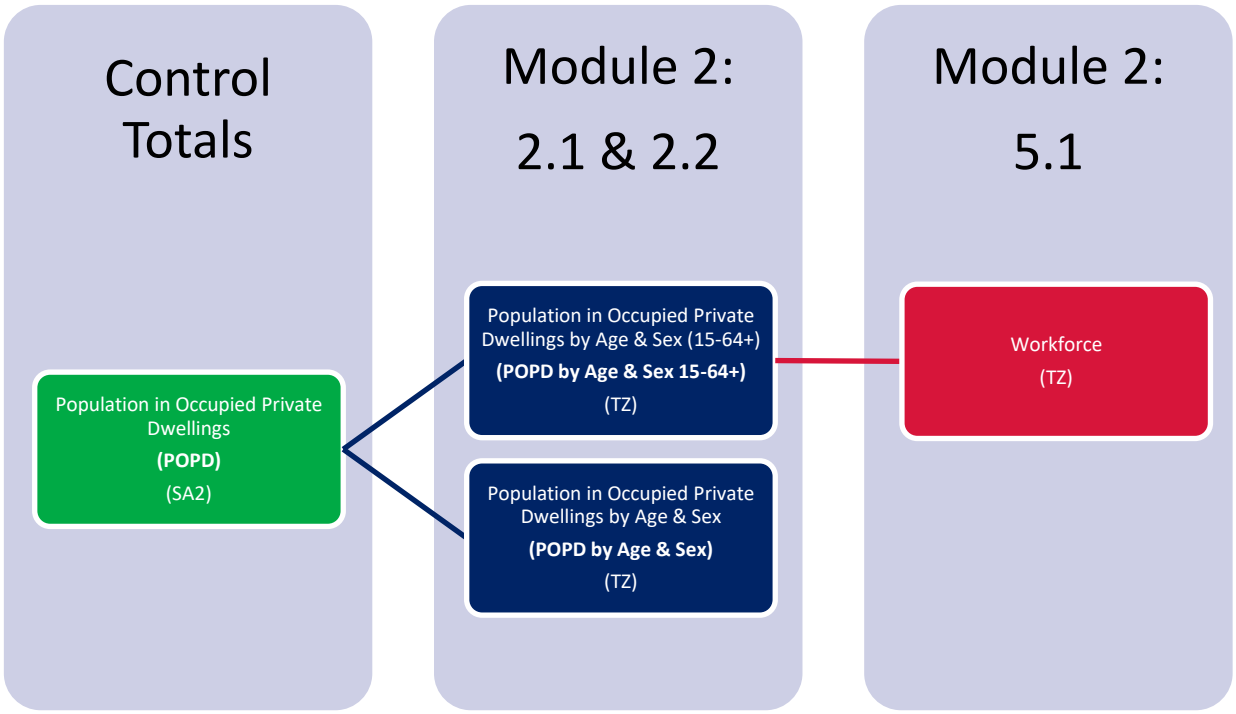
10.3.1 Module 1 Population and Dwellings

Figure 21 Graphical representation of control total check for Module 1 output files



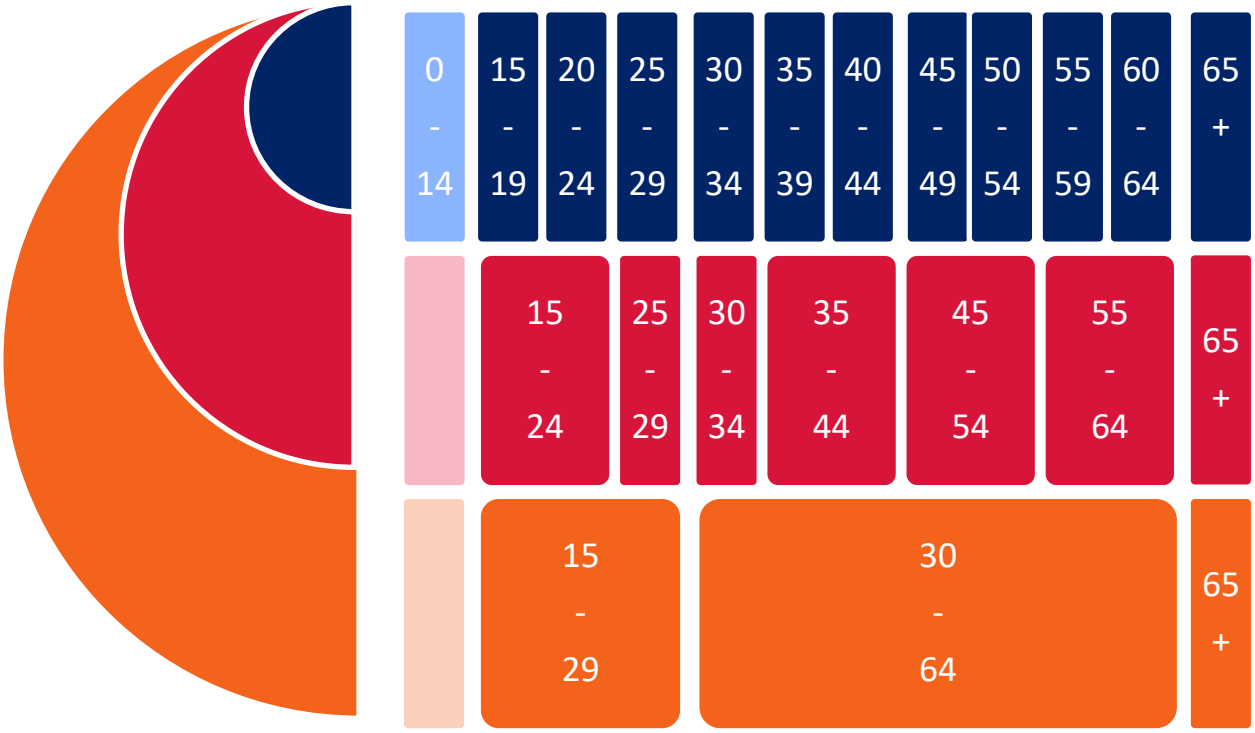
10.3.2 Module 2 Age-Sex

Figure 22 Graphical representation of control total check for Module 2 output files



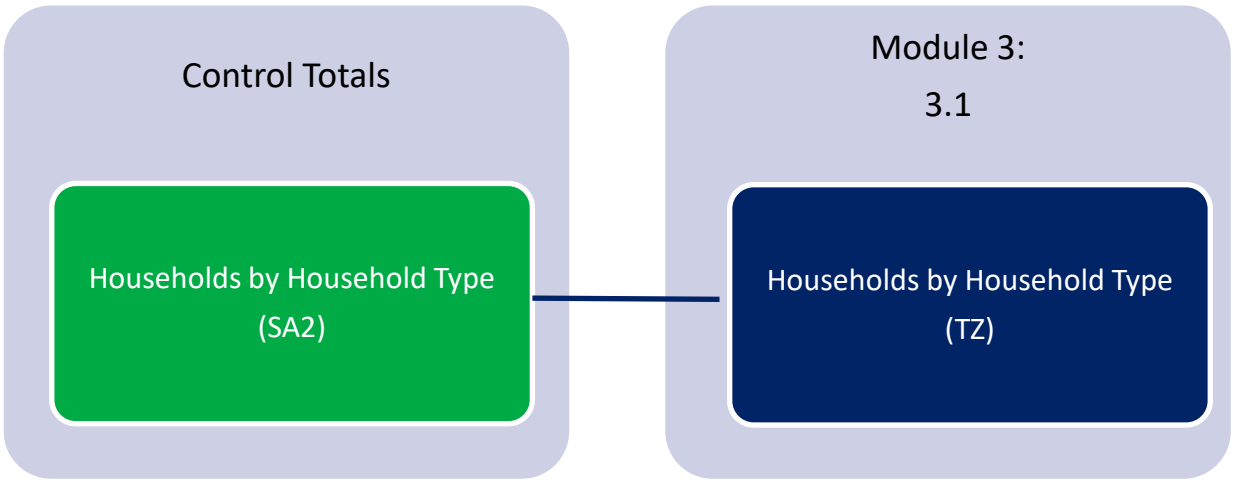
Checks are also completed between Module 2 output files, to check that the sum of the 5-year age brackets in output file 2.1 is equivalent to each of the aggregated age bracket output files 2.2 and 2.3 as outlined in Figure 23 below:

Figure 23 POPD age categories in Module 2 output files 2.1, 2.2 and 2.3



10.3.3 Module 3 Household Type

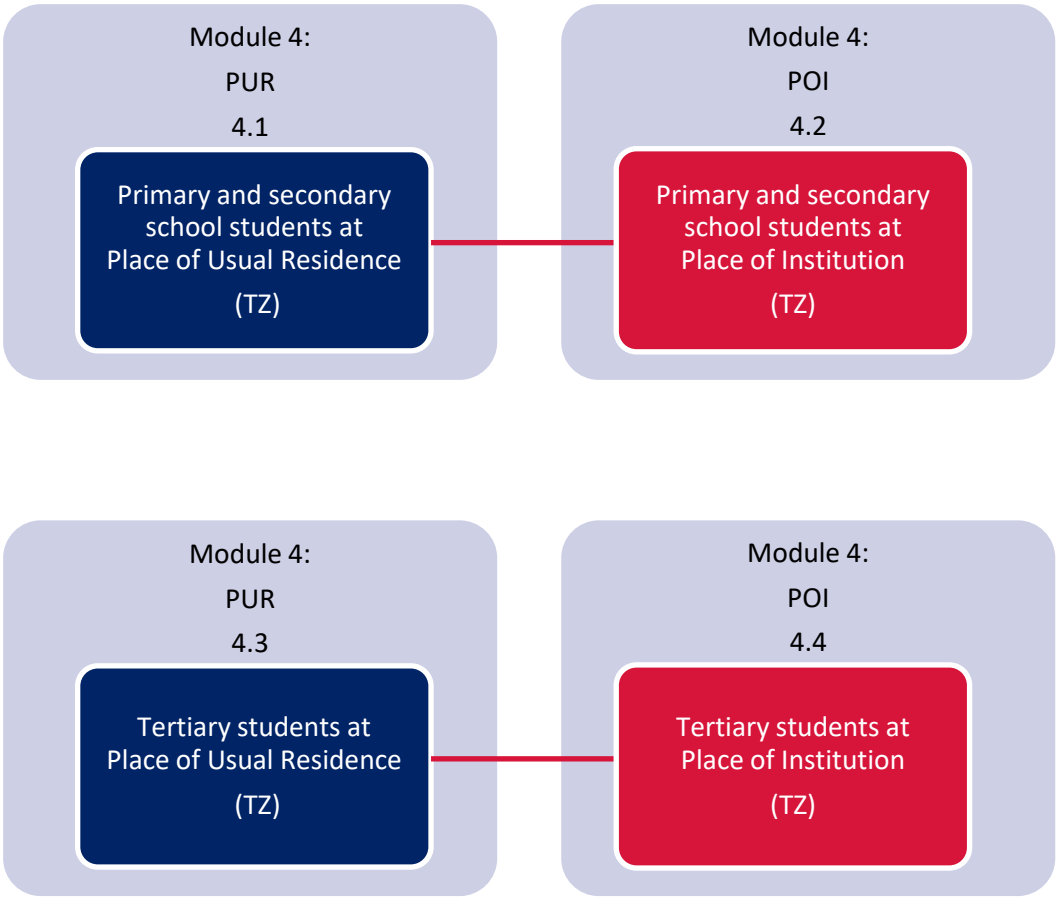
Figure 24 Graphical representation of control total check for Module 3 output file



10.3.4 Module 4 Students

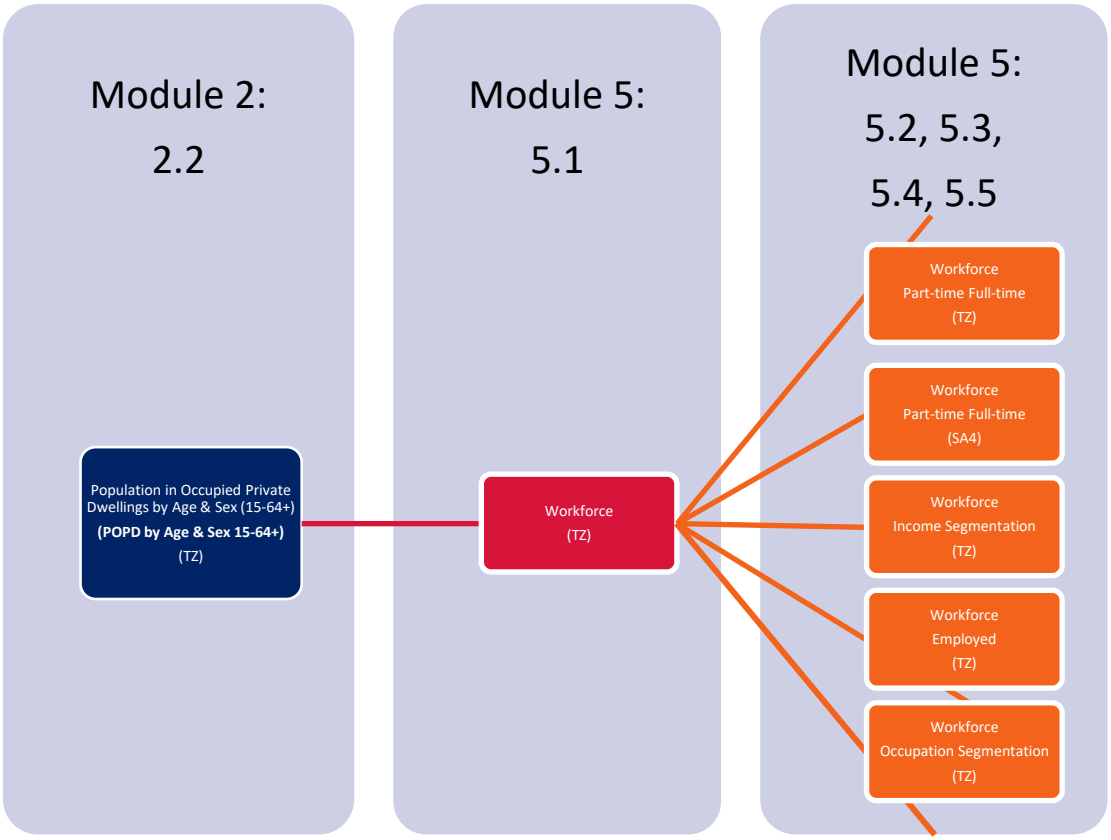
Module 4 is independent of any other Module. It cannot be checked against any DPHI control total or population groups in the output files of any other modules. The output files of Module 4 are checked for internal consistency such that the total number of students within NSW aligns between Place of Usual Residence and Place of Institution.

Figure 25 Graphical representation of control total check for Module 4 output file



10.3.5 Module 5 Workforce

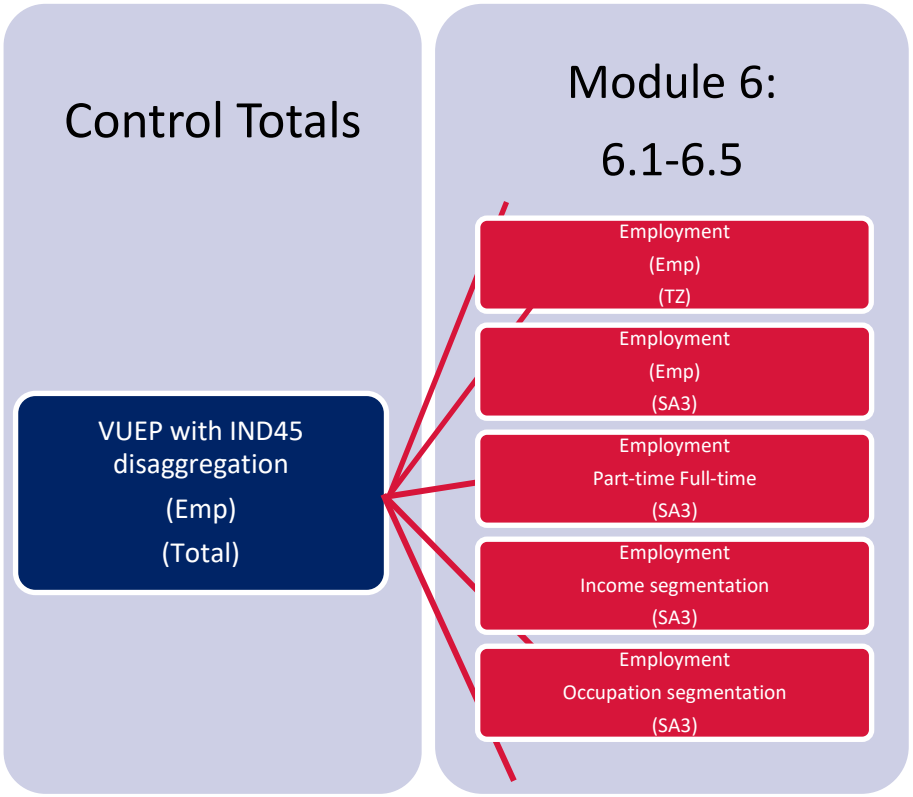
Figure 26 Graphical representation of control total check for Module 5 output files



10.3.6 Module 6 Employment by Industry

Module 6 is self-contained and independent of any other module.

Figure 27 Graphical representation of control total check for Module 6 output files



10.4 Validations

The validations step of the module conducts further consistency checks between figures in module output files, e.g., check that the number of occupied dwellings does not exceed the population in occupied private dwellings in each Travel Zone. Unlike the control totals step outlined above, this step of the module checks for consistency in reported numbers between corresponding geographic sub-areas (travel zones, SA3 and SA4). The validations follow the same general order as the control totals checks.

Table 12 Description of Validation Checks

Module 1 – Population and Dwellings	
1.1 OPD (TZ) / 1.2 SPD (TZ) <= 1	Checks that the number of occupied dwellings (OPD) does not exceed the total dwelling stock (SPD) in the model for each travel zone.
1.3 POPD (TZ) / 1.2 OPD (TZ) >= 1	Checks that the number of people in occupied dwellings (POPD) exceeds the number of private occupied dwellings in the model for each travel zone.
1.3 POPD (TZ) + 1.4 PNPD (TZ) = 1.5 ERP (TZ)	Checks that the population assigned to private and non-private dwellings in travel zones is equivalent to the estimated resident population in the corresponding travel zones.
Module 2 – Age-Sex	
2.1 POPD (Sum of 15-64+) (TZ) = 2.2 POPD (15-64+) (TZ)	Checks that the aggregate of the five-year categories in output file 2.1 is equivalent to the pre-aggregated groups in output file 2.1 for each travel zone.
2.1 POPD (Sum of 15-29) (TZ) = 2.2 POPD (15-29) (TZ)	
2.1 POPD (Sum of 30-64) (TZ) = 2.2 POPD (30-64) (TZ)	
2.1 Age by Sex (Sum of 64+) (TZ) = 2.2 Age by Sex (64+) (TZ)	
2.1 POPD (15+) (TZ) = 2.3 POPD (15+) (SA4)	Checks that the 15+ population reported at the SA4 level is equivalent to the aggregate of corresponding travel zones.
Module 3 – Household Type	
3.1 Household Type (TZ) = Household Type (SA2)	Checks that the aggregate of households by household types aggregated at the travel zone level is equivalent to the DPHI control totals reported at the SA2 level.
Module 4 – Enrolments	
4.1 Total Primary and Secondary enrolments (PUR) = 4.2 Total Primary and Secondary enrolments (POI)	Checks to ensure that the total student count aligns when looking at where the students are located vs. where the students are enrolled.
4.3 Total Tertiary enrolments (PUR) = 4.4 Total Tertiary enrolments (POI)	Checks to ensure that the total tertiary count aligns when looking at where the students are located vs. where the students are enrolled.

Module 5 – Workforce Segmentation	
5.1 Labour Force_TZ= 2.4 Working Age (15+) TZ	Checks that workforce figures are equivalent to the POPD aged over 15 years for each travel zone.
5.2 Labour Force PT FT SA4 = M05c SA4 LF controls (VUEP)	Checks that PT/FT breakdown of employed persons at SA4 geography sums to employed persons from SA4 LF controls.
5.3 Labour Force PT FT TZ = 5.1 Labour Force_TZ iLF_emp	Checks that PT/FT breakdown of employed persons at TZ level lines up with employed persons for each travel zone.
5.4 Labour Force Income Segmentation = 5.1 Labour Force_TZ	Checks that the aggregate workers across all income categories for each travel zone are equivalent to workforce figures from 5.1.
5.5 Labour Force Occupation Segmentation_TZ = 5.1 Labour Force_TZ21 iLF_emp & M05f Occupation controls (VUEP)	Checks that the aggregate of employed persons by occupation at the TZ geography aligns with the control totals provided by VUEP; and that the aggregate of each occupation category sums to employed persons in the workforce.
Module 6 – Employment *No further relevant checks*	

11 Appendix A: Future Employment Development Database (FEDD)

The Future Employment Development Database (FEDD) is a major input into M06d. Table 13 below shows the projects that are considered in the projections.

Table 13: Summary of future developments database for employment

Project Name	Travel Zones impacted by project
13 Endeavour Road Caringbah	2901
Albury RJP	7859
Alexandria Health Centre	264
ANSTO Innovation Precinct	2831
Astra Aerolab	6539
Australian Bay Lobster Facility	8705
Aventus Supacentre Tuggerah	5178
Baiada Integrated Poultry Processing Facility	8145
Bankstown	2301; 2305; 2313; 2337; 2341; 2367
Barangaroo	2; 3
Bays West Stage 1	828; 830; 836
Berry and Walker Street Redevelopment	1951
Biomedical Accelerator	236
Blacktown Private Hospital	4108
BlueScope Port Kembla	5745
Bourke Abattoir	7921
Camellia Rosehill	1068; 1071; 1091; 1092; 1209
Camperdown Modern Private Hospital	820
Campsie Private Hospital	2529
Carter Street Precinct	1326; 1328; 1332; 1354
Castle Hill	4526; 4527; 4533; 4536; 4537
Cedar Mill Hunter Valley	6706
Central Coast Quarter	5328
Central Precinct	146
Charlestown Medical Centre	6414
Cherrybrook Precinct	4553; 4555; 4573; 4574; 4575
Circular Quay	30; 33; 42; 43
Cockle Bay Wharf	90
Coffs Harbour Film Studio	8530
Coffs Harbour Hospital	8534
Concord Repatriation Hospital	715
Crown Street Wollongong Health Services Facility	5650
Dubbo Hospital Redevelopment	7977
Eastern Creek Business Hub	4055
Education Campus Jindabyne	7448

Project Name	Travel Zones impacted by project
Eels Centre of Excellence	4572
Frenchs Forest Precinct	2128; 2140; 2142; 2153
Glenfield to Macarthur - Campbelltown	3210; 3212; 3213; 3215; 3216; 3219
Glenfield to Macarthur - Glenfield	3277; 3279
Glenfield to Macarthur - Ingleburn	3246; 3247; 3248; 3252; 3253
Glenfield to Macarthur - Leumeah	3212; 3269; 3271; 3293; 3295
Glenfield to Macarthur - Macarthur	3209; 3217; 3220; 3221; 3222
Glenfield to Macarthur - Macquarie Fields	3281; 3283
Glenfield to Macarthur - Minto	3289; 3290; 3292; 3293; 3295
GMGA Appin	3028; 3029; 3030; 3031
GMGA Gilead	3259; 3261
GMGA Wilton	3002; 3003; 3008; 3010; 3012; 3026; 3027
GNMP Beresfield - Black Hill	6308; 6310; 6639; 6720
GNMP Broadmeadow	6313; 6314; 6316
GNMP Callaghan	6337; 6367
GNMP East Maitland	6600; 6610; 6612; 6613
GNMP John Hunter Hospital	6323
GNMP Kotara	6301; 6303
GNMP Newcastle City Centre	6317; 6350; 6351; 6352; 6357; 6383
GNMP Newcastle Port	6336; 6359; 6360; 6361; 6384; 6393
GNMP NW Lake Macquarie	6200; 6427; 6430; 6431; 6433; 6457; 6458
GNMP Tomago	6523
Gosford Gateway	5334
Gosford Health Hub	5331
Goulburn Hospital Redevelopment	7295
Greenwich Hospital Redevelopment	1833
Griffith Hospital Redevelopment	7570
Hornsby Ku-Ring-Gai Hospital	1626
Horsley Drive Business Park Stage 2	3480
Hunter Street OSD	50; 58
Hydro Kurri Kurri	6733; 6757
ING Call Centre Wyong	5179; 5199
Kellyville	4559; 4560
Lake Macquarie Private Hospital Expansion	6419
Lakeside Studio	4913
Life City Wollongong	5700
Light Horse Business Hub	4046
Lismore Hospital Redevelopment	8650
Liverpool Hospital Redevelopment	3841
Liverpool Private Hospital	3839
Lovedale Integrated Tourist Development	6706
Macquarie Park	1532; 1536; 1537; 1539; 1541; 1543; 1544; 1545; 1547; 1548; 1550; 1553
Mamre Road	3479; 3483; 3485

Project Name	Travel Zones impacted by project
Martin Place OSD	60; 75
Matilda Nepean Private Hospital	4951
Meadowbank Education and Employment Precinct	1589
Melrose Park	1121; 1136; 1137
Moorebank Intermodal Terminal	3824
Moree SAP	8030; 8033
Moreton Park Road Enterprise Corridor	3005; 3032
Morisset Super Centre	6226
Mount Penang	5342
Nepean Hospital	4951
Northside Private Hospital West Gosford	5331
Norwest Central Precinct	4496; 4514; 4515; 4517; 4585; 4586
Norwest Innovation Precinct	4497; 4516; 4521; 4571; 4572; 4580; 4581; 4583; 4585
Norwest Service Precinct	4532; 4534; 4535; 4539; 4543; 4554; 4587; 4588
NWGA Box Hill inc The Gables	4423; 4424; 4426; 4428; 4429; 4430; 4431
NWGA Marsden Park inc Industrial	3947; 3956; 3961; 3962; 3968; 3977; 3979; 3980
NWGA Riverstone West	3934; 3936; 3937
NWGA Tallawong Station	3948
Pacifica Gosford	5334
Parkes SAP	7069; 7072
Parramatta Metro OSD	1030
Parramatta Square	1055
Pitt Street Gadigal OSD	97; 115
Port Botany Expansion	402
Powerhouse Parramatta	1052
Prospect Logistics Estate	1238
Pyrmont Peninsula	78; 88; 89; 108; 125; 136; 144; 151; 152; 153; 154; 155; 156; 157; 159; 160; 186; 187; 203; 228
Randwick Campus Redevelopment	659
Redfern North Eveleigh	216
Rhodes	667; 668; 711
Rouse Hill	4433; 4436; 4438; 4444
Rouse Hill Hospital	4444
Rouse Hill Private Hospital	4431
Royal Parramatta Private Hospital	1053
RPA Redevelopment	238
Ryde Hospital Redevelopment	1510
Shellharbour Airport Employment Precinct	5801; 5811
Shellharbour Hospital	5834
Shoalhaven Hospital Redevelopment	6129
South Jerrabomberra RJP	7403; 7408
South Nowra Employment Precinct	6135; 6137
Southern Employment Lands	262; 263; 264; 265; 266; 267; 269; 330
St George Hospital	2738

Project Name	Travel Zones impacted by project
St John's College Private Hospital	236
St Leonards Crows Nest	1832; 1836; 1837; 1838; 1841; 1842; 1843; 1844; 1845; 1859; 1860; 1908; 1910; 1911; 1912; 1914; 1915; 1949
St Philips Christian College Charmhaven	5184
Sutherland Hospital Redevelopment	2902
SWGA Austral	3615; 3616; 3621
SWGA Leppington North	3627
SWGA Leppington Town Centre	3634; 3655; 3658
SWGA Lowes Creek Maryland	3649; 3659; 3668
SWGA Oran Park	3678; 3683; 3685; 3695; 3697; 3699; 3700
SWGA Turner Road	3120; 3132; 3687; 3691; 3692; 3693
Sydney Olympic Park	1326; 1328; 1331; 1352; 1353
TAFE Institute of Applied Technology - Kingswood	4947
Tamworth UNE	8143
Telopea	1131
Tweed Valley Hospital Redevelopment	8705
University of Newcastle Gosford Campus	5334
University Of Newcastle Honeysuckle Campus	6351
University of Western Sydney Innovation Hub	1057
University of Wollongong Innovation Campus	5603
UTS Blackfriars Research Building	207
Vertical Innovation Village Haymarket	142
Victoria Cross OSD	1962
Villawood Logistics Estate	1205
Wagga Wagga SAP	7612; 7629; 7646
Wallgrove Business Hub	3484
Warner Business Park	5145
Waterloo Estate South	268
Waterloo Metro Quarter	270
Western Sydney Airport	3598; 3609; 3635; 3636
Western Sydney Employment Area	1234; 1238; 1246; 3477; 3478; 3479; 3506; 4044; 4045; 4046; 4059; 4163; 4938; 5001; 5002
Westfield Liverpool ELP & Commercial Tower	3839
Westfield Parramatta Office Tower	1058
Westmead Place Strategy	997; 998; 1007; 1009; 1011; 1015; 1018; 1036; 1037; 1040; 1043; 1044; 1045; 1046; 1048
WIN Grand Wollongong	5647
Winter Sports World Jamisontown	4940
Wollongong CBD	5639
Woolooware Bay	2914
WOW Customer Fulfilment Centre Auburn	1333
WOW Warehouse and Customer Fulfilment Centre Marrickville	305
WOW Wetherill Park DC	3505
WSA - Aerotropolis Core	3612; 3617; 3618; 3622; 3623; 3629; 3706
WSA - Agribusiness	3704; 4970; 4990; 4991; 4992

Project Name	Travel Zones impacted by project
WSA - Badgerys Creek	3608; 3705; 4984
WSA - North Luddenham	4989
WSA - Northern Gateway	4973; 4983; 4993; 4994; 4995
Wyong Hospital Redevelopment	5192

Source: Transport for NSW, 2024

Table 14 below provides a summary of the realisation of each FEDD project in the final employment outputs. Instances where the ratio of TZP24 employment growth/FEDD growth is 100% or greater is denoted by "100%" and shaded blue in the table below and indicates that all FEDD jobs were realised in the projections by that year. For instance, in 13 Endeavour Road Caringbah, 82% of FEDD jobs were realised in the projections by 2026. However, by 2036 there is a '100%' flag, indicating that all FEDD jobs were realised.

Not all FEDD jobs end up in the final employment dataset of TZP24. This is because the TZP24 model is restricted to its total employment number for each industry across all of NSW and then by SA4. When disaggregating this total job number down to individual TZs, the result is that the FEDD estimate of jobs may be higher than is allowed for that TZ. If all FEDD jobs were given in such a situation, it could draw too many jobs from other TZs and affect the trend in other TZs. It is important to note, not being able to realise 100% of FEDD jobs is not necessarily a poor outcome. As previously mentioned, a majority of planning documents have very optimist jobs numbers, which may or may not be realistic.

Table 14 Realisation of FEDD Projects in TZP24 Employment Projections

Project Name	2026	2031	2036	2041	2046	2051	2056	2061	2066
13 Endeavour Road Caringbah	82%	89%	100%	100%	100%	100%	100%	100%	100%
Albury RJP	71%	74%	75%	76%	77%	77%	77%	77%	77%
Alexandria Health Centre	-	100%	100%	100%	100%	100%	100%	100%	100%
ANSTO Innovation Precinct	96%	92%	82%	78%	77%	78%	80%	81%	83%
Astra Aerolab	100%	100%	100%	100%	100%	100%	100%	100%	100%
Australian Bay Lobster Facility	100%	100%	100%	100%	100%	100%	100%	100%	100%
Aventus Supacentre Tuggerah	-	93%	100%	100%	100%	100%	100%	100%	100%
Baiada Integrated Poultry Processing Facility	25%	29%	35%	40%	46%	49%	51%	52%	54%
Bankstown	100%	100%	99%	99%	100%	100%	100%	100%	100%
Barangaroo	71%	73%	72%	73%	76%	78%	80%	82%	84%
Bays West Stage 1	-	26%	41%	46%	49%	50%	50%	51%	52%
Berry and Walker Street Redevelopment	70%	76%	80%	83%	87%	90%	94%	97%	100%
Biomedical Accelerator	-	100%	100%	100%	100%	100%	100%	100%	100%
Blacktown Private Hospital	-	48%	32%	33%	36%	37%	38%	39%	40%
BlueScope Port Kembla	-	99%	100%	95%	93%	91%	89%	88%	88%
Bourke Abattoir	91%	93%	98%	100%	100%	100%	100%	100%	100%
Camellia Rosehill	44%	50%	58%	64%	67%	68%	70%	71%	73%
Camperdown Modern Private Hospital	-	97%	90%	98%	100%	100%	100%	100%	100%
Campsie Private Hospital	-	81%	86%	90%	96%	100%	100%	100%	100%
Carter Street Precinct	100%	90%	80%	90%	100%	100%	100%	100%	100%
Castle Hill	-	59%	68%	69%	71%	72%	73%	75%	77%
Cedar Mill Hunter Valley	-	100%	100%	100%	100%	100%	100%	100%	100%
Central Coast Quarter	100%	100%	100%	100%	100%	100%	100%	100%	100%
Central Precinct	83%	68%	61%	59%	60%	62%	63%	64%	65%

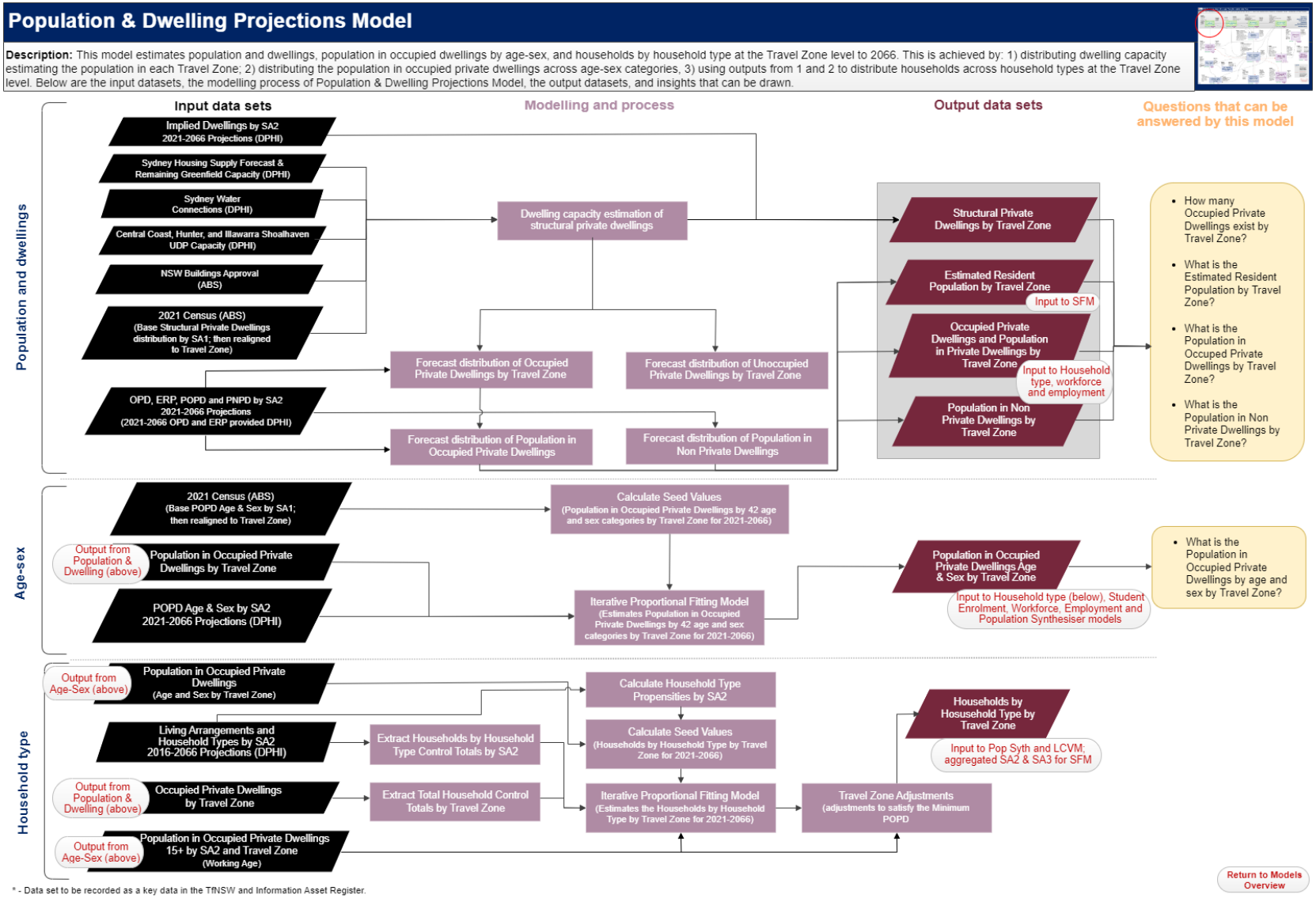
Project Name	2026	2031	2036	2041	2046	2051	2056	2061	2066
Charlestown Medical Centre	100%	100%	100%	100%	100%	100%	100%	100%	100%
Cherrybrook Precinct	-	100%	100%	100%	100%	100%	100%	100%	100%
Circular Quay	69%	59%	59%	60%	62%	65%	67%	69%	72%
Cockle Bay Wharf	-	89%	87%	88%	89%	91%	93%	94%	96%
Coffs Harbour Film Studio	-	86%	90%	92%	95%	97%	98%	100%	100%
Coffs Harbour Hospital	100%	100%	100%	100%	100%	100%	100%	100%	100%
Concord Repatriation Hospital	100%	100%	100%	100%	100%	100%	100%	100%	100%
Crown Street Wollongong Health Services Facility	-	100%	100%	100%	100%	100%	100%	100%	100%
Dubbo Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
Eastern Creek Business Hub	90%	77%	72%	73%	76%	78%	78%	78%	79%
Education Campus Jindabyne	100%	100%	100%	100%	100%	100%	100%	100%	100%
Eels Centre of Excellence	67%	74%	81%	87%	91%	94%	97%	100%	100%
Frenchs Forest Precinct	-	100%	100%	100%	100%	100%	100%	100%	100%
Glenfield to Macarthur - Campbelltown	64%	56%	58%	62%	69%	77%	81%	84%	89%
Glenfield to Macarthur - Glenfield	83%	77%	79%	81%	84%	87%	88%	90%	91%
Glenfield to Macarthur - Ingleburn	57%	57%	68%	80%	95%	100%	100%	100%	100%
Glenfield to Macarthur - Leumeah	81%	62%	70%	82%	100%	100%	100%	100%	100%
Glenfield to Macarthur - Macarthur	91%	67%	61%	64%	72%	79%	83%	87%	93%
Glenfield to Macarthur - Macquarie Fields	79%	34%	29%	33%	44%	56%	61%	67%	74%
Glenfield to Macarthur - Minto	100%	87%	100%	100%	100%	100%	100%	100%	100%
GMGA Appin	-		75%	85%	87%	89%	94%	99%	100%
GMGA Gilead	99%	92%	90%	89%	91%	94%	95%	96%	98%
GMGA Wilton	100%	91%	92%	96%	96%	95%	99%	100%	100%
GNMP Beresfield - Black Hill	93%	93%	94%	98%	100%	100%	100%	100%	100%
GNMP Broadmeadow	100%	100%	100%	100%	100%	100%	100%	100%	100%
GNMP Callaghan	100%	100%	100%	100%	100%	100%	100%	100%	100%
GNMP East Maitland	100%	100%	100%	100%	100%	100%	100%	100%	100%
GNMP John Hunter Hospital	100%	100%	100%	100%	100%	100%	100%	100%	100%
GNMP Kotara	100%	92%	78%	94%	100%	100%	100%	100%	100%
GNMP Newcastle City Centre	100%	100%	100%	100%	100%	100%	100%	100%	100%
GNMP Newcastle Port	65%	68%	70%	78%	93%	100%	100%	100%	100%
GNMP NW Lake Macquarie	100%	100%	100%	100%	100%	100%	100%	100%	100%
GNMP Tomago	100%	100%	100%	100%	100%	100%	100%	100%	100%
Gosford Gateway	-	82%	83%	91%	97%	100%	100%	100%	100%
Gosford Health Hub	100%	100%	100%	100%	100%	100%	100%	100%	100%
Goulburn Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
Greenwich Hospital Redevelopment	-	100%	100%	100%	100%	100%	100%	100%	100%
Griffith Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
Hornsby Ku-Ring-Gai Hospital	100%	100%	100%	100%	100%	100%	100%	100%	100%
Horsley Drive Business Park Stage 2	51%	55%	58%	61%	61%	61%	62%	61%	61%
Hunter Street OSD	-	70%	78%	78%	81%	85%	89%	92%	96%
Hydro Kurri Kurri	72%	80%	82%	83%	84%	85%	87%	88%	90%
ING Call Centre Wyong	100%	100%	100%	100%	100%	100%	100%	100%	100%
Kellyville	-	100%	100%	97%	95%	97%	98%	100%	100%
Lake Macquarie Private Hospital Expansion	-	100%	100%	100%	100%	100%	100%	100%	100%
Lakeside Studio	-	56%	58%	61%	62%	63%	65%	66%	68%
Life City Wollongong	-	88%	98%	100%	100%	100%	100%	100%	100%

Project Name	2026	2031	2036	2041	2046	2051	2056	2061	2066
Light Horse Business Hub	100%	100%	100%	100%	100%	100%	100%	100%	100%
Lismore Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
Liverpool Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
Liverpool Private Hospital	-	100%	100%	100%	100%	100%	100%	100%	100%
Lovedale Integrated Tourist Development	-	100%	100%	100%	100%	100%	100%	100%	100%
Macquarie Park	100%	100%	100%	100%	100%	100%	100%	100%	100%
Mamre Road	67%	66%	68%	70%	71%	73%	74%	76%	77%
Martin Place OSD	74%	74%	74%	75%	78%	80%	83%	86%	89%
Matilda Nepean Private Hospital	100%	100%	100%	100%	100%	100%	100%	100%	100%
Meadowbank Education and Employment Precinct	100%	100%	100%	100%	100%	100%	100%	100%	100%
Melrose Park	-	77%	77%	90%	100%	100%	100%	100%	100%
Moorebank Intermodal Terminal	66%	89%	85%	91%	93%	94%	95%	94%	94%
Moree SAP	100%	100%	100%	100%	100%	100%	100%	100%	100%
Moreton Park Road Enterprise Corridor	-	-	-	-	100%	99%	96%	95%	95%
Morisset Super Centre	100%	100%	100%	100%	100%	100%	100%	100%	100%
Mount Penang	100%	95%	93%	94%	97%	98%	100%	100%	100%
Nepean Hospital	100%	100%	100%	100%	100%	100%	100%	100%	100%
Northside Private Hospital West Gosford	100%	100%	100%	100%	100%	100%	100%	100%	100%
Norwest Central Precinct	100%	86%	86%	83%	84%	86%	89%	93%	97%
Norwest Innovation Precinct	100%	100%	100%	100%	100%	100%	100%	100%	100%
Norwest Service Precinct	100%	100%	100%	100%	97%	97%	100%	100%	100%
NWGA Box Hill inc The Gables	100%	94%	97%	96%	97%	99%	100%	100%	100%
NWGA Marsden Park inc Industrial	100%	100%	100%	100%	100%	100%	100%	100%	100%
NWGA Riverstone West	-	100%	100%	100%	100%	100%	100%	100%	100%
NWGA Tallawong Station	-	100%	100%	100%	100%	100%	100%	100%	100%
Pacifica Gosford	-	100%	100%	100%	100%	100%	100%	100%	100%
Parkes SAP	82%	84%	87%	89%	90%	90%	92%	92%	94%
Parramatta Metro OSD	82%	48%	56%	57%	57%	58%	59%	59%	60%
Parramatta Square	61%	52%	49%	49%	50%	51%	52%	53%	54%
Pitt Street Gadigal OSD	47%	41%	41%	43%	49%	55%	61%	67%	74%
Port Botany Expansion	78%	72%	75%	78%	82%	83%	85%	86%	87%
Powerhouse Parramatta	74%	65%	67%	77%	92%	100%	100%	100%	100%
Prospect Logistics Estate	95%	100%	100%	100%	100%	100%	100%	100%	100%
Pyrmont Peninsula	78%	56%	61%	65%	71%	75%	80%	84%	89%
Randwick Campus Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
Redfern North Eveleigh	-	91%	86%	87%	94%	96%	97%	98%	100%
Rhodes	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rouse Hill	100%	100%	100%	100%	100%	100%	100%	100%	100%
Rouse Hill Hospital	-	100%	100%	100%	100%	100%	100%	100%	100%
Rouse Hill Private Hospital	-	100%	100%	100%	100%	100%	100%	100%	100%
Royal Parramatta Private Hospital	-	95%	95%	100%	100%	100%	100%	100%	100%
RPA Redevelopment	-	100%	100%	100%	100%	100%	100%	100%	100%
Ryde Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
Shellharbour Airport Employment Precinct	100%	79%	81%	83%	86%	86%	87%	86%	84%
Shellharbour Hospital	-	86%	99%	100%	100%	100%	100%	100%	100%
Shoalhaven Hospital Redevelopment	-	100%	100%	100%	100%	100%	100%	100%	100%

Project Name	2026	2031	2036	2041	2046	2051	2056	2061	2066
South Jerrabomberra RJP	-	74%	83%	87%	90%	92%	93%	95%	98%
South Nowra Employment Precinct	100%	100%	100%	100%	100%	100%	100%	100%	100%
Southern Employment Lands	100%	75%	80%	88%	97%	100%	100%	100%	100%
St George Hospital	-	100%	100%	100%	100%	100%	100%	100%	100%
St John's College Private Hospital	-	100%	100%	100%	100%	100%	100%	100%	100%
St Leonards Crows Nest	100%	100%	100%	100%	100%	100%	100%	100%	100%
St Philips Christian College Charmhaven	-	100%	100%	100%	100%	100%	100%	100%	100%
Sutherland Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
SWGA Austral	100%	100%	100%	100%	100%	100%	100%	100%	100%
SWGA Leppington North	-	100%	100%	100%	100%	100%	100%	100%	100%
SWGA Leppington Town Centre	100%	100%	96%	100%	100%	100%	100%	100%	100%
SWGA Lowes Creek Maryland	-	100%	98%	100%	100%	98%	100%	100%	100%
SWGA Oran Park	100%	100%	100%	100%	100%	100%	100%	100%	100%
SWGA Turner Road	100%	100%	100%	100%	100%	100%	100%	100%	100%
Sydney Olympic Park	100%	100%	86%	85%	86%	86%	89%	91%	94%
TAFE Institute of Applied Technology - Kingswood	100%	100%	100%	100%	100%	100%	100%	100%	100%
Tamworth UNE	100%	100%	100%	100%	100%	100%	100%	100%	100%
Telopea	100%	100%	100%	100%	100%	100%	100%	100%	100%
Tweed Valley Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%
University of Newcastle Gosford Campus	100%	100%	100%	100%	100%	100%	100%	100%	100%
University Of Newcastle Honeysuckle Campus	100%	100%	100%	100%	100%	100%	100%	100%	100%
University of Western Sydney Innovation Hub	42%	42%	36%	37%	38%	38%	39%	40%	42%
University of Wollongong Innovation Campus	100%	100%	100%	100%	100%	100%	100%	100%	100%
UTS Blackfriars Research Building	-	100%	87%	92%	99%	100%	100%	100%	100%
Vertical Innovation Village Haymarket	-	100%	91%	91%	93%	95%	98%	100%	100%
Victoria Cross OSD	59%	60%	62%	64%	67%	69%	72%	74%	76%
Villawood Logistics Estate	48%	51%	64%	81%	100%	100%	100%	100%	100%
Wagga Wagga SAP	78%	80%	85%	87%	88%	88%	88%	88%	88%
Wallgrove Business Hub	-	91%	97%	100%	100%	100%	100%	100%	100%
Warner Business Park	68%	75%	80%	85%	88%	91%	93%	95%	97%
Waterloo Estate South	-	86%	91%	89%	92%	94%	97%	99%	100%
Waterloo Metro Quarter	82%	83%	83%	83%	85%	86%	88%	89%	91%
Western Sydney Airport	62%	73%	75%	76%	77%	79%	81%	81%	81%
Western Sydney Employment Area	100%	100%	100%	100%	100%	100%	100%	100%	100%
Westfield Liverpool ELP & Commercial Tower	-	100%	100%	100%	100%	100%	100%	100%	100%
Westfield Parramatta Office Tower	-	84%	63%	65%	70%	73%	77%	80%	85%
Westmead Place Strategy	100%	89%	90%	92%	96%	95%	99%	100%	100%
WIN Grand Wollongong	-	100%	100%	100%	100%	100%	100%	100%	100%
Winter Sports World Jamisontown	-	100%	100%	100%	100%	100%	100%	100%	100%
Wollongong CBD	100%	100%	100%	100%	100%	100%	100%	100%	100%
Woolooware Bay	51%	54%	56%	59%	63%	66%	70%	74%	79%
WOW Customer Fulfilment Centre Auburn	95%	100%	100%	100%	100%	100%	100%	100%	100%
WOW Warehouse and Customer Fulfilment Centre Marrickville	100%	100%	100%	100%	100%	100%	100%	100%	100%
WOW Wetherill Park DC	28%	45%	57%	63%	64%	66%	68%	69%	70%
WSA - Aerotropolis Core	80%	83%	83%	83%	82%	82%	81%	82%	82%

Project Name	2026	2031	2036	2041	2046	2051	2056	2061	2066
WSA - Agribusiness	-	95%	96%	95%	95%	95%	96%	96%	96%
WSA - Badgerys Creek	-	93%	94%	93%	92%	92%	92%	92%	92%
WSA - North Luddenham	-	-	-	-	96%	94%	93%	91%	91%
WSA - Northern Gateway	-	85%	86%	86%	86%	86%	86%	86%	87%
Wyong Hospital Redevelopment	100%	100%	100%	100%	100%	100%	100%	100%	100%

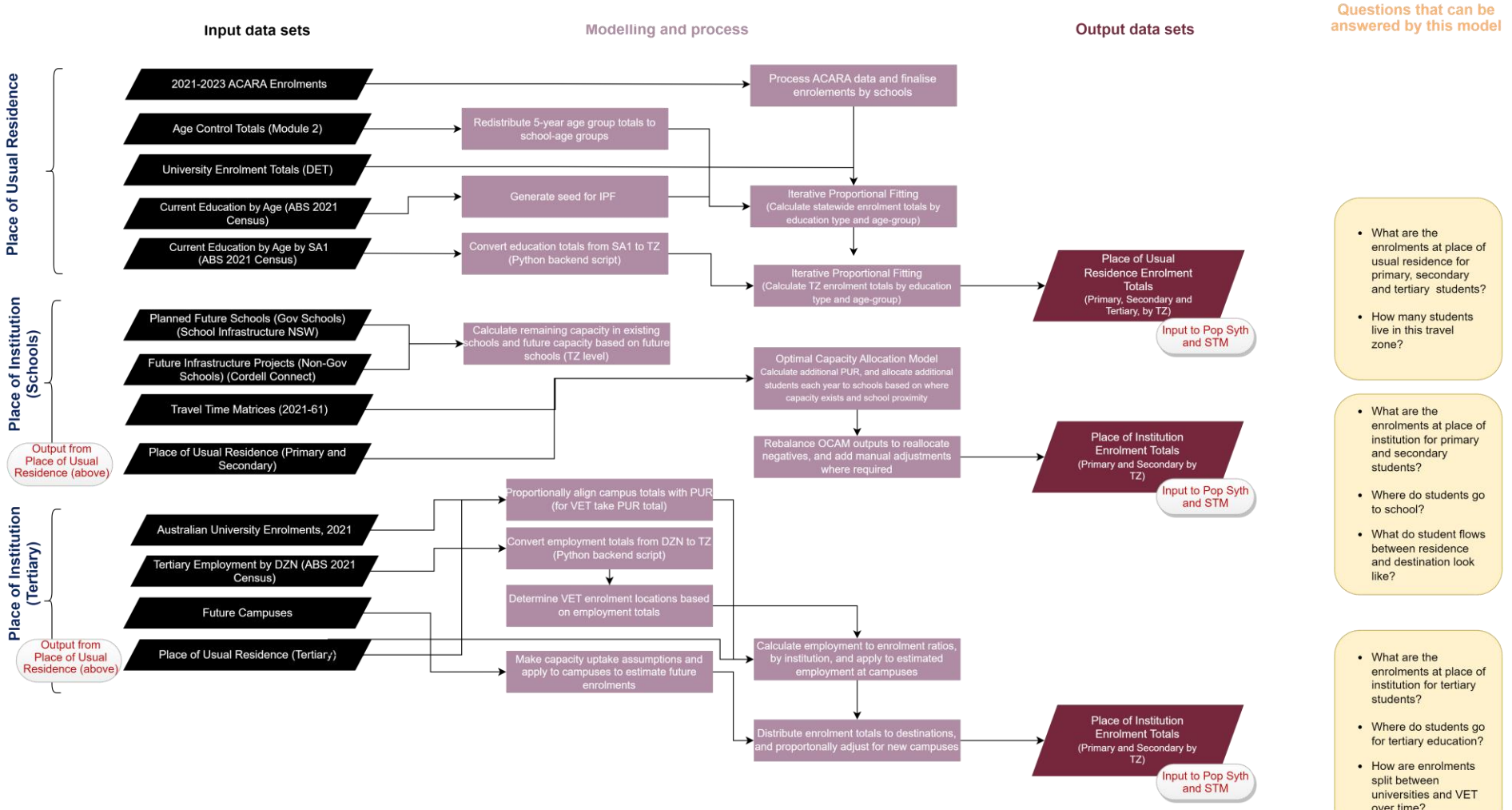
12 Appendix B: Travel Zone Projections 2024: Process Maps



* - Data set to be recorded as a key data in the TfNSW and Information Asset Register.
Source: TfNSW, *'2024 Travel Zone Projections (TZP24) – Part 1: Model Overview Results'*.

Student Enrolment Projections Model

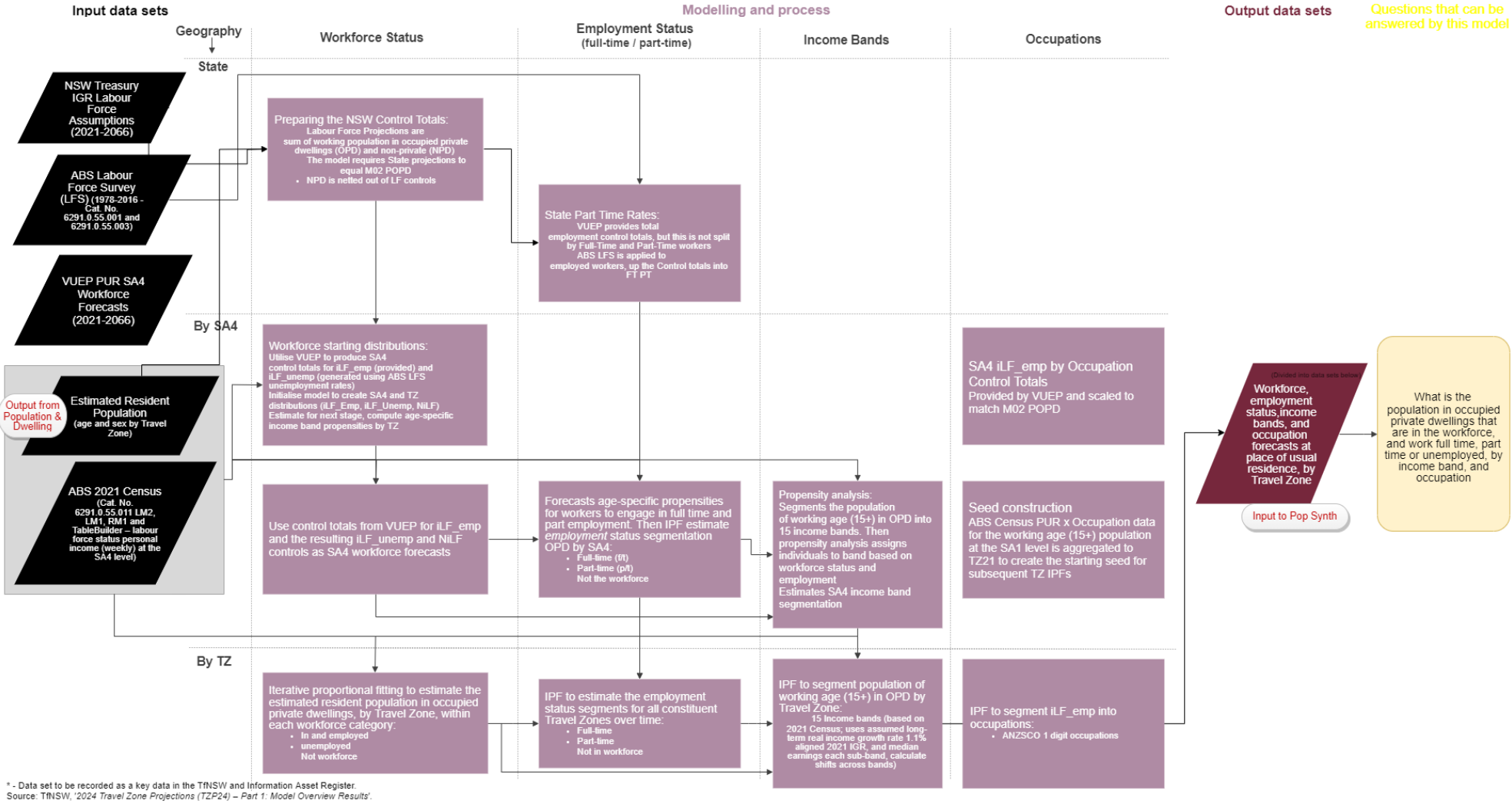
Description: This model uses outputs from the Population & Dwelling Projections (population in occupied private dwellings – age and sex), to estimate student enrolments for primary, secondary tertiary education, by place of residence institution at Travel Zone level 2066. Below are input data sets, modelling process Student Enrolments Model, output insights that can be drawn.



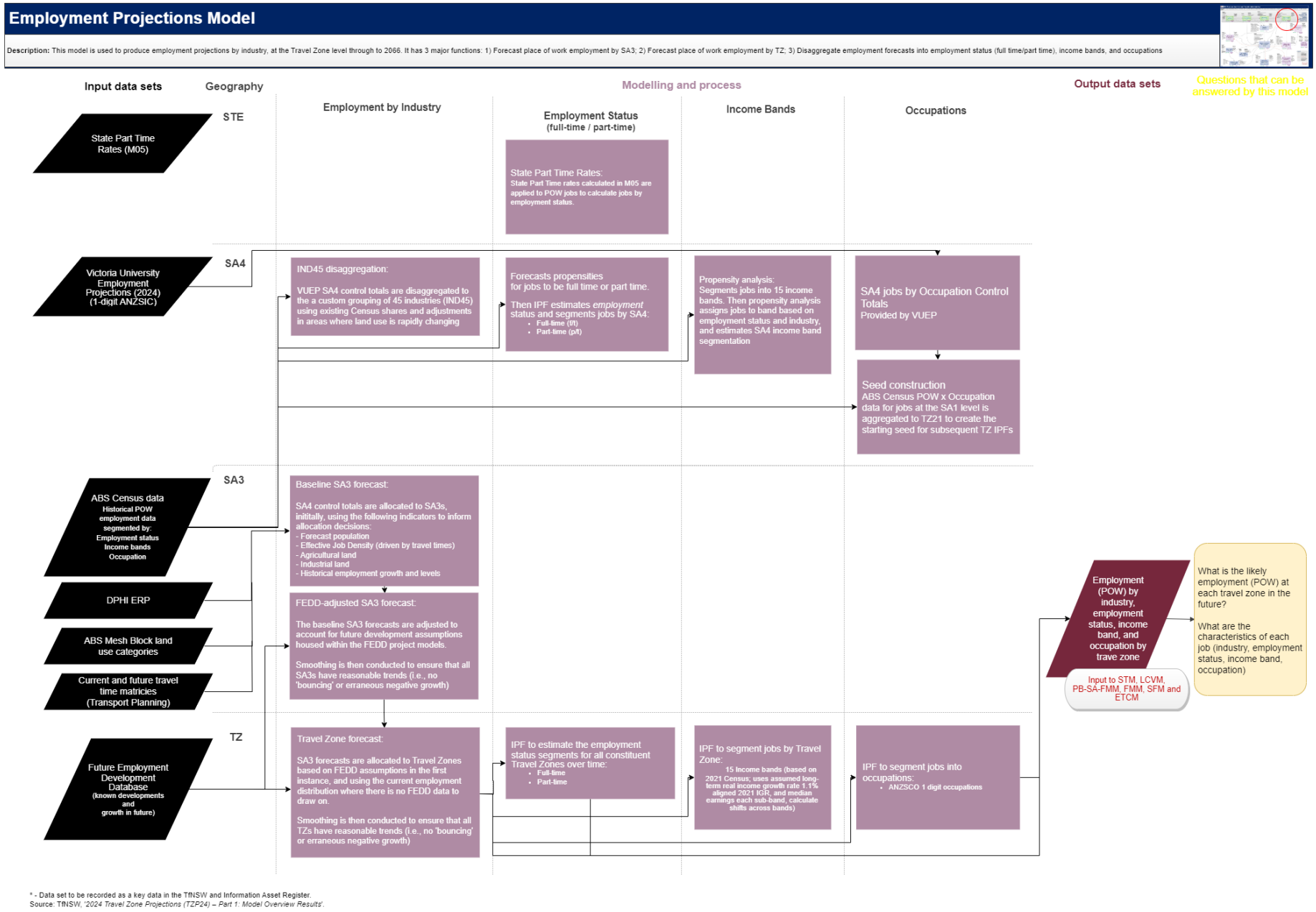
* - Data set to be recorded as a key data in the TfNSW and Information Asset Register.
Source: TfNSW, '*2024 Travel Zone Projections (TZP24) – Part 1: Model Overview Results*'.

Workforce Projections Model

Description: This model uses outputs from the Population & Dwelling Projections Model to estimate various segmentations of working age population at 3 geographic scales: NSW, SA4s and Travel Zones 2066. The working age population is broken down by workforce status: Employed (a.k.a 'Workforce'), Unemployed Not in Labour Force (NiLF). Employed persons are disaggregated further by employment status (employed full-time or part-time), income bands and occupation. Below are input data sets, modelling processes, output & insights that can be drawn.



* - Data set to be recorded as a key data in the TfNSW and Information Asset Register.
Source: TfNSW, '*2024 Travel Zone Projections (TZP24) – Part 1: Model Overview Results*'.



* - Data set to be recorded as a key data in the TfNSW and Information Asset Register.
Source: TfNSW, *'2024 Travel Zone Projections (TZP24) – Part 1: Model Overview Results'*.

13 Appendix C: Table of Assumptions

Module	Assumption
M01a - Capacity Estimation	SHSF & Additional Greenfield Capacity data is assumed to have the highest degree of certainty and is assigned to priority capacity.
	Sydney Water connections data is assigned to priority capacity.
	Central Coast Urban Development Program capacity data is assigned to priority capacity.
	Hunter Urban Development Program capacity data is assigned to priority capacity.
	Illawarra Shoalhaven Urban Development Program capacity data is assigned to priority capacity.
	ABS Building Approvals are assigned to priority capacity. Data was removed in locations where it overlaps with the Sydney Water connections data, Hunter UDP capacity data, and Illawarra Shoalhaven UDP capacity data.
M01b - Dwelling Forecasting	Structural Private Dwellings by Travel Zone are aligned to SA2 Implied Dwelling Demand control totals (based on DPHI data).
	The collated capacity inputs are used to allocate dwellings using a Capacity Allocation Algorithm.
	In cases where Priority Capacity exceeds the SA2 dwelling growth from the control totals, any unused capacity is pushed out to the next forecast year in order to meet the DPHI projections.
	In cases where Priority Capacity is lower than the SA2 dwelling growth from the control totals, all of the Priority Capacity is allocated, and any remaining developments are allocated on a pro rata basis using the distribution of dwellings in the previous forecast year.
M01c - Households and Population by Travel Zone	Occupied Private Dwellings by Travel Zone are aligned to SA2 Total Household control totals (based on DPHI data).
	OPD forecasts are rebalanced to the SA2 control totals prorated with the number of UPD to ensure OPD does not exceed SPD.
	Population in Occupied Private Dwellings by Travel Zone are aligned to SA2 POPD control totals (prepared by SGS & TfNSW, using DPHI inputs).
	POPD forecasts are rebalanced to the SA2 POPD control totals, either by POPD growth or POPD stock. The choice of methodology for rebalancing is based on user input.
	Population in Non-Private Dwellings by Travel Zone are aligned to SA2 PNPD control totals (prepared by SGS & TfNSW, using DPHI inputs).
	Estimated Resident Population by Travel Zone are aligned to SA2 Total ERP control totals (based on DPHI data).
	Within a SA2, relative differences in travel zone occupancy rates and household sizes are based on SA1 geography (using ABS Census data).
	Population in Occupied Private Dwellings data in selected travel zones were smoothed to reflect local trends.

M02a - Age by Sex Base Distribution	SA1 Census data is used to inform the base distribution of POPD by age and sex at Travel Zone level.
	Due to the randomisation of small numbers in census data, Travel Zones with a base estimate below 20 POPD in any category are assigned the distribution of its encompassing SA2. This is particularly relevant for future growth zones, which have no historical data available.
M02b - Age by Sex	The base year to run the IPF is 2021.
	To ensure that PNPD does not influence the IPF results (i.e. POPD by age by sex), travel zones with an ERP/OPD ratio less than 50% are assigned a seed distribution equal to the encompassing SA2.
	For each future year, the IPF procedure uses the age-sex results of the previous period as the seed distribution.
	Future growth Travel Zones (which have no historical age-sex distribution) are assumed to have a starting distribution that mirrors the distribution of the overarching SA2.
	Where any small differences exist, SA2 DPHI population forecasts by age from 2021 to 2066 are proportionally adjusted each year to match the POPD control totals by Travel Zone.
M02c - Module Outputs and Summaries	None
M03a - Living Arrangement Propensities	To convert the POPD projections by age and living arrangement to POPD projections by age and household type, the number of persons in each household type is calculated by summing up one or more living arrangement types.
M03b - Calculating seed values	Only persons of age 15+ are considered in the Household by Type categories. This is a simplifying assumption to remove the need for additional assumptions, such as needing to know the average number of children per household for each category.
	This module coverts population forecasts to household forecasts. Therefore, we need conversion factors. Couples are assumed to have 2 adults per household (scaling factor is 0.5), singles are assumed to have 1 adult per household (scaling factor is 1.0), other households have slightly >2 adults per household (based on the average household size from ABS census – this gives a scaling factor of 0.4204).
	Future growth Travel Zones (which have no historical age-sex distribution) are assumed to have a starting distribution that mirrors the distribution of the overarching SA2.
M03c - IPF	The base year to run the IPF is 2021.
	Minimum household sizes used to calculate SA2 Minimum POPD 15+ are as follows: Couples with children - 2.0, Couples only – 2.0, Single parent – 1.0, Single person – 1.0, Other – 2.0.
	The DPHI SA2 households by household type projections up to and including 2041 will satisfy the SA2 Minimum POPD 15+ criteria.
	Adjustments to satisfy the SA2 Minimum POPD 15+ criteria result in changes to the DPHI SA2 Households by Household Type data

	The smallest adjustment possible is made to satisfy the SA2 Minimum POPD 15+ criteria. That is, POPD 15+ will equal Minimum POPD 15+ for any SA2s needing adjustment for the relevant years.
	For each future year, the IPF procedure uses the year-specific computed distribution from M03b as the seed distribution.
	Where any small differences exist, OPD control totals by Travel Zone from 2021 to 2066 are proportionally adjusted each year to match the SA2 DPHI household forecasts.
M03d - Travel Zone Adjustments	Minimum household sizes used to calculate Travel Zone Minimum POPD 15+ are as follows: Couples with children - 2.0, Couples only – 2.0, Single parent – 1.0, Single person – 1.0, Other – 2.0.
	The changes in this module are entirely contained within SA2 geographies (to ensure DPHI SA2 control totals are met) independent of other areas and are output via intra travel zone shifts within the higher geography (SA2).
	For any adjustments made, the smallest adjustment possible is used to satisfy the Travel Zone Minimum POPD 15+ criteria. That is, POPD 15+ will equal Minimum POPD 15+ for any travel zones needing adjustment for the relevant years.
M04a_1-School Data Analysis	School Infrastructure and ACARA school enrolment forecast concorded to Travel Zone. Data has been further processed for correct TZ locations and redistribution of enrolments where rolled reporting had occurred.
M04a_2-Age Control Totals	The single age distribution derived from the 2021 Census data is applied to the population forecast by 5-year age groups to obtain the school age groups.
M04b - Enrolment Control Totals	The 2021 Census age by education attendance is used as seed values into the IPF to obtain enrolment control totals by institution type.
M04c - Enrolments at Origin	The 2021 distribution of school attendance is applied to the age group forecast from 2021-2066.
	Where data on actual enrolments exists as per ACARA, control totals are set to be equal to historical actual enrolments.
	Where there is no base data input in the initial distribution of persons, the regional distribution is applied. This accounts for growth areas where there is no precedent of population.
	SA1 Census data is used to inform the base distribution of POPD by schooling age at travel zone level.
	The base year to run the IPF is 2021.
	For each future year, the IPF procedure uses the household results of the previous period as the seed distribution.
M04d - Enrolments at Destination	School capacity for primary schools is assumed to be the 90th percentile of existing enrolments for both Primary and Secondary schools.
M04e - OCAM	The capacity of the secondary schools adjusted in future years to assist the model run.

	For each year of allocation in the OCAM, the most applicable travel time matrix is used to assess the proximity of schools based on travel zones
	The 2061 travel time matrix is used to allocate students from origin to destinations for 2066 forecasts.
M04g - Tertiary Enrolments	The spatial distribution of tertiary students across the State is assumed to remain consistent across the forecast.
M05a – State Part-Time Rate	VUEP provide State and SA4 level control totals. Consequently, only an overall part-time rate for the State was required. The upper limit for part-time rate across New South Wales is considered to be 50%.
M05b/c/d/f-Starting Distributions, Labour Force Status/ Time/ Occupation IPF	VUEP Labour Force Control Totals (Emp + Unemp + NiLF) slightly proportioned to align with M02 POPD. ABS LFS 2024 SA4 participation and unemployment rate distribution carried forward in forecast years
	SA1 Census data is used to inform base distribution for all labour force segments at travel zone level.
	Due to the randomisation of small numbers in census data, travel zones with a base estimate below 20 POPD in any category are assigned the distribution of its SA2. This is particularly relevant for future growth zones, which have no historical data available.
	For each future year, the IPF procedure uses the labour force status results of the previous period as the seed distribution.
M05e - Income Segmentation	Due to the randomisation of small numbers in census data, travel zones with a base estimate below 20 POPD in any income category are assigned the distribution of its encompassing 'SA2'. This is particularly relevant for future growth zones, which have no historical data available.
	Assumed real income growth rate of 1.1%. This is the compound average growth rate in real GSP per capita from the 2021 NSW IGR.
	For each future year, the IPF procedure uses the labour force status results of the previous period as the seed distribution.
M06b – Input processing	VUEP SA4 employment control totals disaggregated using Census 2021 2-digit industry share of 1-digit industries. These relationships are assumed to be maintained through to 2066, except where adjustments have been made in rapidly changing areas of NSW.
M06c – SA3 forecasts	Retail Trade and Food and Beverage Services industries have been reverted to their 2016 Census spatial distributions in order to combat the skewing of Census responses due to COVID-19. Where no FEDD data is available, the spatial distribution of future growth is assumed to cluster where employment currently exists.
M06d – TZ forecasts	Where no FEDD data is available, the spatial distribution of future growth is assumed to cluster where employment currently exists.

M06e – POW disaggregation	Assumed real income growth rate of 1.1%. This is the compound average growth rate in real GSP per capita from the 2021 NSW IGR.
	For each future year, the IPF procedure uses the labour force status results of the previous period as the seed distribution.
	Income band distributions are linked to the evolution in industry composition, under the assumption that changing industries will drive changes in income.

14 Appendix D: Output Files

14.1 Data Source of Output Files

File name	Source module	Excel sheet/notes
1.1 Structural Private Dwellings_TZ.csv	M01b	SPD Forecast
1.2 Occupied Private Dwellings_TZ.csv	M01c	OPD Forecast
1.3 Population Occupied Private Dwellings_TZ.csv	M01c	POPD Forecast
1.4 Population Non Private Dwellings_TZ.csv	M01c	PNPD Forecast
1.5 Estimated Resident Population_TZ	M01c	ERP Forecast
1.6 Estimated Resident Population_SA3	M01c	ERP_SA3
1.7 Population Non Private Dwellings_SA3	M01c	PNPD_SA3
2.1 Age by Sex 5 Year Age Groups (0-100) _TZ.csv	M02b	IPF Output (Output generated using M02c)
2.2 Age Groups (15-64+) _TZ.csv	M02b	IPF Output Aggregated (Output generated using M02c)
2.3 Age by Sex 5 Year Age Groups (15-64+) _SA4.csv	M02b	SA4 IPF Output Aggregated (Output generated using M02c)
3.1 Household Type_TZ.csv	M03d	TZ HH Output_Sorted (Output generated using M03d Backend)
3.2 Adjusted SA2 Household Type.csv	M03a	Household Type Propensities (Output generated using M03d Backend)
4.1 Primary and Secondary School students PUR_TZ.csv	M04c	Summary_P&S
4.2 Primary and Secondary School students POI_TZ.csv	M04f	POI_Final_Cut
4.3 Tertiary Students PUR_TZ.csv	M04c	Summary_T
4.4 Tertiary Students POI_TZ.csv	M04g	Output_Final
5.1 Labour Force_TZ.csv	M05c	TZ21 IPF Output
5.2 Labour Force Part Time Full Time_SA4.csv	M05d	SA4 IPF Output
5.3 Labour Force Part Time Full Time_TZ.csv	M05d	TZ21 IPF Output
5.4 Labour Force Income Segmentation TZ.csv	M05e	TZ21 IPF Output
5.5 Labour Force Occupation Segmenation_TZ21	M05f	TZ21 IPF Output
6.1 Employment SA3 Forecast.csv	M06d	Generated via python script

6.2 Employment TZ Forecast.csv	M06e	Generated via python script
6.3 Employment Part Time Full Time_TZ.csv	M06f	TZ21 IPF Output
6.4 Employment Income Segmentation_TZ.csv	M06f	TZ21 IPF Output
6.5 Employment Occupation Segmentation_TZ21.csv	M06f	Generated via python script

15 Appendix E: Employment Allocation Model

15.1 Employment Allocation Model

A historical employment dataset is used to provide the basis for small area employment projections in TZP24. The dataset allocates employment data using ABS Census 2021 obtained at a Destination Zone (DZN) level to Travel Zones (TZ).

Due to issues inherent in census data such as undercount or poor self-reporting accuracy, the JTW data is recalibrated to align with the Labour Force Survey (adjusted to reflect Place of Work (POW) rather than Place of Usual Residence (PUR) at a State level). The following information provides a brief description of the methodology used to convert DZN data to TZ data, as found in the JTW dataset.

15.2 Building the conversion tables

To obtain the estimated number of jobs within a TZ, estimates are initially prepared at the ABS mesh block level which is a smaller geography than TZ. Mesh blocks usually align with the TZ geography and are designed by the ABS to represent a small area of relative demographic homogeneity.

Where a TZ and Mesh Block boundary aligns, TZs are a summation of, of the constituent mesh blocks. Where ABS mesh blocks do not align exactly with travel zones, the spatial area within mesh blocks overlapping with travel zones is used to estimate the size of the travel zone.

The ABS publishes estimates of the count of dwellings at the mesh block level (ABS 2074.0), Employment estimates, however, are more complex, as this data is not available. To obtain these estimates of employment at a Travel Zone level, it is necessary to build a model that utilises Mesh Block land use categories, in combination with employment by ANZSIC category and occupation (i.e., DZN data).

The allocation process involves separating jobs according to ANZSIC category and Occupation (Blue Collar, White Collar – Low Skilled, White Collar – High Skilled).

These jobs are then allocated to Mesh Blocks within the DZN according to their associated land use category (i.e., Residential, Parkland, Commercial, Primary Production, Industrial, etc.).

The process involves a "50/30/20" hierarchical split, as detailed in Table 15. 50% of jobs are allocated to the first set of Mesh Block Categories, the following 30% of jobs are allocated to the second set and the final 20% are allocated to the final set.

A process is then undertaken to identify yes or no if that Category and Occupation are to be associated with the respective mesh block category (through a 1 or 0 identifier as shown in Table 15. Once this mesh block allocation is complete, a mesh block to TZ concordance then creates employment at a TZ level.

Example: 50% of Blue Collar Jobs in Example Industry #2 are allocated to Industrial Mesh Blocks. The next 30% are distributed across Industrial Mesh Blocks a second time. The final 20% is allocated evenly across Mesh Blocks with Commercial, Industrial Agricultural and Other land use categories.

Table 15: Example of employment allocation model (example industry)

	Example Industry #1			Example Industry #2		
	Blue Collar	White Collar (Low Skilled)	White Collar (High Skilled)	Blue Collar	White Collar (Low Skilled)	White Collar (High Skilled)
1st Allocation	50%	50%	50%	50%	50%	50%
Residential						
Commercial		1	1		1	1
Industrial	1	0		1	0	
Education		0			0	
Hospital/Medical		0			0	
Agricultural		0			0	
Transport		0			0	
Parkland		0			0	
Water		0			0	
Other		0			0	
2nd Allocation	30%	30%	30%	30%	30%	30%
Residential	1	1	1		0	
Commercial	1	1	1		1	1
Industrial	1	1	1	1	0	
Education	1	0			0	
Hospital/Medical	1	0			0	
Agricultural	1	0	0		0	
Transport	1	0			0	
Parkland		0			0	
Water		0			0	
Other		0			0	
3rd Allocation	20%	20%	20%	20%	20%	20%

Residential	1	1	1		0	
Commercial	1	1	1	1	1	1
Industrial	1	1	1	1	1	1
Education	1	1	1		0	
Hospital/Medical	1	1	1		0	
Agricultural	1	1	1	1	1	1
Transport	1	0			0	
Parkland		0			0	
Water		0			0	
Other	1	1	1	1	1	1

Source: SGS Economics and Planning, 2024

16 Appendix F: Important notes for TZP24 users

16.1 TZP24 Data sets and information

TZP24 output datasets are available from the TfNSW Open Data Hub. To download data, users will need to register and create an account. The data is available in CSV or MS Excel format. The MS Excel files contain additional notes and cautions.

The spatial file for the Travel Zones 2021 geography is also available from the Open Data Hub.

Data visualisations are available on the TfNSW Corporate Website.

An issues register is kept for TZP24 to capture issues found in the TZP dataset or to flag new information that could be used for future versions of the projections. To flag items please contact the Place Forecasting team at TfNSW using model.selection@transport.nsw.gov.au - Attention Place Forecasting.

16.2 Cautions and notes for TZP24 users

16.2.1 Considerations

TZP provides a long-term view of the future aligned with the NSW Government's Common Planning Assumptions (CPA) for population and employment projections.

- The projections are developed to support a strategic view of NSW and are calibrated as an input into TfNSW travel models, including the Strategic Travel Model (STM).
- The TZP are not based on specific assumptions about future new transport infrastructure but do take into account known land-use developments underway or planned, and strategic plans.
- The projections present a small area geography, long-term view of the future patterns of population, dwellings, workforce and employment across NSW.
- The projections are not government targets.
- The projections rely on best available information as at early 2024. Caution is recommended as they are forward looking estimates only and not meant to be absolute forecasts of population and employment for NSW.
- The projections incorporate results of the National Census conducted by the ABS in August 2021. The 2021 Census occurred during COVID-19 lockdowns throughout Australia. This will have affected the answers to some Census questions, and the data may not align with trends or patterns seen up until 2016. Therefore, some analysis of the 2021 Census may have been excluded when setting the underlying assumptions for the 2024 NSW Population Projections.
- For Sydney the projections include the Transport Orientated Developments TODs, that are in the 2023 Sydney Housing Supply Forecast; it does not include TODs announced in April 2024 or later, or any TODs outside of Sydney.
- The projections do not include the Low and Mid Rise Housing Reforms or LGA Housing Targets.

16.2.2 Limitations and cautions

Travel Zone Projections are a strategic state-wide dataset and caution should be exercised when considering results at detailed breakdowns.

- The TZP24 outputs represent a point in time set of projections (as at early 2024).
- Travel Zone (TZ) level outputs are projections only and should be used as a guide.
- As a general rule, TZ level projections are illustrative of a possible future only.
- A high degree of caution should be exercised when using the TZP dataset at more detailed levels. Results for an individual TZ should not be considered accurate, even in base or historic years, as source data is generally not available at this geographic extent. Instead, estimates have been derived using rules to disaggregate source data from larger geographic areas down to this level. As with all small area data, aggregation of travel zone projections to higher geographies leads to more robust results.
- Users should further note that comprehensive analysis of individual sites or precincts has not been undertaken in the development of TZP.
- Population and Employment estimates in the base year (2021) may not align with published ABS Census results as they are adjusted for Census undercount.

16.2.3 Alignment to the 2024 Common Planning Assumptions

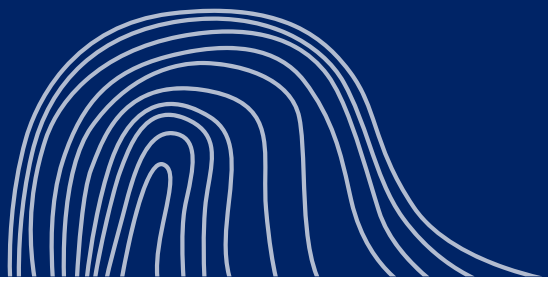
- TZP24 Estimated Resident Population (ERP) outputs align with DPHI's ERP control totals for the State and SA2.
- Population in Occupied Private Dwellings (POPD) and Population in Non Private Dwellings (PNPD) added together in TZP24 align with DPHI's ERP at the SA2 level.
- More detailed breakdowns of the population dataset, such as by age and sex may not align perfectly due to minor differences in modelling approach and the use of spatial concordances.
- TZP24 Structural Private Dwellings (SPDs) outputs align with DPHI's Implied Dwellings projections at State and SA2 level.
- TZP24 Occupied Private Dwellings (OPDs) outputs align with DPHI's Household projections at State and SA2 level.
- An assessment of the reliability of the TZP data has been completed, with a view to inform the best way to use it.

16.2.4 Important note on alignment with DPHI's 2024 NSW Population projections

- As per above note, TZP24 aligns with the following variables in DPHI's 2024 NSW Population projections at SA2 and State level:
    - Estimated Resident Population
    - Implied Dwellings (equivalent to Structural Private Dwellings in TZP24)
    - Households (equivalent to Occupied Private Dwellings in TZP24)

- DPHI published the 2024 NSW Population Projections in November 2024. The published projections by DPHI do not include:
    - Implied Dwelling projections for the 43 councils across Greater Sydney, Illawarra-Shoalhaven, Central Coast, Lower Hunter and Greater Newcastle
    - Household projections

- As per DPHI's published projections, the following variables are not be published as part of the TZP24 Population and Dwellings Projections on the TfNSW Open Data Hub:
    - Structural Private Dwellings for Travel Zones in 43 councils across Greater Sydney, Illawarra-Shoalhaven, Central Coast, Lower Hunter and Greater Newcastle
    - Occupied Private Dwellings



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